Oracle® Spatial

Spatial Developer's Guide

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Preface

Oracle Spatial Developer's Guide provides usage and reference information for indexing and storing spatial data and for developing spatial applications using Oracle Spatial.

Oracle Spatial is a foundation for the deployment of enterprise-wide spatial information systems, and Web-based and wireless location-based applications requiring complex spatial data management.

The Standard and Enterprise Editions of Oracle Database have the same basic features. However, some advanced features, such as parallel operations, are available only with the Enterprise Edition. For more information relevant when using spatial data with Standard Edition 2 (SE2), see the "Spatial and Graph Data" table in *Oracle Database Licensing Information User Manual*.

- Audience
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Audience

This guide is intended for anyone who needs to store spatial data in an Oracle database.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc.

Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info or visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs if you are hearing impaired.

Related Documents

For more information, see the following documents:

- *Oracle Spatial GeoRaster Developer's Guide*
- *Oracle Spatial Topology and Network Data Model Developer's Guide*
- *Oracle Spatial Map Visualization Developer's Guide*
- *Oracle Database SQL Language Reference*
- *Oracle Database Administrator's Guide*

- *Oracle Database Development Guide*
- *Oracle Database Error Messages* - Spatial and Graph messages are in the range of 13000 to 13499.
- *Oracle Database Performance Tuning Guide*
- *Oracle Database SQL Tuning Guide*
- *Oracle Database Utilities*
- *Oracle Database Data Cartridge Developer's Guide*

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

Changes in This Release for Oracle Spatial Developer's Guide

The preface contains:

- Changes in Oracle Database Release 23ai

Changes in Oracle Database Release 23ai

The following are the new Oracle Database Release 23ai features for core Spatial capabilities covered in this document:

New Procedures in SDO_PC_PKG Package

You can use the `PC_DIFFERENCE` procedure to detect the difference between two point clouds. See SDO_PC_PKG.PC_DIFFERENCE for more information.

You can use the `GENERATE_CROSS_SECTION_AS_GEOMS` procedure to perform cross section computation of a point cloud. See SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS for more information.

New Procedure in SDO_TIN_PKG Package

You can use the `CREATE_MESHES` procedure to generate a 3D mesh. See SDO_TIN_PKG.CREATE_MESHES for more information.

Using Predefined Constants for SDO_GTYPE and SDO_SRID Values

Predefined constants having descriptive names can be used to replace selected `SDO_GTYPE` and `SDO_SRID` values in SDO_GEOMETRY constructors and spatial queries.

- See SDO_GTYPE Constants for more information.
- See SDO_SRID Constants for more information.

Spatial Metadata Automatically Updated in USER_SDO_GEOM_METADATA View

If you are creating a spatial index on a spatial column, then the spatial metadata for the table is automatically created in the USER_SDO_GEOM_METADATA view, if it had not been created earlier. Therefore, effective with Release 23ai, it is optional to manually insert the spatial metadata in USER_SDO_GEOM_METADATA view. See Geometry Metadata Views for more information.

New Geometry Constructor for Creating Longitude and Latitude Spatial Data

You can use the new **SDO_GEOMETRY(longitude, latitude)** constructor to store the longitude and latitude spatial data. See Getting Started with Longitude/Latitude Spatial Data for more information.

Vector Tiles Generation

Vector tiles support efficient streaming of spatial data to map visualization web clients with a simple SQL call. They are compatible with the popular Mapbox vector tile specification. Vector tiles enable dynamic styling, fast performance, smooth map interactions, and dynamic map queries.

Using the SDO_UTIL.GET_VECTORTILE function, you can generate vector tiles from spatial data in database tables. See Vector Tiles for more information.

In addition, Oracle Spatial supports caching of vector tiles, which enables you to render the vector tiles more efficiently. See Vector Tile Cache for more information.

H3 Indexing Support

Oracle Spatial supports hexagonal hierarchical spatial indexing (H3) in Oracle Database. H3 is an indexing system that uses hexagons in a grid to cover the earth’s surface. For very large volumes of point data, H3 is useful to easily aggregate and visualize it on thematic maps. Developer-ready database functions are provided to create H3 cells, and generate vector tiles for map visualization.

See H3 Indexing for more information.

Part I

Conceptual and Usage Information

This document has the following parts:

- Part I provides conceptual and usage information about Oracle Spatial.
- Spatial Web Services provides conceptual and usage information about Oracle Spatial web services.
- Reference Information provides reference information about Oracle Spatial operators, functions, and procedures.
- Supplementary Information provides supplementary information (appendixes and a glossary).

Part I is organized for efficient learning about Oracle Spatial. It covers basic concepts and techniques first, and proceeds to more advanced material, such as coordinate systems, the linear referencing system, geocoding, and extending spatial indexing.

- Spatial Concepts
- Spatial Data Types and Metadata
  The spatial features in Oracle Spatial consist of a set of object data types, type methods, and operators, functions, and procedures that use these types. A geometry is stored as an object, in a single row, in a column of type SDO_GEOMETRY. Spatial index creation and maintenance is done using basic DDL (CREATE, ALTER, DROP) and DML (INSERT, UPDATE, DELETE) statements.
- SQL Multimedia Type Support
  Oracle Spatial supports the use of the ST_*xxx* types specified in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.
- Loading Spatial Data
  This chapter describes how to load spatial data into a database, including storing the data in a table with a column of type SDO_GEOMETRY.
- Indexing and Querying Spatial Data
  After you have loaded spatial data, you should create a spatial index on it to enable efficient query performance using the data.
- Coordinate Systems (Spatial Reference Systems)
  This chapter describes in detail the Oracle Spatial coordinate system support.
- Linear Referencing System
  Linear referencing is a natural and convenient means to associate attributes or events to locations or portions of a linear feature. It has been widely used in transportation applications (such as for highways, railroads, and transit routes) and utilities applications (such as for gas and oil pipelines).
- Location Tracking Server
  The Oracle Spatial location tracking server enables you to define regions, track the movement of objects into or out of those regions, and receive notifications when certain movements occur.

- Spatial Analysis and Mining
  This chapter describes the Oracle Spatial features that enable the use of spatial data in data mining applications.
- Extending Spatial Indexing Capabilities
  This chapter shows how to create and use spatial indexes on objects other than a geometry column. In other chapters, the focus is on indexing and querying spatial data that is stored in a single column of type SDO_GEOMETRY.

1

Spatial Concepts

Oracle Spatial is an integrated set of functions, procedures, data types, and data models that support spatial analytics. The spatial features enable spatial data to be stored, accessed, and analyzed quickly and efficiently in an Oracle database.
Spatial data represents the essential location characteristics of real or conceptual objects as those objects relate to the real or conceptual space in which they exist.

Major topics:

- What Is Oracle Spatial?
  Oracle Spatial, often referred to as Spatial, includes advanced features for spatial data and analysis and for physical, logical, network, and social applications.
- Object-Relational Model
  Oracle Spatial supports the **object-relational** model for representing geometries. This model stores an entire geometry in the Oracle native spatial data type for vector data, SDO_GEOMETRY.
- Introduction to Spatial Data
  Oracle Spatial is designed to make spatial data management easier and more natural to users of location-enabled applications and geographic information system (GIS) applications. Once spatial data is stored in an Oracle database, it can be easily manipulated, retrieved, and related to all other data stored in the database.
- Geometry Types
  A **geometry** is an ordered sequence of vertices that are connected by straight line segments or circular arcs.
- Data Model
  The spatial data model in Oracle Spatial is a hierarchical structure consisting of elements, geometries, and layers. Layers are composed of geometries, which in turn are made up of elements.
- Query Model
  Spatial uses a **two-tier query model** to resolve spatial queries and spatial joins.
- Indexing of Spatial Data
  The integration of spatial indexing capabilities into the Oracle Database engine is a key feature of the Spatial product.
- Spatial Relationships and Filtering
  Spatial uses secondary filters to determine the spatial relationship between entities in the database. The spatial relationship is based on geometry locations.
- Spatial Operators, Procedures, and Functions
  The Spatial PL/SQL application programming interface (API) includes several operators and many procedures and functions.
- Spatial Aggregate Functions
  SQL has long had aggregate functions, which are used to aggregate the results of a SQL query.

- Vector Tiles
  Oracle Spatial provides support for generating vector tiles from spatial data in database tables. The vector tile format is designed for highly efficient streaming of spatial data to map visualization clients.
- H3 Indexing
  Oracle Spatial provides support for hexagonal hierarchical spatial indexing (H3) in Oracle Database.
- Three-Dimensional Spatial Objects
  Oracle Spatial supports the storage and retrieval of three-dimensional spatial data, which can include points, point clouds (collections of points), lines, polygons, surfaces, and solids.
- Geocoding
  Geocoding is the process of converting tables of address data into standardized address, location, and possibly other data.
- Location Data Enrichment
  Oracle Spatial includes a place name data set, with hierarchical geographical data from HERE, that you can load into the database.
- JSON and GeoJSON Support in Oracle Spatial
  Spatial supports the use of JSON and GeoJSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.
- NURBS Curve Support in Oracle Spatial
  Spatial supports non-uniform rational B-spline (NURBS) curve geometries.
- Sharded Database Support by Oracle Spatial
  Spatial supports the use of sharded database technology.
- Database In-Memory Support by Oracle Spatial
  Spatial supports the use of Oracle Database In-Memory technology.
- Spatial Java Application Programming Interface
  Oracle Spatial provides a Java application programming interface (API) .
- Predefined User Accounts Created by Spatial
  During installation, Spatial creates user accounts that have the minimum privileges needed to perform their jobs.
- Performance and Tuning Information
  Many factors can affect the performance of Oracle Spatial applications, such as the use of optimizer hints to influence the plan for query execution.
- OGC and ISO Compliance
  Oracle Spatial is conformant with Open Geospatial Consortium (OGC) Simple Features Specification 1.1.1 (Document 99-049), starting with Oracle Database release 10*g* (version 10.1.0.4).
- Spatial Release (Version) Number
  To check which release of Spatial you are running, use the SDO_VERSION function.
- SPATIAL_VECTOR_ACCELERATION System Parameter
  To optimize the performance of spatial operators, the SPATIAL_VECTOR_ACCELERATION database system parameter value must be `TRUE`.
- Spatially Enabling a Table
  If you have a regular Oracle table without an SDO_GEOMETRY column, but containing location-related information (such as latitude/longitude values for points), you can *spatially enable* the table by adding an SDO_GEOMETRY column and using existing (and future) location-related information in records to populate the SDO_GEOMETRY column values.

- Moving Spatial Metadata (MDSYS.MOVE_SDO)
  Database administrators (DBAs) can use the MDSYS.MOVE_SDO procedure to move all Oracle Spatial metadata tables to a specified target tablespace.
- Spatial Application Hardware Requirement Considerations
  This topic discusses some general guidelines that affect the amount of disk storage space and CPU power needed for applications that use Oracle Spatial.
- Spatial Studio Application
  Oracle Spatial Studio, also referred to as Spatial Studio, is a free tool that lets you connect with, visualize, explore, and analyze geospatial data stored in and managed by Oracle Spatial.
- Spatial Error Messages
  Spatial has a set of error messages.
- Spatial Examples
  Oracle Spatial provides examples that you can use to reinforce your learning and to create models for coding certain operations.
- Getting Started with Longitude/Latitude Spatial Data
  Get started on creating spatial data using the WGS 84 (longitude/latitude) coordinate system.
- README File for Spatial and Related Features
  A `README.txt` file supplements the information in several manuals.

1.1 What Is Oracle Spatial?

Oracle Spatial, often referred to as Spatial, includes advanced features for spatial data and analysis and for physical, logical, network, and social applications.

The spatial features provide a schema and functions that facilitate the storage, retrieval, update, and query of collections of spatial features in an Oracle database. Spatial consists of the following:

- A schema (MDSYS) that prescribes the storage, syntax, and semantics of supported geometric data types
- A spatial indexing mechanism
- Operators, functions, and procedures for performing area-of-interest queries, spatial join queries, and other spatial analysis operations
- Functions and procedures for utility and tuning operations
- Topology data model for working with data about nodes, edges, and faces in a topology (described in *Oracle Spatial Topology and Network Data Model Developer's Guide*).
- Network data model for representing capabilities or objects that are modeled as nodes and links (vertices and edges) in a graph (described in *Oracle Spatial Topology and Network Data Model Developer's Guide*).
- GeoRaster, a feature that lets you store, index, query, analyze, and deliver GeoRaster data, that is, raster image and gridded data and its associated metadata (described in *Oracle Spatial GeoRaster Developer's Guide*).

The spatial component of a spatial feature is the geometric representation of its shape in some coordinate space. This is referred to as its **geometry**.

> **Note:**
>
> Do not modify any packages, tables, or other objects under the MDSYS schema. (The only exception is if you need to create a user-defined coordinate reference system, as explained in Creating a User-Defined Coordinate Reference System.)

1.2 Object-Relational Model

Oracle Spatial supports the **object-relational** model for representing geometries. This model stores an entire geometry in the Oracle native spatial data type for vector data, SDO_GEOMETRY.

An Oracle table can contain one or more SDO_GEOMETRY columns. The object-relational model corresponds to a "SQL with Geometry Types" implementation of spatial feature tables in the Open GIS ODBC/SQL specification for geospatial features.

The benefits provided by the object-relational model include:

- Support for many geometry types, including arcs, circles, compound polygons, compound line strings, and optimized rectangles
- Ease of use in creating and maintaining indexes and in performing spatial queries
- Index maintenance by the Oracle database
- Geometries modeled in a single column
- Optimal performance

1.3 Introduction to Spatial Data

Oracle Spatial is designed to make spatial data management easier and more natural to users of location-enabled applications and geographic information system (GIS) applications. Once spatial data is stored in an Oracle database, it can be easily manipulated, retrieved, and related to all other data stored in the database.

A common example of spatial data can be seen in a road map. A road map is a two-dimensional object that contains points, lines, and polygons that can represent cities, roads, and political boundaries such as states or provinces. A road map is a visualization of geographic information. The location of cities, roads, and political boundaries that exist on the surface of the Earth are projected onto a two-dimensional display or piece of paper, preserving the relative positions and relative distances of the rendered objects.

The data that indicates the Earth location (such as longitude and latitude) of these rendered objects is the spatial data. When the map is rendered, this spatial data is used to project the locations of the objects on a two-dimensional piece of paper. A GIS is often used to store, retrieve, and render this Earth-relative spatial data.

Types of spatial data (other than GIS data) that can be stored using Spatial include data from computer-aided design (CAD) and computer-aided manufacturing (CAM) systems. Instead of operating on objects on a geographic scale, CAD/CAM systems work on a smaller scale, such as for an automobile engine or printed circuit boards.

The differences among these systems are in the size and precision of the data, not the data's complexity. The systems might all involve the same number of data points. On a geographic scale, the location of a bridge can vary by a few tenths of an inch without causing any noticeable problems to the road builders, whereas if the diameter of an engine's pistons is off by a few tenths of an inch, the engine will not run.

In addition, the complexity of data is independent of the absolute scale of the area being represented. For example, a printed circuit board is likely to have many thousands of objects etched on its surface, containing in its small area information that may be more complex than the details shown on a road builder's blueprints.

These applications all store, retrieve, update, or query some collection of features that have both nonspatial and spatial attributes. Examples of nonspatial attributes are name, soil_type, landuse_classification, and part_number. The spatial attribute is a coordinate geometry, or vector-based representation of the shape of the feature.

1.4 Geometry Types

A **geometry** is an ordered sequence of vertices that are connected by straight line segments or circular arcs.

The semantics of the geometry are determined by its type. Spatial supports several primitive types, and geometries composed of collections of these types, including two-dimensional:

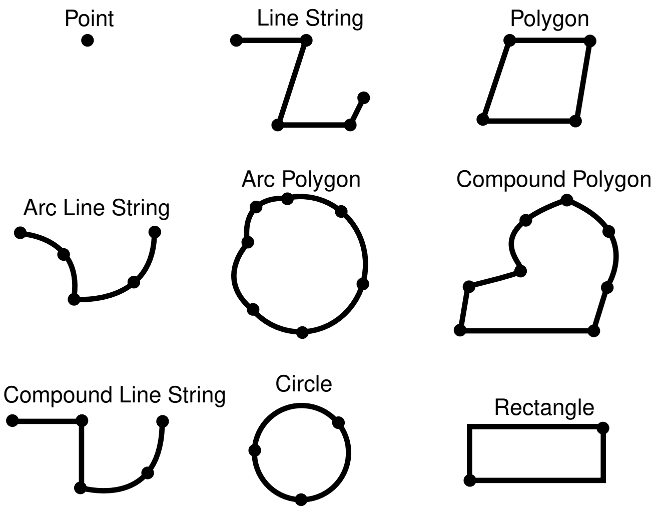
- Points and point clusters
- Line strings
- *n*-point polygons
- Arc line strings (All arcs are generated as circular arcs.)
- Arc polygons
- Compound polygons
- Compound line strings
- Circles
- Optimized rectangles

Two-dimensional points are elements composed of two ordinates, X and Y, often corresponding to longitude and latitude. **Line strings** are composed of one or more pairs of points that define line segments. **Polygons** are composed of connected line strings that form a closed ring, and the area of the polygon is implied. For example, a point might represent a building location, a line string might represent a road or flight path, and a polygon might represent a state, city, zoning district, or city block.

Self-crossing polygons are not supported, although self-crossing line strings are supported. If a line string crosses itself, it does not become a polygon. A self-crossing line string does not have any implied area.

The following figure illustrates the geometric types.

Figure 1-1 Geometric Types



Spatial also supports the storage and indexing of three-dimensional and four-dimensional geometric types, where three or four coordinates are used to define each vertex of the object being defined. For information about support for three-dimensional geometries, see Three-Dimensional Spatial Objects.

1.5 Data Model

The spatial data model in Oracle Spatial is a hierarchical structure consisting of elements, geometries, and layers. Layers are composed of geometries, which in turn are made up of elements.

- Element
- Geometry
- Layer
- Coordinate System
- Tolerance

1.5.1 Element

An **element** is the basic building block of a geometry. The supported spatial element types are points, line strings, and polygons. For example, elements might model star constellations (point clusters), roads (line strings), and county boundaries (polygons). Each coordinate in an element is stored as an X,Y pair. The exterior ring and zero or more interior rings (holes) of a complex polygon are considered a single element.

Point data consists of one coordinate. **Line data** consists of two coordinates representing a line segment of the element. **Polygon data** consists of coordinate pair values, one vertex pair for each line segment of the polygon. Coordinates are defined in order around the polygon (counterclockwise for an exterior polygon ring, clockwise for an interior polygon ring).

1.5.2 Geometry

A **geometry** (or **geometry object**) is the representation of a spatial feature, modeled as an ordered set of primitive elements. A geometry can consist of a single element, which is an instance of one of the supported primitive types, or a homogeneous or heterogeneous collection of elements. A multipolygon, such as one used to represent a set of islands, is a homogeneous collection. A heterogeneous collection is one in which the elements are of different types, for example, a point and a polygon.

An example of a geometry might describe the buildable land in a town. This could be represented as a polygon with holes where water or zoning prevents construction.

1.5.3 Layer

A **layer** is a collection of geometries having the same attribute set. For example, one layer in a GIS might include topographical features, while another describes population density, and a third describes the network of roads and bridges in the area (lines and points). The geometries and associated spatial index for each layer are stored in the database in standard tables.

1.5.4 Coordinate System

A **coordinate system** (also called a *spatial reference system*) is a means of assigning coordinates to a location and establishing relationships between sets of such coordinates. It enables the interpretation of a set of coordinates as a representation of a position in a real world space.

Any spatial data has a coordinate system associated with it. The coordinate system can be *georeferenced* (related to a specific representation of the Earth) or not georeferenced (that is, Cartesian, and not related to a specific representation of the Earth). If the coordinate system is georeferenced, it has a default *unit of measurement* (such as meters) associated with it, but you can have Spatial automatically return results in another specified unit (such as miles).

Spatial data can be associated with a Cartesian, geodetic (geographical), projected, or local coordinate system:

- **Cartesian coordinates** are coordinates that measure the position of a point from a defined origin along axes that are perpendicular in the represented two-dimensional or three-dimensional space.

  If a coordinate system is not explicitly associated with a geometry, a Cartesian coordinate system is assumed.
- **Geodetic coordinates** (sometimes called *geographic coordinates*) are angular coordinates (longitude and latitude), closely related to spherical polar coordinates, and are defined relative to a particular Earth geodetic datum. (A geodetic datum is a means of representing the figure of the Earth and is the reference for the system of geodetic coordinates.)
- **Projected coordinates** are planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.
- **Local coordinates** are Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system. Local coordinate systems are often used for CAD applications and local surveys.

When performing operations on geometries, Spatial uses either a Cartesian or curvilinear computational model, as appropriate for the coordinate system associated with the spatial data.

Related Topics

- Unit of Measurement Support
  Geometry functions that involve measurement allow an optional `unit` parameter to specify the unit of measurement for a specified distance or area, if a georeferenced coordinate system (SDO_SRID value) is associated with the input geometry or geometries.
- Coordinate Systems (Spatial Reference Systems)
  This chapter describes in detail the Oracle Spatial coordinate system support.

1.5.5 Tolerance

Tolerance is used to associate a level of precision with spatial data. **Tolerance** reflects the *distance that two points can be apart and still be considered the same* (for example, to accommodate rounding errors). The tolerance value must be a positive number greater than zero. The significance of the value depends on whether or not the spatial data is associated with a geodetic coordinate system. (Geodetic and other types of coordinate systems are described in Coordinate System.)

- For geodetic data (such as data identified by longitude and latitude coordinates), the tolerance value is expressed as number of meters. For example, a tolerance value of 10 indicates a tolerance of 10 meters. A tolerance of 0.001 is a millimeter, and 0.000001 is a micrometer. Note that specifying any tolerance of less than a millimeter for geodetic data can result in a loss of precision in the internal geodetic calculations, potentially leading to unexpected results.
- For non-geodetic data, the tolerance value is a number of the units that are associated with the coordinate system associated with the data. For example, if the unit of measurement is miles, a tolerance value of 0.005 indicates a tolerance of 0.005 (that is, 1/200) mile (approximately 26 feet or 7.9 meters), and a tolerance value of 2 indicates a tolerance of 2 miles.

In both cases, the smaller the tolerance value, the more precision is to be associated with the data.

For geodetic and projected data, the tolerance value should be less than 10. In addition, ensure that geometries are valid at the specified tolerance.

For geometries that have 16 or more digits of precision, Spatial boolean operations (such as SDO_GEOM.SDO_UNION and SDO_GEOM.SDO_INTERSECTION) and the SDO_GEOM.RELATE function might produce inconsistent results due to the loss of precision in floating point arithmetic. The number of digits of precision is calculated as in the following example: if the tolerance is set to 0.0000000005 and the coordinates have 6 digits to the left of decimal (for example, 123456.4321), the precision is 10 + 6 digits (16). In such cases, it is better to use a larger tolerance value (fewer leading zeros after the decimal) to get consistent results using spatial operations.

> **Note:**
>
> Floating point operations tend to lose precision when the number of digits used in the computation is more than 15, so make sure the number of digits specified for computations is less than 15. For example, if the number is 123456.789 and the tolerance is 10E-10, then this effectively means 16 (10+6) digits of precision, which is more than the recommended 15.

A tolerance value is specified in two cases:

- In the geometry metadata definition for a layer
- As an input parameter to certain functions

- Tolerance in the Geometry Metadata for a Layer
- Tolerance as an Input Parameter
- SDO_TOLERANCE SQL Function

Related Topics

- Tolerance Values with LRS Functions

1.5.5.1 Tolerance in the Geometry Metadata for a Layer

The dimensional information for a layer includes a tolerance value. Specifically, the DIMINFO column (described in DIMINFO) of the xxx_SDO_GEOM_METADATA views includes an SDO_TOLERANCE value for each dimension, and the value should be the same for each dimension.

If a function accepts an optional `tolerance` parameter and this parameter is null or not specified, the SDO_TOLERANCE value of the layer is used. Using the non-geodetic data from the example in Simple Example: Inserting, Indexing, and Querying Spatial Data, the actual distance between geometries `cola_b` and `cola_d` is 0.846049894. If a query uses the SDO_GEOM.SDO_DISTANCE function to return the distance between `cola_b` and `cola_d` and does not specify a `tolerance` parameter value, the result depends on the SDO_TOLERANCE value of the layer. For example:

- If the SDO_TOLERANCE value of the layer is 0.005, this query returns .846049894.
- If the SDO_TOLERANCE value of the layer is 0.5, this query returns 0.

  The zero result occurs because Spatial first constructs an imaginary buffer of the tolerance value (0.5) around each geometry to be considered, and the buffers around `cola_b` and `cola_d` overlap in this case. (If the two geometries being considered have different tolerance values, the higher value is used for the imaginary buffer.)

You can, therefore, take either of two approaches in selecting an SDO_TOLERANCE value for a layer:

- The value can reflect the desired level of precision in queries for distances between objects. For example, if two non-geodetic geometries 0.8 units apart should be considered as separated, specify a small SDO_TOLERANCE value such as 0.05 or smaller.
- The value can reflect the precision of the values associated with geometries in the layer. For example, if all geometries in a non-geodetic layer are defined using integers and if two objects 0.8 units apart should not be considered as separated, an SDO_TOLERANCE

value of 0.5 is appropriate. To have greater precision in any query, you must override the default by specifying the `tolerance` parameter.

With non-geodetic data, the guideline to follow for most instances of the second case (precision of the values of the geometries in the layer) is: take the highest level of precision in the geometry definitions, and use .5 at the next level as the SDO_TOLERANCE value. For example, if geometries are defined using integers (as in the simplified example in Simple Example: Inserting, Indexing, and Querying Spatial Data), the appropriate value is 0.5; however, if geometries are defined using numbers up to four decimal positions (for example, 31.2587), the appropriate value is 0.00005.

Note:

This guideline should not be used if the geometries include any polygons that are so narrow at any point that the distance between facing sides is less than the proposed tolerance value. Be sure that the tolerance value is less than the shortest distance between any two sides in any polygon.

Moreover, if you encounter "invalid geometry" errors with inserted or updated geometries, and if the geometries are in fact valid, consider increasing the precision of the tolerance value (for example, changing 0.00005 to 0.000005).

1.5.5.2 Tolerance as an Input Parameter

Many spatial functions accept a `tolerance` parameter, which (if specified) overrides the default tolerance value for the layer (explained in Tolerance in the Geometry Metadata for a Layer). If the distance between two points is less than or equal to the tolerance value, Spatial considers the two points to be a single point. Thus, tolerance is usually a reflection of how accurate or precise users perceive their spatial data to be.

For example, assume that you want to know which restaurants are within 5 kilometers of your house. Assume also that Maria's Pizzeria is 5.1 kilometers from your house. If the spatial data has a geodetic coordinate system and if you ask, *Find all restaurants within 5 kilometers and use a tolerance of 100* (or greater, such as 500), Maria's Pizzeria will be included, because 5.1 kilometers (5100 meters) is within 100 meters of 5 kilometers (5000 meters). However, if you specify a tolerance less than 100 (such as 50), Maria's Pizzeria will not be included.

Tolerance values for spatial functions are typically very small, although the best value in each case depends on the kinds of applications that use or will use the data. See also the tolerance guidelines in Tolerance in the Geometry Metadata for a Layer, and ensure that all input geometries are valid. (Spatial functions may not work as expected if the geometry data is not valid.)

If you explicitly want to use the tolerance value from the dimensional information array for the geometry layer, and if a subprogram has separate formats with `tolerance` (or `tol`) and `dim` parameters, use the format with `dim`. In the following example, the first statement uses the tolerance value from the dimensional information array, and the second statement specifies a numeric tolerance value (0.005):

```
-- Return the area of the cola_a geometry.

SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_a';
```

```
SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
   WHERE c.name = 'cola_a';
```

1.5.5.3 SDO_TOLERANCE SQL Function

You can use the SDO_TOLERANCE SQL function to find the tolerance value associated with a spatial column in a table. This SQL function has the format:

```
SQL_TOLERANCE(<schema-name>, <table-name>, <column-name>)
```

The following example returns the tolerance value for the SHAPE geometry column in the COLA_MARKETS table:

```
SQL> select SDO_TOLERANCE('SCOTT', 'COLA_MARKETS', 'SHAPE') from dual;

SDO_TOLERANCE('SCOTT','COLA_MARKETS','SHAPE')
------------------------------------------------

                                        5.0E-003
```

The value returned by this example matches the "0.005" that was specified for the X and Y dimensions of the SHAPE column when the spatial table was registered in the USER_SDO_GEOM_METADATA view:

```
INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'cola_markets',
  'shape',
  SDO_DIM_ARRAY(   -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
     ),
  NULL   -- SRID
);
```

Note:

For ***geodetic*** geometries, the value returned is in unit-spheres, where 1 unit-sphere is a sphere with a radius of 1.0. For example:

```
1.56961053E-008 = 0.1 / 6371007.2 (0.1 = 0.1 meter; 6371007.2 =
Earth's authalic radius in meters)
```

1.6 Query Model

Spatial uses a **two-tier query model** to resolve spatial queries and spatial joins.

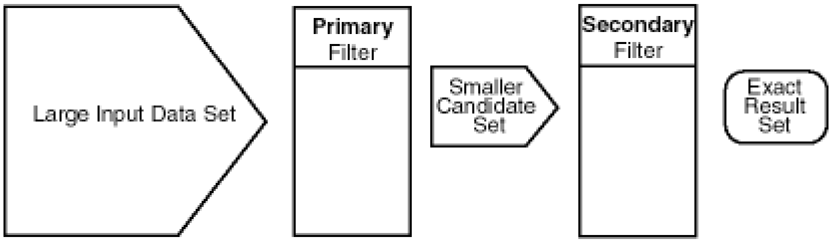
The term is used to indicate that two distinct operations are performed to resolve queries. The output of the two combined operations yields the exact result set.

The two operations are referred to as *primary* and *secondary* filter operations.

- The **primary filter** permits fast selection of candidate records to pass along to the secondary filter. The primary filter compares geometry approximations to reduce computation complexity and is considered a lower-cost filter. Because the primary filter compares geometric approximations, it returns a superset of the exact result set.
- The **secondary filter** applies exact computations to geometries that result from the primary filter. The secondary filter yields an accurate answer to a spatial query. The secondary filter operation is computationally expensive, but it is only applied to the primary filter results, not the entire data set.

Figure 1-2 illustrates the relationship between the primary and secondary filters.

Figure 1-2 Query Model



As shown in Figure 1-2, the primary filter operation on a large input data set produces a smaller candidate set, which contains at least the exact result set and may contain more records. The secondary filter operation on the smaller candidate set produces the exact result set.

Spatial uses a spatial index to implement the primary filter. Spatial does not require the use of both the primary and secondary filters. In some cases, just using the primary filter is sufficient. For example, a *zoom* feature in a mapping application queries for data that has any interaction with a rectangle representing visible boundaries. The primary filter very quickly returns a superset of the query. The mapping application can then apply clipping routines to display the target area.

The purpose of the primary filter is to quickly create a subset of the data and reduce the processing burden on the secondary filter. The primary filter, therefore, should be as efficient (that is, selective yet fast) as possible. This is determined by the characteristics of the spatial index on the data.

Related Topics

- Querying Spatial Data
  The structures of a spatial layer are used to resolve spatial queries and spatial joins.

1.7 Indexing of Spatial Data

The integration of spatial indexing capabilities into the Oracle Database engine is a key feature of the Spatial product.

A spatial index, like any other index, provides a mechanism to limit searches, but in this case the mechanism is based on spatial criteria such as intersection and containment. For example, a spatial index is used to:

- Find objects within an indexed data space that interact with a given point or area of interest (window query)
- Find pairs of objects from within two indexed data spaces that interact spatially with each other (spatial join)

Effective with Release 12.2 and later, creating and using a spatial index is not mandatory for the use of any Oracle Spatial features (except for the SDO_NN operator). However, spatial indexes are highly recommended, and not using them can negatively affect performance in some cases.

Testing of spatial indexes with many workloads and operators is ongoing, and further results and recommendations will be documented as they become available.

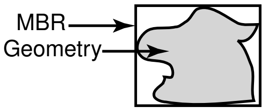
The following sections explain the concepts and options associated with R-tree indexing.

- R-Tree Indexing
- R-Tree Quality

1.7.1 R-Tree Indexing

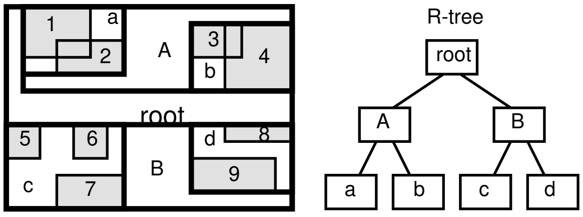
A spatial R-tree index can index spatial data of up to four dimensions. An R-tree index approximates each geometry by a single rectangle that minimally encloses the geometry (called the minimum bounding rectangle, or MBR), as shown in Figure 1-3.

Figure 1-3 MBR Enclosing a Geometry



For a layer of geometries, an R-tree index consists of a hierarchical index on the MBRs of the geometries in the layer, as shown in Figure 1-4.

Figure 1-4 R-Tree Hierarchical Index on MBRs



In Figure 1-4:

- *1* through *9* are geometries in a layer.
- *a*, *b*, *c*, and *d* are the leaf nodes of the R-tree index, and contain minimum bounding rectangles of geometries, along with pointers to the geometries. For example, *a* contains the MBR of geometries *1* and *2*, *b* contains the MBR of geometries *3* and *4*, and so on.
- *A* contains the MBR of *a* and *b*, and *B* contains the MBR of *c* and *d*.

- The root contains the MBR of *A* and *B* (that is, the entire area shown).

An R-tree index is stored in the spatial index table (SDO_INDEX_TABLE in the USER_SDO_INDEX_METADATA view, described in Spatial Index-Related Structures). The R-tree index also maintains a sequence object (SDO_RTREE_SEQ_NAME in the USER_SDO_INDEX_METADATA view) to ensure that simultaneous updates by concurrent users can be made to the index.

1.7.2 R-Tree Quality

A substantial number of insert and delete operations affecting an R-tree index may degrade the quality of the R-tree structure, which may adversely affect query performance.

The R-tree is a hierarchical tree structure with nodes at different heights of the tree. The performance of an R-tree index structure for queries is roughly proportional to the area and perimeter of the index nodes of the R-tree. The area covered at level 0 represents the area occupied by the minimum bounding rectangles of the data geometries, the area at level 1 indicates the area covered by leaf-level R-tree nodes, and so on. The original ratio of the area at the root (topmost level) to the area at level 0 can change over time based on updates to the table; and if there is a degradation in that ratio (that is, if it increases significantly), rebuilding the index may help the performance of queries.

If the performance of SDO_FILTER operations has degraded, and if there have been a large number of insert, update, or delete operations affecting geometries, the performance degradation may be due to a degradation in the quality of the associated R-tree index.

To rebuild an R-tree index, use the ALTER INDEX REBUILD statement.

1.8 Spatial Relationships and Filtering

Spatial uses secondary filters to determine the spatial relationship between entities in the database. The spatial relationship is based on geometry locations.

The most common spatial relationships are based on topology and distance. For example, the *boundary* of an area consists of a set of curves that separates the area from the rest of the coordinate space. The *interior* of an area consists of all points in the area that are not on its boundary. Given this, two areas are said to be adjacent if they share part of a boundary but do not share any points in their interior.

The distance between two spatial objects is the minimum distance between any points in them. Two objects are said to be *within a given distance* of one another if their distance is less than the given distance.

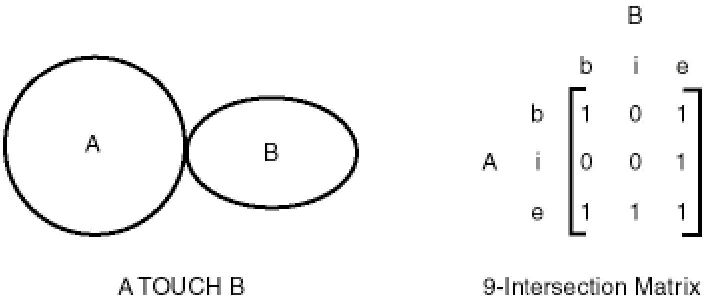
To determine spatial relationships, Spatial has several secondary filter methods:

- The SDO_RELATE operator evaluates topological criteria.
- The SDO_WITHIN_DISTANCE operator determines if two spatial objects are within a specified distance of each other.
- The SDO_NN operator identifies the nearest neighbors for a spatial object.

The SDO_RELATE operator implements a nine-intersection model for categorizing binary topological relationships between points, lines, and polygons. Each spatial object has an interior, a boundary, and an exterior. The boundary consists of points or lines that separate the interior from the exterior. The boundary of a line string consists of its end points; however, if the end points overlap (that is, if they are the same point), the line string has no boundary. The boundaries of a multiline string are the end points of each of the component line strings; however, if the end points overlap, only the end points that overlap an odd number of times are boundaries. The boundary of a polygon is the line that describes its perimeter. The interior consists of points that are in the object but not on its boundary, and the exterior consists of those points that are not in the object and are not on its boundary.

Given that an object A has three components (a boundary Ab, an interior Ai, and an exterior Ae), any pair of objects has nine possible interactions between their components. Pairs of components have an empty (0) or not empty (1) set intersection. The set of interactions between two geometries is represented by a nine-intersection matrix that specifies which pairs of components intersect and which do not. Figure 1-5 shows the nine-intersection matrix for two polygons that are adjacent to one another. This matrix yields the following bit mask, generated in row-major form: "101001111".

Figure 1-5 The Nine-Intersection Model

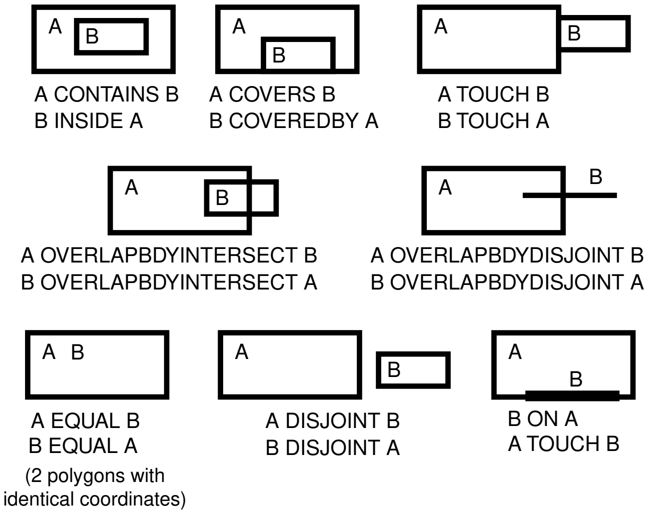


Some of the topological relationships identified in the seminal work by Professor Max Egenhofer (University of Maine, Orono) and colleagues have names associated with them. Spatial uses the following names:

- DISJOINT: The boundaries and interiors do not intersect.
- TOUCH: The boundaries intersect but the interiors do not intersect.
- OVERLAPBDYDISJOINT: The interior of one object intersects the boundary and interior of the other object, but the two boundaries do not intersect. This relationship occurs, for example, when a line originates outside a polygon and ends inside that polygon.
- OVERLAPBDYINTERSECT: The boundaries and interiors of the two objects intersect.
- EQUAL: The two objects have the same boundary and interior.
- CONTAINS: The interior and boundary of one object is completely contained in the interior of the other object.
- COVERS: The boundary and interior of one object is completely contained in the interior or the boundary of the other object, their interiors intersect, and the boundary or the interior of one object and the boundary of the other object intersect.
- INSIDE: The opposite of CONTAINS. A INSIDE B implies B CONTAINS A.
- COVEREDBY: The opposite of COVERS. A COVEREDBY B implies B COVERS A.
- ON: The interior and boundary of one object is on the boundary of the other object. This relationship occurs, for example, when a line is on the boundary of a polygon.
- ANYINTERACT: The objects are non-disjoint.

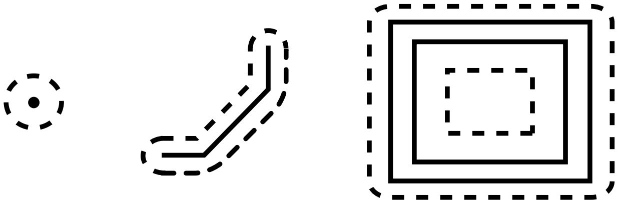
Figure 1-6 illustrates these topological relationships.

Figure 1-6   Topological Relationships



The SDO_WITHIN_DISTANCE operator determines if two spatial objects, A and B, are within a specified distance of one another. This operator first constructs a distance buffer, D_b, around the reference object B. It then checks that A and D_b are non-disjoint. The distance buffer of an object consists of all points within the given distance from that object. Figure 1-7 shows the distance buffers for a point, a line, and a polygon.

Figure 1-7   Distance Buffers for Points, Lines, and Polygons



In the point, line, and polygon geometries shown in Figure 1-7:

- The dashed lines represent distance buffers. Notice how the buffer is rounded near the corners of the objects.
- The geometry on the right is a polygon with a hole: the large rectangle is the exterior polygon ring and the small rectangle is the interior polygon ring (the hole). The dashed line outside the large rectangle is the buffer for the exterior ring, and the dashed line inside the small rectangle is the buffer for the interior ring.

The SDO_NN operator returns a specified number of objects from a geometry column that are closest to a specified geometry (for example, the five closest restaurants to a city park). In determining how close two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

1.9 Spatial Operators, Procedures, and Functions

The Spatial PL/SQL application programming interface (API) includes several operators and many procedures and functions.

Spatial operators, such as SDO_FILTER and SDO_RELATE, provide optimum performance when they use a spatial index. (Spatial operators perform most efficiently when the geometry column in the first parameter has a spatial index defined on it.) Spatial operators must be used in the WHERE clause of a query. The first parameter of any operator specifies the geometry column to be searched, and the second parameter specifies a query window. If the query window does not have the same coordinate system as the geometry column, Spatial performs an implicit coordinate system transformation. For detailed information about the spatial operators, see Spatial Operators .

Spatial procedures and functions are provided as subprograms in PL/SQL packages, such as SDO_GEOM, SDO_CS, and SDO_LRS. These subprograms do not require that a spatial index be defined, and they do not use a spatial index if it is defined. These subprograms can be used in the WHERE clause or in a subquery. If two geometries are input parameters to a spatial procedure or function, both must have the same coordinate system.

> **Note:**
>
> For any numbers in string (VARCHAR2) parameters to Spatial operators and subprograms, the period (.) must be used for any decimal points regardless of the locale. Example: `'distance=3.7'`

The following performance-related guidelines apply to the use of spatial operators, procedures, and functions:

- If an operator and a procedure or function perform comparable operations, and if the operator satisfies your requirements, use the operator. For example, unless you need to do otherwise, use SDO_RELATE instead of SDO_GEOM.RELATE, and use SDO_WITHIN_DISTANCE instead of SDO_GEOM.WITHIN_DISTANCE.
- With operators, always specify `TRUE` in uppercase. That is, specify `= 'TRUE'`, and do not specify `<> 'FALSE'` or `= 'true'`.
- With operators, use the `/*+ ORDERED */` optimizer hint if the query window comes from a table. (You must use this hint if multiple windows come from a table.) See the Usage Notes and Examples for specific operators for more information.

For information about using operators with topologies, see *Oracle Spatial Topology and Network Data Model Developer's Guide*.

1.10 Spatial Aggregate Functions

SQL has long had aggregate functions, which are used to aggregate the results of a SQL query.

The following example uses the SUM aggregate function to aggregate employee salaries by department:

```
SELECT SUM(salary), dept
   FROM employees
   GROUP BY dept;
```

Spatial aggregate functions aggregate the results of SQL queries involving geometry objects. Spatial aggregate functions return a geometry object of type SDO_GEOMETRY. For example, the following statement returns the minimum bounding rectangle of all geometries in a table (using the definitions and data from Simple Example: Inserting, Indexing, and Querying Spatial Data):

```
SELECT SDO_AGGR_MBR(shape) FROM cola_markets;
```

The following example returns the union of all geometries except `cola_d`:

```
SELECT SDO_AGGR_UNION(SDOAGGRTYPE(c.shape, 0.005))
  FROM cola_markets c WHERE c.name <> 'cola_d';
```

For reference information about the spatial aggregate functions and examples of their use, see the Spatial Aggregate Functions reference chapter.

> **Note:**
>
> Spatial aggregate functions are supported for two-dimensional geometries only, except for SDO_AGGR_MBR, which is supported for both two-dimensional and three-dimensional geometries.

- SDOAGGRTYPE Object Type

1.10.1 SDOAGGRTYPE Object Type

Many spatial aggregate functions accept an input parameter of type SDOAGGRTYPE. Oracle Spatial defines the object type SDOAGGRTYPE as:

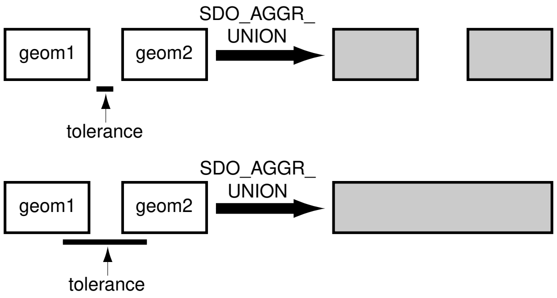
```
CREATE TYPE sdoaggrtype AS OBJECT (
 geometry SDO_GEOMETRY,
 tolerance NUMBER);
```

> **Note:**
>
> Do not use SDOAGGRTYPE as the data type for a column in a table. Use this type only in calls to spatial aggregate functions.

The `tolerance` value in the SDOAGGRTYPE definition should be the same as the SDO_TOLERANCE value specified in the DIMINFO column in the xxx_SDO_GEOM_METADATA views for the geometries, unless you have a specific reason for wanting a different value. For more information about tolerance, see Tolerance; for information about the xxx_SDO_GEOM_METADATA views, see Geometry Metadata Views.

The `tolerance` value in the SDOAGGRTYPE definition can affect the result of a spatial aggregate function. Figure 1-8 shows a spatial aggregate union (SDO_AGGR_UNION) operation of two geometries using two different tolerance values: one smaller and one larger than the distance between the geometries.

Figure 1-8 Tolerance in an Aggregate Union Operation



In the first aggregate union operation in Figure 1-8, where the tolerance is less than the distance between the rectangles, the result is a compound geometry consisting of two rectangles. In the second aggregate union operation, where the tolerance is greater than the distance between the rectangles, the result is a single geometry.

1.11 Vector Tiles

Oracle Spatial provides support for generating vector tiles from spatial data in database tables. The vector tile format is designed for highly efficient streaming of spatial data to map visualization clients.

Vector tiles contain geometry and attribute data in a compressed binary format covering square areas defined by a tiling scheme. In a tiling scheme, the world is divided into square tiles identified by X and Y ordinates at each of a predefined set of zoom levels. Modern mapping clients are designed to consume spatial data from vector tiles and style information from style sheets. This affords tremendous flexibility and agility by allowing a single vector tile dataset to be leveraged for numerous map styles.

Oracle Spatial supports the generation of vector tiles from spatial data in tables with the SDO_UTIL.GET_VECTORTILE function. Vector tiles may be generated based on either the Google or TMS tiling scheme.

Also, vector tile caching is supported.

- Vector Tile Cache
  Oracle Spatial supports caching of vector tiles which significantly improves the performance when working with vector tiles.

1.11.1 Vector Tile Cache

Oracle Spatial supports caching of vector tiles which significantly improves the performance when working with vector tiles.

When a tile is requested through SDO_UTIL.GET_VECTORTILE, the procedure first checks for the tile in the cache. If the tile exists, then the cached version of the tile is returned (without comuputing the tile again). If the tile is not found in the cache, then the tile is computed and returned. The computed tile is also placed in the cache for later use. However, note that vector tile caching is supported only when you call SDO_UTIL.GET_VECTORTILE by providing the table and geometry column name. If you provide a cursor input when requesting a vector tile, then the tile is not cached.

A tile cache is defined as a set of vector tiles that share a `table_name`/`geom_col_name` pair. For example `table_a/geom_col` and `table_b/geom_col` are two different tile caches. Each of these caches are maintained in the following two tables:

- **`SDO_VECTOR_TILE_CACHE$INFO`**: This table contains one row of the cache metadata.
- **`SDO_VECTOR_TILE_CACHE$TABLE`**: This table contains many rows, each of which is an individual vector tile.

For more information on managing vector tile caches, refer to the following procedures:

- SDO_UTIL.ENABLE_VECTORTILE_CACHE
- SDO_UTIL.DISABLE_VECTORTILE_CACHE
- SDO_UTIL.PURGE_VECTORTILE_CACHE
- SDO_UTIL.GRANT_VECTORTILE_CACHE
- SDO_UTIL.REVOKE_VECTORTILE_CACHE

DML and DDL Operations on Vector Tile Cache Source Table

In order to ensure that the cache remains consistent during DML and DDL operations, triggers are placed appropriately on the database table that provides the source data for the vector tiles in the cache. If a DML operation is performed on the source table, then those tiles in the cache that contain data generated from the modified, inserted, or deleted rows are removed from the cache. The next time `SDO_UTIL.GET_VECTORTILE` is called, these tiles are rebuilt using the new data, and are stored back in the cache.

It is strongly recommended that the vector tile caches are disabled before any large scale DML operations. It is because each DML operation performs a spatial operation to check if the row being modified interacts with any of the tiles in the cache. This has the potential to slow the DML operation substantially. Therefore, disabling the cache before the DML operations removes this slow down. You can reenable the cache after the DML operations are completed. In case of small DML operations, you may leave the cache enabled. Although the DML operations may be comparatively slower, it is still preferable than having to rebuild the cache.

However, if a DDL operation needs to be done on the source table, then all vector tile caches based on that table must be disabled. The only exception to this rule is `TRUNCATE TABLE` which may be run with a tile cache enabled.

1.12 H3 Indexing

Oracle Spatial provides support for hexagonal hierarchical spatial indexing (H3) in Oracle Database.

H3 is an open source indexing system developed by Uber that uses hexagons in a grid system to cover the earth’s surface. Data points are bucketed in hexagon cells, and attributes can be aggregated and summarized over these hexagons. For very large volumes of point data, H3 cells are very useful to visualize aggregated attribute data in thematic maps.

Oracle Spatial H3 support includes several functions in the database to generate H3 cells from point data. Additionally, functions are provided to directly generate vector tiles from the aggregated H3 data. These vector tiles can be shared with web clients to create map visualizations.

Hexagonal indexing is translating a point in geodetic (longitude, latitude) coordinate system to a space defined by sphere circumscribed Icosahedron (polygon with 20 faces) approximation of Earth, which essentially is a grid of hexagons (also a few pentagon special cases). H3 index comprises 16 such grids, arranged in a hierarchy. The level 0 grid contains 122 hexagons (110 hexagons, 12 pentagons).

The following functions in the SDO_UTIL package provides H3 indexing support for spatial data in Oracle Database:

- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_VECTORTILE
- SDO_UTIL.H3_KEY
- SDO_UTIL.H3SUM_AS_TABLE
- SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION
- SDO_UTIL.H3_MBR
- SDO_UTIL.H3_PENTAGON_EDGELEN
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_BASE_CELL
- SDO_UTIL.H3SUM_GET_CURSOR
- SDO_UTIL.H3_RESOLUTION
- SDO_UTIL.H3_PARENT
- SDO_UTIL.H3_IS_CLASS3
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_IS_VALID_CELL
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_CENTER
- SDO_UTIL.H3_BOUNDARY

1.13 Three-Dimensional Spatial Objects

Oracle Spatial supports the storage and retrieval of three-dimensional spatial data, which can include points, point clouds (collections of points), lines, polygons, surfaces, and solids.

> **Note:**
>
> Three-dimensional spatial objects are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

Table 1-1 shows the SDO_GTYPE and element-related attributes of the SDO_GEOMETRY type that are relevant to three-dimensional geometries. (The SDO_GEOMETRY type is explained in SDO_GEOMETRY Object Type.)

Table 1-1 SDO_GEOMETRY Attributes for Three-Dimensional Geometries

Type of 3-D Data	SDO_GTYPE	Element Type, Interpretation in SDO_ELEM_INFO
Point	3001	Does not apply. Specify all 3 dimension values in the SDO_POINT_TYPE attribute.
Line	3002	2, 1
Polygon	3003	1003, 1: planar exterior polygon 2003, 1: planar interior polygon 1003, 3: planar exterior rectangle 2003, 3: planar interior rectangle
Surface	3003	1006, 1: surface (followed by element information for the polygons)
Collection	3004	Same considerations as for two-dimensional
Multipoint (point cloud)	3005	1, *n* (where *n* is the number of points)
Multiline	3006	2, 1 (same as for Line)
Multisurface	3007	Element definitions for one or more surfaces
Solid	3008	Simple solid formed by a single closed surface: one element type 1007, followed by one element type 1006 (the external surface) and optionally one or more element type 2006 (internal surfaces) Composite solid formed by multiple adjacent simple solids: one element type 1008 (holding the count of simple solids), followed by any number of element type 1007 (each describing one simple solid)
Multisolid	3009	Element definitions for one or more simple solids (element type 1007) or composite solids (element type 1008)

The following spatial operators consider all three dimensions in their computations:

- SDO_ANYINTERACT
- SDO_FILTER
- SDO_INSIDE (for solid geometries only)
- SDO_NN
- SDO_WITHIN_DISTANCE

The other operators consider only the first two dimensions. For some of preceding operators the height information is ignored when dealing with geodetic data, as explained later in this section. (Spatial operators are described in Spatial Operators .)

The SDO_GEOM.SDO_VOLUME function applies only to solid geometries, which are by definition three-dimensional; however, this function cannot be used with geodetic data. For information about support for three-dimensional geometries with other SDO_GEOM subprograms, see the usage information in SDO_GEOM Package (Geometry).

For distance computations with three-dimensional geometries:

- If the data is geodetic (geographic 3D), the distance computations are done on the geodetic surface.
- If the data is non-geodetic (projected or local), the distance computations are valid only if the unit of measure is the same for all three dimensions.

To have any functions, procedures, or operators consider all three dimensions, you must specify `PARAMETERS ('sdo_indx_dims=3')` in the CREATE INDEX statement when you create the spatial index on a spatial table containing Geographic3D data (longitude, latitude, ellipsoidal height). If you do not specify that parameter in the CREATE INDEX statement, a two-dimensional index is created.

For spatial functions, procedures, and operators that consider all three dimensions, distance and length computations correctly factor in the height or elevation. For example, consider two three-dimensional points, one at the origin of a Cartesian space (0,0,0), and the other at X=3 on the Y axis and a height (Z) of 4 (3,0,4).

- If the operation considers all three dimensions, the distance between the two points is 5. (Think of the hypotenuse of a 3-4-5 right triangle.)
- If the operation considers only two dimensions, the distance between the two points is 3. (That is, the third dimension, or height, is ignored.)

However, for the following operators and subprograms, when dealing with geodetic data, the distances with three-dimensional geometries are computed between the "ground" representations (for example, the longitude/latitude extent of the footprint of a building), and the height information is approximated:

- SDO_NN operator
- SDO_WITHIN_DISTANCE operator
- SDO_GEOM.SDO_DISTANCE function
- SDO_GEOM.WITHIN_DISTANCE function

For a two-dimensional query window with three-dimensional data, you can use the SDO_FILTER operator, but not any other spatial operators.

For examples of creating different types of three-dimensional spatial geometries, see Three-Dimensional Geometry Types. That section also includes an example showing how to update the spatial metadata and create spatial indexes for three-dimensional geometries.

For information about support for three-dimensional coordinate reference systems, see Three-Dimensional Coordinate Reference System Support.

Three-dimensional support does not apply to many spatial aggregate functions and PL/SQL packages and subprograms. The following are supported for two-dimensional geometries only:

- Spatial aggregate functions, except for SDO_AGGR_MBR, which is supported for both two-dimensional and three-dimensional geometries.
- SDO_GEOM (geometry) subprograms, except for the following, which are supported for both two-dimensional and three-dimensional geometries:
  - SDO_GEOM.RELATE with the ANYINTERACT mask

  - SDO_GEOM.SDO_AREA
  - SDO_GEOM.SDO_DISTANCE
  - SDO_GEOM.SDO_LENGTH
  - SDO_GEOM.SDO_MAX_MBR_ORDINATE
  - SDO_GEOM.SDO_MBR
  - SDO_GEOM.SDO_MIN_MBR_ORDINATE
  - SDO_GEOM.SDO_VOLUME
  - SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
  - SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
  - SDO_GEOM.WITHIN_DISTANCE
- SDO_SAM (spatial analysis and mining) subprograms
- SDO_MIGRATE.TO_CURRENT procedure

Table 1-2 describes how Oracle Spatial internally performs certain ***geodetic*** three-dimensional calculations.

Table 1-2 How Geodetic 3D Calculations Are Performed

Type of Calculation	Internal Calculations Performed
ANYINTERACT	The input geometries are transformed using Gnomonic transformation; then the ANYINTERACT relationship is computed with the resulting geometries.
Area	The input geometry is projected onto a local tangent plane; then the area is computed with the resulting input geometry.
Distance or Length	The 2D precise ellipsoidal distance is computed using the longitude/latitude of the two closest points of approach; then the height or length difference is included using an approximation.
Volume	The input geometry is projected onto a local tangent plane; then the volume is computed with the resulting input geometry.

- Modeling Surfaces
- Modeling Solids
- Three-Dimensional Optimized Rectangles
- Using Texture Data
- Validation Checks for Three-Dimensional Geometries

1.13.1 Modeling Surfaces

A surface contains an area but not a volume, and it can have two or three dimensions. A surface is often constructed by a set of planar regions.

Surfaces can be modeled as surface-type SDO_GEOMETRY objects or, if they are very large, as SDO_TIN objects. The surface-type in SDO_GEOMETRY can be an arbitrary surface defining a contiguous area bounded by adjacent three-dimensional polygons. The number of polygons in the SDO_GEOMETRY is limited by the number of ordinates that can be in the SDO_ORDINATES_ARRAY. An SDO_TIN object, on the other hand, models the surface as a network of triangles with no explicit limit on the number of triangles.

Surfaces are stored as a network of triangles, called triangulated irregular networks, or **TINs**. The TIN model represents a surface as a set of contiguous, non-overlapping triangles. Within each triangle the surface is represented by a plane. The triangles are made from a set of points called mass points. If mass points are carefully selected, the TIN represents an accurate representation of the model of the surface. Well-placed mass points occur where there is a major change in the shape of the surface, for example, at the peak of a mountain, the floor of a valley, or at the edge (top and bottom) of cliffs.

TINs are generally computed from a set of three-dimensional points specifying coordinate values in the longitude (x), latitude (y), and elevation (z) dimensions. Oracle TIN generation software uses the Delaunay triangulation algorithm, but it is not required that TIN data be formed using only Delaunay triangulation techniques.

The general process for working with a TIN is as follows:

1. Initialize the TIN, using the SDO_TIN_PKG.INIT function.
2. Create the TIN, using the SDO_TIN_PKG.CREATE_TIN procedure.
3. As needed for queries, clip the TIN, using the SDO_TIN_PKG.CLIP_TIN function.
4. If necessary, use the SDO_TIN_PKG.TO_GEOMETRY function (for example, to convert the result of a clip operation into a single SDO_GEOMETRY object).

For a Java example of working with TINs, see the following files:

```
$ORACLE_HOME/md/demo/TIN/examples/java/README.txt
$ORACLE_HOME/md/demo/TIN/examples/java/readTIN.java
```

- 3D Mesh Modeling

1.13.1.1 3D Mesh Modeling

Oracle Spatial support for TIN is extended to support 3D meshes. A mesh can model a 3D triangulation of objects, including vertical surfaces, overhangs, and closed volumes which are currently not supported by TIN. Although a sloping surface is better represented by a TIN, 3D meshes can be used for modeling more complex landscapes, waterfalls, cliffs, buildings, cars, and so on.

In contrast to the Delaunay triangulation of a TIN, a 3D mesh is generated from a point set based on the Ball-Pivoting Algorithm. The shape of the mesh blocks are different from the slim vertical blocks generated for a TIN.

A 3D mesh is also represented by a `SDO_TIN` data type. To distinguish between a TIN and a 3D mesh, you can query the object metadata using the following functions:

- SDO_TIN_PKG.GET_BLOCKING_METHOD
- SDO_TIN_PKG.GET_NUM_POINTS
- SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER

The following shows an example which queries the metadata of the SDO_TIN objects in the `meshes` table:

```
SQL> SELECT
  2 (cols.table_name || ':' || cols.column_name) "Column Name",
  3 meshes.tin.tin_id "TIN ID",
  4 sdo_tin_pkg.get_blocking_method(tin) "Model",
  5 sdo_tin_pkg.get_num_points(tin) "# Pts",
  6 sdo_tin_pkg.get_tin_block_sort_order(meshes.tin) "Blk Sort Order"
  7 FROM
```

```
TABLE(sdo_tin_pkg.list_tin_columns()) cols,
TABLE(sdo_tin_pkg.list_tins(cols.table_name, cols.column_name)) meshes
ORDER BY
cols.table_name,
cols.column_name,
meshes.tin.tin_id;
```

The example query produces the following output:

```
Column Name      TIN ID     Model                  # Pts      Blk Sort Order
---------------- ---------- ---------------------- ----------
--------------------------------
MESHES:TIN                2 TIN                             4 TIN by Delaunay
triangulation
MESHES:TIN                3 Mesh                         1097 Mesh by
consecutive submesh

2 rows selected.
```

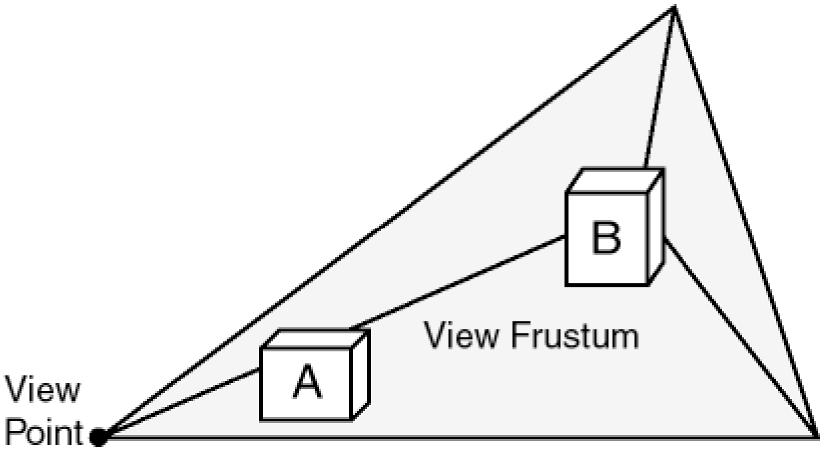
See Also:

- SDO_TIN_PKG.CREATE_MESHES for more information on how to generate a 3D mesh
- SDO_TIN_PKG.LIST_TIN_COLUMNS to list all the column names containing the `SDO_TIN` object
- SDO_TIN_PKG.LIST_TINS to list all the `SDO_TIN` objects

1.13.2 Modeling Solids

The simplest types of solids can be represented as cuboids, such as a cube or a brick. A more complex solid is a **frustum**, which is a pyramid formed by cutting a larger pyramid (with three or more faces) by a plane parallel to the base of that pyramid. Frustums are sometimes used as query windows to spatial operators. Frustums and cubes are typically modeled as solid-type SDO_GEOMETRY objects. Figure 1-9 shows a frustum as a query window, with two spatial objects at different distances from the view point.

Figure 1-9 Frustum as Query Window for Spatial Objects



Point clouds, which are large collections of points, can sometimes be used to model the shape or structure of solid and surface geometries. Most applications that use point cloud data contain queries based on location. Applications can also go outside Spatial to add visibility logic to perform queries based on both location and visibility.

Most applications that use point cloud data seek to minimize data transfer by retrieving objects based on their distance from a view point. For example, in Figure 1-9, object B is farther from the view point than object A, and therefore the application might retrieve object A in great detail (high resolution) and object B in less detail (low resolution). In most scenarios, the number of objects or points increases significantly as the distance from the view point increases; and if farther objects are retrieved at lower resolutions than nearer objects, the number of bytes returned by the query and the rendering time for the objects decrease significantly.

For storage of point cloud data, you can use either an SDO_PC object or is a flat table. The approach to use depends on your hardware environment and usage patterns. An advantage of the flat format is its efficient and dynamic nature, because updates to the point data do not require reblocking.

The general process for working with a point cloud is as follows, depending on whether the point cloud data will be stored in an SDO_PC object or in a flat table.

- To use point cloud data stored as an SDO_PC object:
    1. Initialize the point cloud, using the SDO_PC_PKG.INIT function.
    2. Create the point cloud, using the SDO_PC_PKG.CREATE_PC procedure.
    3. As needed for queries, clip the point cloud, using the SDO_PC_PKG.CLIP_PC function.
    4. Additionally, you can use:
        - SDO_PC_PKG.TO_GEOMETRY: To convert the result of a clip operation into a single SDO_GEOMETRY object.
        - SDO_PC_PKG.PC_DIFFERENCE: To detect the difference between two point clouds.
        - SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS: To perform a cross section computation of a point cloud.
- To use point cloud data stored in a flat table:

1. Create the table (or a view based on an appropriate table) for the point cloud data.

   Each row will contain the values of the first three spatial dimensions of a point, and optionally values for nonspatial dimensions. The table or view definition must start with the following columns: VAL_D1 NUMBER, VAL_D2 NUMBER, VAL_D3 NUMBER. It can also contain columns for point cloud nonspatial dimensions.
2. Populate the table with point data.
3. As needed for queries, clip the point cloud, using the SDO_PC_PKG.CLIP_PC_FLAT function.

For a Java example of working with point clouds, see the following files:

```
$ORACLE_HOME/md/demo/PointCloud/examples/java/README.txt
$ORACLE_HOME/md/demo/PointCloud/examples/java/readPointCloud.java
```

1.13.3 Three-Dimensional Optimized Rectangles

Instead of specifying all the vertices for a three-dimensional rectangle (a polygon in the shape of rectangle in three-dimensional space), you can represent the rectangle by specifying just the two corners corresponding to the minimum ordinate values (*min-corner*) and the maximum ordinate values (*max-corner*) for the X, Y, and Z dimensions.

The orientation of a three-dimensional rectangle defined in this way is as follows:

- If the rectangle is specified as <*min-corner, max-corner*>, the normal points in the positive direction of the perpendicular third dimension.
- If the rectangle is specified as <*max-corner, min-corner*>, the normal points in the negative direction of the perpendicular third dimension.

For example, if the rectangle is in the XY plane and the order of the vertices is <*min-corner, max-corner*>, the normal is along the positive Z-axis; but if the order is <*max-corner, min-corner*>, the normal is along the negative Z-axis.

Using these orientation rules for rectangles, you can specify the order of the *min-corner* and *max-corner* vertices for a rectangle appropriately so that the following requirements are met:

- The normal for each polygon in a solid always points outward from the solid when the rectangle is part of the solid.
- An inner rectangle polygon is oriented in the reverse direction as its outer when the rectangle is part of a surface.

1.13.4 Using Texture Data

> **Note:**
>
> This section describes concepts that you will need to understand for using texture data with Spatial. However, the texture metadata is not yet fully implemented in Oracle Spatial, and a viewer is not yet supported. This section will be updated when texture support is released.

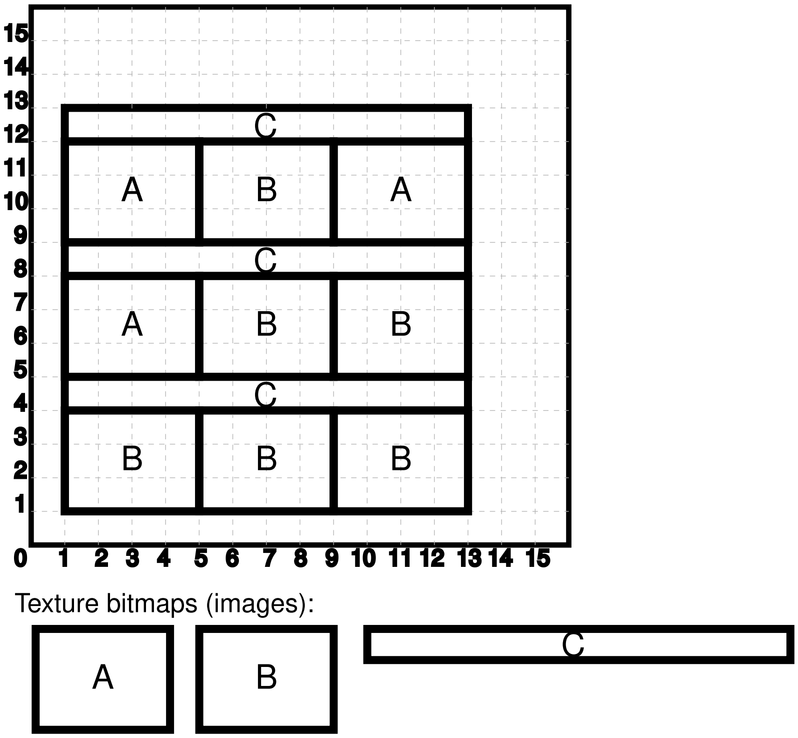
A **texture** is an image that represents one or more parts of a feature. Textures are commonly used with visualizer applications (viewers) that display objects stored as spatial geometries. For example, a viewer might display an office building (three-dimensional solid) using textures, to allow a more realistic visualization than using just colors. Textures can be used with two-dimensional and three-dimensional geometries.

In the simplest case, a rectangular geometry can be draped with a texture bitmap. However, often only a subregion of a texture bitmap is used, as in the following example cases:

- If the texture bitmap contains multiple sides of the same building, as well as the roof and roof gables. In this case, each bitmap portion is draped over one of the geometry faces.
- If the texture bitmap represents a single panel or window on the building surface, and a geometric face represents a wall with 15 such panels or windows (five on each of three floors). In this case, the single texture bitmap is tiled 15 times over the face.
- If the face is non-rectangular sub-faces, such as roof gables. In this case, only a portion (possible triangular) of the texture bitmap is used.

Figure 1-10 shows a large rectangular surface that, when viewed, appears to consist of three textures, each of which is repeated multiple times in various places on the surface.

Figure 1-10 Faces and Textures

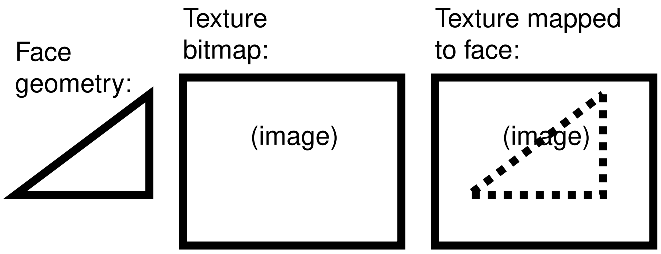


As shown in Figure 1-10:

- The entire image is a large surface that consists of 12 smaller rectangular faces (surface geometries), each of which can be represented by one of three images (labeled A, B, and C).
- Three texture bitmaps (labeled A, B, and C) can be used to visualize all of the faces. In this case, bitmap A is used 3 times, bitmap B is used 6 times, and bitmap C is used 3 times.

Figure 1-11 shows a texture bitmap mapped to a triangular face.

Figure 1-11 Texture Mapped to a Face



As shown in Figure 1-11:

- The face (surface geometry) is a triangle. (For example, a side or roof of a building may contain several occurrences of this face.)
- The texture bitmap (image) is a rectangle, shown in the box in the middle.
- A portion of the texture bitmap represents an image of the face. This portion is shown by a dashed line in the box on the right.

  In your application, you will need to specify coordinates within the texture bitmap to map the appropriate portion to the face geometry.

To minimize the storage requirements for image data representing surfaces, you should store images for only the distinct textures that will be needed. The data type for storing a texture is SDO_ORDINATE_ARRAY, which is used in the SDO_GEOMETRY type definition (explained in SDO_GEOMETRY Object Type).

For example, assume that the large surface in Figure 1-10 has the following definition:

```
SDO_GEOMETRY(
  SDO_POLYGON2D,  -- two-dimensional polygon
  NULL,
  NULL,
  SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
  SDO_ORDINATE_ARRAY(1,1. 1,13, 13,13, 1,13, 1,1)
)
```

Assume that you have a MY_TEXTURE_COORDINATES table with the following definition:

```
CREATE TABLE my_texture_coordinates (
  texture_coord_id NUMBER PRIMARY KEY,
  texture_name VARCHAR2(32),
  texture_coordinates SDO_ORDINATE_ARRAY);
```

Example 1-1 inserts three texture coordinate definitions into this table. For each texture, its coordinates reflect one of the appropriate smaller rectangles shown in Figure 1-10; however, you can choose any one of the appropriate rectangles for each texture. In Example 1-1, the SDO_ORDINATE_ARRAY definitions for each texture reflect a polygon near the top of Figure 1-10.

Example 1-1 Inserting Texture Coordinate Definitions

```
INSERT INTO my_texture_coordinates VALUES(
  1,
  'Texture_A',
   SDO_ORDINATE_ARRAY(1,9, 1,5, 5,12, 1,12, 1,9)
  );

INSERT INTO my_texture_coordinates VALUES(
  2,
  'Texture_B',
  SDO_ORDINATE_ARRAY(5,9, 9,9, 9,12, 5,12, 5,9)
  );

INSERT INTO my_texture_coordinates VALUES(
  3,
  'Texture_C',
  SDO_ORDINATE_ARRAY(1,12, 13,12, 13,13, 1,13, 1,12)
  );
```

- Schema Considerations with Texture Data

1.13.4.1 Schema Considerations with Texture Data

Texture bitmaps (stored as BLOBs or as URLs in VARCHAR2 format) and texture coordinate arrays (stored using type SDO_ORDINATE_ARRAY) can be stored in the same table as the SDO_GEOMETRY column or in separate tables; however, especially for the texture bitmaps, it is usually better to use separate tables. Texture bitmaps are likely to be able to be shared among features (such as different office buildings), but texture coordinate definitions are less likely to be sharable among features. (For example, many office buildings may share the same general type of glass exterior, but few of the buildings have the same number of windows and floors. In designing your textures and applications, you must consider how many buildings use the same texture subregion or drape the texture in the same size of repetitive matrix.)

An exception is a texture coordinate array that drapes an entire texture bitmap over a rectangular geometric face. In this case, the texture coordinate array can be specified as (0,0, 1,0, 1,1, 0,1, 1,1), defined by vertices "lower left", "lower right", "upper right", "upper left", and closing with "lower left". Many data sets use this texture coordinate array extensively, because they have primarily rectangular faces and they store one facade for each texture bitmap.

If you used separate tables, you could link them to the surface geometries using foreign keys, as in Example 1-2.

Example 1-2   Creating Tables for Texture Coordinates, Textures, and Surfaces

```
-- One row for each texture coordinates definition.
CREATE TABLE my_texture_coordinates (
  texture_coord_id NUMBER PRIMARY KEY,
  texture_coordinates SDO_ORDINATE_ARRAY);

-- One row for each texture.
CREATE TABLE my_textures(
  texture_id NUMBER PRIMARY KEY,
  texture BLOB);

-- One row for each surface (each individual "piece" of a
-- potentially larger surface).
CREATE TABLE my_surfaces(
  surface_id NUMBER PRIMARY KEY,
  surface_geometry SDO_GEOMETRY,
  texture_id NUMBER,
  texture_coord_id NUMBER,
  CONSTRAINT texture_id_fk
    FOREIGN KEY (texture_id) REFERENCES my_textures(texture_id),
  CONSTRAINT texture_coord_id_fk
    FOREIGN KEY (texture_coord_id) REFERENCES
      my_texture_coordinates(texture_coord_id));
```

1.13.5 Validation Checks for Three-Dimensional Geometries

The SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT and SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT subprograms can validate two-dimensional and three-dimensional geometries. For a three-dimensional geometry, these subprograms perform any necessary checks on any two-dimensional geometries (see the Usage Notes for SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT) within the overall three-dimensional geometry, but also several checks specific to the three-dimensional nature of the overall object.

For a simple solid (one outer surface and any number of inner surfaces), these subprograms perform the following checks:

- Closedness: The solid must be closed.
- Reachability: Each face of a solid must have a full-edge intersection with its neighboring faces, and all faces must be reachable from any face. (However, inner shells are ignored, because inner shells can, by definition, be not connected to the other shells.)
- Inner-outer disjointedness: An inner surface must not intersect the outer surface at more than a point or a line; that is, there must be no overlapping areas with inner surfaces.
- No surface patch: No additional surfaces can be defined on the surfaces that make up the solid.
- Orientation: For all surfaces, the vertices must be aligned so that the normal vector (or surface normal, or "the normal") points to the outside of (away from) the outer solid. Thus, the volume of the outer solid must be greater than zero, and the volume of any inner solid must be less than zero.

For a composite solid (one or more solids connected to each other), these subprograms perform the following checks:

- Connectedness: All solids of a composite solid must share at least one face.
- Zero-volume intersections: Any intersections of the solids in a composite solid must have a volume of zero.

For a multisolid (one or more solids, each of which is a simple or composite solid), these subprograms perform the following check:

- Disjointedness: Any two solids of a multisolid can share points or lines, but must not intersect in any other manner.

1.14 Geocoding

Geocoding is the process of converting tables of address data into standardized address, location, and possibly other data.

The result of a geocoding operation includes the pair of longitude and latitude coordinates that correspond with the input address or location. For example, if the input address is *22 Monument Square, Concord, MA 01742*, the longitude and latitude coordinates in the result of the geocoding operation may be (depending on the geocoding data provider) -71.34937 and 42.46101, respectively.

Given a geocoded address, you can perform proximity or location queries using a spatial engine, such as Oracle Spatial, or demographic analysis using tools and data from Oracle's business partners. In addition, you can use geocoded data with other spatial data such as block group, postal code, and county code for association with demographic information.

Results of analyses or queries can be presented as maps, in addition to tabular formats, using third-party software integrated with Oracle Spatial.

For conceptual and usage information about the geocoding capabilities of Oracle Spatial, see Geocoding Address Data. For reference information about the MDSYS.SDO_GCDR PL/SQL package, see SDO_GCDR Package (Geocoding) .

1.15 Location Data Enrichment

Oracle Spatial includes a place name data set, with hierarchical geographical data from HERE, that you can load into the database.

You can then then search this place name data set using the SDO_UTIL.GEO_SEARCH function. The data set includes commonly used textual location data such as place names, addresses and partial addresses, and latitude and longitude information.

Location tags are extracted from text data, and are matched with well known place names using Oracle Text and enhanced with other geographic information associated with the well known place names.

The results can be stored as additional attributes with the original data.

This feature enables you to process less structured geographic and location data so that the information can be categorized, compared, filtered, and associated with other data. For example, data with only partial names can be enriched to include city, county, state, and country, allowing it to be joined or analyzed with other data sets that may have state level information. This is especially useful when comparing Big Data results with structured information in operational systems and data warehouses.

Setting Up and Using Location Data Enrichment Support

To use the location data enrichment support, you just perform certain setup actions, such as editing scripts that will create the necessary database objects and load the data set into Oracle Database, and running those scripts.

1. Go to `$ORACLE_HOME//md/demo/GeoSearch`, which contains all the required files.
2. Read the `README` file, a text file containing an overview of the basic steps.
3. Perform the actions indicated in the `README` file.

   These actions include reading the `LICENSES.TXT` file, creating a single zip file from split files, editing the `load_data.sql` and `create_index.sql` script files (which contain explanatory comments), and running those scripts.

The `create_index.sql` file includes some example queries using the SDO_UTIL.GEO_SEARCH function. You can use those examples, plus the SDO_UTIL.GEO_SEARCH reference and usage information, to develop your own uses of the location data enrichment support.

- ELOC_ADMIN_AREA_SEARCH Table
- Adding User Data to the Geographic Name Hierarchy

1.15.1 ELOC_ADMIN_AREA_SEARCH Table

The ELOC_ADMIN_AREA_SEARCH table is used to store the data for location data enrichment. It is created only if you have performed the required setup actions described in Location Data Enrichment, and it is created in the database schema that you chose.

This table is accessed by the SDO_UTIL.GEO_SEARCH procedure. The table has the following columns.

Table 1-3 LOC_ADMIN_AREA_SEARCH Table

Column Name	Description
AREA_ID	Unique ID for the place name.
FULL_NAME	The name of the place as a searchable string. For example, “NASHUA,HILLSBOROUGH,NEW HAMPSHIRE,NH,UNITED STATES,USA” is the searchable name for the city of Nashua in NH, USA. This entry is a concatenated list of all possible names for each level of the name hierarchy. That is, for state it can have both the abbreviation and the full name. Similarly, for country it can have both the abbreviation and the full name. This enables the search to find this entry even when different search terms are used for each of these administrative areas.
AREA_NAME	The actual area name of the administrative place.
KEY	A standardized text key that is returned from the search API. This is a normalized standard key that can be used for joining the search term with other terms.
LANG_CODE	3- letter ISO code of the language used for this entry.
PART_ID	A number that is used when this table is partitioned (see the README for more details).
CENTER_LONG	Longitude of the place name.
CENTER_LAT	Latitude of the place name.
POPULATION	A number that is used to order the results when multiple matches are found for a given search term. The intent is to return more populated areas first before retuning less populated areas where multiple matches are found for the same search term.

1.15.2 Adding User Data to the Geographic Name Hierarchy

In some cases, users might want to add their own data to augment the data provided by Oracle. For example, if the users wants to create an entry for a park in the city (like Central Park in New York City) they can create an entry for it in this table.

For example, they can do :

```
insert into ELOC_ADMIN_AREA_SEARCH values (1469286010, 'CENTRAL PARK,NEW YORK
CITY,NEW YORK,NYC,RICHMOND,NEW YORK,NY,UNITED STATES,USA', 'CENTRAL PARK',
'CENTRAL PARK|NEW YORK|RICHMOND|NEW YORK|UNITED STATES', 'ENG', 7,
73.9654,40.7829, 0);
commit;
```

The COMMIT statement after inserting new data is important, because the text index performs a synchronization only after the commit is issued.

In this example, the area_id is chosen to be some value that does not already exist in the table, and a random partition_id value is used (7 in this case). However, a suitable value should be chosen based on the partitioning scheme used for the table (see the README for more details).

Now a search for central park will result a match:

```
select * from table(sdo_util.geo_search('central park,new york,NY,UNITED
STATES'));
CENTRAL PARK
CENTRAL PARK|NEW YORK|RICHMOND|NEW YORK|UNITED STATES
ENG    73.9654    40.7829      100
```

1.16 JSON and GeoJSON Support in Oracle Spatial

Spatial supports the use of JSON and GeoJSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.

JSON support, introduced in Release 18.1, substantially expands the limited GeoJSON support available in the previous release, in that it supports a larger range of geometries, including 2D and 3D, solid, surface, and LRS geometries. While the Spatial GeoJSON-specific APIs are still supported, you are encouraged to use the more comprehensive JSON support.

- JSON Support in Oracle Spatial
  Spatial supports the use of JSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.
- GeoJSON Support in Oracle Spatial
  Oracle Spatial supports the use of GeoJSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.
- JSON Schema for Spatial Geometry Objects
  Spatial uses an internal schema for storing spatial data in JSON (JavaScript Object Notation) format.

1.16.1 JSON Support in Oracle Spatial

Spatial supports the use of JSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.

You can convert any Oracle Spatial SDO_GEOMETRY object to a JSON geometry object, and geometry JSON object back to an SDO_GEOMETRY object.

JSON support in Spatial includes the following:

- SDO_UTIL.TO_JSON converts an SDO_GEOMETRY object to a JSON object in CLOB format.
- SDO_UTIL.TO_JSON_VARCHAR converts an SDO_GEOMETRY object to a JSON object in VARCHAR2 format.
- SDO_UTIL.FROM_JSON converts a JSON object (in CLOB or VARCHAR2 format) to an SDO_GEOMETRY object. This function can also convert a GeoJSON object to an SDO_GEOMETRY object.

Example 1-3   JSON Support in Spatial

This example shows some operations using the JSON support in Oracle Spatial. The example creates a simple table with JSON columns (in `CLOB`, `JSON`, and `VARCHAR2` data types) and an SDO_GEOMETRY column, inserts some sample data, performs some simple queries, creates a spatial index, and performs a query using the SDO_WITHIN_DISTANCE operator.

The example uses the `IS JSON` Oracle SQL condition as a check constraint in the CREATE TABLE statement to ensure that the CLOB column contains JSON data. See *Oracle Database JSON Developer's Guide* for more information.

The example includes descriptive comments and the output of the SQL statements. (The output has been reformatted for readability.)

```
-- Some operations using JSON support in Spatial.
-- Create a table with 3 columns: one JSONC (JSON CLOB), one JSONV (JSON
VARCHAR2),
-- and one SDO_GEOMETRY.
CREATE TABLE JSON_TBL (
  jsonc CLOB, jsonj JSON, jsonv VARCHAR2(4000),
       geom SDO_GEOMETRY,
      CONSTRAINT json_tbl_json CHECK (jsonc IS JSON) ) tablespace tbs_3;
Table created.


-- Test the constraint
INSERT INTO json_tbl VALUES ('Not JSON', NULL, NULL, NULL);
ORA-02290: check constraint (SCOTT.JSON_TBL_JSON) violated

-- Insert some data (2 points).
INSERT INTO JSON_TBL(jsonc)
      VALUES ('{"srid": 4326, "point": {"directposition": [123.4, -10.1]}}');
1 row created.

INSERT INTO JSON_TBL(jsonc)
      VALUES ('{"srid": 4326, "point": {"directposition": [123.5, -10.2]}}');
1 row created.

COMMIT;
Commit complete.

-- Update the table with the VARCHAR formatted JSON object and
-- an SDO_GEOMETRY created from a JSON object
UPDATE JSON_TBL SET
      jsonj=SDO_UTIL.TO_JSON_JSON(SDO_UTIL.FROM_JSON(jsonc)),
      jsonv=SDO_UTIL.TO_JSON_VARCHAR(SDO_UTIL.FROM_JSON(jsonc)),
      geom=SDO_UTIL.FROM_JSON(jsonc);
2 rows updated.

COMMIT;
Commit complete.

SELECT jsonc, jsonj, jsonv, geom FROM json_tbl;

JSONC
------------------------------------------------------------------------------
--
JSONJ
------------------------------------------------------------------------------
--
JSONV
------------------------------------------------------------------------------
--
GEOM(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
--
{"srid": 4326, "point": {"directposition": [123.4, -10.1]}}
```

```
{"srid": 4326, "point": {"directposition": [123.4, -10.1]}}
{"srid": 4326, "point": {"directposition": [123.4, -10.1]}}
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(123.4, -10.1, NULL), NULL, NULL)

{"srid": 4326, "point": {"directposition": [123.5, -10.2]}}
{"srid": 4326, "point": {"directposition": [123.5,-10.2]}}
{"srid": 4326, "point": {"directposition": [123.5, -10.2]}}
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(123.5, -10.2, NULL), NULL, NULL)
```

1.16.2 GeoJSON Support in Oracle Spatial

Oracle Spatial supports the use of GeoJSON objects to store, index, and manage geographic data that is in JSON (JavaScript Object Notation) format.

You can convert Spatial SDO_GEOMETRY objects to GeoJSON objects, and GeoJSON objects to SDO_GEOMETRY objects. You can use spatial operators, functions, and a special SDO_GEOMETRY method to work with GeoJSON data.

GeoJSON support in Spatial includes the following:

- SDO_UTIL.TO_GEOJSON function to convert an SDO_GEOMETRY object to a GeoJSON object..
- SDO_UTIL.FROM_GEOJSON function to convert a GeoJSON object to an SDO_GEOMETRY object.
- Get_GeoJson method (member function) of the SDO_GEOMETRY type (see SDO_GEOMETRY Methods for an explanation and an example).

Example 1-4   GeoJSON Support in Spatial

This example shows some operations using the GeoJSON support in Spatial. The example creates a simple table with a GeoJSON column and an SDO_GEOMETRY column, inserts some sample data, performs some simple queries, creates a spatial index, and performs a query using the SDO_WITHIN_DISTANCE operator.

The example uses the following JSON-related features of Oracle Database, which are documented in *Oracle Database JSON Developer's Guide*:

- The JSON_VALUE Oracle SQL function with `RETURNING SDO_GEOMETRY` to return SDO_GEOMETRY objects reflecting GeoJSON objects
- The IS JSON Oracle SQL condition in a check constraint in the CREATE TABLE statement to ensure that a column contains JSON data

The example includes descriptive comments and the output of the SQL statements. (The output has been reformatted for readability.)

```
-- Some operations using GeoJSON support in Spatial.
-- Create a table with 2 columns: one GeoJSON, one SDO_GEOMETRY.
CREATE TABLE GEO_TABLE (geojson_col VARCHAR2(4000), geom_col SDO_GEOMETRY,
                CONSTRAINT CHECK (geojson_col IS JSON));

Table created.

-- Insert some data (2 points).
INSERT INTO GEO_TABLE(geojson_col)
      values ('{"a":{"type":"Point","coordinates":[+123.4,+10.1]}}');
```

```
1 row created.

INSERT INTO GEO_TABLE(geojson_col)
      values ('{"a":{"type":"Point","coordinates":[+123.5,-10.1]}}');

1 row created.

commit;

Commit complete.

SQL> -- For each geojson_col value, return what its SDO_GEOMETRY equivalent
would be.
SQL> SELECT JSON_VALUE(geojson_col, '$.a' RETURNING SDO_GEOMETRY) from
GEO_TABLE;

JSON_VALUE(GEOJSON_COL,'$.A'RETURNINGSDO_GEOMETRY)(SDO_GTYPE, SDO_SRID,
SDO_POIN
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(123.4, 10.1, NULL), NULL,
NULL)
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(123.5, -10.1, NULL), NULL,
NULL)

-- For a specified GeoJSON object definition, return what its SDO_GEOMETRY
-- equivalent would be.
SELECT JSON_VALUE('{"type":"Point","coordinates":[+123.5,-10.1]}',
               '$' RETURNING SDO_GEOMETRY) from DUAL;

JSON_VALUE('{"TYPE":"POINT","COORDINATES":
[+123.5,-10.1]}','$'RETURNINGSDO_GEOME
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(123.5, -10.1, NULL), NULL,
NULL)

-- Update to populate geom_col with SDO_GEOMETRY objects reflecting the JSON
data
-- in the geojson_col column.
UPDATE GEO_TABLE
    set geom_col = JSON_VALUE(geojson_col, '$.a' RETURNING SDO_GEOMETRY);

2 rows updated.

commit;

Commit complete.

-- Create spatial index on the returned SDO_GEOMETRY objects from the JSON
data.
CREATE INDEX GEO_TABLE_IX
         ON GEO_TABLE
          (
          JSON_VALUE(geojson_col, '$.a' RETURNING SDO_GEOMETRY)
          )
```

```
       INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

Index created.

-- SDO_WITHIN_DISTANCE query: Are two grometries within 100 miles apart?
SELECT 1
  FROM GEO_TABLE
 WHERE SDO_WITHIN_DISTANCE(
          JSON_VALUE(geojson_col, '$.a' RETURNING SDO_GEOMETRY),
          JSON_VALUE('{"type":"Point","coordinates":[+123.5,-10.1]}',
             '$' RETURNING SDO_GEOMETRY),
       'distance=100 unit=mile') = 'TRUE';



1
----------

         1
```

1.16.3 JSON Schema for Spatial Geometry Objects

Spatial uses an internal schema for storing spatial data in JSON (JavaScript Object Notation) format.

The information if this topic is useful if you want to write a parser to read such data on the client side. The JSON schema used for spatial data is as follows.

```
  "$schema": "http://json-schema.org/draft-06/schema#",
  "type": "object",
  "anyOf": [
    { "$ref": "#/definitions/CompoundCurveSchema" },
    { "$ref": "#/definitions/CurveSchema" },
    { "$ref": "#/definitions/MultiGeometrySchema" },
    { "$ref": "#/definitions/PointSchema" },
    { "$ref": "#/definitions/PolygonSchema" },
    { "$ref": "#/definitions/SolidSchema" },
    { "$ref": "#/definitions/SurfaceSchema" }
  ],
  "definitions": {
    "CompoundCurveSchema": {
      "description": "A JSON schema for compound curve geometry",
      "type": "object",
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "compoundcurve": { "$ref": "#/definitions/compoundcurve" }
      }
    },
    "CurveSchema": {
      "description": "A JSON schema for curve geometry",
      "type": "object",
      "oneOf": [{
        "required": [ "circulararc" ],
        "properties": {
          "srid": { "$ref": "#/definitions/srid" },
          "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
          "circulararc": { "$ref": "#/definitions/circulararc" }
        }
      }, {
      "required": [ "line " ],
      "properties": {
            "srid": { "$ref": "#/definitions/srid" },
            "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
            "line": { "$ref": "#/definitions/line" }
        }
      }, {
      "required": [ "nurbscurve " ],
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "nurbscurve": { "$ref": "#/definitions/nurbscurve" }
      }}]
    },
    "MultiGeometrySchema": {
      "description": "JSON schema for collections & multi-* curves, points
and polygons",
      "type": "object",
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "geometrycollection": { "$ref": "#/definitions/geometrycollection" }
      }
    },
    "PointSchema": {
      "description": "A JSON schema for point geometry",
      "type": "object",
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "point": { "$ref": "#/definitions/point" }
      }
    },
    "PolygonSchema": {
      "description": "A JSON schema for polygon geometry",
      "type": "object",
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "polygon": { "$ref": "#/definitions/polygon" }
      }
    },
    "SolidSchema": {
      "description": "A JSON schema for surface geometry",
      "type": "object",
      "properties": {
        "srid": { "$ref": "#/definitions/srid" },
        "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
        "polygon": { "$ref": "#/definitions/solid" }
      }
    },
    "SurfaceSchema": {
```

```
    "description": "A JSON schema for surface geometry",
    "type": "object",
    "properties": {
      "srid": { "$ref": "#/definitions/srid" },
      "spatialdimension": { "$ref": "#/definitions/spatialdimension" },
      "polygon": { "$ref": "#/definitions/polygons" }
    }
  },

  "circle": {
    "description": "An SDO_GEOMETRY optimized circle Polygon",
    "type": "object",
    "required": [ "datapoints" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/datapoints" }
    }
  },
  "circulararc": {
    "description": "An SDO_GEOMETRY arc string",
    "type": "object",
    "required": [ "datapoints" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/datapoints" }
    }
  },
  "geometrycollection": {
    "description": "A collection of SDO_GEOMETRY",
    "type": "object",
    "required": [ "geometries" ],
    "properties": {
      "geometries": { "$ref": "#/definitions/geometries" }
    }
  },
  "knot": {
    "description": "A Knot (value/multiplicity pair) in a NURBS curve",
    "type": "object",
    "required": [ "value", "multiplicity" ],
    "properties": {
      "value": { "$ref": "#/definitions/value" },
      "multiplicity": { "$ref": "#/definitions/multiplicity" }
    }
  },
  "line": {
    "description": "An SDO_GEOMETRY linestring",
    "type": "object",
    "required": [ "datapoints" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/datapoints" }
    }
  },
  "multipoint": {
    "description": "An SDO_GEOMETRY MultiPoint",
    "type": "object",
    "required": [ "datapoints" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/datapoints" }
    }
  },
  "nurbscurve": {
    "description": "An SDO_GEOMETRY nurbscurve",
    "type": "object",
    "required": [ "degree", "controlpoints", "knots" ],
    "properties": {
      "degree": { "type": "integer" },
      "controlpoints": { "$ref": "#/definitions/controlpoints" },
      "knots": { "$ref": "#/definitions/knots" }
    }
  },
  "nurbspoint": {
    "description": "A weighted point/weight pair in a NURBS curve",
    "type": "object",
    "required": [ "weightedpoint", "weight" ],
    "properties": {
      "weightedpoint": { "$ref": "#/definitions/weightedpoint" },
      "weight": { "$ref": "#/definitions/weight" }
    }
  },
  "point": {
    "description": "An SDO_GEOMETRY Point",
    "type": "object",
    "required": [ "directposition" ],
    "properties": {
      "optimized": { "$ref": "#/definitions/optimized" },
      "directposition": { "$ref": "#/definitions/directposition" }
    }
  },
  "polygon": {
    "description": "An SDO_GEOMETRY Polygon",
    "type": "object",
    "required": [ "boundary" ],
    "properties": {
      "boundary": { "$ref": "#/definitions/boundary" }
    }
  },
  "rectangle": {
    "description": "An SDO_GEOMETRY optimized rectangle Polygon",
    "type": "object",
    "required": [ "datapoints" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/datapoints" }
    }
  },
  "solid": {
    "description": "An SDO_GEOMETRY solid",
    "type": "object",
    "required": [ "surfaces" ],
    "properties": {
      "datapoints": { "$ref": "#/definitions/surfaces" }
    }
  },
  "surface": {
    "description": "An SDO_GEOMETRY surface",
      "type": "object",
      "required": [ "polygons" ],
      "properties": {
        "datapoints": { "$ref": "#/definitions/polygons" }
      }
    },

    "boundary": {
      "description": "An array of geometries that make up a polygon's
boundary",
      "type": "array",
      "minItems": 1,
      "items":{
        "anyOf": [
          { "$ref": "#/definitions/circle" },
          { "$ref": "#/definitions/circulararc" },
          { "$ref": "#/definitions/compoundcurve" },
          { "$ref": "#/definitions/line" },
          { "$ref": "#/definitions/rectangle" }
        ]
      }
    },
    "compoundcurve": {
      "description": "An array of curves the make up the compound curve",
      "type": "array",
      "minItems": 2,
      "items":{
        "anyOf": [
          { "$ref": "#/definitions/circulararc" },
          { "$ref": "#/definitions/line" },
          { "$ref": "#/definitions/nurbscurve" }
        ]
      }
    },
    "controlpoints": {
      "description": "An array of nurbspoints in a NURBS curve",
      "type": "array",
      "minItems": 1,
      "items": { "$ref": "#/definitions/nurbspoint" }
    },
    "datapoints": {
      "description": "An array of coordinates",
      "type": "array",
      "minItems": 4,
      "items": { "type": "number" }
    },
    "directposition": {
      "description": "A single coordinate",
      "type": "array",
      "minItems": 2,
      "maxItems": 3,
      "items": { "type": "number" }
    },
    "geometries": {
      "description": "An array of geometries",
      "type": "array",
      "minItems": 1,
      "items":{
        "anyOf": [
          { "$ref": "#/definitions/circulararc" },
          { "$ref": "#/definitions/line" },
          { "$ref": "#/definitions/nurbscurve" },
          { "$ref": "#/definitions/point" },
          { "$ref": "#/definitions/polygon" },
          { "$ref": "#/definitions/multipoint" }
        ]
      }
    },
    "knots": {
      "description": "An array of Knots in a NURBS curve",
      "type": "array",
      "minItems": 1,
      "items": { "$ref": "#/definitions/knot" }
    },
    "multiplicity": {
      "description": "A Multiplicity in a NURBS curve",
      "type": "integer",
      "minimum": 1
    },
    "optimized": {
      "description": "An SDO optimized point",
      "type": "boolean",
      "default": true
    },
    "polygons": {
      "description": "An array of polygon geometries that make up a surface",
      "type": "array",
      "minItems": 1,
      "items": { "$ref": "#/definitions/polygon" }
    },
    "spatialdimension": {
      "description": "A geometry's spatial dimension ",
      "minimum": 2,
      "maximum": 3,
      "type": "integer"
    },
    "srid": {
      "description": "A geometry's SRID",
      "type": "integer"
    },
    "surfaces": {
      "description": "An array of surface geometries that make up a solid",
      "type": "array",
      "minItems": 1,
      "items": { "$ref": "#/definitions/surface" }
    },
    "value": {
      "description": "A Value in a NURBS curve",
      "type": "number"
    },
    "weight": {
      "description": "Weight of a weighted point in a NURBS curve",
      "type": "integer"
    },
    "weightedpoint": {
      "description": "An array of weighted points in a NURBS curve",
      "type": "array",
      "minItems": 2,
      "maxItems": 2,
      "items": { "type": "number" }
    }
  }
}
```

Example 1-5   JSON Representations of Various Spatial Geometries

The following examples show JSON representations produced by Spatial for various types of spatial geometries.

```
Point: JGeometry (gtype=1, dim=2, srid=0, Point=(10.0,5.0))
  {
  "point" : {
    "directposition" : [ 10.0, 5.0 ]
  }
}
Line segment: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,1),
 Ordinates(10.0,10.0
20.0,10.0
))
  {
  "line" : {
    "datapoints" : [ [ 10.0, 10.0 ], [ 20.0, 10.0 ] ]
  }
}
Arc segment: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,2),
 Ordinates(10.0,15.0
15.0,20.0
20.0,15.0
))
  {
  "circulararc" : {
    "datapoints" : [ [ 10.0, 15.0 ], [ 15.0, 20.0 ], [ 20.0, 15.0 ] ]
  },
  "interpolation" : "CIRCULAR"
}
Line string: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,1),
 Ordinates(10.0,25.0
20.0,30.0
25.0,25.0
30.0,30.0
))
  {
  "line" : {
    "datapoints" : [ [ 10.0, 25.0 ], [ 20.0, 30.0 ], [ 25.0, 25.0 ], [ 30.0,
30.0 ] ]
```

```
  }
}
Arc string: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,2),
 Ordinates(10.0,35.0
15.0,40.0
20.0,35.0
25.0,30.0
30.0,35.0
))
  {
  "circulararc" : {
    "datapoints" : [ [ 10.0, 35.0 ], [ 15.0, 40.0 ], [ 20.0, 35.0 ], [ 25.0,
30.0 ], [ 30.0, 35.0 ] ]
  },
  "interpolation" : "CIRCULAR"
}
Compound line string: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,4,3,1,2,1,3,2,2,7,2,1),
 Ordinates(10.0,45.0
20.0,45.0
23.0,48.0
20.0,51.0
10.0,51.0
))
  {
  "compoundcurve" : [ {
    "line" : {
      "datapoints" : [ [ 10.0, 45.0 ], [ 20.0, 45.0 ] ]
    }
  }, {
    "circulararc" : {
      "datapoints" : [ [ 20.0, 45.0 ], [ 23.0, 48.0 ], [ 20.0, 51.0 ] ]
    },
    "interpolation" : "CIRCULAR"
  }, {
    "line" : {
      "datapoints" : [ [ 20.0, 51.0 ], [ 10.0, 51.0 ] ]
    }
  } ]
}
Closed line string: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,1),
 Ordinates(10.0,55.0
15.0,55.0
20.0,60.0
10.0,60.0
10.0,55.0
))
  {
  "line" : {
    "datapoints" : [ [ 10.0, 55.0 ], [ 15.0, 55.0 ], [ 20.0, 60.0 ], [ 10.0,
60.0 ], [ 10.0, 55.0 ] ]
  }
}
Closed arc string: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,2),
 Ordinates(15.0,65.0
10.0,68.0
15.0,70.0
20.0,68.0
15.0,65.0
))
  {
  "circulararc" : {
    "datapoints" : [ [ 15.0, 65.0 ], [ 10.0, 68.0 ], [ 15.0, 70.0 ], [ 20.0, 
68.0 ], [ 15.0, 65.0 ] ]
  },
  "interpolation" : "CIRCULAR"
}
Closed mixed line: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,4,2,1,2,1,7,2,2),
 Ordinates(10.0,78.0
10.0,75.0
20.0,75.0
20.0,78.0
15.0,80.0
10.0,78.0
))
  {
  "compoundcurve" : [ {
    "line" : {
      "datapoints" : [ [ 10.0, 78.0 ], [ 10.0, 75.0 ], [ 20.0, 75.0 ], 
[ 20.0, 78.0 ] ]
    }
  }, {
    "circulararc" : {
      "datapoints" : [ [ 20.0, 78.0 ], [ 15.0, 80.0 ], [ 10.0, 78.0 ] ]
    },
    "interpolation" : "CIRCULAR"
  } ]
}
Self-crossing line: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,1),
 Ordinates(10.0,-75.0
20.0,-70.0
20.0,-75.0
10.0,-70.0
10.0,-75.0
))
  {
  "line" : {
    "datapoints" : [ [ 10.0, -75.0 ], [ 20.0, -70.0 ], [ 20.0, -75.0 ], 
[ 10.0, -70.0 ], [ 10.0, -75.0 ] ]
  }
}
Polygon: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1003,1),
 Ordinates(10.0,-55.0
15.0,-55.0
20.0,-50.0
10.0,-50.0
10.0,-55.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 10.0, -55.0 ], [ 15.0, -55.0 ], [ 20.0, -50.0 ],
[ 10.0, -50.0 ], [ 10.0, -55.0 ] ]
      }
    } ]
  }
}
Arc polygon: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1003,2),
 Ordinates(15.0,-45.0
20.0,-42.0
15.0,-40.0
10.0,-42.0
15.0,-45.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "circulararc" : {
        "datapoints" : [ [ 15.0, -45.0 ], [ 20.0, -42.0 ], [ 15.0, -40.0 ],
[ 10.0, -42.0 ], [ 15.0, -45.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Compound polygon: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1005,2,1,2,1,7,2,2),
 Ordinates(10.0,-32.0
10.0,-35.0
20.0,-35.0
20.0,-32.0
15.0,-30.0
10.0,-32.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "compoundcurve" : [ {
        "line" : {
          "datapoints" : [ [ 10.0, -32.0 ], [ 10.0, -35.0 ], [ 20.0, -35.0 ],
[ 20.0, -32.0 ] ]
        }
      }, {
        "circulararc" : {
          "datapoints" : [ [ 20.0, -32.0 ], [ 15.0, -30.0 ], [ 10.0, -32.0 ] ]
        },
        "interpolation" : "CIRCULAR"
      } ]
    } ]
  }
```

```
}
Rectangle: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1003,1),
 Ordinates(10.0,-25.0
20.0,-25.0
20.0,-20.0
10.0,-20.0
10.0,-25.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 10.0, -25.0 ], [ 20.0, -25.0 ], [ 20.0, -20.0 ],
[ 10.0, -20.0 ], [ 10.0, -25.0 ] ]
      }
    } ]
  }
}
Circle: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1003,2),
 Ordinates(15.0,-15.0
20.0,-10.0
15.0,-5.0
10.0,-10.0
15.0,-15.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "circulararc" : {
        "datapoints" : [ [ 15.0, -15.0 ], [ 20.0, -10.0 ], [ 15.0, -5.0 ],
[ 10.0, -10.0 ], [ 15.0, -15.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Point cluster: JGeometry (gtype=5, dim=2, srid=0,
 ElemInfo(1,1,3),
 Ordinates(50.0,5.0
55.0,7.0
60.0,5.0
))
  {
  "multipoint" : {
    "datapoints" : [ [ 50.0, 5.0 ], [ 55.0, 7.0 ], [ 60.0, 5.0 ] ]
  }
}
Multipoint: JGeometry (gtype=5, dim=2, srid=0,
 ElemInfo(1,1,3),
 Ordinates(65.0,5.0
70.0,7.0
75.0,5.0
))
  {
```

```
  "multipoint" : {
    "datapoints" : [ [ 65.0, 5.0 ], [ 70.0, 7.0 ], [ 75.0, 5.0 ] ]
  }
}
Multiline: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,1,5,2,1),
 Ordinates(50.0,15.0
55.0,15.0
60.0,15.0
65.0,15.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "line" : {
        "datapoints" : [ [ 50.0, 15.0 ], [ 55.0, 15.0 ] ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 60.0, 15.0 ], [ 65.0, 15.0 ] ]
      }
    } ]
  }
}
Multiline - crossing: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,1,5,2,1),
 Ordinates(50.0,22.0
60.0,22.0
55.0,20.0
55.0,25.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "line" : {
        "datapoints" : [ [ 50.0, 22.0 ], [ 60.0, 22.0 ] ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 55.0, 20.0 ], [ 55.0, 25.0 ] ]
      }
    } ]
  }
}
Multiarc: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,2,7,2,2),
 Ordinates(50.0,35.0
55.0,40.0
60.0,35.0
65.0,35.0
70.0,30.0
75.0,35.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "circulararc" : {
        "datapoints" : [ [ 50.0, 35.0 ], [ 55.0, 40.0 ], [ 60.0, 35.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    }, {
      "circulararc" : {
        "datapoints" : [ [ 65.0, 35.0 ], [ 70.0, 30.0 ], [ 75.0, 35.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Multiline - closed: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,1,9,2,1),
 Ordinates(50.0,55.0
50.0,60.0
55.0,58.0
50.0,55.0
56.0,58.0
60.0,55.0
60.0,60.0
56.0,58.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "line" : {
        "datapoints" : [ [ 50.0, 55.0 ], [ 50.0, 60.0 ], [ 55.0, 58.0 ],
[ 50.0, 55.0 ] ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 56.0, 58.0 ], [ 60.0, 55.0 ], [ 60.0, 60.0 ],
[ 56.0, 58.0 ] ]
      }
    } ]
  }
}
Multiarc - touching: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,2,7,2,2),
 Ordinates(50.0,65.0
50.0,70.0
55.0,68.0
55.0,68.0
60.0,65.0
60.0,70.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "circulararc" : {
        "datapoints" : [ [ 50.0, 65.0 ], [ 50.0, 70.0 ], [ 55.0, 68.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    }, {
      "circulararc" : {
        "datapoints" : [ [ 55.0, 68.0 ], [ 60.0, 65.0 ], [ 60.0, 70.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Multipolygon - disjoint: JGeometry (gtype=7, dim=2, srid=0,
 ElemInfo(1,1003,1,11,1003,1),
 Ordinates(50.0,-55.0
55.0,-55.0
60.0,-50.0
50.0,-50.0
50.0,-55.0
62.0,-52.0
65.0,-52.0
65.0,-48.0
62.0,-48.0
62.0,-52.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 50.0, -55.0 ], [ 55.0, -55.0 ], [ 60.0,
-50.0 ], [ 50.0, -50.0 ], [ 50.0, -55.0 ] ]
          }
        } ]
      }
    }, {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 62.0, -52.0 ], [ 65.0, -52.0 ], [ 65.0,
-48.0 ], [ 62.0, -48.0 ], [ 62.0, -52.0 ] ]
          }
        } ]
      }
    } ]
  }
}
Multipolygon - touching: JGeometry (gtype=7, dim=2, srid=0,
 ElemInfo(1,1003,1,11,1003,1),
 Ordinates(50.0,-45.0
55.0,-45.0
55.0,-40.0
50.0,-40.0
50.0,-45.0
55.0,-40.0
58.0,-40.0
58.0,-38.0
55.0,-38.0
55.0,-40.0
))
  {
```

```
  "geometrycollection" : {
    "geometries" : [ {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 50.0, -45.0 ], [ 55.0, -45.0 ], [ 55.0,
-40.0 ], [ 50.0, -40.0 ], [ 50.0, -45.0 ] ]
          }
        } ]
      }
    }, {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 55.0, -40.0 ], [ 58.0, -40.0 ], [ 58.0,
-38.0 ], [ 55.0, -38.0 ], [ 55.0, -40.0 ] ]
          }
        } ]
      }
    } ]
  }
}

Polygon with void: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1003,1,11,2003,1),
 Ordinates(50.0,-25.0
60.0,-25.0
60.0,-20.0
50.0,-20.0
50.0,-25.0
51.0,-24.0
51.0,-21.0
59.0,-21.0
59.0,-24.0
51.0,-24.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 50.0, -25.0 ], [ 60.0, -25.0 ], [ 60.0, -20.0 ],
[ 50.0, -20.0 ], [ 50.0, -25.0 ] ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 51.0, -24.0 ], [ 51.0, -21.0 ], [ 59.0, -21.0 ],
[ 59.0, -24.0 ], [ 51.0, -24.0 ] ]
      }
    } ]
  }
}

Polygon+void+island touch: JGeometry (gtype=7, dim=2, srid=0,
 ElemInfo(1,1003,1,11,2003,1,31,1003,1),
 Ordinates(50.0,8.0
50.0,0.0
```

```
55.0,0.0
55.0,8.0
50.0,8.0
51.0,7.0
54.0,7.0
54.0,1.0
51.0,1.0
51.0,2.0
52.0,3.0
51.0,4.0
51.0,5.0
51.0,6.0
51.0,7.0
52.0,6.0
52.0,2.0
53.0,2.0
53.0,6.0
52.0,6.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 50.0, 8.0 ], [ 50.0, 0.0 ], [ 55.0, 0.0 ],
[ 55.0, 8.0 ], [ 50.0, 8.0 ] ]
          }
        }, {
          "line" : {
            "datapoints" : [ [ 51.0, 7.0 ], [ 54.0, 7.0 ], [ 54.0, 1.0 ],
[ 51.0, 1.0 ], [ 51.0, 2.0 ], [ 52.0, 3.0 ], [ 51.0, 4.0 ], [ 51.0, 5.0 ],
[ 51.0, 6.0 ], [ 51.0, 7.0 ] ]
          }
        } ]
      }
    }, {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 52.0, 6.0 ], [ 52.0, 2.0 ], [ 53.0, 2.0 ],
[ 53.0, 6.0 ], [ 52.0, 6.0 ] ]
          }
        } ]
      }
    } ]
  }
}
NURBS deg=3 CP=7: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,3),
 Ordinates(3.0,7.0
0.0,0.0
1.0,-0.5
1.0,1.0
0.2,2.0
1.0,0.5
```

```
3.5,1.0
0.8,2.0
1.0,0.9
1.0,1.0
0.3,0.0
1.0,11.0
0.0,0.0
0.0,0.0
0.25,0.5
0.75,1.0
1.0,1.0
,1.0))
  {
  "nurbscurve" : {
    "degree" : 3,
    "controlpoints" : [ {
      "nurbspoint" : {
        "weightedpoint" : [ 0.0, 0.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ -0.5, 1.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.2, 2.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.5, 3.5 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.8, 2.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.9, 1.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.3, 0.0 ],
        "weight" : 1.0
      }
    } ],
    "knots" : [ {
      "value" : 0.0,
      "multiplicity" : 4
    }, {
      "value" : 0.25,
        "multiplicity" : 1
      }, {
        "value" : 0.5,
        "multiplicity" : 1
      }, {
        "value" : 0.75,
        "multiplicity" : 1
      }, {
        "value" : 1.0,
        "multiplicity" : 4
      } ]
  }
}
Compound, linestring + NURBS: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,4,2,1,2,1,5,2,3),
 Ordinates(-1.0,-1.0
0.0,0.0
3.0,7.0
0.0,0.0
1.0,-0.5
1.0,1.0
0.2,2.0
1.0,0.5
3.5,1.0
0.8,2.0
1.0,0.9
1.0,1.0
0.3,0.0
1.0,11.0
0.0,0.0
0.0,0.0
0.25,0.5
0.75,1.0
1.0,1.0
,1.0))
  {
  "compoundcurve" : [ {
    "line" : {
      "datapoints" : [ [ -1.0, -1.0 ], [ 0.0, 0.0 ] ]
    }
  }, {
    "nurbscurve" : {
      "degree" : 3,
      "controlpoints" : [ {
        "nurbspoint" : {
          "weightedpoint" : [ 0.0, 0.0 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ -0.5, 1.0 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ 0.2, 2.0 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ 0.5, 3.5 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ 0.8, 2.0 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ 0.9, 1.0 ],
          "weight" : 1.0
        }
      }, {
        "nurbspoint" : {
          "weightedpoint" : [ 0.3, 0.0 ],
          "weight" : 1.0
        }
      } ],
      "knots" : [ {
        "value" : 0.0,
        "multiplicity" : 4
      }, {
        "value" : 0.25,
        "multiplicity" : 1
      }, {
        "value" : 0.5,
        "multiplicity" : 1
      }, {
        "value" : 0.75,
        "multiplicity" : 1
      }, {
        "value" : 1.0,
        "multiplicity" : 4
      } ]
    }
  } ]
}
3D optimized point: JGeometry (gtype=1, dim=3, srid=0, Point=(11.0,22.0,33.0))
  {
  "spatialdimension" : 3,
  "point" : {
    "directposition" : [ 11.0, 22.0, 33.0 ]
  }
}
3D elemInfo point: JGeometry (gtype=1, dim=3, srid=0,
 ElemInfo(1,1,1),
 Ordinates(11.0,22.0,33.0
))
  {
  "spatialdimension" : 3,
  "point" : {
    "directposition" : [ 11.0, 22.0, 33.0 ]
  }
}
Geom1:
JGeometry (gtype=1, dim=3, srid=0, Point=(11.0,22.0,33.0))
Geom2:
JGeometry (gtype=1, dim=3, srid=0,
 ElemInfo(1,1,1),
 Ordinates(11.0,22.0,33.0
))
3D multipoint: JGeometry (gtype=5, dim=3, srid=0,
 ElemInfo(1,1,2),
 Ordinates(1.0,1.0,1.0
0.0,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "multipoint" : {
    "datapoints" : [ [ 1.0, 1.0, 1.0 ], [ 0.0, 0.0, 0.0 ] ]
  }
}
3D linestring: JGeometry (gtype=2, dim=3, srid=0,
 ElemInfo(1,2,1),
 Ordinates(1.0,1.0,1.0
0.0,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "line" : {
    "datapoints" : [ [ 1.0, 1.0, 1.0 ], [ 0.0, 0.0, 0.0 ] ]
  }
}
3D polygon A: JGeometry (gtype=3, dim=3, srid=0,
 ElemInfo(1,1003,1),
 Ordinates(0.5,0.0,0.0
0.5,1.0,0.0
0.0,1.0,1.0
0.0,0.0,1.0
0.5,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 0.5, 0.0, 0.0 ], [ 0.5, 1.0, 0.0 ], [ 0.0, 1.0, 
1.0 ], [ 0.0, 0.0, 1.0 ], [ 0.5, 0.0, 0.0 ] ]
      }
    } ]
  }
}
3D polygon B: JGeometry (gtype=3, dim=3, srid=0,
 ElemInfo(1,1003,1),
 Ordinates(6.0,6.0,6.0
5.0,6.0,10.0
3.0,4.0,8.0
```

```
4.0,4.0,4.0
6.0,6.0,6.0
))
  {
  "spatialdimension" : 3,
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 6.0, 6.0, 6.0 ], [ 5.0, 6.0, 10.0 ], [ 3.0, 4.0, 
8.0 ], [ 4.0, 4.0, 4.0 ], [ 6.0, 6.0, 6.0 ] ]
      }
    } ]
  }
}
3D polygon C: JGeometry (gtype=7, dim=3, srid=0,
 ElemInfo(1,1003,1,16,1003,1),
 Ordinates(6.0,6.0,6.0
5.0,6.0,10.0
3.0,4.0,8.0
4.0,4.0,4.0
6.0,6.0,6.0
0.5,0.0,0.0
0.5,1.0,0.0
0.0,1.0,1.0
0.0,0.0,1.0
0.5,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "geometrycollection" : {
    "geometries" : [ {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 6.0, 6.0, 6.0 ], [ 5.0, 6.0, 10.0 ], [ 3.0, 
4.0, 8.0 ], [ 4.0, 4.0, 4.0 ], [ 6.0, 6.0, 6.0 ] ]
          }
        } ]
      }
    }, {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 0.5, 0.0, 0.0 ], [ 0.5, 1.0, 0.0 ], [ 0.0, 
1.0, 1.0 ], [ 0.0, 0.0, 1.0 ], [ 0.5, 0.0, 0.0 ] ]
          }
        } ]
      }
    } ]
  }
}
3D polygon with hole all on one plane: JGeometry (gtype=3, dim=3, srid=0,
 ElemInfo(1,1003,1,16,2003,1),
 Ordinates(0.5,0.0,0.0
0.5,1.0,0.0
0.0,1.0,1.0
```

```
0.0,0.0,1.0
0.5,0.0,0.0
0.25,0.5,0.5
0.15,0.5,0.7
0.15,0.6,0.7
0.25,0.6,0.5
0.25,0.5,0.5
))
  {
  "spatialdimension" : 3,
  "polygon" : {
    "boundary" : [ {
      "line" : {
        "datapoints" : [ [ 0.5, 0.0, 0.0 ], [ 0.5, 1.0, 0.0 ], [ 0.0, 1.0, 
1.0 ], [ 0.0, 0.0, 1.0 ], [ 0.5, 0.0, 0.0 ] ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 0.25, 0.5, 0.5 ], [ 0.15, 0.5, 0.7 ], [ 0.15, 0.6, 
0.7 ], [ 0.25, 0.6, 0.5 ], [ 0.25, 0.5, 0.5 ] ]
      }
    } ]
  }
}

Multicurve end-to-end, mixed: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,1,5,2,2,11,2,1),
 Ordinates(10.0,45.0
20.0,45.0
23.0,48.0
20.0,51.0
20.0,45.0
23.0,48.0
10.0,51.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "line" : {
        "datapoints" : [ [ 10.0, 45.0 ], [ 20.0, 45.0 ] ]
      }
    }, {
      "circulararc" : {
        "datapoints" : [ [ 23.0, 48.0 ], [ 20.0, 51.0 ], [ 20.0, 45.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    }, {
      "line" : {
        "datapoints" : [ [ 23.0, 48.0 ], [ 10.0, 51.0 ] ]
      }
    } ]
  }
}
Mixed curve from Oracle docs: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,4,2,1,2,1,3,2,2),
 Ordinates(10.0,10.0
10.0,14.0
6.0,10.0
14.0,10.0
))
  {
  "compoundcurve" : [ {
    "line" : {
      "datapoints" : [ [ 10.0, 10.0 ], [ 10.0, 14.0 ] ]
    }
  }, {
    "circulararc" : {
      "datapoints" : [ [ 10.0, 14.0 ], [ 6.0, 10.0 ], [ 14.0, 10.0 ] ]
    },
    "interpolation" : "CIRCULAR"
  } ]
}
Closed mixed curve: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,4,2,1,2,1,7,2,2),
 Ordinates(10.0,78.0
10.0,75.0
20.0,75.0
20.0,78.0
15.0,80.0
10.0,78.0
))
  {
  "compoundcurve" : [ {
    "line" : {
      "datapoints" : [ [ 10.0, 78.0 ], [ 10.0, 75.0 ], [ 20.0, 75.0 ],
[ 20.0, 78.0 ] ]
    }
  }, {
    "circulararc" : {
      "datapoints" : [ [ 20.0, 78.0 ], [ 15.0, 80.0 ], [ 10.0, 78.0 ] ]
    },
    "interpolation" : "CIRCULAR"
  } ]
}
Compound polygon: JGeometry (gtype=3, dim=2, srid=0,
 ElemInfo(1,1005,2,1,2,1,7,2,2),
 Ordinates(10.0,-32.0
10.0,-35.0
20.0,-35.0
20.0,-32.0
15.0,-30.0
10.0,-32.0
))
  {
  "polygon" : {
    "boundary" : [ {
      "compoundcurve" : [ {
        "line" : {
          "datapoints" : [ [ 10.0, -32.0 ], [ 10.0, -35.0 ], [ 20.0, -35.0 ],
[ 20.0, -32.0 ] ]
        }
      }, {
        "circulararc" : {
          "datapoints" : [ [ 20.0, -32.0 ], [ 15.0, -30.0 ], [ 10.0, -32.0 ] ]
        },
        "interpolation" : "CIRCULAR"
      } ]
    } ]
  }
}
Point cluster: JGeometry (gtype=5, dim=2, srid=0,
 ElemInfo(1,1,1,3,1,1,5,1,1),
 Ordinates(50.0,5.0
55.0,7.0
60.0,5.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "point" : {
        "directposition" : [ 50.0, 5.0 ]
      }
    }, {
      "point" : {
        "directposition" : [ 55.0, 7.0 ]
      }
    }, {
      "point" : {
        "directposition" : [ 60.0, 5.0 ]
      }
    } ]
  }
}
Multipoint: JGeometry (gtype=5, dim=2, srid=0,
 ElemInfo(1,1,1,3,1,1,5,1,1),
 Ordinates(65.0,5.0
70.0,7.0
75.0,5.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "point" : {
        "directposition" : [ 65.0, 5.0 ]
      }
    }, {
      "point" : {
        "directposition" : [ 70.0, 7.0 ]
      }
    }, {
      "point" : {
        "directposition" : [ 75.0, 5.0 ]
      }
    } ]
  }
}
Multiarc: JGeometry (gtype=4, dim=2, srid=0,
 ElemInfo(1,2,2,7,2,2),
 Ordinates(50.0,35.0
55.0,40.0
60.0,35.0
65.0,35.0
70.0,30.0
75.0,35.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "circulararc" : {
        "datapoints" : [ [ 50.0, 35.0 ], [ 55.0, 40.0 ], [ 60.0, 35.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    }, {
      "circulararc" : {
        "datapoints" : [ [ 65.0, 35.0 ], [ 70.0, 30.0 ], [ 75.0, 35.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Multiarc - touching: JGeometry (gtype=4, dim=2, srid=0,
 ElemInfo(1,2,2,7,2,2),
 Ordinates(50.0,65.0
50.0,70.0
55.0,68.0
55.0,68.0
60.0,65.0
60.0,70.0
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "circulararc" : {
        "datapoints" : [ [ 50.0, 65.0 ], [ 50.0, 70.0 ], [ 55.0, 68.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    }, {
      "circulararc" : {
        "datapoints" : [ [ 55.0, 68.0 ], [ 60.0, 65.0 ], [ 60.0, 70.0 ] ]
      },
      "interpolation" : "CIRCULAR"
    } ]
  }
}
Heterogeneous collection: JGeometry (gtype=4, dim=2, srid=0,
 ElemInfo(1,1,1,3,2,1,7,1003,1),
 Ordinates(10.0,5.0
10.0,10.0
20.0,10.0
10.0,-55.0
15.0,-55.0
20.0,-50.0
10.0,-50.0
10.0,-55.0
```

```
))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "point" : {
        "directposition" : [ 10.0, 5.0 ]
      }
    }, {
      "line" : {
        "datapoints" : [ [ 10.0, 10.0 ], [ 20.0, 10.0 ] ]
      }
    }, {
      "polygon" : {
        "boundary" : [ {
          "line" : {
            "datapoints" : [ [ 10.0, -55.0 ], [ 15.0, -55.0 ], [ 20.0, 
-50.0 ], [ 10.0, -50.0 ], [ 10.0, -55.0 ] ]
          }
        } ]
      }
    } ]
  }
}
NURBS deg=3 CP=7: JGeometry (gtype=2, dim=2, srid=0,
 ElemInfo(1,2,3),
 Ordinates(3.0,7.0
0.0,0.0
1.0,-0.5
1.0,1.0
0.2,2.0
1.0,0.5
3.5,1.0
0.8,2.0
1.0,0.9
1.0,1.0
0.3,0.0
1.0,11.0
0.0,0.0
0.0,0.0
0.25,0.5
0.75,1.0
1.0,1.0
,1.0))
  {
  "nurbscurve" : {
    "degree" : 3,
    "controlpoints" : [ {
      "nurbspoint" : {
        "weightedpoint" : [ 0.0, 0.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ -0.5, 1.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.2, 2.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.5, 3.5 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.8, 2.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.9, 1.0 ],
        "weight" : 1.0
      }
    }, {
      "nurbspoint" : {
        "weightedpoint" : [ 0.3, 0.0 ],
        "weight" : 1.0
      }
    } ],
    "knots" : [ {
      "value" : 0.0,
      "multiplicity" : 4
    }, {
      "value" : 0.25,
      "multiplicity" : 1
    }, {
      "value" : 0.5,
      "multiplicity" : 1
    }, {
      "value" : 0.75,
      "multiplicity" : 1
    }, {
      "value" : 1.0,
      "multiplicity" : 4
    } ]
  }
}
Multicurve linestring/NURBS: JGeometry (gtype=6, dim=2, srid=0,
 ElemInfo(1,2,1,5,2,3),
 Ordinates(-1.0,-1.0
0.0,0.0
3.0,7.0
0.0,0.0
1.0,-0.5
1.0,1.0
0.2,2.0
1.0,0.5
3.5,1.0
0.8,2.0
```

```
1.0,0.9
1.0,1.0
0.3,0.0
1.0,11.0
0.0,0.0
0.0,0.0
0.25,0.5
0.75,1.0
1.0,1.0
,1.0))
  {
  "geometrycollection" : {
    "geometries" : [ {
      "line" : {
        "datapoints" : [ [ -1.0, -1.0 ], [ 0.0, 0.0 ] ]
      }
    }, {
      "nurbscurve" : {
        "degree" : 3,
        "controlpoints" : [ {
          "nurbspoint" : {
            "weightedpoint" : [ 0.0, 0.0 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ -0.5, 1.0 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ 0.2, 2.0 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ 0.5, 3.5 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ 0.8, 2.0 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ 0.9, 1.0 ],
            "weight" : 1.0
          }
        }, {
          "nurbspoint" : {
            "weightedpoint" : [ 0.3, 0.0 ],
            "weight" : 1.0
          }
        } ],
        "knots" : [ {
          "value" : 0.0,
          "multiplicity" : 4
        }, {
          "value" : 0.25,
          "multiplicity" : 1
        }, {
          "value" : 0.5,
          "multiplicity" : 1
        }, {
          "value" : 0.75,
          "multiplicity" : 1
        }, {
          "value" : 1.0,
          "multiplicity" : 4
        } ]
      }
    } ]
  }
}
3D elemInfo point: JGeometry (gtype=1, dim=3, srid=0,
 ElemInfo(1,1,1),
 Ordinates(11.0,22.0,33.0
))
  {
  "spatialdimension" : 3,
  "point" : {
    "directposition" : [ 11.0, 22.0, 33.0 ]
  }
}
Geom1:
JGeometry (gtype=1, dim=3, srid=0, Point=(11.0,22.0,33.0))
Geom2:
JGeometry (gtype=1, dim=3, srid=0,
 ElemInfo(1,1,1),
 Ordinates(11.0,22.0,33.0
))
3D multipoint: JGeometry (gtype=5, dim=3, srid=0,
 ElemInfo(1,1,1,4,1,1),
 Ordinates(1.0,1.0,1.0
0.0,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "geometrycollection" : {
    "geometries" : [ {
      "point" : {
        "directposition" : [ 1.0, 1.0, 1.0 ]
      }
    }, {
      "point" : {
        "directposition" : [ 0.0, 0.0, 0.0 ]
      }
    } ]
  }
}
```

```
Simple SOLID with 6 polygons - All polygons are described using the optimized
rectangle representation: JGeometry (gtype=8, dim=3, srid=0,

ElemInfo(1,1007,1,1,1006,6,1,1003,3,7,1003,3,13,1003,3,19,1003,3,25,1003,3,31,
1003,3),
 Ordinates(1.0,0.0,-1.0
1.0,1.0,1.0
1.0,0.0,1.0
0.0,0.0,-1.0
0.0,1.0,1.0
0.0,0.0,-1.0
0.0,1.0,-1.0
1.0,1.0,1.0
0.0,0.0,1.0
1.0,1.0,1.0
1.0,1.0,-1.0
0.0,0.0,-1.0
))
  {
  "spatialdimension" : 3,
  "solid" : {
    "surfaces" : [ {
      "surface" : {
        "polygons" : [ {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 1.0, 0.0, -1.0 ], [ 1.0, 1.0, 1.0 ] ]
              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 1.0, 0.0, 1.0 ], [ 0.0, 0.0, -1.0 ] ]
              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 0.0, 1.0, 1.0 ], [ 0.0, 0.0, -1.0 ] ]
              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 0.0, 1.0, -1.0 ], [ 1.0, 1.0, 1.0 ] ]
              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 0.0, 0.0, 1.0 ], [ 1.0, 1.0, 1.0 ] ]
              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "rectangle" : {
                "datapoints" : [ [ 1.0, 1.0, -1.0 ], [ 0.0, 0.0, -1.0 ] ]
              }
            } ]
          }
        } ]
      }
    } ]
  }
}
MULTISOLID, 2x using optimized representation: JGeometry (gtype=9, dim=3,
srid=0,
 ElemInfo(1,1007,3,7,1007,3),
 Ordinates(-2.0,1.0,3.0
-3.0,-1.0,0.0
0.0,0.0,0.0
1.0,1.0,1.0
))
  {
  "spatialdimension" : 3,
  "geometrycollection" : {
    "geometries" : [ {
      "solid" : {
        "surfaces" : [ {
          "box" : {
            "datapoints" : [ [ -2.0, 1.0, 3.0 ], [ -3.0, -1.0, 0.0 ] ]
          }
        } ]
      }
    }, {
      "solid" : {
        "surfaces" : [ {
          "box" : {
            "datapoints" : [ [ 0.0, 0.0, 0.0 ], [ 1.0, 1.0, 1.0 ] ]
          }
        } ]
      }
    } ]
  }
}
Multi-Solid - like multi-polygon in 2D - disjoint solids: JGeometry (gtype=9,
dim=3, srid=0,

ElemInfo(1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,1,76
,1003,1,91,1007,1,91,1006,7,91,1003,1,106,1003,1,121,1003,1,136,1003,1,151,100
```

```
3,1,166,1003,1,184,1003,1),
 Ordinates(1.0,0.0,4.0
1.0,1.0,4.0
1.0,1.0,6.0
1.0,0.0,6.0
1.0,0.0,4.0
1.0,0.0,6.0
0.0,0.0,6.0
0.0,0.0,4.0
1.0,0.0,4.0
1.0,0.0,6.0
0.0,1.0,6.0
0.0,1.0,4.0
0.0,0.0,4.0
0.0,0.0,6.0
0.0,1.0,6.0
1.0,1.0,4.0
0.0,1.0,4.0
0.0,1.0,6.0
1.0,1.0,6.0
1.0,1.0,4.0
1.0,1.0,6.0
0.0,1.0,6.0
0.0,0.0,6.0
1.0,0.0,6.0
1.0,1.0,6.0
1.0,1.0,4.0
1.0,0.0,4.0
0.0,0.0,4.0
0.0,1.0,4.0
1.0,1.0,4.0
2.0,0.0,3.0
2.0,0.0,0.0
4.0,2.0,0.0
4.0,2.0,3.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,0.0
2.0,0.0,0.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,-2.0,0.0
4.5,-2.0,0.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,2.0,3.0
-2.0,2.0,0.0
-2.0,-2.0,0.0
-2.0,-2.0,3.0
4.0,2.0,3.0
4.0,2.0,0.0
-2.0,2.0,0.0
-2.0,2.0,3.0
4.0,2.0,3.0
```

```
2.0,0.0,3.0
4.0,2.0,3.0
-2.0,2.0,3.0
-2.0,-2.0,3.0
4.5,-2.0,3.0
2.0,0.0,3.0
2.0,0.0,0.0
4.5,-2.0,0.0
-2.0,-2.0,0.0
-2.0,2.0,0.0
4.0,2.0,0.0
2.0,0.0,0.0
))
  {
  "spatialdimension" : 3,
  "geometrycollection" : {
    "geometries" : [ {
      "solid" : {
        "surfaces" : [ {
          "surface" : {
            "polygons" : [ {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 1.0, 0.0, 4.0 ], [ 1.0, 1.0, 4.0 ],
[ 1.0, 1.0, 6.0 ], [ 1.0, 0.0, 6.0 ], [ 1.0, 0.0, 4.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 1.0, 0.0, 6.0 ], [ 0.0, 0.0, 6.0 ],
[ 0.0, 0.0, 4.0 ], [ 1.0, 0.0, 4.0 ], [ 1.0, 0.0, 6.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 0.0, 1.0, 6.0 ], [ 0.0, 1.0, 4.0 ],
[ 0.0, 0.0, 4.0 ], [ 0.0, 0.0, 6.0 ], [ 0.0, 1.0, 6.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 1.0, 1.0, 4.0 ], [ 0.0, 1.0, 4.0 ],
[ 0.0, 1.0, 6.0 ], [ 1.0, 1.0, 6.0 ], [ 1.0, 1.0, 4.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 1.0, 1.0, 6.0 ], [ 0.0, 1.0, 6.0 ],
[ 0.0, 0.0, 6.0 ], [ 1.0, 0.0, 6.0 ], [ 1.0, 1.0, 6.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 1.0, 1.0, 4.0 ], [ 1.0, 0.0, 4.0 ],
[ 0.0, 0.0, 4.0 ], [ 0.0, 1.0, 4.0 ], [ 1.0, 1.0, 4.0 ] ]
                  }
                } ]
              }
            } ]
          }
        } ]
      }
    }, {
      "solid" : {
        "surfaces" : [ {
          "surface" : {
            "polygons" : [ {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 2.0, 0.0, 3.0 ], [ 2.0, 0.0, 0.0 ],
[ 4.0, 2.0, 0.0 ], [ 4.0, 2.0, 3.0 ], [ 2.0, 0.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 4.5, -2.0, 3.0 ], [ 4.5, -2.0, 0.0 ],
[ 2.0, 0.0, 0.0 ], [ 2.0, 0.0, 3.0 ], [ 4.5, -2.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 4.5, -2.0, 3.0 ], [ -2.0, -2.0, 3.0 ],
[ -2.0, -2.0, 0.0 ], [ 4.5, -2.0, 0.0 ], [ 4.5, -2.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ -2.0, -2.0, 3.0 ], [ -2.0, 2.0, 3.0 ],
[ -2.0, 2.0, 0.0 ], [ -2.0, -2.0, 0.0 ], [ -2.0, -2.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 4.0, 2.0, 3.0 ], [ 4.0, 2.0, 0.0 ],
[ -2.0, 2.0, 0.0 ], [ -2.0, 2.0, 3.0 ], [ 4.0, 2.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 2.0, 0.0, 3.0 ], [ 4.0, 2.0, 3.0 ],
[ -2.0, 2.0, 3.0 ], [ -2.0, -2.0, 3.0 ], [ 4.5, -2.0, 3.0 ], [ 2.0, 0.0,
3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
                  "line" : {
                    "datapoints" : [ [ 2.0, 0.0, 0.0 ], [ 4.5, -2.0, 0.0 ],
[ -2.0, -2.0, 0.0 ], [ -2.0, 2.0, 0.0 ], [ 4.0, 2.0, 0.0 ], [ 2.0, 0.0,
0.0 ] ]
                  }
                } ]
              }
            } ]
          }
        } ]
      }
    } ]
  }
}
SOLID with a hole: JGeometry (gtype=8, dim=3, srid=0,

ElemInfo(1,1007,1,1,1006,7,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,1,76
,1003,1,94,1003,1,112,2006,6,112,2003,1,127,2003,1,142,2003,1,157,2003,1,172,2
003,1,187,2003,1),
 Ordinates(2.0,0.0,3.0
2.0,0.0,0.0
4.0,2.0,0.0
4.0,2.0,3.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,0.0
2.0,0.0,0.0
2.0,0.0,3.0
```

```
4.5,-2.0,3.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,-2.0,0.0
4.5,-2.0,0.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,2.0,3.0
-2.0,2.0,0.0
-2.0,-2.0,0.0
-2.0,-2.0,3.0
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-2.0,2.0,3.0
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-2.0,-2.0,3.0
4.5,-2.0,3.0
2.0,0.0,3.0
2.0,0.0,0.0
4.5,-2.0,0.0
-2.0,-2.0,0.0
-2.0,2.0,0.0
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1.0,1.0,2.5
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-1.0,-1.0,0.5
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-1.0,1.0,2.5
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1.0,-1.0,2.5
1.0,-1.0,0.5
-1.0,-1.0,0.5
-1.0,-1.0,2.5
1.0,-1.0,2.5
1.0,1.0,2.5
1.0,1.0,0.5
1.0,-1.0,0.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
-1.0,1.0,2.5
1.0,1.0,2.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
1.0,1.0,0.5
-1.0,1.0,0.5
-1.0,-1.0,0.5
```

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            } ]
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        }, {
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            } ]
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        }, {
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            "boundary" : [ {
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3.0 ] ]
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      } ]
     }
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       "line" : {
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[ -2.0, -2.0, 0.0 ], [ -2.0, 2.0, 0.0 ], [ 4.0, 2.0, 0.0 ], [ 2.0, 0.0,
0.0 ] ]
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      } ]
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    } ]
   }
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[ -1.0, 1.0, 0.5 ], [ 1.0, 1.0, 0.5 ], [ 1.0, 1.0, 2.5 ] ]
       }
      } ]
     }
    }, {
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      "boundary" : [ {
       "line" : {
        "datapoints" : [ [ -1.0, 1.0, 2.5 ], [ -1.0, -1.0, 2.5 ],
[ -1.0, -1.0, 0.5 ], [ -1.0, 1.0, 0.5 ], [ -1.0, 1.0, 2.5 ] ]
       }
      } ]
     }
    }, {
     "polygon" : {
      "boundary" : [ {
       "line" : {
        "datapoints" : [ [ -1.0, -1.0, 2.5 ], [ 1.0, -1.0, 2.5 ],
[ 1.0, -1.0, 0.5 ], [ -1.0, -1.0, 0.5 ], [ -1.0, -1.0, 2.5 ] ]
       }
      } ]
     }
    }, {
     "polygon" : {
      "boundary" : [ {
       "line" : {
        "datapoints" : [ [ 1.0, -1.0, 2.5 ], [ 1.0, 1.0, 2.5 ],
[ 1.0, 1.0, 0.5 ], [ 1.0, -1.0, 0.5 ], [ 1.0, -1.0, 2.5 ] ]
       }
      } ]
```

```
          }
        }, {
          "polygon" : {
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              "line" : {
                "datapoints" : [ [ -1.0, -1.0, 2.5 ], [ -1.0, 1.0, 2.5 ],
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              }
            } ]
          }
        }, {
          "polygon" : {
            "boundary" : [ {
              "line" : {
                "datapoints" : [ [ 1.0, 1.0, 0.5 ], [ -1.0, 1.0, 0.5 ],
[ -1.0, -1.0, 0.5 ], [ 1.0, -1.0, 0.5 ], [ 1.0, 1.0, 0.5 ] ]
              }
            } ]
          }
        } ]
      }
    } ]
  }
}
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,1003,1,94,1003,1,112,1006,6,112,1003,1,127,1003,1,142,1003,1,157,1003,1,172,1
003,1,187,1003,1),
 Ordinates(2.0,0.0,3.0
2.0,0.0,0.0
4.0,2.0,0.0
4.0,2.0,3.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,0.0
2.0,0.0,0.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,-2.0,0.0
4.5,-2.0,0.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,2.0,3.0
-2.0,2.0,0.0
-2.0,-2.0,0.0
-2.0,-2.0,3.0
4.0,2.0,3.0
4.0,2.0,0.0
-2.0,2.0,0.0
-2.0,2.0,3.0
4.0,2.0,3.0
2.0,0.0,3.0
```

```
4.0,2.0,3.0
-2.0,2.0,3.0
-2.0,-2.0,3.0
4.5,-2.0,3.0
2.0,0.0,3.0
2.0,0.0,0.0
4.5,-2.0,0.0
-2.0,-2.0,0.0
-2.0,2.0,0.0
4.0,2.0,0.0
2.0,0.0,0.0
1.0,1.0,2.5
-1.0,1.0,2.5
-1.0,1.0,0.5
1.0,1.0,0.5
1.0,1.0,2.5
-1.0,1.0,2.5
-1.0,-1.0,2.5
-1.0,-1.0,0.5
-1.0,1.0,0.5
-1.0,1.0,2.5
-1.0,-1.0,2.5
1.0,-1.0,2.5
1.0,-1.0,0.5
-1.0,-1.0,0.5
-1.0,-1.0,2.5
1.0,-1.0,2.5
1.0,1.0,2.5
1.0,1.0,0.5
1.0,-1.0,0.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
-1.0,1.0,2.5
1.0,1.0,2.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
1.0,1.0,0.5
-1.0,1.0,0.5
-1.0,-1.0,0.5
1.0,-1.0,0.5
1.0,1.0,0.5
))
Geom2:
JGeometry (gtype=8, dim=3, srid=0,

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,1003,1,94,1003,1,112,2006,6,112,2003,1,127,2003,1,142,2003,1,157,2003,1,172,2
003,1,187,2003,1),
 Ordinates(2.0,0.0,3.0
2.0,0.0,0.0
4.0,2.0,0.0
4.0,2.0,3.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,0.0
2.0,0.0,0.0
```

```
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,-2.0,0.0
4.5,-2.0,0.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,2.0,3.0
-2.0,2.0,0.0
-2.0,-2.0,0.0
-2.0,-2.0,3.0
4.0,2.0,3.0
4.0,2.0,0.0
-2.0,2.0,0.0
-2.0,2.0,3.0
4.0,2.0,3.0
2.0,0.0,3.0
4.0,2.0,3.0
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4.5,-2.0,3.0
2.0,0.0,3.0
2.0,0.0,0.0
4.5,-2.0,0.0
-2.0,-2.0,0.0
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2.0,0.0,0.0
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-1.0,1.0,2.5
-1.0,1.0,0.5
1.0,1.0,0.5
1.0,1.0,2.5
-1.0,1.0,2.5
-1.0,-1.0,2.5
-1.0,-1.0,0.5
-1.0,1.0,0.5
-1.0,1.0,2.5
-1.0,-1.0,2.5
1.0,-1.0,2.5
1.0,-1.0,0.5
-1.0,-1.0,0.5
-1.0,-1.0,2.5
1.0,-1.0,2.5
1.0,1.0,2.5
1.0,1.0,0.5
1.0,-1.0,0.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
-1.0,1.0,2.5
1.0,1.0,2.5
1.0,-1.0,2.5
-1.0,-1.0,2.5
1.0,1.0,0.5
-1.0,1.0,0.5
```

```
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1.0,-1.0,0.5
1.0,1.0,0.5
))
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1,151,1003,1,166,1003,1,184,1003,1),
 Ordinates(-2.0,1.0,3.0
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-3.0,1.0,0.0
-3.0,1.0,3.0
-2.0,1.0,3.0
-3.0,1.0,3.0
-3.0,1.0,0.0
-3.0,-1.0,0.0
-3.0,-1.0,3.0
-3.0,1.0,3.0
-3.0,-1.0,3.0
-3.0,-1.0,0.0
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-2.0,-1.0,3.0
-3.0,-1.0,3.0
-2.0,-1.0,3.0
-2.0,-1.0,0.0
-2.0,1.0,0.0
-2.0,1.0,3.0
-2.0,-1.0,3.0
-2.0,-1.0,3.0
-2.0,1.0,3.0
-3.0,1.0,3.0
-3.0,-1.0,3.0
-2.0,-1.0,3.0
-2.0,1.0,0.0
-2.0,-1.0,0.0
-3.0,-1.0,0.0
-3.0,1.0,0.0
-2.0,1.0,0.0
2.0,0.0,3.0
2.0,0.0,0.0
4.0,2.0,0.0
4.0,2.0,3.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,0.0
2.0,0.0,0.0
2.0,0.0,3.0
4.5,-2.0,3.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
-2.0,-2.0,0.0
4.5,-2.0,0.0
4.5,-2.0,3.0
-2.0,-2.0,3.0
```

```
-2.0,2.0,3.0
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-2.0,-2.0,0.0
-2.0,-2.0,3.0
4.0,2.0,3.0
4.0,2.0,0.0
-2.0,2.0,0.0
-2.0,2.0,3.0
4.0,2.0,3.0
2.0,0.0,3.0
4.0,2.0,3.0
-2.0,2.0,3.0
-2.0,-2.0,3.0
4.5,-2.0,3.0
2.0,0.0,3.0
2.0,0.0,0.0
4.5,-2.0,0.0
-2.0,-2.0,0.0
-2.0,2.0,0.0
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                } ]
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                  }
                } ]
              }
            }, {
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                "boundary" : [ {
                  "line" : {
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[ -3.0, -1.0, 0.0 ], [ -3.0, 1.0, 0.0 ], [ -2.0, 1.0, 0.0 ] ]
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                } ]
              }
            } ]
          }
        } ]
      }
    }, {
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                  "line" : {
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[ 4.0, 2.0, 0.0 ], [ 4.0, 2.0, 3.0 ], [ 2.0, 0.0, 3.0 ] ]
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                } ]
              }
            }, {
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                  "line" : {
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[ 2.0, 0.0, 0.0 ], [ 2.0, 0.0, 3.0 ], [ 4.5, -2.0, 3.0 ] ]
                  }
                } ]
              }
            }, {
              "polygon" : {
                "boundary" : [ {
```

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[ -2.0, -2.0, 0.0 ], [ 4.5, -2.0, 0.0 ], [ 4.5, -2.0, 3.0 ] ]
         }
        } ]
       }
      }, {
       "polygon" : {
        "boundary" : [ {
         "line" : {
          "datapoints" : [ [ -2.0, -2.0, 3.0 ], [ -2.0, 2.0, 3.0 ],
[ -2.0, 2.0, 0.0 ], [ -2.0, -2.0, 0.0 ], [ -2.0, -2.0, 3.0 ] ]
         }
        } ]
       }
      }, {
       "polygon" : {
        "boundary" : [ {
         "line" : {
          "datapoints" : [ [ 4.0, 2.0, 3.0 ], [ 4.0, 2.0, 0.0 ],
[ -2.0, 2.0, 0.0 ], [ -2.0, 2.0, 3.0 ], [ 4.0, 2.0, 3.0 ] ]
         }
        } ]
       }
      }, {
       "polygon" : {
        "boundary" : [ {
         "line" : {
          "datapoints" : [ [ 2.0, 0.0, 3.0 ], [ 4.0, 2.0, 3.0 ],
[ -2.0, 2.0, 3.0 ], [ -2.0, -2.0, 3.0 ], [ 4.5, -2.0, 3.0 ], [ 2.0, 0.0,
3.0 ] ]
         }
        } ]
       }
      }, {
       "polygon" : {
        "boundary" : [ {
         "line" : {
          "datapoints" : [ [ 2.0, 0.0, 0.0 ], [ 4.5, -2.0, 0.0 ],
[ -2.0, -2.0, 0.0 ], [ -2.0, 2.0, 0.0 ], [ 4.0, 2.0, 0.0 ], [ 2.0, 0.0,
0.0 ] ]
         }
        } ]
       }
      } ]
     }
    } ]
   }
  } ]
 }
}
```

1.17 NURBS Curve Support in Oracle Spatial

Spatial supports non-uniform rational B-spline (NURBS) curve geometries.

NURBS curves allow representation of free-form shapes with arbitrary shapes. NURBS representation allows control over the shape of the curve because control points and knots guide the shape of the curve, and they allow complex shapes to be represented with little data.

Support for NURBS curves in Spatial includes the following:

- WKT/WKB and GML functions for loading and storing of NURBS curve geometries in Oracle Spatial.
- Validation of NURBS curve geometries.
- Spatial indexing of NURBS curve geometries along with the SDO_FILTER, SDO_RELATE, and other operators. Spatial operators use an approximation of the curve for computation.

A NURBS representation requires specification of the control points and the basis functions. The basis functions, in turn, are defined using the knot vector and the degree of the curve. The control points are used to determine the shape of the NURBS curve. The knot vector does not directly control the shape of the curve, but is used to control the exact placement of end points. The knot vector is also used to create curves with kinks and corners. Non-uniform knot vectors are used for manipulating the curve.

To represent a NURBS curve, the following data must be stored: the control points, the knot vector, and the degree of the curve. The set of control points can be represented in either the Euclidean form as `(x, y, z, w)` where `w` represents the weight of the control point or in the homogeneous form as `(wx, wy, wz, w)`. If `wi`=1 for all `i`, the curve is non-rational. The control points are specified in the weighted Euclidean form. Basis functions can be uniform or non-uniform based on the knot vector. A non-uniform knot vector is useful for placement of end points and creating kinks or corners. A normalized knot vector must be specified, that is, the first knot in the knot vector must be zero and the last knot in the knot vector must be one. It is also required that the knot vector is "clamped" at the end points. This requirement is enforced by ensuring that the first `d`+1 values in the knot vector are all zeros and the last `d`+1 values are all ones, where `d` represents the degree of the NURBS curve.

The implementation of NURBS curves in Oracle Spatial follows the SQL/MM standards. The SQL/MM standards for NURBS curves are used to represent splines, polynomial splines, cubic splines, B-splines, and Bezier curves. In Oracle Spatial, the SDO_GEOMETRY object type is used for NURBS representation. NURBS curves can be included in the Line, Multiline, and Collection type geometry objects. In these geometries, the simple line string and compound line string type elements can contain NURBS.

For compound line strings containing at least one NURBS segment, the last point of the previous segment is the same as the "clamped" first control point of a NURBS segment, and the last "clamped" control point of a NURBS segment is the same as the first point of the next segment. That is, the vertices will be repeated.

For geometry elements with element type value 2 representing a line string, the interpretation value of 3 is used to represent a NURBS curve; interpretation values of 1 and 2 represent linear segments and arcs. The SDO_ELEM_INFO_ARRAY for a NURBS curve is stored as (*offset*, 2, 3), which represents the offset, element type, and the interpretation value.

The SDO_ORDINATE_ARRAY stores the degree of the curve `d`, the set of `m` control points and a knot vector of size `n`. So, the ordinate array is stored as a sequence of values `(d, m, x1, y1, z1, w1…. xm, ym, zm, wm, n, k1….kn)`. The control points are stored in the Euclidean form as specified in the SQL/MM standards. Note that for a NURBS curve the number of knots is equal to the sum of the degree, the number of control points, and 1. Therefore, `n=d+m+1`, an equation which is useful for validating NURBS curve geometries.

The following considerations apply to defining a NURBS curve:

- The degree of the curve should be greater than 1, because a curve of degree 1 represents polylines.
- The number of control points must be greater than or equal to 3, and must be greater than the degree.
- The number of knots must be equal to the (number of control points + degree + 1).
- The weight component of each control point must be positive.
- Control points are represented in "weighted Euclidean" form `[wx, wy, (wz), w]`.
- Knot values should be specified in non-decreasing order, and the knot vector must be a normalized knot vector `[0, .. ……, 1]`.
- If `d` is the degree of the curve, there must be `d`+1 consecutive equal knots at the beginning of the curve (value 0) and `d`+1 consecutive equal knots at the end of the curve (value 1). This is to ensure that the curve is clamped at the end points.
- If `d` is the degree of the curve, there must not be more than `d` consecutive equal knots except at the beginning or end of the curve where `d`+1 knots must be present.

Be sure to validate geometries with NURBS segments before creating the spatial index or performing any spatial operations on them. (This recommendation applies to all geometry types, NURBS or otherwise.)

For examples that specify NURBS curve geometries, see NURBS Curve.

To get a line string geometry that is an approximation of an input NURBS curve geometry, use the SDO_UTIL.GETNURBSAPPROX function.

1.18 Sharded Database Support by Oracle Spatial

Spatial supports the use of sharded database technology.

You create a shaded spatial table in the usual way, but specify CREATE SHARDED TABLE and appropriate partitioning. For example:

```
CREATE SHARDED TABLE departments
(  department_id  NUMBER(4),
   geojson        VARCHAR2(4000) CHECK (geojson IS JSON),
   geoloc         mdsys.sdo_geometry,
   CONSTRAINT dept_id_pk PRIMARY KEY(department_id)
)
PARTITION BY CONSISTENT HASH (department_id)
PARTITIONS AUTO
TABLESPACE SET ts1;
```

Create the special index on this table in the usual way. For example:

```
CREATE INDEX sidx on departments(geoloc) indextype is mdsys.spatial_index_v2
local;
```

However, the following index-related considerations apply:

- A global index is not supported on a sharded special table. The CREATE INDEX statement must include the keyword `LOCAL`.

- The spatial index on a sharded spatial table must be system-managed (`INDEXTYPE=MDSYS.SPATIAL_INDEX_V2`).

Functional spatial indexes are supported. For example:

```
CREATE INDEX sidx on departments(json_value(geojson, ‘$’, returning
sdo_geometry)) indextype is mdsys.spatial_index_v2 local;
```

In addition, other requirements and guidelines for application development with sharded databases apply, including the following:

- The major advantage of a sharded database is the partitioning of data into semi-autonomous "regions" called *shards*. (In a spatial application, the regions might be cities or states.) Using shards means that applications running on a particular region get all the performance benefits of a single database without the interference from users in other shards.
  However, a potential downside is that applications where data moves from partition to partition may not work well in the sharded database environment. For example, applications like truck movement tracking are ideal if the truck remains within a single shard (region), but not ideal if the truck moves from region to region.

  You need to know "where" the data to be manipulated (through DML statements and queries) resides. In an application, accessing data in other shards must be done from the "coordinator" instance. In addition, it can be difficult to migrate data from one shard to another without performing a delete/insert operation because an update may not work as expected.
- Partitioned Management Operations (PMO), such as MERGE PARTITION and SPLIT PARTITION, are not supported by Spatial.

When Spatial performs operations on sharded spatial data, the following actions occur automatically as needed:

- A USER_SDO_GEOM_METADATA view is created on each shard separately.
- All DDL operations (such as CREATE INDEX and ALTER INDEX) are performed on the coordinator and they are automatically propagated to the shards.
- All queries that need to "cross-shards" are performed on the coordinator and are automatically aggregated, and shard-specific queries are performed on the individual shards.

For an overview of Oracle sharding, see *Using Oracle Sharding*.

1.19 Database In-Memory Support by Oracle Spatial

Spatial supports the use of Oracle Database In-Memory technology.

You can enable a spatial table for use with Database In-Memory by adding virtual columns, and then use operators such as SDO_FILTER to query that table without using a spatial index.

You create a spatial table in the usual way. Assume an existing 2D geodetic table named `vz_test1` with spatial column `geoloc`, which has been inserted into the `USER_SDO_GEOM_METADATA` view as follows:

```
INSERT INTO user_sdo_geom_metadata
     VALUES(
     'vz_test1',
     'geoloc',
     SDO_DIM_ARRAY(
        SDO_DIM_ELEMENT('X', -180, 180, .00000005),
        SDO_DIM_ELEMENT('Y',  -90,  90, .00000005)),
        4326);
COMMIT;
```

Modify the table to enable the in-memory spatial feature and specify `INMEMORY` for the spatial table. For example, for the preceding 2D table:

```
ALTER TABLE vz_test1 INMEMORY INMEMORY SPATIAL(geoloc);
```

Then, users can run queries on the table. For example:

```
SELECT * FROM vz_test1 WHERE SDO_FILTER(geoloc, :x) = 'TRUE';
```

This approach does not need a spatial index because the table is in Oracle Database In-Memory.

1.20 Spatial Java Application Programming Interface

Oracle Spatial provides a Java application programming interface (API) .

> **Note:**
>
> Effective with Oracle Database Release 23ai, the Oracle Spatial Java APIs are compiled with JDK 11 as the OJVM in the database supports JDK11. However, the APIs will continue to be supported on JDK8 for backwards compatibility. When using the API, ensure that all the related JAR files are consistent with the JDK version (JDK 8 or JDK 11) that is being used. See RDBMS and JDK Version Compatibility for Oracle JDBC Drivers for more information on the JDBC drivers that are supported for the different JDK versions.

This API includes the following packages:

- `oracle.spatial.geometry` provides support for the Spatial SQL SDO_GEOMETRY data type, which is documented in this guide.
- `oracle.spatial.georaster` provides support for the core GeoRaster features, which are documented in *Oracle Spatial GeoRaster Developer's Guide*.
- `oracle.spatial.georaster.image` provides support for generating Java images from a GeoRaster object or subset of a GeoRaster object, and for processing the images. These features are documented in *Oracle Spatial GeoRaster Developer's Guide*.
- `oracle.spatial.georaster.sql` provides support for wrapping the GeoRaster PL/SQL API, which is documented in *Oracle Spatial GeoRaster Developer's Guide*.
- `oracle.spatial.network` provides support for the Oracle Spatial Network Data Model, which is documented in *Oracle Spatial Topology and Network Data Model Developer's Guide*.

- `oracle.spatial.network.lod` provides support for the load-on-demand (LOD) approach of network analysis in the Oracle Spatial Network Data Model, which is documented in *Oracle Spatial Topology and Network Data Model Developer's Guide*.
- `oracle.spatial.network.lod.config` provides support for the configuration of load-on-demand (LOD) network analysis in the Oracle Spatial Network Data Model, which is documented in *Oracle Spatial Topology and Network Data Model Developer's Guide*.
- `oracle.spatial.topo` provides support for the Oracle Spatial topology data model, which is documented in *Oracle Spatial Topology and Network Data Model Developer's Guide*.
- `oracle.spatial.util` provides classes that perform miscellaneous operations.

For detailed reference information about the classes and interfaces in these packages, see *Oracle Spatial Java API Reference* (Javadoc).

The Spatial Java class libraries are in `.jar` files under the `<ORACLE_HOME>/md/jlib/` directory.

1.21 Predefined User Accounts Created by Spatial

During installation, Spatial creates user accounts that have the minimum privileges needed to perform their jobs.

These accounts are created locked and expired; so if you need to use the accounts, you must unlock them. Table 1-4 lists the predefined user accounts created by Spatial.

Table 1-4 Predefined User Accounts Created by Spatial

User Account	Description
MDSYS	The schema used by Oracle Spatial for prescribing the storage, syntax, and semantics of supported geometric data types.
MDDATA	The schema used by Oracle Spatial for storing data used by geocoding and routing applications. This is the default schema for Oracle software that accesses geocoding and routing data.

1.22 Performance and Tuning Information

Many factors can affect the performance of Oracle Spatial applications, such as the use of optimizer hints to influence the plan for query execution.

This guide contains some information about performance and tuning where it is relevant to a particular topic. For example, R-Tree Quality discusses R-tree quality and its possible effect on query performance, and Spatial Operators_ Procedures_ and Functions explains why spatial operators provide better performance than procedures and functions.

In addition, more spatial performance and tuning information is available in one or more white papers through the Oracle Technology Network (OTN). That information is often more detailed than what is in this guide, and it is periodically updated as a result of internal testing and consultations with Spatial users. To find that information on the OTN, go to

`http://www.oracle.com/technetwork/database/options/spatialandgraph/`

Look for material relevant to spatial performance and tuning.

1.23 OGC and ISO Compliance

Oracle Spatial is conformant with Open Geospatial Consortium (OGC) Simple Features Specification 1.1.1 (Document 99-049), starting with Oracle Database release 10*g* (version 10.1.0.4).

Conformance with the Geometry Types Implementation means that Oracle Spatial supports all the types, functions, and language constructs detailed in Section 3.2 of the specification.

Synonyms are created to match all OGC function names except for `X(p Point)` and `Y(p Point)`. For these functions, you must use the names `OGC_X` and `OGC_Y` instead of just `X` and `Y`.

Oracle Spatial is conformant with the following International Organization for Standardization (ISO) standards:

- ISO 13249-3 SQL Multimedia and Application Packages - Part 3: Spatial
- ISO 19101: Geographic information - Reference model (definition of terms and approach)
- ISO 19109: Geographic information - Rules for application schema (called the General Feature Model)
- ISO 19111: Geographic information - Spatial referencing by coordinates (also OGC Abstract specification for coordinate reference systems)
- ISO 19118: Geographic information - Encoding (GML 2.1 and GML 3.1.1)
- ISO 19107: Geographic information - Spatial schema (also OGC Abstract specification for Geometry)

However, standards compliance testing for Oracle Spatial is ongoing, and compliance with more recent versions of standards or with new standards might be announced at any time. For current information about compliance with standards, see `http://www.oracle.com/technetwork/database/options/spatialandgraph/documentation/`.

1.24 Spatial Release (Version) Number

To check which release of Spatial you are running, use the SDO_VERSION function.

For example:

```
SELECT SDO_VERSION FROM DUAL;

SDO_VERSION
--------------------------------------------------------------------------------
23.0.0.0.0
```

1.25 SPATIAL_VECTOR_ACCELERATION System Parameter

To optimize the performance of spatial operators, the SPATIAL_VECTOR_ACCELERATION database system parameter value must be `TRUE`.

The Vector Performance Accelerator (VPA) feature, which accelerates the performance of spatial operators, is controlled by the value of the SPATIAL_VECTOR_ACCELERATION database system parameter. Effective with Release 21c, the default value for this parameter is `TRUE`.

The benefits of having the SPATIAL_VECTOR_ACCELERATION parameter be `TRUE` include:

- Improved spatial algorithms for spatial operators and functions
- Metadata caching for all spatial operators and functions, which improves their overall performance
- Metadata caching for all DML operations, which makes insert, update, and delete operations on spatial tables run faster

You should not set this parameter to `FALSE` unless you have a very good reason to do so. If you need to explicitly set the value to `TRUE` or `FALSE` (such as to change it to `TRUE` after setting it to `FALSE`), you can set the value for the whole system or for a single session. For example, to set the value for the whole system, do either of the following:

- Enter the following statement from a suitably privileged account:

  ```
  ALTER SYSTEM SET SPATIAL_VECTOR_ACCELERATION = TRUE;
  ```

- Add the following to the database initialization file (*xxx*init.ora):

  ```
  SPATIAL_VECTOR_ACCELERATION = TRUE;
  ```

To set the value for the current session, enter the following statement from a suitably privileged account. For example:

```
ALTER SESSION SET SPATIAL_VECTOR_ACCELERATION = TRUE;
```

See Also:

- *Oracle Database Reference* for reference and usage information about the `SPATIAL_VECTOR_ACCELERATION` database initialization parameter

1.26 Spatially Enabling a Table

If you have a regular Oracle table without an SDO_GEOMETRY column, but containing location-related information (such as latitude/longitude values for points), you can *spatially enable* the table by adding an SDO_GEOMETRY column and using existing (and future) location-related information in records to populate the SDO_GEOMETRY column values.

The following are the basic steps for spatially enabling a regular table. They assume that the regular table has columns that contain location-related values associated with each record in the table.

1. Alter the table to add a geometry (SDO_GEOMETRY) column.
2. Update the table to populate the SDO_GEOMETRY objects using existing location-related data values.
3. Optionally, update the spatial metadata (USER_SDO_GEOM_METADATA).

   By default, Oracle Spatial will automatically create the metadata in the USER_SDO_GEOM_METADATA view when creating the spatial index, using a default tolerance value of 0.05. You must only ensure that the table is populated with atleast one non-`NULL` geometry row for Oracle Spatial to create the required metadata.
   Run this step only if you prefer to use a different tolerance value (other than the default 0.05).
4. Create the spatial index on the table.

Example 1-6 Spatially Enabling a Table

```
-- Original table without a spatial geometry column.
CREATE TABLE city_points (
  city_id NUMBER PRIMARY KEY,
  city_name VARCHAR2(25),
  latitude NUMBER,
  longitude NUMBER);

-- Original data for the table.
-- (The sample coordinates are for a random point in or near the city.)
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (1, 'Boston', 42.207905, -71.015625);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (2, 'Raleigh', 35.634679, -78.618164);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (3, 'San Francisco', 37.661791, -122.453613);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (4, 'Memphis', 35.097140, -90.065918);

-- Add a spatial geometry column.
ALTER TABLE city_points ADD (shape SDO_GEOMETRY);

-- Update the table to populate geometry objects using existing
-- latutide and longitude coordinates.
UPDATE city_points SET shape =
  SDO_GEOMETRY(LONGITUDE, LATITUDE);

-- Optional Step: Update the USER_SDO_GEOM_METADATA view.
-- By default, Oracle Spatial will automatically create the metadata in
-- the USER_SDO_GEOM_METADATA view using a default tolerance value of 0.05.
-- Run this step only if you prefer a different tolerance value.
-- The following example uses a tolerance value of 0.5.
INSERT INTO user_sdo_geom_metadata VALUES (
  'city_points',
  'SHAPE',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude',-180,180,0.5),
    SDO_DIM_ELEMENT('Latitude',-90,90,0.5)
  ),
  4326
);

-- Create the spatial index.
CREATE INDEX city_points_spatial_idx on city_points(SHAPE)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

-- Later, add new records to the table, using original INSERT format
-- (latitude and longitude, no spatial geometry object data).
-- Then update to include spatial geometry object information.
-- Tip: For efficiency, keep track of existing and new records, and use
-- a WHERE clause to restrict the UPDATE to new records (not shown here).

INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (5, 'Chicago', 41.848832, -87.648926);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (6, 'Miami', 25.755043, -80.200195);

UPDATE city_points SET shape =
  SDO_GEOMETRY(LONGITUDE, LATITUDE);
```

Example 1-6 creates a table (CITY_POINTS) that initially does not contain an SDO_GEOMETRY column but does contain latitude and longitude values for each record (a point in or near a specified city). It spatially enables the table, updating the existing records to include the SDO_GEOMETRY information, and it also inserts new records and updates those.

Notes on Example 1-6:

- It does not matter that the original table has the LATITUDE and LONGITUDE values in that order, as long as the column names are specified in the correct order in the geometry constructor (SDO_POINT in this case) in the UPDATE statement. (SDO_GEOMETRY objects have longitude first, then latitude for points.)
- Geometry validation is not included in the example because validation is not relevant for points. However, if you spatially enable a table with other types of geometries, you should validate all initial and added geometries. (To perform validation, use SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT or SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT.)

See Also:

- Spatial Data Types and Metadata
- Indexing and Querying Spatial Data

1.27 Moving Spatial Metadata (MDSYS.MOVE_SDO)

Database administrators (DBAs) can use the MDSYS.MOVE_SDO procedure to move all Oracle Spatial metadata tables to a specified target tablespace.

By default, the spatial metadata tables are created in the `SYSAUX` tablespace in Release 11.1 and later releases, and in the `SYSTEM` tablespace in releases before 11.1.

The MDSYS.MOVE_SDO procedure has the following syntax:

```
MDSYS.MOVE_SDO(
   target_tablespace_name IN VARCHAR2);
```

The required `target_tablespace_name` parameter specifies the name of the tablespace to which to move the spatial metadata tables.

This procedure should be used only by DBAs.

During the move operation, all other Oracle Spatial capabilities are disabled.

The following example moves the spatial metadata tables to the `SYSAUX` tablespace.

```
EXECUTE MDSYS.MOVE_SDO('SYSAUX');
```

1.28 Spatial Application Hardware Requirement Considerations

This topic discusses some general guidelines that affect the amount of disk storage space and CPU power needed for applications that use Oracle Spatial.

These guidelines are intended to supplement, not replace, any other guidelines you use for general application sizing.

The following characteristics of spatial applications can affect the need for storage space and CPU power:

- Data volumes: The amount of storage space needed for spatial objects depends on their complexity (precision of representation and number of points for each object). For example, storing one million point objects takes less space than storing one million road segments or land parcels. Complex natural features such as coastlines, seismic fault lines, rivers, and land types can require significant storage space if they are stored at a high precision.
- Query complexity: The CPU requirements for simple mapping queries, such as *Select all features in this rectangle*, are lower than for more complex queries, such as *Find all seismic fault lines that cross this coastline*.

1.29 Spatial Studio Application

Oracle Spatial Studio, also referred to as Spatial Studio, is a free tool that lets you connect with, visualize, explore, and analyze geospatial data stored in and managed by Oracle Spatial.

Before you can use Spatial Studio, you must download the kit from Oracle Technical Resources (formerly called Oracle Technology Network), install the software, and perform certain administrative actions like creating database users that are authorized to use the tool, and managing those users.

1.30 Spatial Error Messages

Spatial has a set of error messages.

The Spatial error messages are documented in *Oracle Database Error Messages*.

Oracle error message documentation is only available in HTML. You can browse the error messages by range; and once you find the specific range, use your browser's "find in page" feature to locate the specific message. You can also search for a specific error message using the error message search feature of the Oracle online documentation.

1.31 Spatial Examples

Oracle Spatial provides examples that you can use to reinforce your learning and to create models for coding certain operations.

If you installed the demo files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*), several examples are provided in the following directory:

```
$ORACLE_HOME/md/demo/examples
```

The following files in that directory are helpful for applications that use the Oracle Call Interface (OCI):

- `readgeom.c` and `readgeom.h`
- `writegeom.c` and `writegeom.h`

This guide also includes many examples in SQL and PL/SQL. One or more examples are usually provided with the reference information for each function or procedure, and several simplified examples are provided that illustrate table and index creation, combinations of functions and procedures, and advanced features:

- Inserting, indexing, and querying spatial data (Simple Example: Inserting_ Indexing_ and Querying Spatial Data)
- Coordinate systems (spatial reference systems) (Example of Coordinate System Transformation)
- Linear referencing system (LRS) (Example of LRS Functions)
- SDO_GEOMETRY objects in function-based indexes (SDO_GEOMETRY Objects in Function-Based Indexes)
- Complex queries (Complex Spatial Queries: Examples)

1.32 Getting Started with Longitude/Latitude Spatial Data

Get started on creating spatial data using the WGS 84 (longitude/latitude) coordinate system.

Starting with Oracle Database 23ai, you can easily create longitude/latitude spatial data using the `SDO_GEOMETRY(longitude, latitude)` constructor as shown in the following example.

Example 1-7 Creating Longitude/Latitude Spatial Data Using `SDO_GEOMETRY(longitude, latitude)` Constructor

The example creates a table, inserts a row of longitude/latitude spatial data using the `SDO_GEOMETRY(-73.45, 45.2)` constructor, creates the spatial index, and then queries the inserted geometry.

```
-- Create a table
CREATE TABLE t1(i NUMBER, geom SDO_GEOMETRY);

-- Insert lon/lat spatial data using the following constructor
INSERT INTO t1 VALUES (1, SDO_GEOMETRY(-73.45, 45.2));

-- Create the spatial index
-- Required metadata automatically created when index is created
CREATE INDEX lon_lat_sidx ON t1(geom) INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

-- Display the inserted geometry
SQL> SELECT geom FROM t1;

GEOM(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(-73.45, 45.2, NULL), NULL, NULL)
```

The following example refers to concepts that are explained in SDO_GEOMETRY Object Type and Coordinate Systems (Spatial Reference Systems).

Example 1-8 Creating and Indexing Polygonal Longitude/Latitude Data

This example creates a spatial table, inserts three rows of longitude/latitude spatial data, updates the metadata, creates the spatial index, and then performs some miscellaneous operations.

```
-- Create the table.

CREATE TABLE polygons_long_lat (
  geom_id NUMBER PRIMARY KEY,
  geom_name VARCHAR2(32),
  shape SDO_GEOMETRY);

-- The geometries are simple polgons using the
-- WGS 84 (longitude/latitude) coordinate system.
-- The geometries are three simple polygons. The first and third have 4
sides;
-- the second has 3 sides (triangle). These geeometries happen to
-- be in or around Concord in the US state of Massachusetts, but they
-- do not represent any actual identifiable places or areas of interest.

INSERT INTO polygons_long_lat VALUES(
  1,
  'geom_1',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,  -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    SDO_ORDINATE_ARRAY(
                      -71.373742, 42.475827,
                      -71.369622, 42.455059,
                      -71.344903, 42.472788,
                      -71.357949, 42.480638,
                      -71.373742, 42.475827)
              )
);

INSERT INTO polygons_long_lat VALUES(
  2,
  'geom_2',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,  -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    SDO_ORDINATE_ARRAY(
                      -71.358120, 42.464937,
                      -71.352971, 42.454046,
                      -71.357777, 42.475827,
                      -71.358120, 42.464937)
              )
);

INSERT INTO polygons_long_lat VALUES(
  3,
  'geom_3',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,  -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    SDO_ORDINATE_ARRAY(
                      -71.394341, 42.435552,
                      -71.405671, 42.429977,
                      -71.390564, 42.428203,
                        -71.383698, 42.434285,
                        -71.394341, 42.435552)
                )
);


-- Optional Step: Update the USER_SDO_GEOM_METADATA view.
-- By default, Oracle Spatial will automatically create the metadata in
-- USER_SDO_GEOM_METADATA view using a default tolerance value of 0.05.
-- Run this step only if you prefer a different tolerance value.
-- The following example uses a tolerance value of 10 meters.

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'polygons_long_lat',
  'shape',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),  -- 10 meters tolerance
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10)  -- 10 meters tolerance
     ),
  4326   -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);

-- Create the spatial index

CREATE INDEX polygons_long_lat_spatial_idx
   ON polygons_long_lat(shape)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

-----------------
-- Miscellaneous other operations

-- Is a specific geometry (geom_3) valid?
SELECT geom_name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(shape, 10)
   FROM polygons_long_lat WHERE geom_name = 'geom_3';

-- Is a layer valid? (First, create the results table.)
CREATE TABLE val_results (sdo_rowid ROWID, result VARCHAR2(2000));
CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('POLYGONS_LONG_LAT', 'SHAPE',
  'VAL_RESULTS');
-- Next SELECT should process 3 rows and return null (no errors).
SELECT * from val_results;

-- Do two geometries (geom_1 and geom_2) have any spatial relationship?
SELECT SDO_GEOM.RELATE(p_a.shape, 'anyinteract', p_b.shape, 10)
  FROM polygons_long_lat p_a, polygons_long_lat p_b
  WHERE p_a.geom_name = 'geom_1' AND p_b.geom_name = 'geom_2';

-- Return the areas of all geometries.
SELECT geom_name, SDO_GEOM.SDO_AREA(shape, 10) FROM polygons_long_lat;
```

(For an example of bulk loading of longitude/latitude data, see Bulk Loading Point-Only Data in SDO_GEOMETRY Objects.)

Example 1-9 Output of SELECT Statements in Longitude/Latitude Data Example

This example shows the output of the SELECT statements in the preceding example.

```
SQL> -- Miscellaneous other operations
SQL>
SQL> -- Is a specific geometry (geom_3) valid?
SQL> SELECT geom_name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(shape, 10)
  2      FROM polygons_long_lat WHERE geom_name = 'geom_3';

GEOM_NAME
--------------------------------
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(SHAPE,10)
--------------------------------------------------------------------------------
geom_3
TRUE


SQL>
SQL> -- Is a layer valid? (First, create the results table.)
SQL> CREATE TABLE val_results (sdo_rowid ROWID, result VARCHAR2(2000));

Table created.

SQL> CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('POLYGONS_LONG_LAT', 'SHAPE',
  2    'VAL_RESULTS');

Call completed.

SQL> -- Next SELECT should process 3 rows and return null (no errors).
SQL> SELECT * from val_results;

SDO_ROWID
------------------
RESULT
--------------------------------------------------------------------------------

Rows Processed <3>


SQL>
SQL> -- Do two geometries (geom_1 and geom_2) have any spatial relationship?
SQL> SELECT SDO_GEOM.RELATE(p_a.shape, 'anyinteract', p_b.shape, 10)
  2    FROM polygons_long_lat p_a, polygons_long_lat p_b
  3    WHERE p_a.geom_name = 'geom_1' AND p_b.geom_name = 'geom_2';

SDO_GEOM.RELATE(P_A.SHAPE,'ANYINTERACT',P_B.SHAPE,10)
--------------------------------------------------------------------------------
TRUE

SQL>
SQL> -- Return the areas of all geometries.
SQL> SELECT geom_name, SDO_GEOM.SDO_AREA(shape, 10) FROM polygons_long_lat;

GEOM_NAME                        SDO_GEOM.SDO_AREA(SHAPE,10)
-------------------------------- ---------------------------
geom_1                                            3531176.58
geom_2                                            273244.085
geom_3                                            812379.389
```

```
SQL>
```

1.33 README File for Spatial and Related Features

A `README.txt` file supplements the information in several manuals.

These manuals are *Oracle Spatial Developer's Guide* (this manual), *Oracle Spatial GeoRaster Developer's Guide*, and *Oracle Spatial Topology and Network Data Model Developer's Guide*. This file is located at:

```
$ORACLE_HOME/md/doc/README.txt
```

2

Spatial Data Types and Metadata

The spatial features in Oracle Spatial consist of a set of object data types, type methods, and operators, functions, and procedures that use these types. A geometry is stored as an object, in a single row, in a column of type SDO_GEOMETRY. Spatial index creation and maintenance is done using basic DDL (CREATE, ALTER, DROP) and DML (INSERT, UPDATE, DELETE) statements.

This chapter starts with a simple example that inserts, indexes, and queries spatial data. You may find it helpful to read this example quickly before you examine the detailed data type and metadata information later in the chapter.

- Simple Example: Inserting, Indexing, and Querying Spatial Data
  This topic presents a simple example of creating a spatial table, inserting data, creating the spatial index, and performing spatial queries
- SDO_GEOMETRY Object Type
  With Spatial, the geometric description of a spatial object is stored in a single row, in a single column of object type SDO_GEOMETRY in a user-defined table.
- SDO_GEOMETRY Methods
  The SDO_GEOMETRY object type has methods (member functions) that retrieve information about a geometry object.
- SDO_GEOMETRY Constructors
  The SDO_GEOMETRY object type has constructors that create a geometry object from a well-known text (WKT or EWKT) string in CLOB or VARCHAR2 format, or from a well-known binary (WKB or EWKB) object in BLOB format, optionally hex-encoded.
- TIN-Related Object Types
  This topic describes the object types related to support for triangulated irregular networks (TINs),
- Point Cloud-Related Object Types
  This topic describes the following object types related to support for point clouds.
- Geometry Examples
  This topic contains examples of many geometry types.
- Geometry Metadata Views
  The geometry metadata describing the dimensions, lower and upper bounds, and tolerance in each dimension is stored in a global table owned by MDSYS (which users should never directly update). Each Spatial user has the following views available in the schema associated with that user.
- Other Spatial Metadata Views
  Oracle Spatial uses the following other metadata views.
- Spatial Index-Related Structures
  This topic describes the structure of the tables containing the spatial index data and metadata.
- Unit of Measurement Support
  Geometry functions that involve measurement allow an optional `unit` parameter to specify the unit of measurement for a specified distance or area, if a georeferenced coordinate system (SDO_SRID value) is associated with the input geometry or geometries.

2.1 Simple Example: Inserting, Indexing, and Querying Spatial Data

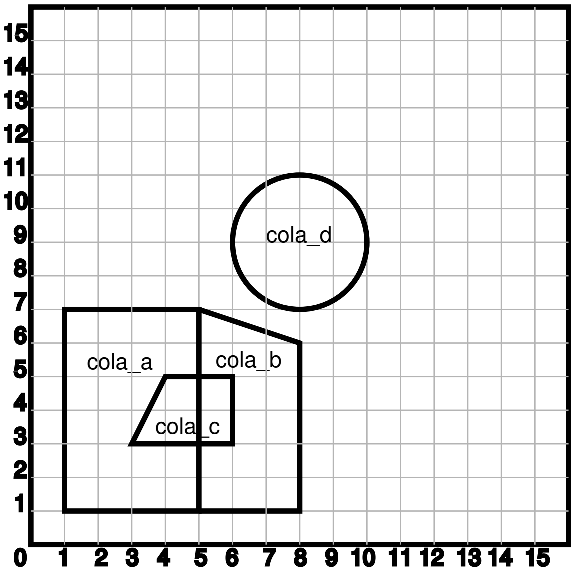
This topic presents a simple example of creating a spatial table, inserting data, creating the spatial index, and performing spatial queries

It refers to concepts that were explained in Spatial Concepts and that will be explained in other sections of this chapter.

The scenario is a soft drink manufacturer that has identified geographical areas of marketing interest for several products (colas). The colas could be those produced by the company or by its competitors, or some combination. Each area of interest could represent any user-defined criterion: for example, an area where that cola has the majority market share, or where the cola is under competitive pressure, or where the cola is believed to have significant growth potential. Each area could be a neighborhood in a city, or a part of a state, province, or country.

The following figure shows the areas of interest for four colas.

Figure 2-1 Areas of Interest for the Simple Example



The example in this topic performs the following operations:

- Creates a table (COLA_MARKETS) to hold the spatial data
- Inserts rows for four areas of interest (`cola_a`, `cola_b`, `cola_c`, `cola_d`)
- Updates the USER_SDO_GEOM_METADATA view to reflect the dimensional information for the areas
- Creates a spatial index (COLA_SPATIAL_IDX)
- Performs some spatial queries

Many concepts and techniques in the following example are explained in detail in other sections of this chapter.

Example 2-1 Example: Inserting, Indexing, and Querying Spatial Data

```
-- Create a table for cola (soft drink) markets in a
-- given geography (such as city or state).
-- Each row will be an area of interest for a specific
-- cola (for example, where the cola is most preferred
-- by residents, where the manufacturer believes the
-- cola has growth potential, and so on).
-- (For restrictions on spatial table and column names, see
-- TABLE_NAME and COLUMN_NAME.)

CREATE TABLE cola_markets (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape SDO_GEOMETRY);

-- The next INSERT statement creates an area of interest for
-- Cola A. This area happens to be a rectangle.
-- The area could represent any user-defined criterion: for
-- example, where Cola A is the preferred drink, where
-- Cola A is under competitive pressure, where Cola A
-- has strong growth potential, and so on.

INSERT INTO cola_markets VALUES(
  1,
  'cola_a',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
    SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
          -- define rectangle (lower left and upper right) with
          -- Cartesian-coordinate data
  )
);

-- The next two INSERT statements create areas of interest for
-- Cola B and Cola C. These areas are simple polygons (but not
-- rectangles).

INSERT INTO cola_markets VALUES(
  2,
  'cola_b',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
  )
);

INSERT INTO cola_markets VALUES(
  3,
  'cola_c',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
  )
);

-- Now insert an area of interest for Cola D. This is a
-- circle with a radius of 2. It is completely outside the
-- first three areas of interest.

INSERT INTO cola_markets VALUES(
  4,
  'cola_d',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,4), -- one circle
    SDO_ORDINATE_ARRAY(8,7, 10,9, 8,11)
  )
);

---------------------------------------------------------------------------
-- UPDATE METADATA VIEW --
---------------------------------------------------------------------------
-- Update the USER_SDO_GEOM_METADATA view.
-- By default, Oracle Spatial will automatically create the metadata in
-- USER_SDO_GEOM_METADATA view using a default tolerance value of 0.05.
-- Run this step only if you prefer a different tolerance value.
-- Do this only once for each layer (that is, table-column combination; here:
COLA_MARKETS and SHAPE).

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'cola_markets',
  'shape',
  SDO_DIM_ARRAY(   -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
     ),
  NULL   -- SRID
);

-------------------------------------------------------------------
-- CREATE THE SPATIAL INDEX --
-------------------------------------------------------------------
CREATE INDEX cola_spatial_idx
   ON cola_markets(shape)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
-- Preceding statement created an R-tree index.

-------------------------------------------------------------------
-- PERFORM SOME SPATIAL QUERIES --
-------------------------------------------------------------------
-- Return the topological intersection of two geometries.
SELECT SDO_GEOM.SDO_INTERSECTION(c_a.shape, c_c.shape, 0.005)
   FROM cola_markets c_a, cola_markets c_c
   WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

-- Do two geometries have any spatial relationship?
SELECT SDO_GEOM.RELATE(c_b.shape, 'anyinteract', c_d.shape, 0.005)
```

```
  FROM cola_markets c_b, cola_markets c_d
  WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

-- Return the areas of all cola markets.
SELECT name, SDO_GEOM.SDO_AREA(shape, 0.005) FROM cola_markets;

-- Return the area of just cola_a.
SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
   WHERE c.name = 'cola_a';

-- Return the distance between two geometries.
SELECT SDO_GEOM.SDO_DISTANCE(c_b.shape, c_d.shape, 0.005)
   FROM cola_markets c_b, cola_markets c_d
   WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

-- Is a geometry valid?
SELECT c.name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(c.shape, 0.005)
   FROM cola_markets c WHERE c.name = 'cola_c';

-- Is a layer valid? (First, create the results table.)
CREATE TABLE val_results (sdo_rowid ROWID, result VARCHAR2(2000));
CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS', 'SHAPE',
  'VAL_RESULTS', 2);
SELECT * from val_results;
```

See Also:

- Getting Started with Longitude/Latitude Spatial Data

2.2 SDO_GEOMETRY Object Type

With Spatial, the geometric description of a spatial object is stored in a single row, in a single column of object type SDO_GEOMETRY in a user-defined table.

Any table that has a column of type SDO_GEOMETRY must have another column, or set of columns, that defines a unique primary key for that table. Tables of this sort are sometimes referred to as spatial tables or spatial geometry tables.

Oracle Spatial defines the object type SDO_GEOMETRY as:

```
CREATE TYPE sdo_geometry AS OBJECT (
 SDO_GTYPE NUMBER,
 SDO_SRID NUMBER,
 SDO_POINT SDO_POINT_TYPE,
 SDO_ELEM_INFO SDO_ELEM_INFO_ARRAY,
 SDO_ORDINATES SDO_ORDINATE_ARRAY);
```

Oracle Spatial also defines the SDO_POINT_TYPE, SDO_ELEM_INFO_ARRAY, and SDO_ORDINATE_ARRAY types, which are used in the SDO_GEOMETRY type definition, as follows:

```
CREATE TYPE sdo_point_type AS OBJECT (
   X NUMBER,
   Y NUMBER,
   Z NUMBER);
```

```
CREATE TYPE sdo_elem_info_array AS VARRAY (1048576) of NUMBER;
CREATE TYPE sdo_ordinate_array AS VARRAY (1048576) of NUMBER;
```

Because the maximum SDO_ORDINATE_ARRAY size is 1,048,576 numbers, the maximum number of vertices in an SDO_GEOMETRY object depends on the number of dimensions per vertex: 524,288 for two dimensions, 349,525 for three dimensions, and 262,144 for four dimensions.

The sections that follow describe the semantics of each SDO_GEOMETRY attribute, and then describe some usage considerations (Usage Considerations).

The SDO_GEOMETRY object type has methods that provide convenient access to some of the attributes. These methods are described in SDO_GEOMETRY Methods.

Some Spatial data types are described in locations other than this section:

- Data Types for Geocoding describes data types for geocoding.
- *Oracle Spatial GeoRaster Developer's Guide* describes data types for Oracle Spatial GeoRaster.
- *Oracle Spatial Topology and Network Data Model Developer's Guide* describes data types for the Oracle Spatial topology data model.

- SDO_GTYPE
- SDO_SRID
- SDO_POINT
- SDO_ELEM_INFO
- SDO_ORDINATES
- Usage Considerations

2.2.1 SDO_GTYPE

The SDO_GTYPE attribute indicates the type of the geometry. Valid geometry types correspond to those specified in the *Geometry Object Model for the OGIS Simple Features for SQL* specification (with the exception of Surfaces). The numeric values differ from those given in the OGIS specification, but there is a direct correspondence between the names and semantics where applicable.

The SDO_GTYPE value is 4 digits in the format *DLTT*, where:

- *D* identifies the number of dimensions (2, 3, or 4)
- *L* identifies the linear referencing measure dimension for a three-dimensional linear referencing system (LRS) geometry, that is, which dimension (3 or 4) contains the measure value. For a non-LRS geometry, specify 0. For information about the linear referencing system (LRS), see Linear Referencing System.
- *TT* identifies the geometry type (00 through 09, with 10 through 99 reserved for future use).

Valid SDO_GTYPE Values shows the valid SDO_GTYPE values. The Geometry Type and Description values reflect the OGIS specification.

Table 2-1   Valid SDO_GTYPE Values

Value	Geometry Type	Description
*DL*00	UNKNOWN_GEOMETRY	Spatial ignores this geometry.

Table 2-1 (Cont.) Valid SDO_GTYPE Values

Value	Geometry Type	Description
*DL*01	POINT	Geometry contains one point.
*DL*02	LINE or CURVE	Geometry contains one line string that can contain straight or circular arc segments, or both. (LINE and CURVE are synonymous in this context.)
*DL*03	POLYGON or SURFACE	Geometry contains one polygon with or without holes,[1] or one surface consisting of one or more polygons. In a three-dimensional polygon, all points must be on the same plane.
*DL*04	COLLECTION	Geometry is a heterogeneous collection of elements. COLLECTION is a superset that includes all other types.
*DL*05	MULTIPOINT	Geometry has one or more points. (MULTIPOINT is a superset of POINT.)
*DL*06	MULTILINE or MULTICURVE	Geometry has one or more line strings. (MULTILINE and MULTICURVE are synonymous in this context, and each is a superset of both LINE and CURVE.)
*DL*07	MULTIPOLYGON or MULTISURFACE	Geometry can have multiple, disjoint polygons (more than one exterior boundary). or surfaces (MULTIPOLYGON is a superset of POLYGON, and MULTISURFACE is a superset of SURFACE.)
*DL*08	SOLID	Geometry consists of multiple surfaces and is completely enclosed in a three-dimensional space. Can be a cuboid or a frustum.
*DL*09	MULTISOLID	Geometry can have multiple, disjoint solids (more than one exterior boundary). (MULTISOLID is a superset of SOLID.)

[1] For a polygon with holes, enter the exterior boundary first, followed by any interior boundaries.

The *D* in the Value column of Valid SDO_GTYPE Values is the number of dimensions: 2, 3, or 4. For example, an SDO_GTYPE value of 2003 indicates a two-dimensional polygon. The number of dimensions reflects the number of ordinates used to represent each vertex (for example, *X,Y* for two-dimensional objects).

In any given layer (column), all geometries must have the same number of dimensions. For example, you cannot mix two-dimensional and three-dimensional data in the same layer.

Also, note that Oracle Spatial supports predefined descriptive names for selected SDO_GTYPE values. See SDO_GTYPE Constants for more information.

The following methods are available for returning the individual *DLTT* components of the SDO_GTYPE for a geometry object: `Get_Dims`, `Get_LRS_Dim`, and `Get_Gtype`. See SDO_GEOMETRY Methods for more information.

See Table 1-1 in Three-Dimensional Spatial Objects for more information about SDO_GTYPE values for three-dimensional geometries.

- SDO_GTYPE Constants

2.2.1.1 SDO_GTYPE Constants

You can use predefined constant values for most of the geometry types. These constants can be used in the SDO_GEOMETRY constructors and also in spatial queries.

The following table describes the supported constants and the SDO_GTYPE values to which they are mapped:

Table 2-2   SDO_GTYPE Constants

Constant	SDO_GTYPE
SDO_POINT2D	2001
SDO_POINT3D	3001
SDO_CURVE2D	2002
SDO_CURVE3D	3002
SDO_LINESTRING2D	2002
SDO_LINESTRING3D	3002
SDO_POLYGON2D	2003
SDO_POLYGON3D	3003
SDO_COLLECTION2D	2004
SDO_COLLECTION3D	3004
SDO_MULTIPOINT2D	2005
SDO_MULTIPOINT3D	3005
SDO_MULTICURVE2D	2006
SDO_MULTICURVE3D	3006
SDO_MULTILINESTRING2D	2006
SDO_MULTILINESTRING3D	3006
SDO_MULTIPOLYGON2D	2007
SDO_MULTIPOLYGON3D	3007

Example 2-2   Using `SDO_POINT2D` and `SDO_LINESTRING2D` constants

The following example creates a spatial table and inserts geometry data using `SDO_POINT2D` and `SDO_LINESTRING2D` constants for `SDO_GTYPE` values. The geometry data is then queried using the constant value.

```
-- Create the table
CREATE TABLE t1(i NUMBER, geom SDO_GEOMETRY);

-- Insert a simple polygon geometry using the SDO_POINT2D constant
INSERT INTO t1 VALUES(
  1,
  SDO_GEOMETRY(
    sdo_polygon2d,
    4326,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(1,1, 5,7)
  )
);
```

```
-- Insert a line string geometry using the SDO_LINESTRING2D constant
INSERT INTO t1 VALUES(
  2,
  SDO_GEOMETRY(
    sdo_linestring2d,
    4326,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1),
    SDO_ORDINATE_ARRAY(10,25, 20,30, 25,25, 30,30))
);
-- Create the spatial index
CREATE INDEX t1_idx ON t1(geom) INDEXTYPE IS mdsys.spatial_index_v2;

-- Query the spatial data to retrieve the polygon geometry
SQL> SELECT geom FROM t1 t WHERE t.geom.SDO_GTYPE=sdo_polygon2d;

GEOM(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
----------------
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(1, 1, 5, 7))
```

2.2.2 SDO_SRID

The SDO_SRID attribute can be used to identify a coordinate system (spatial reference system) to be associated with the geometry. If SDO_SRID is null, no coordinate system is associated with the geometry. If SDO_SRID is not null, it must contain a value from the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table), and this value must be inserted into the SRID column of the USER_SDO_GEOM_METADATA view (described in Geometry Metadata Views). Also, note that effective with Release 23ai, spatial metadata is automatically created in USER_SDO_GEOM_METADATA view if you create a spatial index on the spatial column.

All geometries in a geometry column must have the same SDO_SRID value if a spatial index will be built on that column.

Also, note that Oracle Spatial supports predefined constants for selected SRID values. See SDO_SRID Constants for more information.

See Coordinate Systems (Spatial Reference Systems) for information about coordinate systems.

- SDO_SRID Constants

2.2.2.1 SDO_SRID Constants

You can use predefined SRID constants for selected SRIDs in the SDO_GEOMETRY constructors and in spatial queries.

Table 2-3 describes the supported constants for the following SRID values:

Table 2-3 SRID Constants

Constant	SDO_SRID
SDO_LONLAT	4326

Table 2-3 (Cont.) SRID Constants

Constant	SDO_SRID
SDO_WEBMERCATOR	3857

Example 2-3 Using the `SDO_WEBMERCATOR` constant

The following example creates a spatial table and inserts geometry data using `SDO_WEBMERCATOR` instead of `3857` for the `SRID` value. The geometry data is then queried using the constant value.

```
-- Create the table
CREATE TABLE t2(i NUMBER, geom SDO_GEOMETRY);

-- Insert a simple polygon geometry with SRID as SDO_WEBMERCATOR
INSERT INTO t2 VALUES(
  1,
  SDO_GEOMETRY(
    sdo_polygon2d,
    sdo_webmercator,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(1,1, 5,7)
  )
);

-- Create the spatial index
CREATE INDEX t2_idx ON t2(geom) INDEXTYPE IS mdsys.spatial_index_v2;

-- Query the spatial data to retrieve the polygon geometry
SQL> SELECT geom FROM t2 t WHERE t.geom.SDO_SRID=SDO_WEBMERCATOR;

GEOM(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
---------------
SDO_GEOMETRY(2003, 3857, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(1, 1, 5, 7))
```

2.2.3 SDO_POINT

The SDO_POINT attribute is defined using the SDO_POINT_TYPE object type, which has the attributes X, Y, and Z, all of type NUMBER. (The SDO_POINT_TYPE definition is shown in SDO_GEOMETRY Object Type.) If the SDO_ELEM_INFO and SDO_ORDINATES arrays are both null, and the SDO_POINT attribute is non-null, then the X, Y, and Z values are considered to be the coordinates for a point geometry. Otherwise, the SDO_POINT attribute is ignored by Spatial. You should store point geometries in the SDO_POINT attribute for optimal storage; and if you have only point geometries in a layer, it is strongly recommended that you store the point geometries in the SDO_POINT attribute.

Point illustrates a point geometry and provides examples of inserting and querying point geometries.

> **Note:**
>
> Do not use the SDO_POINT attribute in defining a linear referencing system (LRS) point or an oriented point. For information about LRS, see Linear Referencing System. For information about oriented points, see Oriented Point.

2.2.4 SDO_ELEM_INFO

The SDO_ELEM_INFO attribute is defined using a varying length array of numbers. This attribute lets you know how to interpret the ordinates stored in the SDO_ORDINATES attribute (described in SDO_ORDINATES).

Each triplet set of numbers is interpreted as follows:

- SDO_STARTING_OFFSET -- Indicates the offset within the SDO_ORDINATES array where the first ordinate for this element is stored. Offset values start at 1 and not at 0. Thus, the first ordinate for the first element will be at SDO_GEOMETRY.SDO_ORDINATES(1). If there is a second element, its first ordinate will be at SDO_GEOMETRY.SDO_ORDINATES(*n*), where *n* reflects the position within the SDO_ORDINATE_ARRAY definition (for example, 19 for the 19th number, as in Figure 2-4 in Polygon with a Hole).
- SDO_ETYPE -- Indicates the type of the element. Valid values are shown in Table 2-4.

  SDO_ETYPE values 1, 2, 1003, and 2003 are considered *simple elements*. They are defined by a single triplet entry in the SDO_ELEM_INFO array. For SDO_ETYPE values 1003 and 2003, the first digit indicates *exterior* (1) or *interior* (2):

  1003: exterior polygon ring (must be specified in counterclockwise order)

  2003: interior polygon ring (must be specified in clockwise order)

  > **Note:**
  >
  > The use of 3 as an SDO_ETYPE value for polygon ring elements in a single geometry is discouraged. You should specify 3 only if you do not know if the simple polygon is exterior or interior, and you should then upgrade the table or layer to the current format using the SDO_MIGRATE.TO_CURRENT procedure, described in SDO_MIGRATE Package (Upgrading) .
  >
  > You cannot mix 1-digit and 4-digit SDO_ETYPE values in a single geometry.

  SDO_ETYPE values 4, 1005, 2005, 1006, and 2006 are considered *compound elements*. They contain at least one header triplet with a series of triplet values that belong to the compound element. For 4-digit SDO_ETYPE values, the first digit indicates *exterior* (1) or *interior* (2):

  1005: exterior polygon ring (must be specified in counterclockwise order)

  2005: interior polygon ring (must be specified in clockwise order)

  1006: exterior surface consisting of one or more polygon rings

  2006: interior surface in a solid element

  1007: solid element

The elements of a compound element are contiguous. The last point of a subelement in a compound element is the first point of the next subelement. The point is not repeated.

- SDO_INTERPRETATION -- Means one of two things, depending on whether or not SDO_ETYPE is a compound element.

  If SDO_ETYPE is a compound element (4, 1005, or 2005), this field specifies how many subsequent triplet values are part of the element.

  If the SDO_ETYPE is not a compound element (1, 2, 1003, or 2003), the interpretation attribute determines how the sequence of ordinates for this element is interpreted. For example, a line string or polygon boundary may be made up of a sequence of connected straight line segments or circular arcs.

  Descriptions of valid SDO_ETYPE and SDO_INTERPRETATION value pairs are given in Table 2-4.

If a geometry consists of more than one element, then the last ordinate for an element is always one less than the starting offset for the next element. The last element in the geometry is described by the ordinates from its starting offset to the end of the SDO_ORDINATES varying length array.

For compound elements (SDO_ETYPE values 4, 1005, or 2005), a set of *n* triplets (one for each subelement) is used to describe the element. It is important to remember that subelements of a compound element are contiguous. The last point of a subelement is the first point of the next subelement. For subelements 1 through *n*-1, the end point of one subelement is the same as the starting point of the next subelement. The starting point for subelements 2...*n*-2 is the same as the end point of subelement 1...*n*-1. The last ordinate of subelement *n* is either the starting offset minus 1 of the next element in the geometry, or the last ordinate in the SDO_ORDINATES varying length array.

The current size of a varying length array can be determined by using the function varray_variable.Count in PL/SQL or OCICollSize in the Oracle Call Interface (OCI).

The semantics of each SDO_ETYPE element and the relationship between the SDO_ELEM_INFO and SDO_ORDINATES varying length arrays for each of these SDO_ETYPE elements are given in Table 2-4.

Table 2-4 Values and Semantics in SDO_ELEM_INFO

SDO_ETYPE	SDO_INTERPRETATION	Meaning
0	(any numeric value)	Type 0 (zero) element. Used to model geometry types not supported by Oracle Spatial. For more information, see Type 0 (Zero) Element.
1	1	Point type.
1	0	Orientation for an oriented point. For more information, see Oriented Point.
1	*n* > 1	Point cluster with *n* points.
2	1	Line string whose vertices are connected by straight line segments.
2	2	Line string made up of a connected sequence of circular arcs. Each circular arc is described using three coordinates: the start point of the arc, any point on the arc, and the end point of the arc. The coordinates for a point designating the end of one arc and the start of the next arc are not repeated. For example, five coordinates are used to describe a line string made up of two connected circular arcs. Points 1, 2, and 3 define the first arc, and points 3, 4, and 5 define the second arc, where point 3 is only stored once.

Table 2-4 (Cont.) Values and Semantics in SDO_ELEM_INFO

SDO_ETYPE	SDO_INTERPRETATION	Meaning
2	3	NURBS (non-uniform rational B-spline) curve. For more information, see NURBS Curve Support in Oracle Spatial.
1003 or 2003	1	Simple polygon whose vertices are connected by straight line segments. You must specify a point for each vertex; and the last point specified must be exactly the same point as the first (within the tolerance value), to close the polygon. For example, for a 4-sided polygon, specify 5 points, with point 5 the same as point 1.
1003 or 2003	2	Polygon made up of a connected sequence of circular arcs that closes on itself. The end point of the last arc is the same as the start point of the first arc. Each circular arc is described using three coordinates: the start point of the arc, any point on the arc, and the end point of the arc. The coordinates for a point designating the end of one arc and the start of the next arc are not repeated. For example, five coordinates are used to describe a polygon made up of two connected circular arcs. Points 1, 2, and 3 define the first arc, and points 3, 4, and 5 define the second arc. The coordinates for points 1 and 5 must be the same (tolerance is not considered), and point 3 is not repeated.
1003 or 2003	3	Rectangle type (sometimes called *optimized rectangle*). A bounding rectangle such that only two points, the lower-left and the upper-right, are required to describe it. The rectangle type can be used with geodetic or non-geodetic data. However, with geodetic data, use this type only to create a query window (not for storing objects in the database). For information about using this type with geodetic data, including examples, see Geodetic MBRs. For information about creating three-dimensional optimized rectangles, see Three-Dimensional Optimized Rectangles.
1003 or 2003	4	Circle type. Described by three distinct non-colinear points, all on the circumference of the circle.
4	*n* > 1	Compound line string with some vertices connected by straight line segments and some by circular arcs. The value *n* in the Interpretation column specifies the number of contiguous subelements that make up the line string. The next *n* triplets in the SDO_ELEM_INFO array describe each of these subelements. The subelements can only be of SDO_ETYPE 2. The last point of a subelement is the first point of the next subelement, and must not be repeated. See Compound Line String and Figure 2-5 for an example of a compound line string geometry.

Table 2-4 (Cont.) Values and Semantics in SDO_ELEM_INFO

SDO_ETYPE	SDO_INTERPRETATION	Meaning
1005 or 2005	*n* > 1	Compound polygon with some vertices connected by straight line segments and some by circular arcs. The value *n* in the Interpretation column specifies the number of contiguous subelements that make up the polygon. The next *n* triplets in the SDO_ELEM_INFO array describe each of these subelements. The subelements can only be of SDO_ETYPE 2. The end point of a subelement is the start point of the next subelement, and it must not be repeated. The start and end points of the polygon must be exactly the same point (tolerance is ignored). See Compound Polygon and Figure 2-6 for an example of a compound polygon geometry.
1006 or 2006	*n* > 1	Surface consisting of one or more polygons, with each edge shared by no more than two polygons. A surface contains an area but not a volume. The value *n* in the Interpretation column specifies the number of polygons that make up the surface. The next *n* triplets in the SDO_ELEM_INFO array describe each of these polygon subelements. A surface must be three-dimensional. For an explanation of three-dimensional support in Spatial, see Three-Dimensional Spatial Objects.
1007	*n* = 1 or 3	Solid consisting of multiple surfaces that are completely enclosed in a three-dimensional space, so that the solid has an interior volume. A solid element can have one exterior surface defined by the 1006 elements and zero or more interior boundaries defined by the 2006 elements. The value *n* in the Interpretation column must be 1 or 3. Subsequent triplets in the SDO_ELEM_INFO array describe the exterior 1006 and optional interior 2006 surfaces that make up the solid element. If *n* is 3, the solid is an *optimized box*, such that only two three-dimensional points are required to define it: one with minimum values for the box in the X, Y, and Z dimensions and another with maximum values for the box in the X, Y, and Z dimensions. For example: `SDO_GEOMETRY(3008, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1007,3), SDO_ORDINATE_ARRAY(1,1,1, 3,3,3))` For an explanation of three-dimensional support in Spatial, see Three-Dimensional Spatial Objects.

2.2.5 SDO_ORDINATES

The SDO_ORDINATES attribute is defined using a varying length array (1048576) of NUMBER type that stores the coordinate values that make up the boundary of a spatial object. This array must always be used in conjunction with the SDO_ELEM_INFO varying length array. The values in the array are ordered by dimension. For example, a polygon whose boundary has four two-dimensional points is stored as {X1, Y1, X2, Y2, X3, Y3, X4, Y4, X1, Y1}. If the points are three-dimensional, then they are stored as {X1, Y1, Z1, X2, Y2, Z2, X3, Y3, Z3, X4, Y4, Z4, X1, Y1, Z1}. The number of dimensions associated with each point is stored as metadata in the xxx_SDO_GEOM_METADATA views, described in Geometry Metadata Views.

The values in the SDO_ORDINATES array must all be valid and non-null. There are no special values used to delimit elements in a multielement geometry. The start and end points for the sequence describing a specific element are determined by the STARTING_OFFSET values for that element and the next element in the SDO_ELEM_INFO array, as explained in SDO_ELEM_INFO. The offset values start at 1. SDO_ORDINATES(1) is the first ordinate of the first point of the first element.

2.2.6 Usage Considerations

You should use the SDO_GTYPE values as shown in Valid SDO_GTYPE Values; however, Spatial does not check or enforce all geometry consistency constraints. Spatial does check the following:

- For SDO_GTYPE values *d*001 and *d*005, any subelement not of SDO_ETYPE 1 is ignored.
- For SDO_GTYPE values *d*002 and *d*006, any subelement not of SDO_ETYPE 2 or 4 is ignored.
- For SDO_GTYPE values *d*003 and *d*007, any subelement not of SDO_ETYPE 3 or 5 is ignored. (This includes SDO_ETYPE variants 1003, 2003, 1005, and 2005, which are explained in SDO_ELEM_INFO).

The SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function can be used to evaluate the consistency of a single geometry object or of all geometry objects in a specified feature table.

2.3 SDO_GEOMETRY Methods

The SDO_GEOMETRY object type has methods (member functions) that retrieve information about a geometry object.

Table 2-5 lists these methods.

Table 2-5 SDO_GEOMETRY Methods

Name	Returns	Description
Get_Dims	NUMBER	Returns the number of dimensions of a geometry object, as specified in its SDO_GTYPE value. In Oracle Spatial, the Get_Dims and ST_CoordDim methods return the same result.
Get_GeoJson	CLOB	Returns the GeoJSON representation of a geometry object.
Get_GType	NUMBER	Returns the geometry type of a geometry object, as specified in its SDO_GTYPE value.
Get_LRS_Dim	NUMBER	Returns the measure dimension of an LRS geometry object, as specified in its SDO_GTYPE value. A return value of 0 indicates that the geometry is a standard (non-LRS) geometry, or is an LRS geometry in the format before release 9.0.1 and with measure as the default (last) dimension; 3 indicates that the third dimension contains the measure information; 4 indicates that the fourth dimension contains the measure information.
Get_WKB	BLOB	Returns the well-known binary (WKB) format of a geometry object. (The returned object does not include any SRID information.)

Table 2-5 (Cont.) SDO_GEOMETRY Methods

Name	Returns	Description
Get_WKT	CLOB	Returns the well-known text (WKT) format (explained in Well-Known Text (WKT)) of a geometry object. (The returned object does not include any SRID information.)
ST_CoordDim	NUMBER	Returns the coordinate dimension (as defined by the ISO/IEC SQL Multimedia standard) of a geometry object. In Oracle Spatial, the Get_Dims and ST_CoordDim methods return the same result.
ST_IsValid	NUMBER	Returns 0 if a geometry object is invalid or 1 if it is valid. (The ISO/IEC SQL Multimedia standard uses the term *well formed* for *valid* in this context.) This method uses 0.001 as the tolerance value. (Tolerance is explained in Tolerance.) To specify a different tolerance value or to learn more about why a geometry is invalid, use the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function, which is documented in SDO_GEOM Package (Geometry).

Example 2-4 shows most of the SDO_GEOMETRY methods. (The Get_WKB method is not included because its output cannot be displayed by SQL*Plus.)

Example 2-4 SDO_GEOMETRY Methods

```
SELECT c.shape.Get_Dims()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.GET_DIMS()
------------------
                 2

SELECT c.shape.Get_GeoJson()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.GET_GEOJSON()
--------------------------------------------------------------------------------
{ "type": "Polygon", "coordinates": [ [ [5, 1], [8, 1], [8, 6], [5, 7], [5, 1] ]

SELECT c.shape.Get_GType()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.GET_GTYPE()
-------------------
                  3

SELECT a.route_geometry.Get_LRS_Dim()
  FROM lrs_routes a WHERE  a.route_id = 1;

A.ROUTE_GEOMETRY.GET_LRS_DIM()
------------------------------
                             3

SELECT c.shape.Get_WKT()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.GET_WKT()
--------------------------------------------------------------------------------
POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
```

```
SELECT c.shape.ST_CoordDim()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.ST_COORDDIM()
---------------------
                    2

SELECT c.shape.ST_IsValid()
  FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.ST_ISVALID()
--------------------
                   1
```

2.4 SDO_GEOMETRY Constructors

The SDO_GEOMETRY object type has constructors that create a geometry object from a well-known text (WKT or EWKT) string in CLOB or VARCHAR2 format, or from a well-known binary (WKB or EWKB) object in BLOB format, optionally hex-encoded.

The following constructor formats are available:

```
SDO_GEOMETRY(wkt CLOB, srid NUMBER DEFAULT NULL);
SDO_GEOMETRY(wkt VARCHAR2, srid NUMBER DEFAULT NULL);
SDO_GEOMETRY(wkb BLOB, srid NUMBER DEFAULT NULL);
```

Note that the optional `srid` parameter is used to specify the coordinate system of the WKT or WKB data; it overrides any SRID specification in an EWKT or EWKB input (no transformation is done). If the created geometry is inserted into a table, the `srid` value used with the constructor must match the `SDO_SRID` value of the geometries in the table.

The following simple example constructs a point geometry using a well-known text string. (In a WKT, spaces separate ordinates of a vertex, and commas separate vertices.)

```
SELECT SDO_GEOMETRY('POINT(-79 37)') FROM DUAL;

SDO_GEOMETRY('POINT(-7937)')(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_I
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(-79, 37, NULL), NULL, NULL)
```

Example 2-5 shows SDO_GEOMETRY constructors that create geometry objects, insert the objects into a table, and display the objects that were added to the table.

Example 2-5   SDO_GEOMETRY Constructors to Create Geometries

```
DECLARE
  cola_b_wkb  BLOB;
  cola_b_wkt_clob  CLOB;
  cola_b_wkt_varchar  VARCHAR2(255);
  cola_b_geom  SDO_GEOMETRY;

BEGIN
-- Get cola_b geometry into CLOB, VARCHAR2, and BLOB objects,
-- for use by the constructor.
SELECT c.shape.Get_WKT() INTO cola_b_wkt_clob
  FROM cola_markets c WHERE c.name = 'cola_b';
cola_b_wkt_varchar := cola_b_wkt_clob;
SELECT c.shape.Get_WKB() INTO cola_b_wkb
  FROM cola_markets c WHERE c.name = 'cola_b';

-- Use some SDO_GEOMETRY constructors;
-- insert 3 geometries into the table; display the geometries later.
cola_b_geom := SDO_GEOMETRY(cola_b_wkt_clob);
INSERT INTO cola_markets VALUES (101, 'cola_b_from_clob', cola_b_geom);
cola_b_geom := SDO_GEOMETRY(cola_b_wkt_varchar);
INSERT INTO cola_markets VALUES (102, 'cola_b_from_varchar', cola_b_geom);
cola_b_geom := SDO_GEOMETRY(cola_b_wkb);
INSERT INTO cola_markets VALUES (103, 'cola_b_from_wkb', cola_b_geom);
END;
/

PL/SQL procedure successfully completed.

-- Display the geometries created using SDO_GEOMETRY constructors.
-- All three geometries are identical.
SELECT name, shape FROM cola_markets WHERE mkt_id > 100;

NAME
--------------------------------
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
cola_b_from_clob
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

cola_b_from_varchar
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

cola_b_from_wkb
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

Geometry Constructor for Inserting Longitude and Latitude Spatial Data

You can create a geometry object to store spatial data in longitude and latitude coordinate system using the `SDO_GEOMETRY(longitude, latitude)` constructor as shown in the following example:

```
-- Create a table
CREATE TABLE t1(i NUMBER, geom SDO_GEOMETRY);

-- Insert lon/lat spatial data using the following constructor
INSERT INTO t1 VALUES (1, SDO_GEOMETRY(-73.45, 45.2));

-- Display the inserted geometry
SQL> SELECT geom FROM t1;

GEOM(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(-73.45, 45.2, NULL), NULL, NULL)
```

As seen in the displayed geometry output, the INSERT statement in the preceding example is equivalent to:

```
INSERT INTO t1 VALUES (1, SDO_GEOMETRY(2001, 4326, sdo_point_type(-73.45, 45.2,
null), null, null);
```

2.5 TIN-Related Object Types

This topic describes the object types related to support for triangulated irregular networks (TINs),

> **Note:**
>
> TIN object types are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

- SDO_TIN Object Type
- SDO_TIN_BLK_TYPE and SDO_TIN_BLK Object Types

2.5.1 SDO_TIN Object Type

The description of a TIN is stored in a single row, in a single column of object type SDO_TIN in a user-defined table. The object type SDO_TIN is defined as:

```
CREATE TYPE sdo_tin AS OBJECT
  (base_table          VARCHAR2(70),
   base_table_col      VARCHAR2(1024),
   tin_id              NUMBER.
   blk_table           VARCHAR2(70),
   ptn_params          VARCHAR2(1024),
   tin_extent          SDO_GEOMETRY,
   tin_tol             NUMBER,
   tin_tot_dimensions  NUMBER,
   tin_domain          SDO_ORGSCL_TYPE,
   tin_break_lines     SDO_GEOMETRY,
   tin_stop_lines      SDO_GEOMETRY,
   tin_void_rgns       SDO_GEOMETRY,
   tin_val_attr_tables SDO_STRING_ARRAY,
   tin_other_attrs     XMLTYPE);
```

The SDO_TIN type has the attributes shown in Table 2-6.

Table 2-6 SDO_TIN Type Attributes

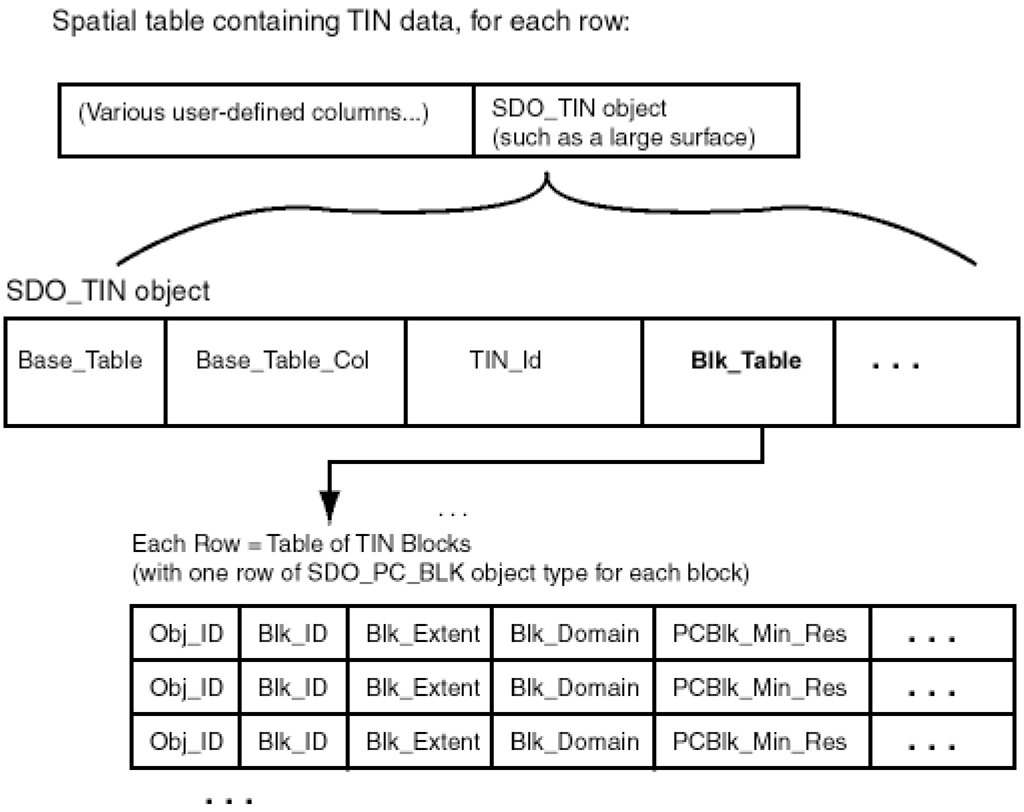
Attribute	Explanation
BASE_TABLE	Name of the base table containing a column of type SDO_TIN
BASE_TABLE_COL	Name of the column of type SDO_TIN in the base table
TIN_ID	ID number for the TIN. (This unique ID number is generated by Spatial. It is unique within the schema for base tables containing a column of type SDO_TIN.)
BLK_TABLE	Name of the table that contains information about each block in the TIN. This table contains the columns shown in Table 2-7.
PTN_PARAMS	Parameters for partitioning the TIN
TIN_EXTENT	SDO_GEOMETRY object representing the spatial extent of the TIN (the minimum bounding object enclosing all objects in the TIN)

Table 2-6 (Cont.) SDO_TIN Type Attributes

Attribute	Explanation
TIN_TOL	Tolerance value for objects in the TIN. (For information about spatial tolerance, see Tolerance.)
TIN_TOT_DIMENSIONS	Total number of dimensions in the TIN. Includes spatial dimensions and any nonspatial dimensions, up to a maximum total of 9.
TIN_DOMAIN	(Not currently used.)
TIN_BREAK_LINES	(Not currently used.)
TIN_STOP_LINES	(Not currently used.)
TIN_VOID_RGNS	(Not currently used.).
TIN_VAL_ATTR_TABLES	SDO_STRING_ARRAY object specifying the names of any value attribute tables for the TIN. Type SDO_STRING_ARRAY is defined as `VARRAY(1048576) OF VARCHAR2(32)`.
TIN_OTHER_ATTRS	XMLTYPE object specifying any other attributes of the TIN. (For more information, see the Usage Notes for the SDO_TIN_PKG.INIT function.)

Figure 2-2 shows the storage model for TIN data, in which the TIN block table (specified in the BLK_TABLE attribute of the SDO_TIN type) stores the blocks associated with the SDO_TIN object.

Figure 2-2 Storage of TIN Data



The TIN block table contains the columns shown in Table 2-7.

Table 2-7 Columns in the TIN Block Table

Column Name	Data Type	Purpose
BLK_ID	NUMBER	ID number of the block.
BLK_EXTENT	SDO_GEOMETRY	Spatial extent of the block.
BLK_DOMAIN	SDO_ORGSCL_TYPE	(Not currently used.)
PCBLK_MIN_RES	NUMBER	For point cloud data, the minimum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.
PCBLK_MAX_RES	NUMBER	For point cloud data, the maximum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.
NUM_POINTS	NUMBER	For point cloud data, the total number of points in the POINTS BLOB
NUM_UNSORTED_POINTS	NUMBER	For point cloud data, the number of unsorted points in the POINTS BLOB
PT_SORT_DIM	NUMBER	For point cloud data, the number of spatial dimensions for the points (2 or 3)
POINTS	BLOB	For point cloud data, BLOB containing the points. Consists of an array of points, with the following information for each point: • *d* 8-byte IEEE doubles, where *d* is the point cloud total number of dimensions • 4-byte big-endian integer for the BLK_ID value • 4-byte big-endian integer for the PT_ID value
TR_LVL	NUMBER	(Not currently used.)
TR_RES	NUMBER	(Not currently used.)
NUM_TRIANGLES	NUMBER	Number of triangles in the TRIANGLES BLOB.
TR_SORT_DIM	NUMBER	(Not currently used.)
TRIANGLES	BLOB	BLOB containing the triangles. Consists of an array of triangles for the block: • Each triangle is specified by three vertices. • Each vertex is specified by the pair (BLK_ID, PT_ID), with each value being a 4-byte big-endian integer.

For each BLOB in the POINTS column of the TIN block table:

- The total size is (*tdim*+1)*8, where *tdim* is the total dimensionality of each block.
- The total size should be less than 5 MB for Oracle Database Release 11.1.0.6 or earlier; it should be less than 12 MB for Oracle Database Release 11.1.0.7 or later.

You can use an attribute name in a query on an object of SDO_TIN. Example 2-6 shows part of a SELECT statement that queries the TIN_EXTENT attribute of the TERRAIN column of a hypothetical LANDSCAPES table.

Example 2-6   SDO_TIN Attribute in a Query

```
SELECT l.terrain.tin_extent FROM landscapes l WHERE ...;
```

2.5.2 SDO_TIN_BLK_TYPE and SDO_TIN_BLK Object Types

When you perform a clip operation using the SDO_TIN_PKG.CLIP_TIN function, an object of SDO_TIN_BLK_TYPE is returned, which is defined as `TABLE OF SDO_TIN_BLK`.

The attributes of the SDO_TIN_BLK object type are the same as the columns in the TIN block table, which is described in Table 2-7 in SDO_TIN_BLK_TYPE and SDO_TIN_BLK Object Types.

2.6 Point Cloud-Related Object Types

This topic describes the following object types related to support for point clouds.

> **Note:**
>
> Point cloud object types are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

- SDO_PC Object Type
- SDO_PC_BLK_TYPE and SDO_PC_BLK Object Type

2.6.1 SDO_PC Object Type

The description of a point cloud is stored in a single row, in a single column of object type SDO_PC in a user-defined table. The object type SDO_PC is defined as:

```
CREATE TYPE sdo_pc AS OBJECT
  (base_table         VARCHAR2(70),
   base_table_col     VARCHAR2(1024),
   pc_id              NUMBER.
   blk_table          VARCHAR2(70),
   ptn_params         VARCHAR2(1024),
   pc_extent          SDO_GEOMETRY,
   pc_tol             NUMBER,
   pc_tot_dimensions  NUMBER,
   pc_domain          SDO_ORGSCL_TYPE,
   pc_val_attr_tables SDO_STRING_ARRAY,
   pc_other_attrs     XMLTYPE);
```

The SDO_PC type has the attributes shown in Table 2-8.

Table 2-8 SDO_PC Type Attributes

Attribute	Explanation
BASE_TABLE	Name of the base table containing a column of type SDO_PC
BASE_TABLE_COL	Name of the column of type SDO_PC in the base table
PC_ID	ID number for the point cloud. (This unique ID number is generated by Spatial. It is unique within the schema for base tables containing a column of type SDO_PC.)
BLK_TABLE	Name of the table that contains information about each block in the point cloud. This table contains the columns shown in Table 2-9.
PTN_PARAMS	Parameters for partitioning the point cloud
PC_EXTENT	SDO_GEOMETRY object representing the spatial extent of the point cloud (the minimum bounding object enclosing all objects in the point cloud)
PC_TOL	Tolerance value for points in the point cloud. (For information about spatial tolerance, see Tolerance.)
PC_TOT_DIMENSIONS	Total number of dimensions in the point cloud. Includes spatial dimensions and any nonspatial dimensions, up to a maximum total of 9.
PC_DOMAINS	(Not currently used.)
PC_VAL_ATTR_TABLES	SDO_STRING_ARRAY object specifying the names of any value attribute tables for the point cloud. Type SDO_STRING_ARRAY is defined as `VARRAY(1048576) OF VARCHAR2(32)`.
PC_OTHER_ATTRS	XMLTYPE object specifying any other attributes of the point cloud. (For more information, see the Usage Notes for the SDO_PC_PKG.INIT function.)

The point cloud block table (specified in the BLK_TABLE attribute of the SDO_PC type) contains the columns shown in Table 2-9.

Table 2-9 Columns in the Point Cloud Block Table

Column Name	Data Type	Purpose
OBJ_ID	NUMBER	ID number of the point cloud object.
BLK_ID	NUMBER	ID number of the block.
BLK_EXTENT	SDO_GEOMETRY	Spatial extent of the block.
BLK_DOMAIN	SDO_ORGSCL_TYPE	(Not currently used.)
PCBLK_MIN_RES	NUMBER	For point cloud data, the minimum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.
PCBLK_MAX_RES	NUMBER	For point cloud data, the maximum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.

Table 2-9 (Cont.) Columns in the Point Cloud Block Table

Column Name	Data Type	Purpose
NUM_POINTS	NUMBER	For point cloud data, the total number of points in the POINTS BLOB
NUM_UNSORTED_POINTS	NUMBER	For point cloud data, the number of unsorted points in the POINTS BLOB
PT_SORT_DIM	NUMBER	Number of the dimension (1 for the first dimension, 2 for the second dimension, and so on) on which the points are sorted.
POINTS	BLOB	BLOB containing the points. Consists of an array of points, with the following information for each point: • *d* 8-byte IEEE doubles, where *d* is the PC_TOT_DIMENSIONS value • 4-byte big-endian integer for the BLK_ID value • 4-byte big-endian integer for the PT_ID value

You can use an attribute name in a query on an object of SDO_PC. Example 2-7 shows part of a SELECT statement that queries the PC_EXTENT attribute of the OCEAN_FLOOR column of a hypothetical OCEAN_FLOOR_MODEL table.

Example 2-7 SDO_PC Attribute in a Query

```
SELECT o.ocean_floor.pc_extent FROM ocean_floor_model o WHERE ...;
```

2.6.2 SDO_PC_BLK_TYPE and SDO_PC_BLK Object Type

When you perform a clip operation using the SDO_PC_PKG.CLIP_PC function, an object of SDO_PC_BLK_TYPE is returned, which is defined as `TABLE OF SDO_PC_BLK`.

The attributes of the SDO_PC_BLK object type are the same as the columns in the point cloud block table, which is described in Table 2-9 in SDO_PC Object Type.

2.7 Geometry Examples

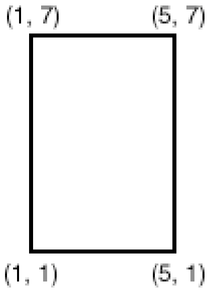
This topic contains examples of many geometry types.

- Rectangle
- Polygon with a Hole
- Compound Line String
- Compound Polygon
- Point
- Oriented Point
- Type 0 (Zero) Element
- NURBS Curve
- Several Two-Dimensional Geometry Types
- Three-Dimensional Geometry Types

2.7.1 Rectangle

Figure 2-3 illustrates the rectangle that represents `cola_a` in the example in Simple Example: Inserting, Indexing, and Querying Spatial Data.

Figure 2-3 Rectangle



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-3:

- SDO_GTYPE = SDO_POLYGON2D. This indicates a two-dimensional polygon.
- SDO_SRID = NULL.
- SDO_POINT = NULL.
- SDO_ELEM_INFO = (1, 1003, 3). The final *3* in 1,1003,3 indicates that this is a rectangle. Because it is a rectangle, only two ordinates are specified in SDO_ORDINATES (lower-left and upper-right).
- SDO_ORDINATES = (1,1, 5,7). These identify the lower-left and upper-right ordinates of the rectangle.

Example 2-8 shows a SQL statement that inserts the geometry illustrated in Figure 2-3 into the database.

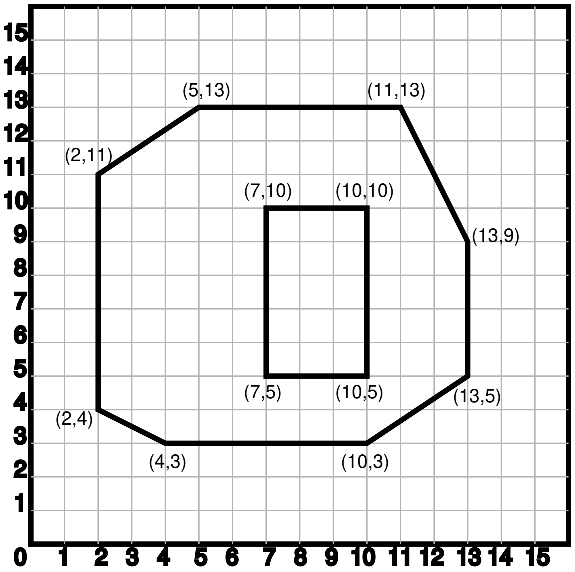
Example 2-8 SQL Statement to Insert a Rectangle

```
INSERT INTO cola_markets VALUES(
  1,
  'cola_a',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
    SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
          -- define rectangle (lower left and upper right) with
          -- Cartesian-coordinate data
  )
);
```

2.7.2 Polygon with a Hole

Figure 2-4 illustrates a polygon consisting of two elements: an exterior polygon ring and an interior polygon ring. The inner element in this example is treated as a void (a hole).

Figure 2-4   Polygon with a Hole



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-4:

- SDO_GTYPE = SDO_POLYGON2D. This indicates a two-dimensional polygon.
- SDO_SRID = NULL.
- SDO_POINT = NULL.
- SDO_ELEM_INFO = (1,1003,1, 19,2003,1). There are two triplet elements: 1,1003,1 and 19,2003,1.

  1003 indicates that the element is an exterior polygon ring; *2003* indicates that the element is an interior polygon ring.

  19 indicates that the second element (the interior polygon ring) ordinate specification starts at the 19th number in the SDO_ORDINATES array (that is, 7, meaning that the first point is 7,5).
- SDO_ORDINATES = (2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4, 7,5, 7,10, 10,10, 10,5, 7,5).
- The area (SDO_GEOM.SDO_AREA function) of the polygon is the area of the exterior polygon minus the area of the interior polygon. In this example, the area is 84 (99 - 15).
- The perimeter (SDO_GEOM.SDO_LENGTH function) of the polygon is the perimeter of the exterior polygon plus the perimeter of the interior polygon. In this example, the perimeter is 52.9193065 (36.9193065 + 16).

Example 2-9   SQL Statement to Insert a Polygon with a Hole

Example 2-9 shows a SQL statement that inserts the geometry illustrated in Figure 2-4 into the database.

```
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
        SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
            7,5, 7,10, 10,10, 10,5, 7,5)
  )
);
```

An example of such a "polygon with a hole" might be a land mass (such as a country or an island) with a lake inside it. Of course, an actual land mass might have many such interior polygons: each one would require a triplet element in SDO_ELEM_INFO, plus the necessary ordinate specification.

Exterior and interior rings cannot be nested. For example, if a country has a lake and there is an island in the lake (and perhaps a lake on the island), a separate polygon must be defined for the island; the island cannot be defined as an interior polygon ring within the interior polygon ring of the lake.

In a **multipolygon** (polygon collection), rings must be grouped by polygon, and the first ring of each polygon must be the exterior ring. For example, consider a polygon collection that contains two polygons (A and B):

- Polygon A (one interior "hole"): exterior ring A0, interior ring A1
- Polygon B (two interior "holes"): exterior ring B0, interior ring B1, interior ring B2

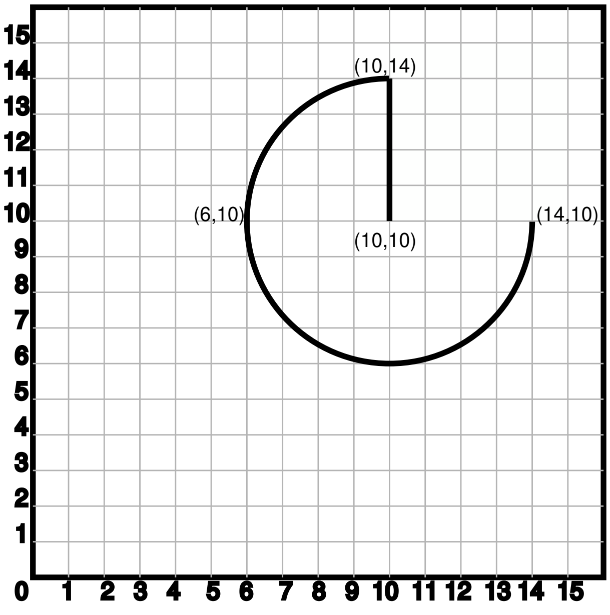
The elements in SDO_ELEM_INFO and SDO_ORDINATES must be in one of the following orders (depending on whether you specify Polygon A or Polygon B first):

- A0, A1; B0, B1, B2
- B0, B1, B2; A0, A1

2.7.3 Compound Line String

Figure 2-5 illustrates a crescent-shaped object represented as a compound line string made up of one straight line segment and one circular arc. Four points are required to represent this shape: points (10,10) and (10,14) describe the straight line segment, and points (10,14), (6,10), and (14,10) describe the circular arc.

Figure 2-5 Compound Line String



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-5:

- SDO_GTYPE = SDO_CURVE2D. The first indicates a two-dimensional line segment.
- SDO_SRID = NULL.
- SDO_POINT = NULL.
- SDO_ELEM_INFO = (1,4,2, 1,2,1, 3,2,2). There are three triplet elements: 1,4,2, 1,2,1, and 3,2,2.

  The first triplet indicates that this element is a compound line string made up of two subelement line strings, which are described with the next two triplets.

  The second triplet indicates that the line string is made up of straight line segments and that the ordinates for this line string start at offset 1. The end point of this line string is determined by the starting offset of the second line string, 3 in this instance.

  The third triplet indicates that the second line string is made up of circular arcs with ordinates starting at offset 3. The end point of this line string is determined by the starting offset of the next element or the current length of the SDO_ORDINATES array, if this is the last element.
- SDO_ORDINATES = (10,10, 10,14, 6,10, 14,10).

Example 2-10 shows a SQL statement that inserts the geometry illustrated in Figure 2-5 into the database.

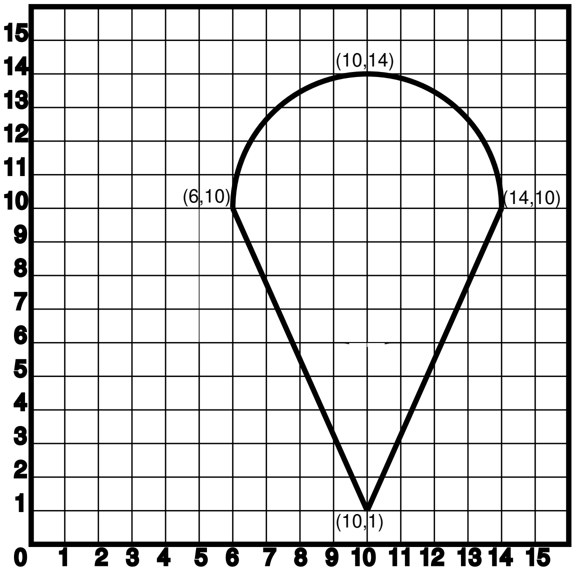
Example 2-10 SQL Statement to Insert a Compound Line String

```
INSERT INTO cola_markets VALUES(
  11,
  'compound_line_string',
  SDO_GEOMETRY(
    SDO_CURVE2D,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,4,2, 1,2,1, 3,2,2), -- compound line string
    SDO_ORDINATE_ARRAY(10,10, 10,14, 6,10, 14,10)
  )
);
```

2.7.4 Compound Polygon

Figure 2-6 illustrates an ice cream cone-shaped object represented as a compound polygon made up of one straight line segment and one circular arc. Five points are required to represent this shape: points (6,10), (10,1), and (14,10) describe one acute angle-shaped line string, and points (14,10), (10,14), and (6,10) describe the circular arc. The starting point of the line string and the ending point of the circular arc are the same point (6,10). The SDO_ELEM_INFO array contains three triplets for this compound line string. These triplets are {(1,1005,2), (1,2,1), (5,2,2)}.

Figure 2-6 Compound Polygon



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-6:

- SDO_GTYPE = SDO_POLYGON2D. This indicates a two-dimensional polygon.
- SDO_SRID = NULL.
- SDO_POINT = NULL.
- SDO_ELEM_INFO = (1,1005,2, 1,2,1, 5,2,2). There are three triplet elements: 1,1005,2, 1,2,1, and 5,2,2.

  The first triplet indicates that this element is a compound polygon made up of two subelement line strings, which are described using the next two triplets.

  The second triplet indicates that the first subelement line string is made up of straight line segments and that the ordinates for this line string start at offset 1. The end point of this line string is determined by the starting offset of the second line string, 5 in this instance. Because the vertices are two-dimensional, the coordinates for the end point of the first line string are at ordinates 5 and 6.

  The third triplet indicates that the second subelement line string is made up of a circular arc with ordinates starting at offset 5. The end point of this line string is determined by the starting offset of the next element or the current length of the SDO_ORDINATES array, if this is the last element.
- SDO_ORDINATES = (6,10, 10,1, 14,10, 10,14, 6,10).

Example 2-11 shows a SQL statement that inserts the geometry illustrated in Figure 2-6 into the database.

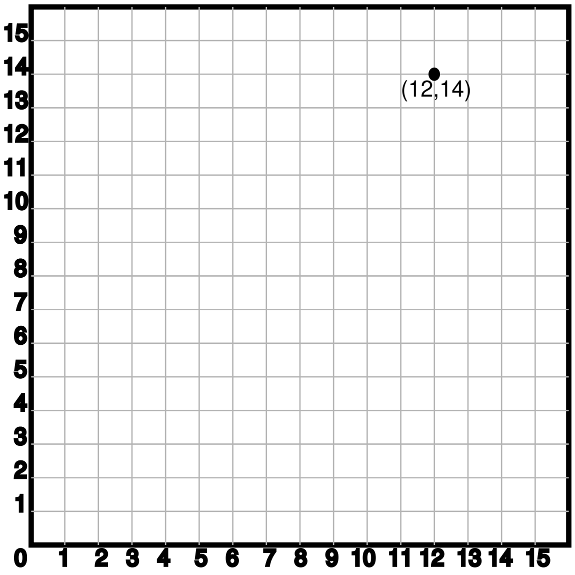
Example 2-11 SQL Statement to Insert a Compound Polygon

```
INSERT INTO cola_markets VALUES(
  12,
  'compound_polygon',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1005,2, 1,2,1, 5,2,2), -- compound polygon
    SDO_ORDINATE_ARRAY(6,10, 10,1, 14,10, 10,14, 6,10)
  )
);
```

2.7.5 Point

Figure 2-7 illustrates a point-only geometry at coordinates (12,14).

Figure 2-7 Point-Only Geometry



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-7:

- SDO_GTYPE = SDO_POINT2D. This indicates a two-dimensional single point.
- SDO_SRID = NULL.
- SDO_POINT = SDO_POINT_TYPE(12, 14, NULL). The SDO_POINT attribute is defined using the SDO_POINT_TYPE object type, because this is a point-only geometry.

  For more information about the SDO_POINT attribute, see SDO_POINT.
- SDO_ELEM_INFO and SDO_ORDINATES are both NULL, as required if the SDO_POINT attribute is specified.

Example 2-12 shows a SQL statement that inserts the geometry illustrated in Figure 2-7 into the database.

Example 2-12 SQL Statement to Insert a Point-Only Geometry

```
INSERT INTO cola_markets VALUES(
   90,
   'point_only',
   SDO_GEOMETRY(
      SDO_POINT2D,
      NULL,
      SDO_POINT_TYPE(12, 14, NULL),
      NULL,
      NULL));
```

You can search for point-only geometries based on the X, Y, and Z values in the SDO_POINT_TYPE specification. Example 2-13 is a query that asks for all points whose first coordinate (the X value) is 12, and it finds the point that was inserted in Example 2-12.

Example 2-13 Query for Point-Only Geometry Based on a Coordinate Value

```
SELECT * from cola_markets c WHERE c.shape.SDO_POINT.X = 12;

    MKT_ID NAME
---------- --------------------------------
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
        90 point_only
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(12, 14, NULL), NULL, NULL)
```

2.7.6 Oriented Point

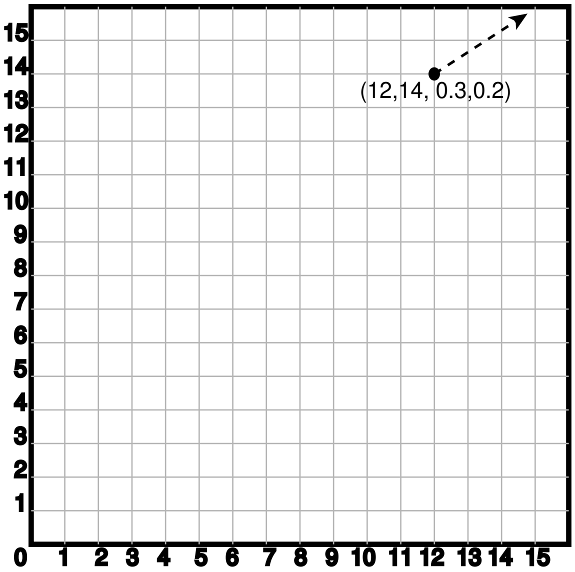
An **oriented point** is a special type of point geometry that includes coordinates representing the locations of the point and a virtual end point, to indicate an orientation vector that can be used for rotating a symbol at the point or extending a label from the point. The main use for an oriented point is in map visualization and display applications that include symbols, such as a shield symbol to indicate a highway.

To specify an oriented point:

- Use an SDO_GTYPE value (explained in SDO_GTYPE) for a point or multipoint geometry.
- Specify a null value for the SDO_POINT attribute.
- In the SDO_ELEM_INFO array (explained in SDO_ELEM_INFO), specify an additional triplet, with the second and third values (SDO_ETYPE and SDO_INTERPRETATION) as 1 and 0. For example, a triplet of 3,1,0 indicates that the point is an oriented point, with the third number in the SDO_ORDINATES array being the first coordinate, or x-axis value, of the end point reflecting the orientation vector for any symbol or label.
- In the SDO_ORDINATES array (explained in SDO_ORDINATES), specify the coordinates of the end point for the orientation vector from the point, with values between -1 and 1. The orientation start point is assumed to be (0,0), and it is translated to the location of the physical point to which it corresponds.

Figure 2-8 illustrates an oriented point geometry at coordinates (12,14), with an orientation vector of approximately 34 degrees (counterclockwise from the x-axis), reflecting the orientation coordinates 0.3,0.2. (To have an orientation that more precisely matches a specific angle, refer to the cotangent or tangent values in the tables in a trigonometry textbook.) The orientation vector in this example goes from (0,0) to (0.3,0.2) and extends onward. Assuming i=0.3 and j=0.2, the angle in radians can be calculated as follows: angle in radians = arctan (j/i). The angle is then applied to the physical point associated with the orientation vector.

Figure 2-8   Oriented Point Geometry



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-8:

- SDO_GTYPE = SDO_POINT2D. This indicates a two-dimensional single point.
- SDO_SRID = NULL.
- SDO_POINT = NULL.
- SDO_ELEM_INFO = (1,1,1, 3,1,0). The final *1,0* in 3,1,0 indicates that this is an oriented point.
- SDO_ORDINATES = (12,14, 0.3,0.2). The 12,14 identifies the physical coordinates of the point; and the 0.3,0.2 identifies the x and y coordinates (assuming 12,14 as the origin) of the end point of the orientation vector. The resulting orientation vector slopes upward at about a 34-degree angle.

Example 2-14 shows a SQL statement that inserts the geometry illustrated in Figure 2-8 into the database.

Example 2-14   SQL Statement to Insert an Oriented Point Geometry

```
INSERT INTO cola_markets VALUES(
  91,
  'oriented_point',
  SDO_GEOMETRY(
    SDO_POINT2D,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1,1, 3,1,0),
    SDO_ORDINATE_ARRAY(12,14, 0.3,0.2)));
```

The following guidelines apply to the definition of an oriented point:

- The numbers defining the orientation vector must be between -1 and 1. (In Example 2-14, these numbers are 0.3 and 0.2.)
- Multipoint oriented points are allowed (see Example 2-15), but the orientation information must follow the point being oriented.

The following considerations apply to the dimensionality of the orientation vector for an oriented point:

- A two-dimensional point has a two-dimensional orientation vector.
- A two-dimensional point with an LRS measure (SDO_GTYPE=3301) has a two-dimensional orientation vector.
- A three-dimensional point (SDO_GTYPE=SDO_POINT3D) has a three-dimensional orientation vector.
- A three-dimensional point with an LRS measure (SDO_GTYPE=4401) has a three-dimensional orientation vector.
- A four-dimensional point (SDO_GTYPE=4001) has a three-dimensional orientation vector.

Example 2-15 SQL Statement to Insert an Oriented Multipoint Geometry

Example 2-15 shows a SQL statement that inserts an oriented multipoint geometry into the database. The multipoint geometry contains two points, at coordinates (12,14) and (12, 10), with the two points having different orientation vectors. The statement is similar to the one in Example 2-14, but in Example 2-15 the second point has an orientation vector pointing down and to the left at 45 degrees (or, 135 degrees clockwise from the x-axis), reflecting the orientation coordinates -1,-1.

```
-- Oriented multipoint: 2 points, different orientations
INSERT INTO cola_markets VALUES(
  92,
  'oriented_multipoint',
  SDO_GEOMETRY(
    SDO_MULTIPOINT2D, -- Multipoint
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1,1, 3,1,0, 5,1,1, 7,1,0),
    SDO_ORDINATE_ARRAY(12,14, 0.3,0.2, 12,10, -1,-1)));
```

2.7.7 Type 0 (Zero) Element

Type 0 (zero) elements are used to model geometry types that are not supported by Oracle Spatial, such as curves and splines. A type 0 element has an SDO_ETYPE value of 0. (See SDO_ELEM_INFO for information about the SDO_ETYPE.) Type 0 elements are not indexed by Oracle Spatial, and they are ignored by spatial functions and procedures.

Geometries with type 0 elements must contain at least one nonzero element, that is, an element with an SDO_ETYPE value that is not 0. The nonzero element should be an approximation of the unsupported geometry, and therefore it must have both:

- An SDO_ETYPE value associated with a geometry type supported by Spatial
- An SDO_INTERPRETATION value that is valid for the SDO_ETYPE value (see Table 2-4)

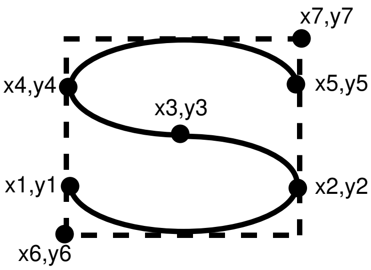
  (The SDO_INTERPRETATION value for the type 0 element can be any numeric value, and applications are responsible for determining the validity and significance of the value.)

The nonzero element is indexed by Spatial, and it will be returned by the spatial index.

The SDO_GTYPE value for a geometry containing a type 0 element must be set to the value for the geometry type of the nonzero element.

Figure 2-9 shows a geometry with two elements: a curve (unsupported geometry) and a rectangle (the nonzero element) that approximates the curve. The curve looks like the letter *S,* and the rectangle is represented by the dashed line.

Figure 2-9 Geometry with Type 0 (Zero) Element



In the example shown in Figure 2-9:

- The SDO_GTYPE value for the geometry is SDO_POLYGON2D (for a two-dimensional polygon).
- The SDO_ELEM_INFO array contains two triplets for this compound line string. For example, the triplets might be {(1,0,57), (11,1003,3)}. That is:

Ordinate Starting Offset (SDO_STARTING_OFFSET)	Element Type (SDO_ETYPE)	Interpretation (SDO_INTERPRETATION)
1	0	57
11	1003	3

In this example:

- The type 0 element has an SDO_ETYPE value of 0.
- The nonzero element (rectangle) has an SDO_ETYPE value of 1003, indicating an exterior polygon ring.
- The nonzero element has an SDO_STARTING_OFFSET value of 11 because ordinate x6 is the eleventh ordinate in the geometry.
- The type 0 element has an SDO_INTERPRETATION value whose significance is application-specific. In this example, the SDO_INTERPRETATION value is 57.
- The nonzero element has an SDO_INTERPRETATION value that is valid for the SDO_ETYPE of 1003. In this example, the SDO_INTERPRETATION value is 3, indicating a rectangle defined by two points (lower-left and upper-right).

Example 2-16 shows a SQL statement that inserts the geometry with a type 0 element (similar to the geometry illustrated in Figure 2-9) into the database. In the SDO_ORDINATE_ARRAY structure, the curve is defined by points (6,6), (12,6), (9,8), (6,10), and (12,10), and the rectangle is defined by points (6,4) and (12,12).

Example 2-16 SQL Statement to Insert a Geometry with a Type 0 Element

```
INSERT INTO cola_markets VALUES(
  13,
  'type_zero_element_geom',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,0,57, 11,1003,3), -- 1st is type 0 element
    SDO_ORDINATE_ARRAY(6,6, 12,6, 9,8, 6,10, 12,10, 6,4, 12,12)
  )
);
```

2.7.8 NURBS Curve

A NURBS (non-uniform rational B-spline) curve allows the representation of free-form shapes with arbitrary shapes. NURBS representation allows control over the shape of the curve because control points and knots guide the shape of the curve, and they allow complex shapes to be represented with little data. For an explanation of NURBS curves and the requirements for defining a NURBS curve geometry, see NURBS Curve Support in Oracle Spatial.

Example 2-17 shows a SQL statement that inserts a NURBS curve geometry into the database.

In the SDO_GEOMETRY definition of the geometry illustrated in Example 2-17:

- SDO_GTYPE = SDO_CURVE2D. This indicates a two-dimensional single line string.
- SDO_SRID = NULL. Note that geodetic NURBS curves are not permitted in Oracle Spatial.
- SDO_POINT = NULL.
- SDO_ELEM_INFO_ARRAY = (1,2,3). The SDO_INTERPRETATION value of 3 indicates a NURBS curve.
- In the SDO_ORDINATE_ARRAY, 3 is the degree of the NURBS curve, 7 is the number of weighted control points, and 11 in the number of knot values.

Example 2-17 SQL Statement to Insert a NURBS Curve Geometry

```
CREATE TABLE nurbs_test (gid  integer, geom sdo_geometry);

INSERT INTO nurbs_test values(
  1,
  SDO_GEOMETRY(
    SDO_CURVE2D,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1, 2, 3),  /* Element type 2 = SDO_ETYPE_CURVE and
Interpretation value 3 = NURBS curve */
    SDO_ORDINATE_ARRAY
      (3,        /* Degree of the NURBS curve */
       7,        /* Number of weighted Control Points */
       0, 0, 1,  /* x1, y1, w1 where w1 denotes the weight of the control point and x1,
y1 are weighted values. Implies the actual coordinate values have been multiplied by w1
*/
       -0.5, 1, 1,
       0.2, 2, 1,
       0.5, 3.5, 1,
       0.8, 2, 1,
       0.9, 1, 1,
       0.3, 0, 1,
       11,     /* Number of knot values = Number of control points + degree + 1 */
       0, 0, 0, 0,  0.25, 0.5, 0.75, 1.0, 1.0, 1.0, 1.0)));  /* Normalized knot vector;
values start at zero and end at 1. Clamped at end points as multiplicity of zero and one
is 4, which is equal to the degree of the curve + 1 */
```

Example 2-18 SQL Statement to Insert a NURBS Compound Curve Geometry

Example 2-18 shows the insertion of a compound curve geometry that has a NURBS segment. It uses the same NURBS_TEST table created in Example 2-17 .

```
INSERT INTO nurbs_test VALUES(
  1,
  SDO_GEOMETRY(SDO_CURVE2D, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 4, 2, 1, 2, 1, 5, 2, 3),
    SDO_ORDINATE_ARRAY(-1, -1, 0, 0, 3, 7, 0, 0, 1, -0.5, 1, 1,
      0.2, 2, 1, 0.5, 3.5, 1, 0.8, 2, 1, 0.9, 1, 1, 0.3,
      0, 1, 11, 0, 0, 0, 0, 0.25, 0.5, 0.75, 1.0, 1.0, 1.0, 1.0)
    ));
```

In the SDO_GEOMETRY definition of the geometry illustrated in Example 2-18:

- SDO_GTYPE = SDO_CURVE2D. This indicates a two-dimensional single line string.
- SDO_SRID = NULL. Note that geodetic NURBS curves are not permitted in Oracle Spatial.
- SDO_POINT = NULL.
- SDO_ELEM_INFO_ARRAY = (1, 4, 2, 1, 2, 1, 5, 2, 3). The first triplet indicates a compound line string (interpretation = 4) with two elements. The next two triplets define the segments of the compound line string: the first segment is a line string beginning at offset 1; the second segment is a NURBS segment beginning at offset 5.
- In the SDO_ORDINATE_ARRAY, the first 4 values define the first segment, which is a simple line string. For compound line strings containing at least one NURBS segment, the common vertices will be repeated across segments. In this example, the last point of the line string (0,0) must be equal to the first "clamped" point of the NURBS curve (0,0). The NURBS segment is defined beginning at offset 5 and the first control point is (0,0), which follows the degree (3) and the number of control points (7). The NURBS segment has 11 knot values.

2.7.9 Several Two-Dimensional Geometry Types

Example 2-19 creates a table and inserts various two-dimensional geometries, including multipoints (point clusters), multipolygons, and collections. At the end, it calls the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function to validate the inserted geometries. Note that some geometries are deliberately invalid, and their descriptions include the string `INVALID`.

Example 2-19   SQL Statements to Insert Various Two-Dimensional Geometries

```
CREATE TABLE t1 (
  i NUMBER,
  d VARCHAR2(50),
  g SDO_GEOMETRY
);
INSERT INTO t1 (i, d, g)
VALUES (
  1,
  'Point',
  sdo_geometry (SDO_POINT2D, null, null, sdo_elem_info_array (1,1,1),
    sdo_ordinate_array (10,5))
);
INSERT INTO t1 (i, d, g)
VALUES (
  2,
  'Line segment',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,1),
    sdo_ordinate_array (10,10, 20,10))
);
INSERT INTO t1 (i, d, g)
VALUES (
  3,
  'Arc segment',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,2),
    sdo_ordinate_array (10,15, 15,20, 20,15))
```

```
);
INSERT INTO t1 (i, d, g)
VALUES (
  4,
  'Line string',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,1),
    sdo_ordinate_array (10,25, 20,30, 25,25, 30,30))
);
INSERT INTO t1 (i, d, g)
VALUES (
  5,
  'Arc string',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,2),
    sdo_ordinate_array (10,35, 15,40, 20,35, 25,30, 30,35))
);
INSERT INTO t1 (i, d, g)
VALUES (
  6,
  'Compound line string',
  sdo_geometry (SDO_LINESTRING2D, null, null,
    sdo_elem_info_array (1,4,3, 1,2,1, 3,2,2, 7,2,1),
    sdo_ordinate_array (10,45, 20,45, 23,48, 20,51, 10,51))
);
INSERT INTO t1 (i, d, g)
VALUES (
  7,
  'Closed line string',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,1),
    sdo_ordinate_array (10,55, 15,55, 20,60, 10,60, 10,55))
);
INSERT INTO t1 (i, d, g)
VALUES (
  8,
  'Closed arc string',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,2),
    sdo_ordinate_array (15,65, 10,68, 15,70, 20,68, 15,65))
);
INSERT INTO t1 (i, d, g)
VALUES (
  9,
  'Closed mixed line',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,4,2, 1,2,1, 7,2,2),
    sdo_ordinate_array (10,78, 10,75, 20,75, 20,78, 15,80, 10,78))
);
INSERT INTO t1 (i, d, g)
VALUES (
  10,
  'Self-crossing line',
  sdo_geometry (SDO_LINESTRING2D, null, null, sdo_elem_info_array (1,2,1),
    sdo_ordinate_array (10,85, 20,90, 20,85, 10,90, 10,85))
);
INSERT INTO t1 (i, d, g)
VALUES (
  11,
  'Polygon',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,1),
    sdo_ordinate_array (10,105, 15,105, 20,110, 10,110, 10,105))
);
INSERT INTO t1 (i, d, g)
VALUES (
  12,
  'Arc polygon',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,2),
    sdo_ordinate_array (15,115, 20,118, 15,120, 10,118, 15,115))
);
INSERT INTO t1 (i, d, g)
VALUES (
  13,
  'Compound polygon',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1005,2, 1,2,1, 7,2,2),
    sdo_ordinate_array (10,128, 10,125, 20,125, 20,128, 15,130, 10,128))
);
INSERT INTO t1 (i, d, g)
VALUES (
  14,
  'Rectangle',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,3),
    sdo_ordinate_array (10,135, 20,140))
);
INSERT INTO t1 (i, d, g)
VALUES (
  15,
  'Circle',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,4),
    sdo_ordinate_array (15,145, 10,150, 20,150))
);
INSERT INTO t1 (i, d, g)
VALUES (
  16,
  'Point cluster',
  sdo_geometry (SDO_MULTIPOINT2D, null, null, sdo_elem_info_array (1,1,3),
    sdo_ordinate_array (50,5, 55,7, 60,5))
);
INSERT INTO t1 (i, d, g)
VALUES (
  17,
  'Multipoint',
  sdo_geometry (SDO_MULTIPOINT2D, null, null, sdo_elem_info_array (1,1,1, 3,1,1, 5,1,1),
    sdo_ordinate_array (65,5, 70,7, 75,5))
);
INSERT INTO t1 (i, d, g)
VALUES (
  18,
  'Multiline',
  sdo_geometry (SDO_MULTICURVE2D, null, null, sdo_elem_info_array (1,2,1, 5,2,1),
    sdo_ordinate_array (50,15, 55,15, 60,15, 65,15))
);
INSERT INTO t1 (i, d, g)
VALUES (
  19,
  'Multiline - crossing',
  sdo_geometry (SDO_MULTICURVE2D, null, null, sdo_elem_info_array (1,2,1, 5,2,1),
    sdo_ordinate_array (50,22, 60,22, 55,20, 55,25))
);
INSERT INTO t1 (i, d, g)
VALUES (
  20,
  'Multiarc',
  sdo_geometry (SDO_MULTICURVE2D, null, null, sdo_elem_info_array (1,2,2, 7,2,2),
    sdo_ordinate_array (50,35, 55,40, 60,35, 65,35, 70,30, 75,35))
);
INSERT INTO t1 (i, d, g)
VALUES (
  21,
  'Multiline - closed',
  sdo_geometry (SDO_MULTICURVE2D, null, null, sdo_elem_info_array (1,2,1, 9,2,1),
    sdo_ordinate_array (50,55, 50,60, 55,58, 50,55, 56,58, 60,55, 60,60, 56,58))
);
INSERT INTO t1 (i, d, g)
VALUES (
  22,
  'Multiarc - touching',
  sdo_geometry (SDO_MULTICURVE2D, null, null, sdo_elem_info_array (1,2,2, 7,2,2),
    sdo_ordinate_array (50,65, 50,70, 55,68, 55,68, 60,65, 60,70))
);
INSERT INTO t1 (i, d, g)
VALUES (
  23,
  'Multipolygon - disjoint',
  sdo_geometry (SDO_MULTIPOLYGON2D, null, null, sdo_elem_info_array (1,1003,1,
11,1003,3),
    sdo_ordinate_array (50,105, 55,105, 60,110, 50,110, 50,105, 62,108, 65,112))
);
INSERT INTO t1 (i, d, g)
VALUES (
  24,
  'Multipolygon - touching',
  sdo_geometry (SDO_MULTIPOLYGON2D, null, null, sdo_elem_info_array (1,1003,3,
5,1003,3),
    sdo_ordinate_array (50,115, 55,120, 55,120, 58,122))
);
INSERT INTO t1 (i, d, g)
VALUES (
  25,
  'Multipolygon - tangent * INVALID 13351',
  sdo_geometry (SDO_MULTIPOLYGON2D, null, null, sdo_elem_info_array (1,1003,3,
5,1003,3),
    sdo_ordinate_array (50,125, 55,130, 55,128, 60,132))
);
INSERT INTO t1 (i, d, g)
VALUES (
  26,
  'Multipolygon - multi-touch',
  sdo_geometry (SDO_MULTIPOLYGON2D, null, null, sdo_elem_info_array (1,1003,1,
17,1003,1),
    sdo_ordinate_array (50,95, 55,95, 53,96, 55,97, 53,98, 55,99, 50,99, 50,95,
      55,100, 55,95, 60,95, 60,100, 55,100))
);
INSERT INTO t1 (i, d, g)
VALUES (
  27,
  'Polygon with void',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,3, 5,2003,3),
    sdo_ordinate_array (50,135, 60,140, 51,136, 59,139))
);
INSERT INTO t1 (i, d, g)
VALUES (
  28,
  'Polygon with void - reverse',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,2003,3, 5,1003,3),
    sdo_ordinate_array (51,146, 59,149, 50,145, 60,150))
);
INSERT INTO t1 (i, d, g)
VALUES (
  29,
  'Crescent (straight lines) * INVALID 13349',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,1),
    sdo_ordinate_array (10,175, 10,165, 20,165, 15,170, 25,170, 20,165,
      30,165, 30,175, 10,175))
);
INSERT INTO t1 (i, d, g)
VALUES (
  30,
  'Crescent (arcs) * INVALID 13349',
  sdo_geometry (SDO_POLYGON2D, null, null, sdo_elem_info_array (1,1003,2),
    sdo_ordinate_array (14,180, 10,184, 14,188, 18,184, 14,180, 16,182,
      14,184, 12,182, 14,180))
);
INSERT INTO t1 (i, d, g)
VALUES (
  31,
  'Heterogeneous collection',
  sdo_geometry (SDO_COLLECTION2D, null, null, sdo_elem_info_array (1,1,1, 3,2,1,
7,1003,1),
    sdo_ordinate_array (10,5, 10,10, 20,10, 10,105, 15,105, 20,110, 10,110,
      10,105))
);
INSERT INTO t1 (i, d, g)
VALUES (
  32,
  'Polygon+void+island touch',
  sdo_geometry (SDO_MULTIPOLYGON2D, null, null,
    sdo_elem_info_array (1,1003,1, 11,2003,1, 31,1003,1),
    sdo_ordinate_array (50,168, 50,160, 55,160, 55,168, 50,168,  51,167,
      54,167, 54,161, 51,161, 51,162, 52,163, 51,164, 51,165, 51,166, 51,167,
      52,166, 52,162, 53,162, 53,166, 52,166))
);
COMMIT;
SELECT i, d, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT (g, 0.5) FROM t1;
```

2.7.10 Three-Dimensional Geometry Types

Note:

Three-dimensional geometry operations are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

Example 2-20 creates several tables (POINTS3D, LINES3D, and POLYGONS3D), and inserts three-dimensional objects into each table as appropriate (points into POINTS3D; lines into LINES3D; and polygons, surfaces, and solids into POLYGONS3D). Example 2-21 then creates the metadata and spatial indexes for the tables.

For information about support for three-dimensional geometries, see Three-Dimensional Spatial Objects.

Example 2-20 SQL Statements to Insert Three-Dimensional Geometries

```
create table points3d(id number, geometry sdo_geometry);
insert into points3d values(1, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(0,0,0), null, null));
insert into points3d values(2, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(1,1,1), null, null));
```

```
insert into points3d values(3, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(0,1,1), null, null));
insert into points3d values(4, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(0,0,1), null, null));
insert into points3d values(5, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(1,1,0), null, null));
insert into points3d values(6, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(1,0,1), null, null));
insert into points3d values(7, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(1,0,0), null, null));
insert into points3d values(8, sdo_geometry(SDO_POINT3D,null,
             sdo_point_type(0,1,0), null, null));
insert into points3d values(9, sdo_geometry(SDO_MULTIPOINT3D,null, null,
             sdo_elem_info_array(1,1,1, 4,1,1),
             sdo_ordinate_array(1,1,1, 0,0,0)));

create table lines3d(id number, geometry sdo_geometry);
insert into lines3d values(1, sdo_geometry(SDO_LINESTRING3D,null, null,
             sdo_elem_info_array(1,2,1),
             sdo_ordinate_array(1,1,1, 0,0,0)));
insert into lines3d values(2, sdo_geometry(SDO_LINESTRING3D,null, null,
             sdo_elem_info_array(1,2,1),
             sdo_ordinate_array(1,0,1, 0,1,0)));
insert into lines3d values(2, sdo_geometry(SDO_LINESTRING3D,null, null,
             sdo_elem_info_array(1,2,1),
             sdo_ordinate_array(0,1,1, 1,0,0)));
insert into lines3d values(3, sdo_geometry(SDO_LINESTRING3D,null, null,
             sdo_elem_info_array(1,2,1),
             sdo_ordinate_array(0,1,1, 1,0,0)));
insert into lines3d values(4, sdo_geometry(SDO_LINESTRING3D,null, null,
             sdo_elem_info_array(1,2,1),
             sdo_ordinate_array(0,1,0, 1,0,1)));

create table polygons3d(id number, geometry sdo_geometry);

-- Simple Polygon
-- All points have to be on the same plane.
insert into polygons3d values(1,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0
)));
insert into polygons3d values(2,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1003,1),
 SDO_Ordinate_Array(6.0,6.0,6.0,
5.0,6.0,10.0,
3.0,4.0,8.0,
4.0,4.0,4.0,
6.0,6.0,6.0
)));
insert into polygons3d values(3,
SDO_Geometry (SDO_MULTIPOLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1003,1,16,1003,1),
 SDO_Ordinate_Array(6.0,6.0,6.0,
5.0,6.0,10.0,
3.0,4.0,8.0,
4.0,4.0,4.0,
6.0,6.0,6.0,
0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0
)));
-- Polygon with a Hole (same rules as 2D) plus all points on the same plane
insert into polygons3d values(4,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1003,1,16,2003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5
)));
-- Surface with 2 3D polygons (on same plane)
insert into polygons3d values(5,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1006,2,1,1003,1,16,1003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,0.0,
0.0,0.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0
)));
-- Surface with 2 3D polygons (on two planes)
insert into polygons3d values(5,
SDO_Geometry(SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1006,2,1,1003,3,7,1003,3),
 SDO_Ordinate_Array(2,2,2,
4,4,2,
2,2,2,
4,2,4
)));
-- Surface with 2 3D polygons
-- First polygon has one ext and one int.
insert into polygons3d values(6,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1006,2,1,1003,1,16,2003,1,31,1003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0
)));
--3D Surface with 3 3D polygons
insert into polygons3d values(7,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1006,3,1,1003,1,16,1003,1,34,1003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
1.5,0.0,0.0,
2.5,0.0,0.0,
2.5,1.0,0.0,
1.5,0.0,0.0
)));
-- 3D surface with 3 3D polygons
insert into polygons3d values(8,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1006,3,1,1003,1,16,2003,1,31,1003,1,49,1003,1),
 SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
0.5,1.0,0.0,
0.5,2.0,0.0,
0.0,2.0,0.0,
0.0,1.0,0.0,
0.5,1.0,0.0
)));
-- Simple 3D polygon
insert into polygons3d values(9,
SDO_Geometry (SDO_POLYGON3D,NULL,NULL ,
 SDO_Elem_Info_Array(1,1003,1),
 SDO_Ordinate_Array(0.0,-4.0,1.0,
4.0,-4.0,1.0,
5.0,-3.0,1.0,
5.0,0.0,1.0,
3.0,1.0,1.0,
-1.0,1.0,1.0,
-3.0,0.5,1.0,
0.0,0.0,1.0,
-6.0,-2.0,1.0,
-6.0,-3.5,1.0,
-2.0,-3.5,1.0,
0.0,-4.0,1.0
)));
-- SOLID with 6 polygons
insert into polygons3d values(10,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,1,76
,1003,1),
 SDO_Ordinate_Array(1.0,0.0,-1.0,
1.0,1.0,-1.0,
1.0,1.0,1.0,
1.0,0.0,1.0,
1.0,0.0,-1.0,
1.0,0.0,1.0,
0.0,0.0,1.0,
0.0,0.0,-1.0,
1.0,0.0,-1.0,
1.0,0.0,1.0,
0.0,1.0,1.0,
0.0,1.0,-1.0,
0.0,0.0,-1.0,
0.0,0.0,1.0,
0.0,1.0,1.0,
1.0,1.0,-1.0,
0.0,1.0,-1.0,
0.0,1.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
1.0,1.0,1.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
1.0,0.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
1.0,0.0,-1.0,
0.0,0.0,-1.0,
0.0,1.0,-1.0,
1.0,1.0,-1.0
)));
-- Simple SOLID with 6 polygons
-- All polygons are described using the optimized rectangle representation.
insert into polygons3d values(11,
SDO_Geometry (3008,NULL,NULL ,
SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,3,7,1003,3,13,1003,3,19,1003,3,25,1003,3,31,
1003,3),
SDO_Ordinate_Array(1.0,0.0,-1.0,
1.0,1.0,1.0,
1.0,0.0,1.0,
0.0,0.0,-1.0,
0.0,1.0,1.0,
0.0,0.0,-1.0,
0.0,1.0,-1.0,
1.0,1.0,1.0,
0.0,0.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
0.0,0.0,-1.0
)));
-- Multi-Solid
-- Both solids use optimized representation.
insert into polygons3d values(12,
SDO_Geometry (3009,NULL,NULL ,
 SDO_Elem_Info_Array(1,1007,3,7,1007,3),
 SDO_Ordinate_Array(-2.0,1.0,3.0,
-3.0,-1.0,0.0,
0.0,0.0,0.0,
1.0,1.0,1.0
)));
-- Multi-Solid - like multipolygon in 2D
-- disjoint solids
insert into polygons3d values(13,
SDO_Geometry (3009,NULL,NULL ,
SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,1,76
,1003,1,91,1007,1,91,1006,7,91,1003,1,106,1003,1,121,1003,1,136,1003,1,151,1003,1,166,100
3,1,184,1003,1),
SDO_Ordinate_Array(1.0,0.0,4.0,
1.0,1.0,4.0,
1.0,1.0,6.0,
1.0,0.0,6.0,
1.0,0.0,4.0,
1.0,0.0,6.0,
0.0,0.0,6.0,
0.0,0.0,4.0,
1.0,0.0,4.0,
1.0,0.0,6.0,
0.0,1.0,6.0,
0.0,1.0,4.0,
0.0,0.0,4.0,
0.0,0.0,6.0,
0.0,1.0,6.0,
1.0,1.0,4.0,
0.0,1.0,4.0,
0.0,1.0,6.0,
1.0,1.0,6.0,
1.0,1.0,4.0,
1.0,1.0,6.0,
0.0,1.0,6.0,
0.0,0.0,6.0,
1.0,0.0,6.0,
1.0,1.0,6.0,
1.0,1.0,4.0,
1.0,0.0,4.0,
0.0,0.0,4.0,
0.0,1.0,4.0,
1.0,1.0,4.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.0,2.0,0.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,0.0,
2.0,0.0,0.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,-2.0,0.0,
4.5,-2.0,0.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,2.0,3.0,
-2.0,2.0,0.0,
-2.0,-2.0,0.0,
-2.0,-2.0,3.0,
4.0,2.0,3.0,
4.0,2.0,0.0,
-2.0,2.0,0.0,
-2.0,2.0,3.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.0,2.0,3.0,
-2.0,2.0,3.0,
-2.0,-2.0,3.0,
4.5,-2.0,3.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.5,-2.0,0.0,
-2.0,-2.0,0.0,
-2.0,2.0,0.0,
4.0,2.0,0.0,
2.0,0.0,0.0
)));

-- SOLID with a hole
-- etype = 1007 exterior solid
-- etype = 2007 is interior solid
-- All polygons of etype=2007 are described as 2003's.
insert into polygons3d values(14,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1007,1,1,1006,7,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,1,76
,1003,1,94,1003,1,112,2006,6,112,2003,1,127,2003,1,142,2003,1,157,2003,1,172,2003,1,187,2
003,1),
 SDO_Ordinate_Array(2.0,0.0,3.0,
2.0,0.0,0.0,
4.0,2.0,0.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,0.0,
2.0,0.0,0.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,-2.0,0.0,
4.5,-2.0,0.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,2.0,3.0,
-2.0,2.0,0.0,
-2.0,-2.0,0.0,
-2.0,-2.0,3.0,
4.0,2.0,3.0,
4.0,2.0,0.0,
-2.0,2.0,0.0,
-2.0,2.0,3.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.0,2.0,3.0,
-2.0,2.0,3.0,
-2.0,-2.0,3.0,
4.5,-2.0,3.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.5,-2.0,0.0,
-2.0,-2.0,0.0,
-2.0,2.0,0.0,
4.0,2.0,0.0,
2.0,0.0,0.0,
1.0,1.0,2.5,
-1.0,1.0,2.5,
-1.0,1.0,0.5,
1.0,1.0,0.5,
1.0,1.0,2.5,
-1.0,1.0,2.5,
-1.0,-1.0,2.5,
-1.0,-1.0,0.5,
-1.0,1.0,0.5,
-1.0,1.0,2.5,
-1.0,-1.0,2.5,
1.0,-1.0,2.5,
1.0,-1.0,0.5,
-1.0,-1.0,0.5,
-1.0,-1.0,2.5,
1.0,-1.0,2.5,
1.0,1.0,2.5,
1.0,1.0,0.5,
1.0,-1.0,0.5,
1.0,-1.0,2.5,
-1.0,-1.0,2.5,
-1.0,1.0,2.5,
1.0,1.0,2.5,
1.0,-1.0,2.5,
-1.0,-1.0,2.5,
1.0,1.0,0.5,
-1.0,1.0,0.5,
-1.0,-1.0,0.5,
1.0,-1.0,0.5,
1.0,1.0,0.5
)));
-- Gtype = SOLID
-- The elements make up one composite solid (non-disjoint solids) like a cube
-- on a cube on a cube.
-- This is made up of two solid elements.
-- Each solid element here is a simple solid.
insert into polygons3d values(15,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1008,2,1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,
1003,1,76,1003,1,91,1007,1,91,1006,7,91,1003,1,106,1003,1,121,1003,1,136,1003,1,151,1003,
1,166,1003,1,184,1003,1),
 SDO_Ordinate_Array(-2.0,1.0,3.0,
-2.0,1.0,0.0,
-3.0,1.0,0.0,
-3.0,1.0,3.0,
-2.0,1.0,3.0,
-3.0,1.0,3.0,
-3.0,1.0,0.0,
-3.0,-1.0,0.0,
-3.0,-1.0,3.0,
-3.0,1.0,3.0,
-3.0,-1.0,3.0,
-3.0,-1.0,0.0,
-2.0,-1.0,0.0,
-2.0,-1.0,3.0,
-3.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,-1.0,0.0,
-2.0,1.0,0.0,
-2.0,1.0,3.0,
-2.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,1.0,3.0,
-3.0,1.0,3.0,
-3.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,1.0,0.0,
-2.0,-1.0,0.0,
-3.0,-1.0,0.0,
-3.0,1.0,0.0,
-2.0,1.0,0.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.0,2.0,0.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,0.0,
2.0,0.0,0.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,-2.0,0.0,
4.5,-2.0,0.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,2.0,3.0,
-2.0,2.0,0.0,
-2.0,-2.0,0.0,
-2.0,-2.0,3.0,
4.0,2.0,3.0,
4.0,2.0,0.0,
-2.0,2.0,0.0,
-2.0,2.0,3.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.0,2.0,3.0,
-2.0,2.0,3.0,
-2.0,-2.0,3.0,
4.5,-2.0,3.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.5,-2.0,0.0,
-2.0,-2.0,0.0,
-2.0,2.0,0.0,
4.0,2.0,0.0,
2.0,0.0,0.0
)));
```

Example 2-21 Updating Metadata and Creating Indexes for 3-Dimensional Geometries

Example 2-21 updates the USER_SDO_GEOM_METADATA view with the necessary information about the tables created in Example 2-20 (POINTS3D, LINES3D, and POLYGONS3D), and it creates a spatial index on the geometry column (named GEOMETRY) in each table. The indexes are created with the `PARAMETERS ('sdo_indx_dims=3')` clause, to ensure that all three dimensions are considered in operations that are supported on three-dimensional geometries.

```
INSERT INTO user_sdo_geom_metadata VALUES('POINTS3D', 'GEOMETRY',
  sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),
  sdo_dim_element('Y', -100,100, 0.000005),
  sdo_dim_element('Z', -100,100, 0.000005)), NULL);

CREATE INDEX points3d_sidx on points3d(geometry)
  INDEXTYPE IS mdsys.spatial_index_v2
  PARAMETERS ('sdo_indx_dims=3');

INSERT INTO user_sdo_geom_metadata VALUES('LINES3D', 'GEOMETRY',
  sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),
  sdo_dim_element('Y', -100,100, 0.000005),
  sdo_dim_element('Z', -100,100, 0.000005)), NULL);

CREATE INDEX lines3d_sidx on lines3d(geometry)
  INDEXTYPE IS mdsys.spatial_index_v2
  PARAMETERS ('sdo_indx_dims=3');

INSERT INTO user_sdo_geom_metadata VALUES('POLYGONS3D', 'GEOMETRY',
  sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),
  sdo_dim_element('Y', -100,100, 0.000005),
  sdo_dim_element('Z', -100,100, 0.000005)), NULL);

CREATE INDEX polygons3d_sidx on polygons3d(geometry)
  INDEXTYPE IS mdsys.spatial_index_v2
  PARAMETERS ('sdo_indx_dims=3');
```

2.8 Geometry Metadata Views

The geometry metadata describing the dimensions, lower and upper bounds, and tolerance in each dimension is stored in a global table owned by MDSYS (which users should never directly update). Each Spatial user has the following views available in the schema associated with that user.

- USER_SDO_GEOM_METADATA contains metadata information for all spatial tables owned by the user (schema). This is the only view that you can update, and it is the one in which Spatial users must insert metadata related to spatial tables.
- ALL_SDO_GEOM_METADATA contains metadata information for all spatial tables on which the user has SELECT permission.

Spatial users are responsible for populating these views. For each spatial column, you must insert an appropriate row into the USER_SDO_GEOM_METADATA view. However, effective with Release 23ai, if you do not update the spatial metadata, then Oracle Spatial will automatically create it when you create the spatial index, using a default tolerance value of 0.05. Note that the spatial table needs to be populated with at least one non-`NULL` geometry row for Oracle Spatial to create the required metadata. It is also ensured that the ALL_SDO_GEOM_METADATA view is updated to reflect the rows that are inserted in USER_SDO_GEOM_METADATA.

Each metadata view has the following definition:

```
(
  TABLE_NAME    VARCHAR2(32),
  COLUMN_NAME   VARCHAR2(32),
  DIMINFO       SDO_DIM_ARRAY,
  SRID          NUMBER
);
```

In addition, the ALL_SDO_GEOM_METADATA view has an OWNER column identifying the schema that owns the table specified in TABLE_NAME.

The following considerations apply to schema, table, column, and index names, and to any SDO_DIMNAME values, that are stored in any Oracle Spatial metadata views:

- They must contain only letters, numbers, and underscores. For example, such a name cannot contain a space ( ), an apostrophe (`'`), a quotation mark (`"`), or a comma (`,`).
- All letters in the names are converted to uppercase before the names are stored in geometry metadata views or before the tables are accessed. This conversion also applies to any schema name specified with the table name.

> **Note:**
>
> Letter case conversion does not apply if you use mixed case (“CamelCase”) names enclosed in quotation marks. However, be aware that many experts recommend against using mixed-case names.

- TABLE_NAME
- COLUMN_NAME
- DIMINFO
- SRID

2.8.1 TABLE_NAME

The TABLE_NAME column contains the name of a feature table, such as COLA_MARKETS, that has a column of type SDO_GEOMETRY.

The table name is stored in the spatial metadata views in all uppercase characters.

The table name cannot contain spaces or mixed-case letters in a quoted string when inserted into the USER_SDO_GEOM_METADATA view, and it cannot be in a quoted string when used in a query (unless it is in all uppercase characters).

The spatial feature table cannot be an index-organized table if you plan to create a spatial index on the spatial column.

2.8.2 COLUMN_NAME

The COLUMN_NAME column contains the name of the column of type SDO_GEOMETRY. For the COLA_MARKETS table, this column is called SHAPE.

The column name is stored in the spatial metadata views in all uppercase characters.

The column name cannot contain spaces or mixed-case letters in a quoted string when inserted into the USER_SDO_GEOM_METADATA view, and it cannot be in a quoted string when used in a query (unless it is in all uppercase characters).

2.8.3 DIMINFO

The DIMINFO column is a varying length array of an object type, ordered by dimension, and has one entry for each dimension. The SDO_DIM_ARRAY type is defined as follows:

```
Create Type SDO_DIM_ARRAY as VARRAY(4) of SDO_DIM_ELEMENT;
```

The SDO_DIM_ELEMENT type is defined as:

```
Create Type SDO_DIM_ELEMENT as OBJECT (
  SDO_DIMNAME VARCHAR2(64),
  SDO_LB NUMBER,
  SDO_UB NUMBER,
  SDO_TOLERANCE NUMBER);
```

The SDO_DIM_ARRAY instance is of size *n* if there are *n* dimensions. That is, DIMINFO contains 2 SDO_DIM_ELEMENT instances for two-dimensional geometries, 3 instances for three-dimensional geometries, and 4 instances for four-dimensional geometries. Each SDO_DIM_ELEMENT instance in the array must have valid (not null) values for the SDO_LB, SDO_UB, and SDO_TOLERANCE attributes.

> **Note:**
>
> The number of dimensions reflected in the DIMINFO information must match the number of dimensions of each geometry object in the layer.

For an explanation of tolerance and how to determine the appropriate SDO_TOLERANCE value, see Tolerance, especially Tolerance in the Geometry Metadata for a Layer.

Spatial assumes that the varying length array is ordered by dimension. The DIMINFO varying length array must be ordered by dimension in the same way the ordinates for the points in SDO_ORDINATES varying length array are ordered. For example, if the SDO_ORDINATES varying length array contains {X1, Y1, ..., X*n*, Y*n*}, then the first DIMINFO entry must define the X dimension and the second DIMINFO entry must define the Y dimension.

Simple Example: Inserting, Indexing, and Querying Spatial Data shows the use of the SDO_GEOMETRY and SDO_DIM_ARRAY types. That example demonstrates how geometry objects (hypothetical market areas for colas) are represented, and how the COLA_MARKETS feature table and the USER_SDO_GEOM_METADATA view are populated with the data for those objects.

- SQL Functions for Min/Max of X/Y/Z Dimensions of a Geometry

2.8.3.1 SQL Functions for Min/Max of X/Y/Z Dimensions of a Geometry

You can use the following SQL functions to find the minimum and maximum X, Y, and Z dimension values for data in a spatial column in a table:

```
SDO_GEOM_MIN_X(<column-name>)
SDO_GEOM_MIN_Y(<column-name>)
SDO_GEOM_MIN_Z(<column-name>)
SDO_GEOM_MAX_X(<column-name>)
```

```
SDO_GEOM_MAX_Y(<column-name>)
SDO_GEOM_MAX_Z(<column-name>)
```

The following examples return the minimum and maximum X dimension values, and the minimum and maximum Y dimension values, of the geometry object named cola_c in the COLA_MARKETS table:

```
SQL> select SDO_GEOM_MIN_X(SHAPE), SDO_GEOM_MAX_X(SHAPE) from cola_markets
where name = 'cola_c';

SDO_GEOM_MIN_X(SHAPE) SDO_GEOM_MAX_X(SHAPE)
--------------------- ---------------------
             3.0E+000              6.0E+000

SQL> select SDO_GEOM_MIN_Y(SHAPE), SDO_GEOM_MAX_Y(SHAPE) from cola_markets
where name = 'cola_c';

SDO_GEOM_MIN_Y(SHAPE) SDO_GEOM_MAX_Y(SHAPE)
--------------------- ---------------------
             3.0E+000              5.0E+000
```

2.8.4 SRID

The SRID column should contain either of the following: the SRID value for the coordinate system for all geometries in the column, or NULL if no specific coordinate system should be associated with the geometries.

Related Topics

- Coordinate Systems (Spatial Reference Systems)

2.9 Other Spatial Metadata Views

Oracle Spatial uses the following other metadata views.

- USER_SDO_3DTHEMES and ALL_SDO_3DTHEMES contain information about three-dimensional themes.
- USER_SDO_SCENES and ALL_SDO_SCENES contain information about scenes.
- USER_SDO_VIEWFRAMES and ALL_SDO_VIEWFRAMES contain information about viewframes.

The USER_SDO_xxx views contain metadata information about objects owned by the user (schema), and the ALL_SDO_xxx views contain metadata information about objects on which the user has SELECT permission.

The ALL_SDO_xxx views include an OWNER column that identifies the schema of the owner of the object. The USER_SDO_xxx views do not include an OWNER column.

- xxx_SDO_3DTHEMES Views
- xxx_SDO_SCENES Views
- xxx_SDO_VIEWFRAMES Views

2.9.1 xxx_SDO_3DTHEMES Views

The USER_SDO_3DTHEMES and ALL_SDO_3DTHEMES views have the columns listed in Table 2-10.

Table 2-10 xxx_SDO_3DTHEMES Views

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the theme (ALL_SDO_3DTHEMES only)
NAME	VARCHAR2(32)	Unique name to be associated with the theme
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the theme
BASE_TABLE	VARCHAR2(64)	Table or view containing the spatial geometry column
THEME_COLUMN	VARCHAR2(2048)	Name of the theme column
STYLE_COLUMN	VARCHAR2(32)	Name of the style column
THEME_TYPE	VARCHAR2(32)	Theme type
DEFINITION	CLOB	XML definition of the theme

2.9.2 xxx_SDO_SCENES Views

The USER_SDO_SCENES and ALL_SDO_SCENES views have the columns listed in Table 2-11.

Table 2-11 xxx_SDO_SCENES Views

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the scene (ALL_SDO_SCENES only)
NAME	VARCHAR2(32)	Unique name to be associated with the scene
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the scene
DEFINITION	CLOB	XML definition of the scene

2.9.3 xxx_SDO_VIEWFRAMES Views

The USER_SDO_VIEWFRAMES and ALL_SDO_VIEWFRAMES views have the columns listed in Table 2-12.

Table 2-12 xxx_SDO_VIEWFRAMES Views

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the scene (ALL_SDO_VIEWFRAMES only)
NAME	VARCHAR2(32)	Unique name to be associated with the viewframe
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the viewframe
SCENE_NAME	VARCHAR2(32)	Name of the scene associated with the viewframe
DEFINITION	CLOB	XML definition of the viewframe

2.10 Spatial Index-Related Structures

This topic describes the structure of the tables containing the spatial index data and metadata.

Concepts and usage notes for spatial indexing are explained in Indexing of Spatial Data. The spatial index data and metadata are stored in tables that are created and maintained by the Spatial indexing routines. These tables are created in the schema of the owner of the feature (underlying) table that has a spatial index created on a column of type SDO_GEOMETRY.

Spatial index names have the same restrictions and considerations as names for spatial tables and columns and for schemas containing them, as explained in Geometry Metadata Views.

- Spatial Index Views
- Spatial Index Table Definition
- R-Tree Index Sequence Object

2.10.1 Spatial Index Views

There are two sets of spatial index metadata views for each schema (user): *xxx*_SDO_INDEX_INFO and *xxx*_SDO_INDEX_METADATA, where *xxx* can be USER or ALL. These views are read-only to users; they are created and maintained by the Spatial indexing routines.

- xxx_SDO_INDEX_INFO Views
- xxx_SDO_INDEX_METADATA Views

2.10.1.1 xxx_SDO_INDEX_INFO Views

The following views contain basic information about spatial indexes:

- USER_SDO_INDEX_INFO contains index information for all spatial tables owned by the user.
- ALL_SDO_INDEX_INFO contains index information for all spatial tables on which the user has SELECT permission.

The USER_SDO_INDEX_INFO and ALL_SDO_INDEX_INFO views contain the same columns, as shown Table 2-13, except that the USER_SDO_INDEX_INFO view does not contain the SDO_INDEX_OWNER column. (The columns are listed in their order in the view definition.)

Table 2-13 Columns in the xxx_SDO_INDEX_INFO Views

Column Name	Data Type	Purpose
SDO_INDEX_OWNER	VARCHAR2	Owner of the index (ALL_SDO_INDEX_INFO view only).
INDEX_NAME	VARCHAR2	Name of the index.
TABLE_OWNER	VARCHAR2	Name of the owner of the table containing the column on which this index is built.
TABLE_NAME	VARCHAR2	Name of the table containing the column on which this index is built.
COLUMN_NAME	VARCHAR2	Name of the column on which this index is built.
SDO_INDEX_TYPE	VARCHAR2	Contains RTREE (for an R-tree index).

Table 2-13 (Cont.) Columns in the xxx_SDO_INDEX_INFO Views

Column Name	Data Type	Purpose
SDO_INDEX_TABLE	VARCHAR2	Name of the spatial index table (described in Spatial Index Table Definition).
SDO_INDEX_STATUS	VARCHAR2	(Reserved for Oracle use.)

2.10.1.2 xxx_SDO_INDEX_METADATA Views

The following views contain detailed information about spatial index metadata:

- USER_SDO_INDEX_METADATA contains index information for all spatial tables owned by the user.
- ALL_SDO_INDEX_METADATA contains index information for all spatial tables on which the user has SELECT permission.

The USER_SDO_INDEX_METADATA and ALL_SDO_INDEX_METADATA views contain the same columns, as shown Table 2-14. (The columns are listed in their order in the view definition.)

Table 2-14 Columns in the xxx_SDO_INDEX_METADATA Views

Column Name	Data Type	Purpose
SDO_INDEX_OWNER	VARCHAR2	Owner of the index.
SDO_INDEX_TYPE	VARCHAR2	Contains RTREE (for an R-tree index).
SDO_LEVEL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_NUMTILES	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_MAXLEVEL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_COMMIT_INTERVAL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_INDEX_TABLE	VARCHAR2	Name of the spatial index table (described in Spatial Index Table Definition).
SDO_INDEX_NAME	VARCHAR2	Name of the index.
SDO_INDEX_PRIMARY	NUMBER	Indicates if this is a primary or secondary index. 1 = primary, 2 = secondary.
SDO_TSNAME	VARCHAR2	Schema name of the SDO_INDEX_TABLE.
SDO_COLUMN_NAME	VARCHAR2	Name of the column on which this index is built.
SDO_RTREE_HEIGHT	NUMBER	Height of the R-tree.
SDO_RTREE_NUM_NODES	NUMBER	Number of nodes in the R-tree.
SDO_RTREE_DIMENSIONALITY	NUMBER	Number of dimensions used internally by Spatial. This may be different from the number of dimensions indexed, which is controlled by the `sdo_indx_dims` keyword in the CREATE INDEX or ALTER INDEX statement, and which is stored in the SDO_INDEX_DIMS column in this view. For example, for an index on geodetic data, the SDO_RTREE_DIMENSIONALITY value is 3, but the SDO_INDEX_DIMS value is 2.
SDO_RTREE_FANOUT	NUMBER	Maximum number of children in each R-tree node.

Table 2-14 (Cont.) Columns in the xxx_SDO_INDEX_METADATA Views

Column Name	Data Type	Purpose
SDO_RTREE_ROOT	VARCHAR2	Rowid corresponding to the root node of the R-tree in the index table.
SDO_RTREE_SEQ_NAME	VARCHAR2	Sequence name associated with the R-tree.
SDO_FIXED_META	RAW	If applicable, this column contains the metadata portion of the SDO_GROUPCODE or SDO_CODE for a fixed-level index.
SDO_TABLESPACE	VARCHAR2	Same as in the SQL CREATE TABLE statement. Tablespace in which to create the SDOINDEX table.
SDO_INITIAL_EXTENT	VARCHAR2	Same as in the SQL CREATE TABLE statement.
SDO_NEXT_EXTENT	VARCHAR2	Same as in the SQL CREATE TABLE statement.
SDO_PCTINCREASE	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_MIN_EXTENTS	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_MAX_EXTENTS	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_INDEX_DIMS	NUMBER	Number of dimensions of the geometry objects in the column on which this index is built, as determined by the value of the `sdo_indx_dims` keyword in the CREATE INDEX or ALTER INDEX statement.
SDO_LAYER_GTYPE	VARCHAR2	Contains DEFAULT if the layer can contain both point and polygon data, or a value from the Geometry Type column of Valid SDO_GTYPE Values in SDO_GTYPE.
SDO_RTREE_PCTFREE	NUMBER	Minimum percentage of slots in each index tree node to be left empty when an R-tree index is created.
SDO_INDEX_PARTITION	VARCHAR2	For a partitioned index, name of the index partition.
SDO_PARTITIONED	NUMBER	Contains 0 if the index is not partitioned or 1 if the index is partitioned.
SDO_RTREE_QUALITY	NUMBER	Quality score for an index. See the information about R-tree quality in R-Tree Quality.
SDO_INDEX_VERSION	NUMBER	Internal version number of the index.
SDO_INDEX_GEODETIC	VARCHAR2	Contains TRUE if the index is geodetic and FALSE if the index is not geodetic.
SDO_INDEX_STATUS	VARCHAR2	(Reserved for Oracle use.)
SDO_NL_INDEX_TABLE	VARCHAR2	Name of a separate index table (with a name in the form MDNT_...$) for nonleaf nodes of the index. For more information, see the description of the `sdo_non_leaf_tbl` parameter for the CREATE INDEX statement in SQL Statements for Indexing Spatial Data.
SDO_DML_BATCH_SIZE	NUMBER	Number of index updates to be processed in each batch of updates after a commit operation. For more information, see the description of the `sdo_dml_batch_size` parameter for the CREATE INDEX statement in SQL Statements for Indexing Spatial Data.
SDO_RTREE_EXT_XPND	NUMBER	(Reserved for future use.)

Table 2-14 (Cont.) Columns in the xxx_SDO_INDEX_METADATA Views

Column Name	Data Type	Purpose
SDO_NUM_ROWS	NUMBER	Number of rows (with non-null geometries) in the base spatial table (table containing the column on which this index is built).
SDO_NUM_BLKS	NUMBER	Number of blocks in the spatial index table (SDO_INDEX_TABLE),
SDO_ROOT_MBR	SDO_GEOMETRY	Minimum bounding rectangle of the maximum extent of the spatial layer. This is greater than or equal to the MBR of the current extent, and is reset to reflect the current extent when the index is rebuilt.

2.10.2 Spatial Index Table Definition

For an R-tree index, a spatial index table (each SDO_INDEX_TABLE entry as described in xxx_SDO_INDEX_METADATA Views) contains the columns shown in Table 2-15.

Table 2-15 Columns in an R-Tree Spatial Index Data Table

Column Name	Data Type	Purpose
NODE_ID	NUMBER	Unique ID number for this node of the tree.
NODE_LEVEL	NUMBER	Level of the node in the tree. Leaf nodes (nodes whose entries point to data items in the base table) are at level 1, their parent nodes are at level 2, and so on.
INFO	BLOB	Other information in a node. Includes an array of `<child_mbr, child_rowid>` pairs (maximum of fanout value, or number of children for such pairs in each R-tree node), where `child_rowid` is the rowid of a child node, or the rowid of a data item from the base table.

2.10.3 R-Tree Index Sequence Object

Each R-tree spatial index table has an associated sequence object (SDO_RTREE_SEQ_NAME in the USER_SDO_INDEX_METADATA view, described inxxx_SDO_INDEX_METADATA Views). The sequence is used to ensure that simultaneous updates can be performed to the index by multiple concurrent users.

The sequence name is the index table name with the letter *S* replacing the letter *T* before the underscore (for example, the sequence object MDRS_5C01$ is associated with the index table MDRT_5C01$).

2.11 Unit of Measurement Support

Geometry functions that involve measurement allow an optional `unit` parameter to specify the unit of measurement for a specified distance or area, if a georeferenced coordinate system (SDO_SRID value) is associated with the input geometry or geometries.

The `unit` parameter is not valid for geometries with a null SDO_SRID value (that is, an orthogonal Cartesian system). For information about support for coordinate systems, see Coordinate Systems (Spatial Reference Systems).

The default unit of measure is the one associated with the georeferenced coordinate system. The unit of measure for most coordinate systems is the meter, and in these cases the default unit for distances is meter and the default unit for areas is square meter. By using the `unit` parameter, however, you can have Spatial automatically convert and return results that are more meaningful to application users, for example, displaying the distance to a restaurant in miles.

The `unit` parameter must be enclosed in single quotation marks and contain the string `unit=` and a valid UNIT_OF_MEAS_NAME value from the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table). For example, 'unit=KM' in the following example (using data and definitions from Example 6-17 in Example of Coordinate System Transformation) specifies kilometers as the unit of measurement:

```
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo, 'unit=KM')
  FROM cola_markets_cs c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE';
```

Spatial uses the information in the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table) to determine which unit names are valid and what ratios to use in comparing or converting between different units. For convenience, you can also use the following legacy views to see the angle, area, and distance units of measure:

- MDSYS.SDO_ANGLE_UNITS (described in MDSYS.SDO_ANGLE_UNITS View)
- MDSYS.SSDO_AREA_UNITS (described in MDSYS.SDO_AREA_UNITS View)
- MDSYS.SSDO_DIST_UNITS (described in MDSYS.SDO_DIST_UNITS View)
- Creating a User-Defined Unit of Measurement

2.11.1 Creating a User-Defined Unit of Measurement

If the area and distance units of measurement supplied by Oracle are not sufficient for your needs, you can create user-defined area and distance units. (You cannot create a user-defined angle unit.) To do so, you must connect to the database as a user that has been granted the DBA role, and insert a row for each desired unit to the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table)

Table 2-16 lists the columns in the SDO_UNITS_OF_MEASURE table and the requirements and recommendations for each if you are inserting a row for a user-defined unit of measurement.

Table 2-16   SDO_UNITS_OF_MEASURE Table Entries for User-Defined Unit

Column Name	Description
UOM_ID	Any unit of measure ID number not currently used for an Oracle-supplied unit or another user-defined unit. Example: `1000001`
UNIT_OF_MEAS_NAME	Name of the user-defined unit of measurement. Example: `HALF_METER`
SHORT_NAME	Optional short name (if any) of the unit of measurement.
UNIT_OF_MEAS_TYPE	Type of measure for which the unit is used. Must be either `area` (for an area unit) or `length` (for a distance unit).
TARGET_UOM_ID	Optional, but for support purposes you should enter one of the following: `10008` for an area unit (10008 = UOM_ID for SQ_METER) or `10032` for a distance unit (10032 = UOM_ID for METER).

Table 2-16 (Cont.) SDO_UNITS_OF_MEASURE Table Entries for User-Defined Unit

Column Name	Description
FACTOR_B	For a value that can be expressed as a floating point number, specify how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit. For example, for a unit defined as one-half of a standard meter, specify: `.5` For a value that cannot be expressed as a simple floating point number, specify the dividend for the expression FACTOR_B/FACTOR_C that determines how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit.
FACTOR_C	For a value that can be expressed as a floating point number, specify 1. For a value that cannot be expressed as a simple floating point number, specify the divisor for the expression FACTOR_B/FACTOR_C that determines how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit.
INFORMATION_SOURCE	Specify the following: `USER_DEFINED`
DATA_SOURCE	A phrase briefly describing the unit. Example: `User-defined half meter`
IS_LEGACY	Specify the following: `FALSE`.
LEGACY_CODE	(Do not use this for a user-defined unit.)

Example 2-22 creates a user-defined distance unit named `HALF_METER`, and uses it in a query to find all customers within 400,000 half-meters (200 kilometers) of a specified store.

Example 2-22 Creating and Using a User-Defined Unit of Measurement

```
-- Distance unit: HALF_METER
-- FACTOR_B specifies how many meters = one of this unit.

INSERT INTO MDSYS.SDO_UNITS_OF_MEASURE
  (UOM_ID, UNIT_OF_MEAS_NAME, UNIT_OF_MEAS_TYPE, TARGET_UOM_ID,
   FACTOR_B, FACTOR_C, INFORMATION_SOURCE, DATA_SOURCE, IS_LEGACY)
VALUES
  (100001, 'HALF_METER', 'length', 100001,
   .5, 1, 'User-defined half meter', 'USER_DEFINED', 'FALSE');

. . .
-- Find all the customers within 400,000 half-meters of store_id = 101
SELECT /*+ordered*/
    c.customer_id,
    c.first_name,
    c.last_name
FROM stores s,
    customers c
WHERE s.store_id = 101
AND sdo_within_distance (c.cust_geo_location,
    s.store_geo_location,
    'distance = 400000 unit = HALF_METER') = 'TRUE';

CUSTOMER_ID FIRST_NAME                     LAST_NAME
----------- ------------------------------ ------------------------------
       1005 Carla                          Rodriguez
       1004 Thomas                         Williams
       1003 Marian                         Chang
       1001 Alexandra                      Nichols
```

3

SQL Multimedia Type Support

Oracle Spatial supports the use of the ST_*xxx* types specified in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

- ST_GEOMETRY and SDO_GEOMETRY Interoperability
  The SQL Multimedia ST_GEOMETRY root type, including its subtypes, and the Oracle Spatial SDO_GEOMETRY type are essentially interoperable.
- ST_xxx Functions and Spatial Counterparts
  The following table lists SQL Multimedia functions and the comparable Spatial SDO_GEOMETRY method or Spatial function, procedure, operator.
- Tolerance Value with SQL Multimedia Types
  Because the SQL Multimedia standard does not define how tolerance is to be used with the ST_ xxx, Spatial uses a default value of 0.005 in all the member methods of the ST_GEOMETRY type.
- Avoiding Name Conflicts
  To avoid possible conflicts between third-party names and Oracle-supplied names, any third-party implementation of ST_*xxx* types on Oracle should use a schema prefix.
- Annotation Text Type and Views
  Oracle Spatial supports annotation text as specified in the *OpenGIS Implementation Specification for Geographic information - Simple feature access - Part 1: Common architecture*, which defines **annotation text** as "simply placed text that can carry either geographically-related or ad-hoc data and process-related information as displayable text. This text may be used for display in editors or in simpler maps. It is usually lacking in full cartographic quality, but may act as an approximation to such text as needed by any application."

3.1 ST_GEOMETRY and SDO_GEOMETRY Interoperability

The SQL Multimedia ST_GEOMETRY root type, including its subtypes, and the Oracle Spatial SDO_GEOMETRY type are essentially interoperable.

The ST_GEOMETRY subtypes are:

- ST_CIRCULARSTRING
- ST_COMPOUNDCURVE
- ST_CURVE
- ST_CURVEPOLYGON
- ST_GEOMCOLLECTION
- ST_LINESTRING
- ST_MULTICURVE
- ST_MULTILINESTRING
- ST_MULTIPOINT

- ST_MULTIPOLYGON
- ST_MULTISURFACE
- ST_POINT
- ST_POLYGON
- ST_SURFACE

The ST_GEOMETRY type has an additional constructor method (that is, in addition to the constructors defined in the ISO standard) for creating an instance of the type using an SDO_GEOMETRY object. This constructor has the following format:

```
ST_GEOMETRY(geom SDO_GEOMETRY);
```

Example 3-1 Using the ST_GEOMETRY Type for a Spatial Column

Example 3-1 creates a table using the ST_GEOMETRY type for a spatial column instead of the SDO_GEOMETRY type, and it uses the ST_GEOMETRY constructor to specify the SHAPE column value when inserting a row into that table.

```
CREATE TABLE cola_markets (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape ST_GEOMETRY);

INSERT INTO cola_markets VALUES(
  1,
  'cola_a',
  ST_GEOMETRY(
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
      SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
            -- define rectangle (lower left and upper right) with
            -- Cartesian-coordinate data
    )
  )
);
```

If you create a table with a spatial column of type ST_GEOMETRY, you should add its information to the USER_SDO_GEOM_METADATA view and create a spatial index on the ST_GEOMETRY column, just as you would for spatial data defined using the SDO_GEOMETRY type. After you have performed these operations, you can use Oracle Spatial operators (described in Spatial Operators) in the ST_GEOMETRY data. In addition to the operators defined in the standard, you can use the SDO_NN and SDO_WITHIN_DISTANCE operators.

Example 3-2 Creating, Indexing, Storing, and Querying ST_GEOMETRY Data

Example 3-2 performs many of the same basic operations as in Simple Example: Inserting, Indexing, and Querying Spatial Data, but it uses the ST_GEOMETRY type instead of the SDO_GEOMETRY type for the spatial column.

```
CREATE TABLE cola_markets (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape ST_GEOMETRY);

INSERT INTO cola_markets VALUES(
  1,
  'cola_a',
  ST_GEOMETRY(
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
      SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
            -- define rectangle (lower left and upper right) with
            -- Cartesian-coordinate data
    )
  )
);

INSERT INTO cola_markets VALUES(
  2,
  'cola_b',
  ST_GEOMETRY(
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
      SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
    )
  )
);

INSERT INTO cola_markets VALUES(
  3,
  'cola_c',
  ST_GEOMETRY(
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
      SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
    )
  )
);

INSERT INTO cola_markets VALUES(
  4,
  'cola_d',
  ST_GEOMETRY(
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,4), -- one circle
      SDO_ORDINATE_ARRAY(8,7, 10,9, 8,11)
    )
  )
);

---------------------------------------------------------------------------
-- UPDATE METADATA VIEW --
---------------------------------------------------------------------------

-- Update the USER_SDO_GEOM_METADATA view. This is required before
-- the spatial index can be created. Do this only once for each layer
-- (that is, table-column combination; here: cola_markets and shape).

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
    'cola_markets',
    'shape',
    SDO_DIM_ARRAY(   -- 20X20 grid
      SDO_DIM_ELEMENT('X', 0, 20, 0.005),
      SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
       ),
    NULL   -- SRID
  );

-------------------------------------------------------------------
-- CREATE THE SPATIAL INDEX --
-------------------------------------------------------------------

CREATE INDEX cola_spatial_idx
ON cola_markets(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

---------------------------
-- SDO_NN and SDO_WITHIN_DISTANCE
--------------------------

-- SDO_NN operator.

SELECT  /*+ INDEX(c cola_spatial_idx) */ c.mkt_id, c.name
   FROM cola_markets c
   WHERE SDO_NN(c.shape,  sdo_geometry(2001, NULL,
      sdo_point_type(10,7,NULL), NULL,  NULL),  'sdo_num_res=2') = 'TRUE';

-- SDO_NN_DISTANCE ancillary operator

SELECT   /*+ INDEX(c cola_spatial_idx) */
   c.mkt_id, c.name, SDO_NN_DISTANCE(1) dist
   FROM cola_markets c
   WHERE SDO_NN(c.shape,  sdo_geometry(2001, NULL,
      sdo_point_type(10,7,NULL), NULL,  NULL),
      'sdo_num_res=2', 1) = 'TRUE' ORDER BY dist;

-- SDO_WITHIN_DISTANCE operator (two examples)

SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'distance=10') = 'TRUE';

-- What geometries are within a distance of 10 from a query window
-- (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8)?
-- But exclude geoms with MBRs with both sides < 4.1, i.e., cola_c and cola_d.

SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'distance=10 min_resolution=4.1') = 'TRUE';

-------------------------------------
```

```
-- Some ST_GEOMETRY member functions
-------------------------------------

SELECT c.shape.GET_WKB()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.GET_WKT()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_COORDDIM()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISVALID()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SRID()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SRID(4326)
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISEMPTY()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ENVELOPE()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_BOUNDARY()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_GEOMETRYTYPE()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISSIMPLE()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DIMENSION()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_CONVEXHULL()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_CENTROID()
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_GETTOLERANCE()
  FROM cola_markets c WHERE c.name = 'cola_b';

-- Some member functions that require a parameter
DECLARE
  cola_a_geom ST_GEOMETRY;
  cola_b_geom ST_GEOMETRY;
  cola_c_geom ST_GEOMETRY;
  cola_d_geom ST_GEOMETRY;
  returned_geom ST_GEOMETRY;
  returned_number NUMBER;

BEGIN

-- Populate geometry variables with cola market shapes.
SELECT c.shape INTO cola_a_geom FROM cola_markets c
  WHERE c.name = 'cola_a';
```

```
SELECT c.shape INTO cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';
SELECT c.shape INTO cola_c_geom FROM cola_markets c
  WHERE c.name = 'cola_c';
SELECT c.shape INTO cola_d_geom FROM cola_markets c
  WHERE c.name = 'cola_d';

SELECT c.shape.ST_EQUALS(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b equal to cola_a?: ' || returned_number);

SELECT c.shape.ST_SYMMETRICDIFFERENCE(cola_a_geom) INTO returned_geom
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DISTANCE(cola_d_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Distance between cola_b equal to cola_d: ' || returned_number);

SELECT c.shape.ST_INTERSECTS(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b intersect cola_a?: ' || returned_number);

SELECT c.shape.ST_CROSS(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b cross cola_a?: ' || returned_number);

SELECT c.shape.ST_DISJOINT(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b disjoint with cola_a?: ' || returned_number);

SELECT c.shape.ST_TOUCH(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b touch cola_a?: ' || returned_number);

SELECT c.shape.ST_WITHIN(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b within cola_a?: ' || returned_number);

SELECT c.shape.ST_OVERLAP(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b overlap cola_a?: ' || returned_number);

SELECT c.shape.ST_CONTAINS(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b contain cola_a?: ' || returned_number);

SELECT c.shape.ST_INTERSECTION(cola_a_geom) INTO returned_geom
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DIFFERENCE(cola_a_geom) INTO returned_geom
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_UNION(cola_a_geom) INTO returned_geom
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SYMDIFFERENCE(cola_a_geom) INTO returned_geom
  FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_TOUCHES(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b touch cola_a?: ' || returned_number);
```

```
SELECT c.shape.ST_CROSSES(cola_a_geom) INTO returned_number
  FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b cross cola_a?: ' || returned_number);

END;
/
```

3.2 ST_xxx Functions and Spatial Counterparts

The following table lists SQL Multimedia functions and the comparable Spatial SDO_GEOMETRY method or Spatial function, procedure, operator.

Note that in some cases the Oracle Spatial counterpart has more features than the SQL Multimedia function.

Table 3-1 ST_xxx Functions and SSpatial Counterparts

SQL Multimedia Function	Comparable Oracle Spatial Interface
FROM_WKB	SDO_UTIL.FROM_WKBGEOMETRY
FROM_WKT	SDO_UTIL.FROM_WKTGEOMETRY
GET_WKB	SDO_GEOMETRY.Get_WKB
GET_WKT	SDO_GEOMETRY.Get_WKT
ST_BUFFER	SDO_GEOM.SDO_BUFFER
ST_CENTROID	SDO_GEOM.SDO_CENTROID
ST_CONTAINS	SDO_CONTAINS
ST_CONVEXHULL	SDO_GEOM.SDO_CONVEXHULL
ST_COORDDIM	SDO_GEOMETRY.Get_Dims and SDO_GEOMETRY.ST_CoordDim (equivalent)
ST_CROSS	(None predefined; requires using SDO_RELATE with a complex mask)
ST_CROSSES	(None predefined; requires using SDO_RELATE with a complex mask)
ST_DIFFERENCE	SDO_GEOM.SDO_DIFFERENCE
ST_DIMENSION	SDO_GEOMETRY.Get_Dims
ST_DISJOINT	SDO_GEOM.RELATE with `mask=DISJOINT`
ST_DISTANCE	SDO_GEOM.SDO_DISTANCE
ST_ENVELOPE	SDO_GEOM.SDO_MBR
ST_EQUALS	SDO_EQUAL
ST_GEOMETRYTYPE	SDO_GEOMETRY.Get_GType
ST_INTERSECTION	SDO_GEOM.SDO_INTERSECTION
ST_INTERSECTS	SDO_ANYINTERACT
ST_ISVALID	SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
ST_OVERLAP	SDO_RELATE with `mask=OVERLAPBDYDISJOINT + OVERLAPBDYINTERSECT`
ST_RELATE	SDO_RELATE
ST_SYMDIFFERENCE	SDO_GEOM.SDO_XOR
ST_SYMMETRICDIFFERENCE	SDO_GEOM.SDO_XOR
ST_TOUCH	SDO_TOUCH

Table 3-1 (Cont.) ST_xxx Functions and SSpatial Counterparts

SQL Multimedia Function	Comparable Oracle Spatial Interface
ST_TOUCHES	SDO_TOUCH
ST_UNION	SDO_GEOM.SDO_UNION
ST_WITHIN	SDO_RELATE with `mask=COVERS+CONTAINS`

3.3 Tolerance Value with SQL Multimedia Types

Because the SQL Multimedia standard does not define how tolerance is to be used with the ST_ xxx, Spatial uses a default value of 0.005 in all the member methods of the ST_GEOMETRY type.

If you want to specify a different tolerance value to be used with ST_GEOMETRY member functions, override the default by inserting the desired value into the SDO_ST_TOLERANCE table.

The SDO_ST_TOLERANCE table is a global temporary table that should have a single row specifying the tolerance to be used with ST_GEOMETRY member methods. This table has a single column, defined as `(tolerance NUMBER)`.

For all spatial operators that use a spatial index, Spatial uses the tolerance value specified for the spatial column in the USER_SDO_GEOM_METADATA view.

3.4 Avoiding Name Conflicts

To avoid possible conflicts between third-party names and Oracle-supplied names, any third-party implementation of ST_*xxx* types on Oracle should use a schema prefix.

Some third-party vendors support their own version of ST_*xxx* types on Oracle. For example, a vendor might create its own version of the ST_GEOMETRY type.

To avoid possible conflicts, that vendor’s implementation of ST_*xxx* types on Oracle should use a schema prefix.. This will ensure that if someone specifies a column type as just ST_GEOMETRY, the column will be created with the Oracle implementation of the ST_GEOMETRY type.

3.5 Annotation Text Type and Views

Oracle Spatial supports annotation text as specified in the *OpenGIS Implementation Specification for Geographic information - Simple feature access - Part 1: Common architecture*, which defines **annotation text** as "simply placed text that can carry either geographically-related or ad-hoc data and process-related information as displayable text. This text may be used for display in editors or in simpler maps. It is usually lacking in full cartographic quality, but may act as an approximation to such text as needed by any application."

The ST_ANNOTATION_TEXT object type can be used to store annotation text. This type has a constructor for inserting annotation text into a table, as explained in Using the ST_ANNOTATION_TEXT Constructor.

The USER_ANNOTATION_TEXT_METADATA and ALL_ANNOTATION_TEXT_METADATA views store metadata related to annotation text, as explained in Annotation Text Metadata Views.

- Using the ST_ANNOTATION_TEXT Constructor
- Annotation Text Metadata Views

3.5.1 Using the ST_ANNOTATION_TEXT Constructor

An annotation text object contains an array of objects, where each object consists of a text label, the point at which to start rendering the text label, a leader line (typically from the text label to the associated point on the map), and optionally extra attribute information. A single annotation text object may typically contain all the text labels for a map.

Each text label object has the following definition:

```
 Name                                         Null?    Type
 -------------------------------------------- -------- ----------------------------
 PRIVATEVALUE                                          VARCHAR2(4000)
 PRIVATELOCATION                                       MDSYS.SDO_GEOMETRY
 PRIVATELEADERLINE                                     MDSYS.SDO_GEOMETRY
 PRIVATETEXTATTRIBUTES                                 VARCHAR2(4000)
```

Example 3-3 Using the ST_ANNOTATION_TEXT Constructor

To insert the annotation for a single point, use the ST_ANNOTATION_TEXT constructor. This constructor specifies the information for a single point using an array, as shown in Example 3-3, which creates a table with a column of type ST_ANNOTATION_TEXT and inserts one row, using the ST_ANNOTATION_TEXT constructor in the INSERT statement.

```
CREATE TABLE my_annotations (id NUMBER, textobj ST_ANNOTATION_TEXT);

INSERT INTO my_annotations VALUES (2,
 ST_ANNOTATION_TEXT(
    ST_ANNOTATIONTEXTELEMENT_ARRAY(
           ST_ANNOT_TEXTELEMENT_ARRAY(
                 ST_ANNOTATIONTEXTELEMENT(
                    'Sample Label 2',
                    SDO_GEOMETRY(SDO_POINT2D,null,sdo_point_type(10,10,null),null,null),
                    SDO_GEOMETRY(SDO_CURVE2D,null,null,
                        SDO_ELEM_INFO_ARRAY(1,2,1),
                        SDO_ORDINATE_ARRAY(5,10, 10,10)),
                    NULL)))));
```

In the ST_ANNOTATION_TEXT constructor in Example 3-3, the ST_ANNOTATIONTEXTELEMENT subelement specifies the following:

- The text for the label, in this case `Sample Label 2`
- A point geometry specifying where to start rendering the label, in this case location (10,10)
- A line string geometry specifying the start and end points of the leader line between the point of interest and the text label, in this case a line between locations (5,10) and (10,10)
- No text display attribute information (NULL), which means that the information TEXT_ATTRIBUTES column of the annotation text metadata views is used (see Table 3-2 in Annotation Text Metadata Views)

3.5.2 Annotation Text Metadata Views

The annotation text metadata is stored in a global table owned by MDSYS (which users should never directly update). Each Spatial user has the following views available in the schema associated with that user:

- USER_ANNOTATION_TEXT_METADATA contains metadata information for all annotation text in tables owned by the user (schema). This is the only view that you can update, and it is the one in which Spatial users must insert metadata related to spatial tables.
- ALL_ANNOTATION_TEXT_METADATA contains metadata information for all annotation text in tables on which the user has SELECT permission.

Spatial users are responsible for populating these views. For each annotation text object, you must insert an appropriate row into the USER_ANNOTATION_TEXT_METADATA view. Oracle Spatial ensures that the ALL_ANNOTATION_TEXT_METADATA view is also updated to reflect the rows that you insert into USER_ANNOTATION_TEXT_METADATA.

The USER_ANNOTATION_TEXT_METADATA and ALL_ANNOTATION_TEXT_METADATA views contain the same columns, as shown Table 3-2, except that the USER_ANNOTATION_TEXT_METADATA view does not contain the OWNER column. (The columns are listed in their order in the view definition.)

Table 3-2 Columns in the Annotation Text Metadata Views

Column Name	Data Type	Purpose
OWNER	VARCHAR2(32)	Owner of the table specified in the TABLE_NAME column (ALL_ANNOTATION_TEXT_METADATA view only).
TABLE_NAME	VARCHAR2(32)	Name of the table containing the column of type ST_ANNOTATION_TEXT.
COLUMN_NAME	VARCHAR2(1024)	Name of the column of type ST_ANNOTATION_TEXT.
TEXT_EXPRESSION	VARCHAR2(4000)	A value that can be used if text is not specified for a label. As explained in the OpenGIS specification: "Text to place is first derived from the contents of VALUE in the current element, if VALUE is not null. Otherwise, text is derived from the first non-null preceding element VALUE. If all preceding elements have null VALUE fields, VALUE is derived from the TEXT_EXPRESSION in the metadata table."
TEXT_ATTRIBUTES	VARCHAR2(4000)	Default text display attributes (font family and size, horizontal and vertical spacing, and so on) for the label text style and layout, unless overridden in the PRIVATETEXTATTRIBUTES attribute of the ST_ANNOTATION_TEXT constructor (described in Using the ST_ANNOTATION_TEXT Constructor). Use the format specified in the "XML for Text Attributes" section of the OpenGIS specification.

4

Loading Spatial Data

This chapter describes how to load spatial data into a database, including storing the data in a table with a column of type SDO_GEOMETRY.

After you have loaded spatial data, you can create a spatial index for it and perform queries on it.

The process of loading data can be classified into two categories:

- Bulk loading of data

  This process is used to load large volumes of data into the database and uses the SQL*Loader utility to load the data.

- Transactional insert operations

  This process is typically used to insert relatively small amounts of data into the database using the INSERT statement in SQL.

- Bulk Loading
  Bulk loading can import large amounts of data into an Oracle database.
- Transactional Insert Operations Using SQL
  Oracle Spatial uses standard Oracle tables that can be accessed or loaded with standard SQL syntax. This topic contains examples of transactional insertions into columns of type SDO_GEOMETRY. This process is typically used to add relatively small amounts of data into the database.
- Recommendations for Loading and Validating Spatial Data
  You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data.

4.1 Bulk Loading

Bulk loading can import large amounts of data into an Oracle database.

Bulk loading is accomplished with the SQL*Loader utility. (For information about SQL*Loader, see *Oracle Database Utilities*.)

- Bulk Loading SDO_GEOMETRY Objects
- Bulk Loading Point-Only Data in SDO_GEOMETRY Objects

4.1.1 Bulk Loading SDO_GEOMETRY Objects

Example 4-1 is the SQL*Loader control file for loading four geometries. When this control file is used with SQL*Loader, it loads the same cola market geometries that are inserted using SQL statements in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.

Example 4-1 Control File for a Bulk Load of Cola Market Geometries

```
LOAD DATA
INFILE *
TRUNCATE
```

```
CONTINUEIF NEXT(1:1) = '#'
INTO TABLE COLA_MARKETS
FIELDS TERMINATED BY '|'
TRAILING NULLCOLS (
mkt_id INTEGER EXTERNAL,
name CHAR,
shape COLUMN OBJECT
(
SDO_GTYPE INTEGER EXTERNAL,
SDO_ELEM_INFO VARRAY TERMINATED BY '|/'
(elements FLOAT EXTERNAL),
SDO_ORDINATES VARRAY TERMINATED BY '|/'
(ordinates FLOAT EXTERNAL)
)
)
begindata
 1|cola_a|
#2003|1|1003|3|/
#1|1|5|7|/
 2|cola_b|
#2003|1|1003|1|/
#5|1|8|1|8|6|5|7|5|1|/
 3|cola_c|
#2003|1|1003|1|/
#3|3|6|3|6|5|4|5|3|3|/
 4|cola_d|
#2003|1|1003|4|/
#8|7|10|9|8|11|/
```

Notes on Example 4-1:

- The `EXTERNAL` keyword in the definition `mkt_id INTEGER EXTERNAL` means that each value to be inserted into the MKT_ID column (1, 2, 3, and 4 in this example) is an integer in human-readable form, not binary format.
- In the data after `begindata`, each MKT_ID value is preceded by one space, because the `CONTINUEIF NEXT(1:1) = '#'` specification causes the first position of each data line to be ignored unless it is the number sign (#) continuation character.

Example 4-2 Control File for a Bulk Load of Polygons

Example 4-2 assumes that a table named POLY_4PT was created as follows:

```
CREATE TABLE POLY_4PT (GID VARCHAR2(32),
                       GEOMETRY SDO_GEOMETRY);
```

Assume that the ASCII data consists of a file with delimited columns and separate rows fixed by the limits of the table with the following format:

```
geometry rows:    GID, GEOMETRY
```

The coordinates in the GEOMETRY column represent polygons. Example 4-2 shows the control file for loading the data.

```
LOAD DATA
 INFILE *
 TRUNCATE
 CONTINUEIF NEXT(1:1) = '#'
 INTO TABLE POLY_4PT
 FIELDS TERMINATED BY '|'
 TRAILING NULLCOLS (
  GID  INTEGER EXTERNAL,
  GEOMETRY COLUMN OBJECT
```

```
    (
      SDO_GTYPE       INTEGER EXTERNAL,
      SDO_ELEM_INFO   VARRAY TERMINATED BY '|/'
        (elements     FLOAT EXTERNAL),
      SDO_ORDINATES   VARRAY TERMINATED BY '|/'
        (ordinates    FLOAT EXTERNAL)
    )
)
begindata
 1|2003|1|1003|1|/
#-122.4215|37.7862|-122.422|37.7869|-122.421|37.789|-122.42|37.7866|
#-122.4215|37.7862|/
 2|2003|1|1003|1|/
#-122.4019|37.8052|-122.4027|37.8055|-122.4031|37.806|-122.4012|37.8052|
#-122.4019|37.8052|/
 3|2003|1|1003|1|/
#-122.426|37.803|-122.4242|37.8053|-122.42355|37.8044|-122.4235|37.8025|
#-122.426|37.803|/
```

4.1.2 Bulk Loading Point-Only Data in SDO_GEOMETRY Objects

Example 4-3 shows a control file for loading a table with point data. (The point coordinates happen to be in San Francisco, California, and reflect the Longitude/Latitude (WGS 84) coordinate system.)

Example 4-3   Control File for a Bulk Load of Point-Only Data

```
LOAD DATA
 INFILE *
 TRUNCATE
 CONTINUEIF NEXT(1:1) = '#'
 INTO TABLE POINT
 FIELDS TERMINATED BY '|'
 TRAILING NULLCOLS (
  GID      INTEGER EXTERNAL,
  GEOMETRY COLUMN OBJECT
    (
      SDO_GTYPE       INTEGER EXTERNAL,
      SDO_POINT COLUMN OBJECT
        (X            FLOAT EXTERNAL,
         Y            FLOAT EXTERNAL)
    )
)

BEGINDATA
 1| 2001| -122.4215| 37.7862|
 2| 2001| -122.4019| 37.8052|
 3| 2001| -122.426| 37.803|
 4| 2001| -122.4171| 37.8034|
 5| 2001| -122.416151| 37.8027228|
```

4.2 Transactional Insert Operations Using SQL

Oracle Spatial uses standard Oracle tables that can be accessed or loaded with standard SQL syntax. This topic contains examples of transactional insertions into columns of type SDO_GEOMETRY. This process is typically used to add relatively small amounts of data into the database.

The INSERT statement in Oracle SQL has a limit of 999 arguments. Therefore, you cannot create a variable-length array of more than 999 elements using the SDO_GEOMETRY constructor inside a transactional INSERT statement; however, you can insert a geometry using a host variable, and the host variable can be built using the SDO_GEOMETRY constructor with more than 999 values in the SDO_ORDINATE_ARRAY specification. (The host variable is an OCI, PL/SQL, or Java program variable.)

To perform transactional insertions of geometries, you can create a procedure to insert a geometry, and then invoke that procedure on each geometry to be inserted. Example 4-4 creates a procedure to perform the insert operation.

Example 4-4 Procedure to Perform a Transactional Insert Operation

```
CREATE OR REPLACE PROCEDURE
        INSERT_GEOM(GEOM SDO_GEOMETRY)
IS

BEGIN
  INSERT INTO TEST_1 VALUES (GEOM);
  COMMIT;
END;
/
```

Using the procedure created in Example 4-4, you can insert data by using a PL/SQL block, such as the one in Example 4-5, which loads a geometry into the variable named `geom` and then invokes the INSERT_GEOM procedure to insert that geometry.

Example 4-5 PL/SQL Block Invoking a Procedure to Insert a Geometry

```
DECLARE
geom SDO_geometry :=
  SDO_geometry (SDO_POLYGON2D, null, null,
          SDO_elem_info_array (1,1003,3),
          SDO_ordinate_array (-109,37,-102,40));
BEGIN
  INSERT_GEOM(geom);
  COMMIT;
END;
/
```

For additional examples with various geometry types, see the following:

- Rectangle
- Polygon with a Hole
- Compound Line String
- Compound Polygon
- Point
- Oriented Point
- Type 0 (Zero) Element

> **See Also:**
>
> Getting Started with Longitude/Latitude Spatial Data

4.3 Recommendations for Loading and Validating Spatial Data

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data.

The recommended procedure for loading and validating spatial data is as follows:

1. Load the data, using a method described in Bulk Loading or Transactional Insert Operations Using SQL.
2. Use the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function or the SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT procedure on all spatial data loaded into the database.
3. For any geometries with the wrong orientation or an invalid ETYPE or GTYPE value, use SDO_MIGRATE.TO_CURRENT on these invalid geometries to fix them.
4. For any geometries that are invalid for other reasons, use SDO_UTIL.RECTIFY_GEOMETRY to fix these geometries.

For detailed information about using any of these subprograms, see the usage notes in its reference information section.

5

Indexing and Querying Spatial Data

After you have loaded spatial data, you should create a spatial index on it to enable efficient query performance using the data.

> **Note:**
>
> Spatial supports the use of sharded database technology. For information about indexing and querying data in a sharded database environment, see Sharded Database Support by Oracle Spatial.

- Creating a Spatial Index
  Once data has been loaded into the spatial tables through either bulk or transactional loading, a spatial index (R-tree index or CBTREE index (for point data), cross-schema spatial index, or partitioned spatial index) should be created on each geometry column in the tables for the most efficient access to the data.
- Querying Spatial Data
  The structures of a spatial layer are used to resolve spatial queries and spatial joins.

Related Topics

- Loading Spatial Data

5.1 Creating a Spatial Index

Once data has been loaded into the spatial tables through either bulk or transactional loading, a spatial index (R-tree index or CBTREE index (for point data), cross-schema spatial index, or partitioned spatial index) should be created on each geometry column in the tables for the most efficient access to the data.

For example, the following statement creates a spatial index named `territory_idx` using default values for all parameters:

```
CREATE INDEX territory_idx ON territories (territory_geom)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
```

> **Note:**
>
> For an explanation of the “_V2” in INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2, see Using System-Managed Spatial Indexes

For detailed information about options for creating a spatial index, see the documentation for the CREATE INDEX statement.

If the index creation does not complete for any reason, the index is invalid and must be deleted with the DROP INDEX <index_name> [FORCE] statement.

Within each geometry column to be indexed, all the geometries must have the same SDO_SRID value.

Spatial indexes can be built on two, three, or four dimensions of data. The default number of dimensions is two, but if the data has more than two dimensions, you can use the `sdo_indx_dims` parameter keyword to specify the number of dimensions on which to build the index. (For information about support for three-dimensional geometries, see Three-Dimensional Spatial Objects. For an explanation of support for various combinations of dimensionality in query elements, see Data and Index Dimensionality, and Spatial Queries.)

If you are *not* using the automatic undo management feature or the PGA memory management feature, or both, of Oracle Database, see Rollback Segments and Sort Area Size for information about initialization parameter values that you may need to set. Both automatic undo management and PGA memory management are enabled by default, and their use is highly recommended.

The tablespace specified with the `tablespace` keyword in the CREATE INDEX statement (or the default tablespace if the `tablespace` keyword is not specified) is used to hold both the index data table and some transient tables that are created for internal computations. If you specify WORK_TABLESPACE as the tablespace, the transient tables are stored in the work tablespace.

For large tables (over 1 million rows), a temporary tablespace may be needed to perform internal sorting operations. The recommended size for this temporary tablespace is 100**n* bytes, where *n* is the number of rows in the table, up to a maximum requirement of 1 gigabyte of temporary tablespace.

To estimate the space that will be needed to create a spatial index, use the SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE function.

Spatial indexes are not supported on nested tables.

- Using System-Managed Spatial Indexes
- Constraining Data to a Geometry Type
- Creating a Composite B-tree Spatial Index on Points
- Creating a Cross-Schema Index
- Using Partitioned Spatial Indexes
- Exchanging Partitions Including Indexes
- Export and Import Considerations with Spatial Indexes and Data
- Distributed and Oracle XA Transactions Supported with R-Tree Spatial Indexes
- Enabling Access to Spatial Index Statistics
- Rollback Segments and Sort Area Size

See Also:

Getting Started with Longitude/Latitude Spatial Data

5.1.1 Using System-Managed Spatial Indexes

Effective with Release 12.2, spatial indexes can be system-managed by specifying INDEXTYPE=MDSYS.SPATIAL_INDEX_**V2** at index creation. You are strongly encouraged to use this index type for all new spatial indexes you create, regardless of whether the spatial table or the spatial index is partitioned, and you may also want to use it if you decide to re-create legacy spatial indexes.

The main benefit is simplified spatial index management. This is most beneficial in cases of partitioning, because this new index type eliminates the need for most, if not all, index partitioning management operations. Full support is provided for almost all Oracle Database base table partitioning models, including:

- Single-level partitioning: range, hash, list
- Composite partitioning: range-range, range-hash, range-list, list-range, list-hash, list-list, hash-hash, hash-list, hash-range
- Partitioning extensions: interval (but not interval-based composite partitions), reference, virtual column-based partitioning

The old INDEXTYPE=MDSYS.SPATIAL_INDEX (without the “_V2”) is still available for use. It may provide slightly better index creation performance, especially with small data sets and no partitioning involved. You might also want to use the old type if you need to drop a legacy spatial index and then want to re-create it in exactly the same form as it was before. However, in all or almost all cases you will want to specify INDEXTYPE=MDSYS.SPATIAL_INDEX_V2 when creating any spatial index.

The following topics provide examples of using INDEXTYPE=MDSYS.SPATIAL_INDEX_V2.

- Spatial Indexing Example: Interval Partitioning
- Spatial Indexing Example: Virtual Column Partitioning

5.1.1.1 Spatial Indexing Example: Interval Partitioning

Interval partitioning is a partitioning method where Oracle Database automatically creates base table partitions when the inserted value does not match any existing partition ranges.

The following restrictions apply:

- You can only specify one base table partitioning key column, and it must be of type NUMBER or DATE.
- Interval partitioning is not supported for index-organized tables.

Consider the following example of a base table named DEST_TABLE, partitioned based on the month of the “currently last seen” column:

```
CREATE TABLE dest_table
PARTITION BY RANGE ("CURR_LAST_SEEN_AT")
INTERVAL(NUMTOYMINTERVAL(1, 'MONTH'))
  (PARTITION "YEAR_1999"
     VALUES LESS THAN (TIMESTAMP' 2000-01-01 00:00:00'),
   PARTITION "YEAR_2000"
     VALUES LESS THAN (TIMESTAMP' 2001-01-01 00:00:00'))
PARALLEL
AS SELECT imo_num,
          last_seen_at           curr_last_seen_at,
          a.geometry.sdo_point.x curr_longitude,
          a.geometry.sdo_point.y curr_latitude,
LAG(last_seen_at)
  OVER (partition by imo_num ORDER BY last_seen_at) prev_last_seen_at,
LEAD(last_seen_at)
  OVER (partition by imo_num ORDER BY last_seen_at) next_last_seen_at,
LAG(a.geometry.sdo_point.x)
  OVER (partition by imo_num ORDER BY last_seen_at) prev_longitude,
LAG(a.geometry.sdo_point.y)
  OVER (partition by imo_num ORDER BY last_seen_at) prev_latitude,
LEAD(a.geometry.sdo_point.x)
  OVER (partition by imo_num ORDER BY last_seen_at) next_longitude,
LEAD(a.geometry.sdo_point.y)
  OVER (partition by imo_num ORDER BY last_seen_at) next_latitude
FROM source_table a;
```

As data is selected from the source table (source_table) into this DEST_TABLE table, Oracle Database automatically partitions the data by the month of the CURR_LAST_SEEN_AT column. If the corresponding partition does not exist, Oracle Database will automatically create a new partition without any action required on your part.

The preceding example created two explicit partitions. To see what our actual data looks like, use a query such as for following to the database dictionary to see what partitions were created:

```
SQL> select partition_name, high_value
  2  from user_tab_partitions
  3  where table_name = 'DEST_TABLE'
  4  order by partition_name;

PARTITION_NAME
------------------------------------------------------------------------------
--
HIGH_VALUE
------------------------------------------------------------------------------
--
SYS_P2881
TIMESTAMP' 2014-08-01 00:00:00'

SYS_P2882
TIMESTAMP' 2014-09-01 00:00:00'

SYS_P2883
TIMESTAMP' 2014-10-01 00:00:00'

SYS_P2884
TIMESTAMP' 2014-11-01 00:00:00'

YEAR_1999
TIMESTAMP' 2000-01-01 00:00:00'

YEAR_2000
TIMESTAMP' 2001-01-01 00:00:00'

6 rows selected.
```

Now create the spatial index. The following example uses function-based index; the function will convert the base table scalar longitude and latitude columns into a virtual spatial geometry, which will be the index “key value”:

```
CREATE OR REPLACE FUNCTION get_geometry(in_longitude NUMBER,
                                        in_latitude  NUMBER)
  return SDO_GEOMETRY DETERMINISTIC PARALLEL_ENABLE IS
BEGIN
  RETURN sdo_geometry(in_longitude, in_latitude);
END;
/

INSERT INTO user_sdo_geom_metadata VALUES (
  'DEST_TABLE','SCOTT.GET_GEOMETRY(CURR_LONGITUDE,CURR_LATITUDE)',
   SDO_DIM_ARRAY(SDO_DIM_ELEMENT('Longitude', '-180', '180', '.05'),
                 SDO_DIM_ELEMENT('Latitude',   '-90',  '90', '.05')),
   4326);
COMMIT;

CREATE INDEX geom_idx1
ON dest_table(GET_GEOMETRY(CURR_LONGITUDE, CURR_LATITUDE))
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2 LOCAL PARALLEL;
```

Notice that no partitioning information was specified for the spatial index. To see the partitions that were automatically created, use a query such as for following:

```
SQL> select partition_name, high_value
  2  from user_ind_partitions
  3  where index_name = 'PRECOMPUTE_GEOM_IDX1'
  4  order by partition_name;

PARTITION_NAME
------------------------------------------------------------------------------
--
HIGH_VALUE
------------------------------------------------------------------------------
--
SYS_P2921
TIMESTAMP' 2014-08-01 00:00:00'
SYS_P2922
TIMESTAMP' 2014-09-01 00:00:00'
SYS_P2923
TIMESTAMP' 2014-10-01 00:00:00'
SYS_P2924
TIMESTAMP' 2014-11-01 00:00:00'
YEAR_1999
TIMESTAMP' 2000-01-01 00:00:00'
YEAR_2000
TIMESTAMP' 2001-01-01 00:00:00'
6 rows selected.
```

Notice that the number of index partitions is the same as were created for the base table, including two partitions with the same name as those explicitly specified in the CREATE TABLE statement. However, the system-generated index partition names are different from the base table name.

5.1.1.2 Spatial Indexing Example: Virtual Column Partitioning

A virtual column is an expression based on one or more existing columns in the base table. While a virtual column is only stored as metadata and does not consume physical space, it can be indexed and also contain optimizer statistics and histograms. Partitioning is supported for a table using a partitioning key on a virtual column

If system-managed spatial indexing is not used, then to partition a table by using a derived value, a DBA must create and populate an additional physical column in order to achieve the same result. The derived value then must be populated by the application or by a trigger that evaluates the expression before insertion. In either case, achieving this goal without system-managed indexing requires additional overhead and increased disk space for the physical column.

If system-managed indexing is used, the ability to use an expression as a partitioning key provides a more efficient way to meet comprehensive business requirements without incurring unnecessary overhead. This can be very useful when a table cannot be partitioned by the existing data columns.

Consider the following example of a base table named ACCOUNTS that contains a virtual column named REGION:

```
create table accounts_v
( account_number varchar2(30),
  account_name varchar2(30),
  contact_person varchar2(30),
  region AS (case
             when substr(account_name,1,1) = 'N' then 'NORTH'
             when substr(account_name,1,1) = 'E' then 'EAST'
             when substr(account_name,1,1) = 'S' then 'SOUTH'
             when substr(account_name,1,1) = 'W' then 'WEST'
             end),
  shape mdsys.sdo_geometry
)
partition by list (region)
( partition pN values ('NORTH'),
  partition pE values ('EAST'),
  partition pS values ('SOUTH'),
  partition pW values ('WEST')
);
```

Now create a system-managed local domain spatial index on the SHAPE column:

```
insert into user_sdo_geom_metadata
values('ACCOUNTS_V',
       'SHAPE',
       mdsys.sdo_dim_array(
         mdsys.sdo_dim_element('Longitude', -180, 180, 0.05),
         mdsys.sdo_dim_element('Latitude',   -90,  90, 0.05)),
       NULL);
commit;
create index shape_v_idx on accounts_v(shape)
indextype is mdsys.spatial_index_v2 LOCAL;
```

Notice that no spatial index partition information was specified. However, a full set of spatial index partitions was created automatically and without user intervention.

To verify the placement of records in the appropriate partitions, query a specific partition. The following query is for the accounts in the East region (:

```
SQL> select * from accounts_v partition(PE)
  2  order by account_number;

ACCOUNT_NUMBER                 ACCOUNT_NAME
------------------------------ ------------------------------
CONTACT_PERSON                 REGIO
------------------------------ -----
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
--
8778-5435-5345-5223            E-HORIZON-AUTOMOTIVE
RICK                           EAST
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(2, 2, NULL), NULL, NULL)

1 row selected.
```

5.1.2 Constraining Data to a Geometry Type

When you create or rebuild a spatial index, you can ensure that all geometries that are in the table or that are inserted later are of a specified geometry type. To constrain the data to a geometry type in this way, use the `layer_gtype` keyword in the PARAMETERS clause of the CREATE INDEX or ALTER INDEX REBUILD statement, and specify a value from the Geometry Type column of the Valid SDO_GTYPE Values table described in SDO_GTYPE. For example, to constrain spatial data in a layer to polygons:

```
CREATE INDEX cola_spatial_idx
ON cola_markets(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2
PARAMETERS ('layer_gtype=POLYGON');
```

The geometry types in SDO_GTYPE are considered as a hierarchy when data is checked:

- The *MULTI* forms include the regular form also. For example, specifying `'layer_gtype=MULTIPOINT'` allows the layer to include both POINT and MULTIPOINT geometries.
- COLLECTION allows the layer to include all types of geometries.

5.1.3 Creating a Composite B-tree Spatial Index on Points

Effective with Release 12.2, you can create a composite B-tree index (CBTREE index) on point data by specifying the `cbtree_index=true` and `layer_gtype=POINT` keywords in the `PARAMETERS` clause of the `CREATE INDEX` statement.

> **Note:**
>
> You can create a composite B-tree spatial index only when the point data is stored in the SDO_POINT attribute and the SDO_ORDINATES attribute of the geometry is NULL.

For example:

```
CREATE INDEX pt_idx on PT_CB(c2) indextype is mdsys.spatial_index_v2
  PARAMETERS ('layer_gtype=POINT cbtree_index=true');
```

The preceding example creates a composite B-tree spatial index, not an R-tree spatial index. Using a composite B-tree spatial index for point data can:

- Improve the performance of spatial index creation.
- Improve DML performance when performing concurrent DML from many Oracle sessions.

However, while composite B-tree spatial query performance is very fast, optimal spatial query performance may be obtained by using an R-tree spatial index on that data (especially with SPATIAL_VECTOR_ACCELERATION set to the recommended value of `TRUE`).

The `cbtree_index=true` keyword can used only for spatial index creation (CREATE INDEX statement). It cannot be used with ALTER INDEX or ALTER INDEX REBUILD.

The SDO_JOIN operator is not supported when a composite B-tree spatial index is used.

5.1.4 Creating a Cross-Schema Index

You can create a spatial index on a table that is not in your schema. Assume that user B wants to create a spatial index on column GEOMETRY in table T1 under user A's schema. Follow these steps:

1. Connect to the database as a privileged user (for example, as SYSTEM), and execute the following statements:

   ```
   GRANT create table, create sequence to A;
   GRANT create table, create sequence to B;
   ```

2. Connect as a privileged user or as user A (or have user A connect), and execute the following statement:

   ```
   GRANT select, index on A.T1 to B;
   ```

3. Connect as user B and execute a statement such as the following:

   ```
   CREATE INDEX t1_spatial_idx on A.T1(geometry)
     INDEXTYPE IS mdsys.spatial_index_v2;
   ```

5.1.5 Using Partitioned Spatial Indexes

You can create a partitioned spatial index on a partitioned table. This section describes usage considerations specific to Oracle Spatial. For a detailed explanation of partitioned tables and partitioned indexes, see *Oracle Database VLDB and Partitioning Guide*.

A partitioned spatial index can provide the following benefits:

- Reduced response times for long-running queries, because partitioning reduces disk I/O operations

- Reduced response times for concurrent queries, because I/O operations run concurrently on each partition
- Easier index maintenance, because of partition-level create and rebuild operations

  Indexes on partitions can be rebuilt without affecting the queries on other partitions, and storage parameters for each local index can be changed independent of other partitions.
- Parallel query on multiple partition searching

  The degree of parallelism is the value from the DEGREE column in the row for the index in the USER_INDEXES view (that is, the value specified or defaulted for the PARALLEL keyword with the CREATE INDEX, ALTER INDEX, or ALTER INDEX REBUILD statement).
- Improved query processing in multiprocessor system environments

  In a multiprocessor system environment, if a spatial operator is invoked on a table with partitioned spatial index and if multiple partitions are involved in the query, multiple processors can be used to evaluate the query. The number of processors used is determined by the degree of parallelism and the number of partitions used in evaluating the query.

The following restrictions apply to spatial index partitioning:

- The partition key for spatial tables must be a scalar value, and must not be a spatial column.
- Only range partitioning is supported on the underlying table. All other kinds of partitioning are not currently supported for partitioned spatial indexes.

To create a partitioned spatial index, you must specify the LOCAL keyword. (If you do not specify the LOCAL keyword, a nonpartitioned spatial index is created on the data in all table partitions.) The following example creates a partitioned spatial index:

```
CREATE INDEX counties_idx ON counties(geometry)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2 LOCAL;
```

In this example, the default values are used for the number and placement of index partitions, namely:

- Index partitioning is based on the underlying table partitioning. For each table partition, a corresponding index partition is created.
- Each index partition is placed in the default tablespace.

If you do specify parameters for individual partitions, the following considerations apply:

- The storage characteristics for each partition can be the same or different for each partition. If they are different, it may enable parallel I/O (if the tablespaces are on different disks) and may improve performance.
- The `sdo_indx_dims` value must be the same for all partitions.
- The `layer_gtype` parameter value (see Constraining Data to a Geometry Type) used for each partition may be different.

To override the default partitioning values, use a CREATE INDEX statement with the following general format:

```
CREATE INDEX <indexname> ON <table>(<column>)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2
     [PARAMETERS ('<spatial-params>, <storage-params>')] LOCAL
     [( PARTITION <index_partition>
        PARAMETERS ('<spatial-params>, <storage-params>')
     [, PARTITION <index_partition>
```

```
      PARAMETERS ('<spatial-params>, <storage-params>')]
   )]
```

Queries can operate on partitioned tables to perform the query on only one partition. For example:

```
SELECT * FROM counties PARTITION(p1)
    WHERE ...<some-spatial-predicate>;
```

Querying on a selected partition may speed up the query and also improve overall throughput when multiple queries operate on different partitions concurrently.

When queries use a partitioned spatial index, the semantics (meaning or behavior) of spatial operators and functions is the same with partitioned and nonpartitioned indexes, except in the case of SDO_NN (nearest neighbor). With SDO_NN, the requested number of geometries is returned for each partition that is affected by the query. (See the description of the SDO_NN operator in Spatial Operators for more information.)

For example, if you request the 5 closest restaurants to a point and the spatial index has 4 partitions, SDO_NN returns up to 20 (5*4) geometries. In this case, you must use the ROWNUM pseudocolumn (here, `WHERE ROWNUM <=5`) to return the 5 closest restaurants, and the ORDER BY clause to sort the results by distance in miles. Example 5-1 returns the 5 nearest restaurants from a partitioned spatial index.

> **See Also:**
>
> SDO_NN Examples for more examples of using the SDO_NN operator.

For a cross-schema query when a table has a partitioned spatial index, the user must be granted SELECT or READ privilege on both the spatial table and the index table (MDRT_*xxx*) for the spatial index that was created on the spatial table. For more information and an example, see "Cross-Schema Invocation of SDO_JOIN" in the Usage Notes for the SDO_JOIN operator.

Example 5-1   SDO_NN Query with Partitioned Spatial Index

```
SELECT * FROM
(
SELECT r.name, r.location, SDO_NN_DISTANCE(1) distance_in_miles
FROM restaurants_part_table r
WHERE SDO_NN(r.location,
      MDSYS.SDO_GEOMETRY(SDO_POINT2D,4326,MDSYS.SDO_POINT_TYPE(-110,35,Null),Null,Null),
     'SDO_NUM_RES=5 distance=2  unit=MILE', 1) = 'TRUE'
ORDER BY distance_in_miles
)
WHERE ROWNUM<=5;
```

- Creating a Local Partitioned Spatial Index

5.1.5.1 Creating a Local Partitioned Spatial Index

If you want to create a local partitioned spatial index, Oracle recommends that you use the procedure in this section instead of using the PARALLEL keyword, to avoid having to start over if the creation of any partition's index fails for any reason (for example, because the tablespace is full). Follow these steps:

1. Create a local spatial index and specify the UNUSABLE keyword. For example:

```
CREATE INDEX sp_idx ON my_table (location)
  INDEXTYPE IS mdsys.spatial_index_v2
  PARAMETERS ('tablespace=tb_name work_tablespace=work_tb_name')
  LOCAL UNUSABLE;
```

This statement executes quickly and creates metadata associated with the index.

2. Create scripts with ALTER INDEX REBUILD statements, but without the PARALLEL keyword. For example, if you have 100 partitions and 10 processors, create 10 scripts with 10 ALTER INDEX statements such as the following:

```
ALTER INDEX sp_idx REBUILD PARTITION ip1;
ALTER INDEX sp_idx REBUILD PARTITION ip2;
. . .
ALTER INDEX sp_idx REBUILD PARTITION ip10;
```

3. Run all the scripts at the same time, so that each processor works on the index for a single partition, but all the processors are busy working on their own set of ALTER INDEX statements.

If any of the ALTER INDEX statements fails, you do not need to rebuild any partitions for which the operation has successfully completed.

5.1.6 Exchanging Partitions Including Indexes

You can use the ALTER TABLE statement with the EXCHANGE PARTITION ... INCLUDING INDEXES clause to exchange a spatial table partition and its index partition with a corresponding table and its index. For information about exchanging partitions, see the description of the ALTER TABLE statement in *Oracle Database SQL Language Reference*.

This feature can help you to operate more efficiently in a number of situations, such as:

- Bringing data into a partitioned table and avoiding the cost of index re-creation.
- Managing and creating partitioned indexes. For example, the data could be divided into multiple tables. The index for each table could be built one after the other to minimize the memory and tablespace resources needed during index creation. Alternately, the indexes could be created in parallel in multiple sessions. The tables (along with the indexes) could then be exchanged with the partitions of the original data table.
- Managing offline insert operations. New data can be stored in a temporary table and periodically exchanged with a new partition (for example, in a database with historical data).

To exchange partitions including indexes with spatial data and indexes, the two spatial indexes (one on the partition, the other on the table) must have the same dimensionality (`sdo_indx_dims` value). If the indexes do not have the same dimensionality, an error is raised. The table data is exchanged, but the indexes are not exchanged and the indexes are marked as failed. To use the indexes, you must rebuild them

5.1.7 Export and Import Considerations with Spatial Indexes and Data

If you use the Export utility to export tables with spatial data, the behavior of the operation depends on whether or not the spatial data has been spatially indexed:

- If the spatial data has not been spatially indexed, the table data is exported. However, you must update the USER_SDO_GEOM_METADATA view with the appropriate information on the target system.
- If the spatial data has been spatially indexed, the table data is exported, the appropriate information is inserted into the USER_SDO_GEOM_METADATA view on the target

system, and the spatial index is built on the target system. However, if the insertion into the USER_SDO_GEOM_METADATA view fails (for example, if there is already a USER_SDO_GEOM_METADATA entry for the spatial layer), the spatial index is not built.

If you use the Import utility to import data that has been spatially indexed, the following considerations apply:

- If the index on the exported data was created with a `TABLESPACE` clause and if the specified tablespace does not exist in the database at import time, the index is not built. (This is different from the behavior with other Oracle indexes, where the index is created in the user's default tablespace if the tablespace specified for the original index does not exist at import time.)
- If the import operation must be done by a privileged database user, and if the `FROMUSER` and `TOUSER` format is used, the `TOUSER` user must be granted the CREATE TABLE and CREATE SEQUENCE privileges before the import operation, as shown in the following example (and enter the password for the SYSTEM account when prompted):

  ```
  sqlplus system
  SQL> grant CREATE TABLE, CREATE SEQUENCE to CHRIS;
  SQL> exit;
  imp system file=spatl_data.dmp fromuser=SCOTT touser=CHRIS
  ```

For information about using the Export and Import utilities, see *Oracle Database Utilities*.

5.1.8 Distributed and Oracle XA Transactions Supported with R-Tree Spatial Indexes

The use of R-tree spatial indexes is supported in distributed and Oracle XA transactions.

However, spatial DML operations are not allowed in a serializable distributed transaction.

For more information about distributed transactions, see *Oracle Database Administrator's Guide*.

5.1.9 Enabling Access to Spatial Index Statistics

The Oracle Database optimizer collects statistics that describe details about the database and its objects. Statistics are critical to the optimizer's ability to pick the best execution plan for a SQL statement. For more information about optimizer statistics, see *Oracle Database SQL Tuning Guide*.

To be able to use procedures such as `DBMS_STATS.GATHER_INDEX_STATS` and `DBMS_STATS.GATHER_SCHEMA_STATS` to gather index statistics related to spatial indexes, the CREATE TABLE privilege must be granted to all database users that will perform the statistics collection.

When you run ANALYZE INDEX on a spatial domain index for a different schema (user), the user performing the ANALYZE operation needs the following privileges:

- CREATE ANY TABLE to create missing temporary tables
- DROP ANY TABLE to truncate or remove existing temporary tables

5.1.10 Rollback Segments and Sort Area Size

This section applies *only* if you (or the database administrator) are not using the automatic undo management feature or the PGA memory management feature, or both, of Oracle

Database. Automatic memory management and PGA memory management are enabled by default, and their use is highly recommended. For explanations of these features, see:

- The section about automatic undo management and undo segments in *Oracle Database Concepts*
- The section about PGA memory management in *Oracle Database Concepts*

If you are not using automatic undo management and if the rollback segment is not large enough, an attempt to create a spatial index will fail. The rollback segment should be 100**n* bytes, where *n* is the number of rows of data to be indexed. For example, if the table contains 1 million (1,000,000) rows, the rollback segment size should be 100,000,000 (100 million) bytes.

To ensure an adequate rollback segment, or if you have tried to create a spatial index and received an error that a rollback segment cannot be extended, review (or have a DBA review) the size and structure of the rollback segments. Create a public rollback segment of the appropriate size, and place that rollback segment online. In addition, ensure that any small inappropriate rollback segments are placed offline during large spatial index operations.

If you are not using the PGA memory management feature, the database parameter SORT_AREA_SIZE affects the amount of time required to create the index. The SORT_AREA_SIZE value is the maximum amount, in bytes, of memory to use for a sort operation. The optimal value depends on the database size, but a good guideline is to make it at least 1 million bytes when you create a spatial index. To change the SORT_AREA_SIZE value, use the ALTER SESSION statement. For example, to change the value to 20 million bytes:

```
ALTER SESSION SET SORT_AREA_SIZE = 20000000;
```

5.2 Querying Spatial Data

The structures of a spatial layer are used to resolve spatial queries and spatial joins.

Spatial uses a two-tier query model with primary and secondary filter operations to resolve spatial queries and spatial joins, as explained in Query Model. The term *two-tier* indicates that two distinct operations are performed to resolve queries. If both operations are performed, the exact result set is returned.

You cannot append a database link (dblink) name to the name of a spatial table in a query if a spatial index is defined on that table.

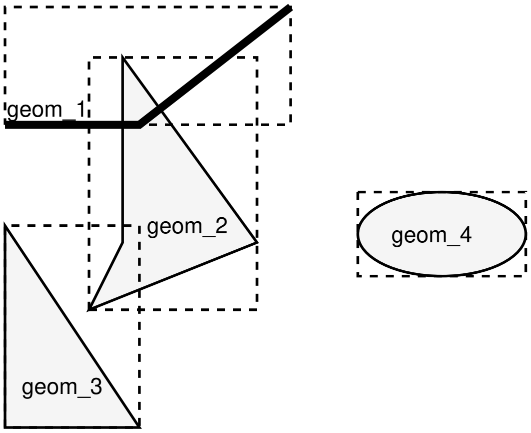
- Spatial Query
- Spatial Join
- Data and Index Dimensionality, and Spatial Queries
- Using Event 54700 to Require a Spatial Index for Spatial Queries

> **See Also:**
>
> Getting Started with Longitude/Latitude Spatial Data

5.2.1 Spatial Query

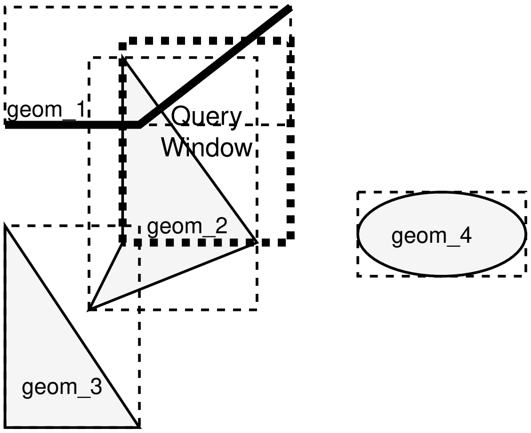
In a spatial R-tree index, each geometry is represented by its minimum bounding rectangle (MBR), as explained in R-Tree Indexing. Consider the following layer containing several objects in Figure 5-1. Each object is labeled with its geometry name (geom_1 for the line string, geom_2 for the four-sided polygon, geom_3 for the triangular polygon, and geom_4 for the ellipse), and the MBR around each object is represented by a dashed line.

Figure 5-1 Geometries with MBRs



A typical spatial query is to request all objects that lie within a **query window**, that is, a defined fence or window. A dynamic query window refers to a rectangular area that is not defined in the database, but that must be defined before it is used. Figure 5-2 shows the same geometries as in Figure 5-1, but adds a query window represented by the heavy dotted-line box.

Figure 5-2 Layer with a Query Window



In Figure 5-2, the query window covers parts of geometries geom_1 and geom_2, as well as part of the MBR for geom_3 but none of the actual geom_3 geometry. The query window does not cover any part of the geom_4 geometry or its MBR.

- Primary Filter Operator
- Primary and Secondary Filter Operator
- Within-Distance Operator
- Nearest Neighbor Operator
- Spatial Functions

5.2.1.1 Primary Filter Operator

The SDO_FILTER operator, described in Spatial Operators , implements the primary filter portion of the two-step process involved in the Oracle Spatial query processing model. The primary filter uses the index data to determine only if a set of candidate object pairs may interact. Specifically, the primary filter checks to see if the MBRs of the candidate objects interact, not whether the objects themselves interact. The SDO_FILTER operator syntax is as follows:

```
SDO_FILTER(geometry1 SDO_GEOMETRY, geometry2 SDO_GEOMETRY, param VARCHAR2)
```

In the preceding syntax:

- `geometry1` is a column of type SDO_GEOMETRY in a table. This column must be spatially indexed.
- `geometry2` is an object of type SDO_GEOMETRY. This object may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- `param` is an optional string of type VARCHAR2. It can specify either or both of the `min_resolution` and `max_resolution` keywords.

The following examples perform a primary filter operation only (with no secondary filter operation). They will return all the geometries shown in Figure 5-2 that have an MBR that interacts with the query window. The result of the following examples are geometries geom_1, geom_2, and geom_3.

Example 5-2 performs a primary filter operation without inserting the query window into a table. The window will be indexed in memory and performance will be very good.

Example 5-2 Primary Filter with a Temporary Query Window

```
SELECT A.Feature_ID FROM TARGET A
 WHERE sdo_filter(A.shape, SDO_geometry(SDO_POLYGON2D,NULL,NULL,
                                       SDO_elem_info_array(1,1003,3),
                                       SDO_ordinate_array(x1,y1, x2,y2))
                           ) = 'TRUE';
```

In Example 5-2, `(x1,y1)` and `(x2,y2)` are the lower-left and upper-right corners of the query window.

In Example 5-3, a transient instance of type SDO_GEOMETRY was constructed for the query window instead of specifying the window parameters in the query itself.

Example 5-3 Primary Filter with a Transient Instance of the Query Window

```
SELECT A.Feature_ID FROM TARGET A
 WHERE sdo_filter(A.shape, :theWindow) = 'TRUE';
```

Example 5-4 assumes the query window was inserted into a table called WINDOWS, with an ID of WINS_1.

Example 5-4 Primary Filter with a Stored Query Window

```
SELECT A.Feature_ID FROM TARGET A, WINDOWS B
 WHERE B.ID = 'WINS_1' AND
  sdo_filter(A.shape, B.shape) = 'TRUE';
```

If the B.SHAPE column is not spatially indexed, the SDO_FILTER operator indexes the query window in memory and performance is very good.

5.2.1.2 Primary and Secondary Filter Operator

The SDO_RELATE operator, described in Spatial Operators , performs both the primary and secondary filter stages when processing a query. The secondary filter ensures that only candidate objects that actually interact are selected. This operator can be used only if a spatial index has been created on two dimensions of data. The syntax of the SDO_RELATE operator is as follows:

```
SDO_RELATE(geometry1  SDO_GEOMETRY,
           geometry2  SDO_GEOMETRY,
           param      VARCHAR2)
```

In the preceding syntax:

- `geometry1` is a column of type SDO_GEOMETRY in a table. This column must be spatially indexed.
- `geometry2` is an object of type SDO_GEOMETRY. This object may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- `param` is a quoted string with the `mask` keyword and a valid mask value, and optionally either or both of the `min_resolution` and `max_resolution` keywords, as explained in the documentation for the SDO_RELATE operator in Spatial Operators .

The following examples perform both primary and secondary filter operations. They return all the geometries in Figure 5-2 that lie within or overlap the query window. The result of these examples is objects geom_1 and geom_2.

Example 5-5 performs both primary and secondary filter operations without inserting the query window into a table. The window will be indexed in memory and performance will be very good.

Example 5-5 Secondary Filter Using a Temporary Query Window

```
SELECT A.Feature_ID FROM TARGET A
   WHERE sdo_relate(A.shape, SDO_geometry(SDO_POLYGON2D,NULL,NULL,
                                    SDO_elem_info_array(1,1003,3),
                                   SDO_ordinate_array(x1,y1, x2,y2)),
                        'mask=anyinteract') = 'TRUE';
```

In Example 5-5, `(x1,y1)` and `(x2,y2)` are the lower-left and upper-right corners of the query window.

Example 5-6 assumes the query window was inserted into a table called WINDOWS, with an ID value of WINS_1.

Example 5-6 Secondary Filter Using a Stored Query Window

```
SELECT A.Feature_ID FROM TARGET A, WINDOWS B
 WHERE B.ID = 'WINS_1' AND
        sdo_relate(A.shape, B.shape,
          'mask=anyinteract') = 'TRUE';
```

If the B.SHAPE column is not spatially indexed, the SDO_RELATE operator indexes the query window in memory and performance is very good.

5.2.1.3 Within-Distance Operator

The SDO_WITHIN_DISTANCE operator, described in Spatial Operators , is used to determine the set of objects in a table that are within *n* distance units from a reference object. This operator can be used only if a spatial index has been created on two dimensions of data. The reference object may be a transient or persistent instance of SDO_GEOMETRY, such as a temporary query window or a permanent geometry stored in the database. The syntax of the operator is as follows:

```
SDO_WITHIN_DISTANCE(geometry1  SDO_GEOMETRY,
                    aGeom      SDO_GEOMETRY,
                    params     VARCHAR2);
```

In the preceding syntax:

- `geometry1` is a column of type SDO_GEOMETRY in a table. This column must be spatially indexed.
- `aGeom` is an instance of type SDO_GEOMETRY.
- `params` is a quoted string of keyword value pairs that determines the behavior of the operator. See the SDO_WITHIN_DISTANCE operator in Spatial Operators for a list of parameters.

The following example selects any objects within 1.35 distance units from the query window:

```
SELECT A.Feature_ID
  FROM TARGET A
  WHERE SDO_WITHIN_DISTANCE( A.shape, :theWindow, 'distance=1.35') = 'TRUE';
```

The distance units are based on the geometry coordinate system in use. If you are using a geodetic coordinate system, the units are meters. If no coordinate system is used, the units are the same as for the stored data.

The SDO_WITHIN_DISTANCE operator is not suitable for performing spatial joins. That is, a query such as *Find all parks that are within 10 distance units from coastlines* will not be processed as an index-based spatial join of the COASTLINES and PARKS tables. Instead, it will be processed as a nested loop query in which each COASTLINES instance is in turn a reference object that is buffered, indexed, and evaluated against the PARKS table. Thus, the SDO_WITHIN_DISTANCE operation is performed *n* times if there are *n* rows in the COASTLINES table.

For non-geodetic data, there is an efficient way to accomplish a spatial join that involves buffering all geometries of a layer. This method does not use the SDO_WITHIN_DISTANCE operator. First, create a new table COSINE_BUFS as follows:

```
CREATE TABLE cosine_bufs UNRECOVERABLE AS
   SELECT SDO_BUFFER (A.SHAPE, B.DIMINFO, 1.35)
     FROM COSINE A, USER_SDO_GEOM_METADATA B
     WHERE TABLE_NAME='COSINES' AND COLUMN_NAME='SHAPE';
```

Next, create a spatial index on the SHAPE column of COSINE_BUFS. Then you can perform the following query:

```
SELECT /*+ ordered */ a.gid, b.gid
  FROM TABLE(SDO_JOIN('PARKS', 'SHAPE',
                      'COSINE_BUFS', 'SHAPE',
                      'mask=ANYINTERACT')) c,
       parks a,
       cosine_bufs b
  WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

5.2.1.4 Nearest Neighbor Operator

The SDO_NN operator, described in Spatial Operators , is used to identify the nearest neighbors for a geometry. This operator can be used only if a spatial index has been created on two dimensions of data. The syntax of the operator is as follows:

```
SDO_NN(geometry1  SDO_GEOMETRY,
       geometry2  SDO_GEOMETRY,
       param      VARCHAR2
       [, number  NUMBER]);
```

In the preceding syntax:

- `geometry1` is a column of type SDO_GEOMETRY in a table. This column must be spatially indexed.
- `geometry2` is an instance of type SDO_GEOMETRY.
- `param` is a quoted string of keyword-value pairs that can determine the behavior of the operator, such as how many nearest neighbor geometries are returned. See the SDO_NN operator in Spatial Operators for information about this parameter.
- `number` is the same number used in the call to SDO_NN_DISTANCE. Use this only if the SDO_NN_DISTANCE ancillary operator is included in the call to SDO_NN. See the SDO_NN operator in Spatial Operators for information about this parameter.

The following example finds the two objects from the SHAPE column in the COLA_MARKETS table that are closest to a specified point (10,7). (Note the use of the optimizer hint in the SELECT statement, as explained in the Usage Notes for the SDO_NN operator in Spatial Operators .)

```
SELECT /*+ INDEX(cola_markets cola_spatial_idx) */
 c.mkt_id, c.name  FROM cola_markets c  WHERE SDO_NN(c.shape,
   SDO_geometry(SDO_POINT2D, NULL, SDO_point_type(10,7,NULL), NULL,
   NULL),  'sdo_num_res=2') = 'TRUE';
```

5.2.1.5 Spatial Functions

Spatial also supplies functions for determining relationships between geometries, finding information about single geometries, changing geometries, and combining geometries. These functions all take into account two dimensions of source data. If the output value of these functions is a geometry, the resulting geometry will have the same dimensionality as the input geometry, but only the first two dimensions will accurately reflect the result of the operation.

5.2.2 Spatial Join

A **spatial join** is the same as a regular join except that the predicate involves a spatial operator. In Spatial, a spatial join takes place when you compare all geometries of one layer to all geometries of another layer. This is unlike a query window, which compares a single geometry to all geometries of a layer.

Spatial joins can be used to answer questions such as *Which highways cross national parks?*

The following table structures illustrate how the join would be accomplished for this example:

```
PARKS(    GID VARCHAR2(32), SHAPE SDO_GEOMETRY)
HIGHWAYS( GID VARCHAR2(32), SHAPE SDO_GEOMETRY)
```

To perform a spatial join, use the SDO_JOIN operator, which is described in Spatial Operators . The following spatial join query, to list the GID column values of highways and parks where a highway interacts with a park, performs a primary filter operation only (`'mask=FILTER'`), and thus it returns only approximate results:

```
SELECT /*+ ordered */ a.gid, b.gid
  FROM TABLE(SDO_JOIN('PARKS', 'SHAPE',
                      'HIGHWAYS', 'SHAPE',
                      'mask=FILTER')) c,
       parks a,
       highways b
  WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

> **Note:**
>
> The SDO_JOIN operator is not supported when a composite B-tree spatial index is used.

The following spatial join query requests the same information as in the preceding example, but it performs both primary and secondary filter operations (`'mask=ANYINTERACT'`), and thus it returns exact results:

```
SELECT /*+ ordered */ a.gid, b.gid
  FROM TABLE(SDO_JOIN('PARKS', 'SHAPE',
                      'HIGHWAYS', 'SHAPE',
                      'mask=ANYINTERACT')) c,
       parks a,
       highways b
  WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

5.2.3 Data and Index Dimensionality, and Spatial Queries

The elements of a spatial query can, in theory, have the following dimensionality:

- The base table geometries (or `geometry1` in spatial operator formats) can have two, three, or more dimensions.
- The spatial index created on the base table (or `geometry1`) can be two-dimensional or three-dimensional.
- The query window (or `geometry2` in spatial operator formats) can have two, three, or more dimensions.

Some combinations of dimensionality among the three elements are supported and some are not. Table 5-1 explains what happens with the possible combinations involving two and three dimensions.

Table 5-1 Data and Index Dimensionality, and Query Support

Base Table (geometry1) Dimensionality	Spatial Index Dimensionality	Query Window (geometry2) Dimensionality	Query Result
2-dimensional	2-dimensional	2-dimensional	Performs a two-dimensional query.
2-dimensional	2-dimensional	3-dimensional	Supported if the query window has an appropriate SDO_GTYPE value less than 3008.
2-dimensional	3-dimensional	2-dimensional	Not supported: 3D index not permitted on 2D data.
2-dimensional	3-dimensional	3-dimensional	Not supported: 3D index not permitted on 2D data.
3-dimensional	2-dimensional	2-dimensional	Ignores the third (Z) dimension in each base geometry and performs a two-dimensional query.
3-dimensional	2-dimensional	3-dimensional	Supported if the query window has an appropriate SDO_GTYPE value less than 3008.
3-dimensional	3-dimensional	2-dimensional	Converts the 2D query window to a 3D window with zero Z values and performs a three-dimensional query.
3-dimensional	3-dimensional	3-dimensional	Performs a three-dimensional query.

5.2.4 Using Event 54700 to Require a Spatial Index for Spatial Queries

Although a spatial index is recommended for spatial queries, by default is it not required. However, you can require that a spatial index be defined and used for spatial queries by setting event 54700 to the `level` value `1`. You can reset the behavior to the default by setting event 54700 to the `level` value `0` (zero).

You can apply the event for the session or system by using the ALTER SESSION or ALTER SYSTEM statement, respectively. For example:

```
ALTER SESSION set events '54700 trace name context forever, level 1';
```

The possible `level` values are:

- 0 (default): Indicates that spatial queries can be performed even when a spatial index is not present on the query candidate geometry column.
- 1: Indicates indicates that spatial queries **must** have a spatial index present on the query candidate geometry column.

6

Coordinate Systems (Spatial Reference Systems)

This chapter describes in detail the Oracle Spatial coordinate system support.

This support was introduced in Coordinate System. You can store and manipulate SDO_GEOMETRY objects in a variety of coordinate systems.

For reference information about coordinate system transformation functions and procedures in the MDSYS.SDO_CS package, see SDO_CS Package (Coordinate System Transformation) .

- Terms and Concepts
  This topic explains important terms and concepts related to coordinate system support in Oracle Spatial.
- Geodetic Coordinate Support
  Effective with Oracle9*i*, Spatial provides a rational and complete treatment of geodetic coordinates.
- Local Coordinate Support
  Spatial provides a level of support for local coordinate systems.
- EPSG Model and Spatial
  The Oracle Spatial coordinate system support is based on, but is not always identical to, the European Petroleum Survey Group (EPSG) data model and dataset.
- Three-Dimensional Coordinate Reference System Support
  The Oracle Spatial support for three-dimensional coordinate reference systems complies with the EPSG model.
- TFM_PLAN Object Type
  The object type TFM_PLAN is used is by several SDO_CS package subprograms to specify a transformation plan.
- Coordinate Systems Data Structures
  The coordinate systems functions and procedures use information provided in the tables and views supplied with Oracle Spatial. The tables and views are part of the MDSYS schema; however, public synonyms are defined, so you do not need to specify *MDSYS.* before the table or view name.
- Legacy Tables and Views
  In releases of Spatial before 10.2, the coordinate systems functions and procedures used information provided in the following tables, some of which have new names or are now views instead of tables.
- Creating a User-Defined Coordinate Reference System
  If the coordinate systems supplied by Oracle are not sufficient for your needs, you can create user-defined coordinate reference systems.
- Notes and Restrictions with Coordinate Systems Support
  The following notes and restrictions apply to coordinate systems support in the current release of Oracle Spatial.

- U.S. National Grid Support
  The U.S. National Grid is a point coordinate representation using a single alphanumeric coordinate (for example, 18SUJ2348316806479498).
- Geohash Support
  A **geohash** is a standard String encoding of a longitude/latitude point.
- Google Maps Considerations
  Google Maps uses spherical math in its projections, as opposed to the ellipsoidal math used by Oracle Spatial. This difference can lead to inconsistencies in applications, such as when overlaying a map based on Google Maps with a map based on an Oracle Spatial ellipsoidal projection.
- Example of Coordinate System Transformation
  This topic presents a simplified example that uses coordinate system transformation functions and procedures.

6.1 Terms and Concepts

This topic explains important terms and concepts related to coordinate system support in Oracle Spatial.

- Coordinate System (Spatial Reference System)
- Cartesian Coordinates
- Geodetic Coordinates (Geographic Coordinates)
- Projected Coordinates
- Local Coordinates
- Geodetic Datum
- Transformation

6.1.1 Coordinate System (Spatial Reference System)

A **coordinate system** (also called a *spatial reference system*) is a means of assigning coordinates to a location and establishing relationships between sets of such coordinates. It enables the interpretation of a set of coordinates as a representation of a position in a real world space.

The term **coordinate reference system** has the same meaning as coordinate system for Spatial, and the terms are used interchangeably. European Petroleum Survey Group (EPSG) specifications and documentation typically use the term coordinate reference system. (EPSG has its own meaning for the term *coordinate system*, as noted in SDO_COORD_SYS Table.)

6.1.2 Cartesian Coordinates

Cartesian coordinates are coordinates that measure the position of a point from a defined origin along axes that are perpendicular in the represented two-dimensional or three-dimensional space.

6.1.3 Geodetic Coordinates (Geographic Coordinates)

Geodetic coordinates (sometimes called *geographic coordinates*) are angular coordinates (longitude and latitude), closely related to spherical polar coordinates, and are defined relative to a particular Earth geodetic datum (described in Geodetic Datum). For more information about geodetic coordinate support, see Geodetic Coordinate Support.

6.1.4 Projected Coordinates

Projected coordinates are planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.

6.1.5 Local Coordinates

Local coordinates are Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system. Local Coordinate Support describes local coordinate support in Spatial.

6.1.6 Geodetic Datum

A **geodetic datum** (or **datum**) is a means of shifting and rotating an ellipsoid to represent the figure of the Earth, usually as an oblate spheroid, that approximates the surface of the Earth locally or globally, and is the reference for the system of geodetic coordinates.

Each geodetic coordinate system is based on a datum.

6.1.7 Transformation

Transformation is the conversion of coordinates from one coordinate system to another coordinate system.

If the coordinate system is georeferenced, transformation can involve datum transformation: the conversion of geodetic coordinates from one geodetic datum to another geodetic datum, usually involving changes in the shape, orientation, and center position of the reference ellipsoid.

6.2 Geodetic Coordinate Support

Effective with Oracle9*i*, Spatial provides a rational and complete treatment of geodetic coordinates.

Before Oracle9*i*, spatial computations were based solely on flat (Cartesian) coordinates, regardless of the coordinate system specified for the layer of geometries. Consequently, computations for data in geodetic coordinate systems were inaccurate, because they always treated the coordinates as if they were on a flat surface, and they did not consider the curvature of the surface.

Now, ellipsoidal surface computations consider the curvatures of the Earth in the specified geodetic coordinate system and return correct, accurate results. In other words, spatial queries return the right answers all the time.

- Geodesy and Two-Dimensional Geometry
- Choosing a Geodetic or Projected Coordinate System
- Choosing Non-Ellipsoidal or Ellipsoidal Height
- Geodetic MBRs
- Distance: Spherical versus Ellipsoidal with Geodetic Data

- Other Considerations and Requirements with Geodetic Data

> **See Also:**
>
> Getting Started with Longitude/Latitude Spatial Data

6.2.1 Geodesy and Two-Dimensional Geometry

A two-dimensional geometry is a surface geometry, but the important question is: What is the *surface*? A flat surface (plane) is accurately represented by Cartesian coordinates. However, Cartesian coordinates are not adequate for representing the surface of a solid. A commonly used surface for spatial geometry is the surface of the Earth, and the laws of geometry there are different than they are in a plane. For example, on the Earth's surface there are no parallel lines: lines are geodesics, and all geodesics intersect. Thus, closed curved surface problems cannot be done accurately with Cartesian geometry.

Spatial provides accurate results regardless of the coordinate system or the size of the area involved, without requiring that the data be projected to a flat surface. The results are accurate regardless of where on the Earth's surface the query is focused, even in "special" areas such as the poles. Thus, you can store coordinates in any datum and projections that you choose, and you can perform accurate queries regardless of the coordinate system.

6.2.2 Choosing a Geodetic or Projected Coordinate System

For applications that deal with the Earth's surface, the data can be represented using a geodetic coordinate system or a projected plane coordinate system. In deciding which approach to take with the data, consider any needs related to accuracy and performance:

- Accuracy

  For many spatial applications, the area is sufficiently small to allow adequate computations on Cartesian coordinates in a local projection. For example, the New Hampshire State Plane local projection provides adequate accuracy for most spatial applications that use data for that state.

  However, Cartesian computations on a plane projection will never give accurate results for a large area such as Canada or Scandinavia. For example, a query asking if Stockholm, Sweden and Helsinki, Finland are within a specified distance may return an incorrect result if the specified distance is close to the actual measured distance. Computations involving large areas or requiring very precise accuracy must account for the curvature of the Earth's surface.

- Performance

  Spherical computations use more computing resources than Cartesian computations. Some operations using geodetic coordinates may take longer to complete than the same operations using Cartesian coordinates.

It is important that you choose the correct type of coordinate system, because it affects the point at which anomalies related to floating point arithmetic are likely to appear.

6.2.3 Choosing Non-Ellipsoidal or Ellipsoidal Height

This section discusses guidelines for choosing the appropriate type of height for three-dimensional data: non-ellipsoidal or ellipsoidal. Although ellipsoidal height is widely used and is the default for many GPS applications, and although ellipsoidal computations incur less performance overhead in many cases, there are applications for which a non-ellipsoidal height may be preferable or even necessary.

Also, after any initial decision, you can change the reference height type, because transformations between different height datums are supported.

- Non-Ellipsoidal Height
- Ellipsoidal Height

6.2.3.1 Non-Ellipsoidal Height

Non-ellipsoidal height is measured from some point other than the reference ellipsoid. Some common non-ellipsoidal measurements of height are from ground level, mean sea level (MSL), or the reference geoid.

- **Ground level**: Measuring height from the ground level is conceptually the simplest approach, and it is common in very local or informal applications. For example, when modeling a single building or a cluster of buildings, ground level may be adequate.

  Moreover, if you ever need to integrate local ground height with a global height datum, you can achieve this with a transformation (EPSG method 9616) adding a local constant reference height. If you need to model local terrain undulations, you can achieve this with a transformation using an offset matrix (EPSG method 9635), just as you can between the geoid and the ellipsoid.

- **Mean sea level (MSL)**: MSL is a common variation of sea level that provides conceptual simplicity, ignoring local variations and changes over time in sea level. It can also be extrapolated to areas covered by land.

  Height relative to MSL is useful for a variety of applications, such as those dealing with flooding risk, gravitational potential, and how thin the air is. MSL is commonly used for the heights of aircraft in flight.

- **Geoid**: The geoid, the equipotential surface closest to MSL, provides the most precise measurements of height in terms of gravitational pull, factoring in such things as climate and tectonic changes. The geoid can deviate from MSL by approximately 2 meters (plus or minus).

  If an application is affected more by purely gravitational effects than by actual local sea level, you may want to use the geoid as the reference rather than MSL. To perform transformations between MSL, geoid, or ellipsoid, you can use EPSG method 9635 and the appropriate time-stamped offset matrix.

Because most non-ellipsoidal height references are irregular and undulating surfaces, transformations between them are more complicated than with ellipsoidal heights. One approach is to use an offset grid file to define the transformation. This approach is implemented in EPSG method 9635. The grid file has to be acquired (often available publicly from government websites). Moreover, because most such non-ellipsoidal height datums (including the geoid, sea level, and local terrain) change over time, the timestamp of an offset matrix may matter, even if not by much. (Of course, the same principle applies to ellipsoids as well, since they are not static in the long term. After all, they are intended to approximate the changing geoid, MSL, or terrain.)

Regarding performance and memory usage with EPSG method 9635, at runtime the grid must be loaded before the transformation of a dataset. This load operation temporarily increases the footprint in main memory and incurs one-time loading overhead. If an entire dataset is transformed, the overhead can be relatively insignificant; however, if frequent transformations are performed on single geometries, the cumulative overhead can become significant.

6.2.3.2 Ellipsoidal Height

Ellipsoidal height is measured from a point on the reference ellipsoid. The ellipsoid is a convenient and relatively faithful approximation of the Earth. Although using an ellipsoid is more complex than using a sphere to represent the Earth, using an ellipsoid is, for most applications, simpler than using a geoid or local heights (although with some sacrifice in precision). Moreover, geoidal and sea-level heights are often not well suited for mathematical analysis, because the undulating and irregular shapes would make certain computations prohibitively complex and expensive.

GPS applications often assume ellipsoidal height as a reference and use it as the default. Because the ellipsoid is chosen to match the geoid (and similar sea level), ellipsoidal height tends not to deviate far from MSL height. For example, the geoid diverges from the NAD83 ellipsoid by only up to 50 meters. Other ellipsoids may be chosen to match a particular country even more closely.

Even if different parties use different ellipsoids, a WKT can conveniently describe such differences. A simple datum transformation can efficiently and accurately perform transformations between ellipsoids. Because no offset matrix is involved, no loading overhead is required. Thus, interoperability is simplified with ellipsoidal height, although future requirements or analysis might necessitate the use of MSL, a geoid, or other non-ellipsoidal height datums.

6.2.4 Geodetic MBRs

To create a query window for certain operations on geodetic data, use an MBR (minimum bounding rectangle) by specifying an SDO_ETYPE value of 1003 or 2003 (optimized rectangle) and an SDO_INTERPRETATION value of 3, as described in Table 2-4 in SDO_ELEM_INFO. A geodetic MBR can be used with the following operators: SDO_FILTER, SDO_RELATE with the `ANYINTERACT` mask, SDO_ANYINTERACT, and SDO_WITHIN_DISTANCE.

Example 6-1 requests the names of all cola markets that are likely to interact spatially with a geodetic MBR.

Example 6-1 Using a Geodetic MBR

```
SELECT c.name FROM cola_markets_cs c WHERE
   SDO_FILTER(c.shape,
       SDO_GEOMETRY(
           SDO_POLYGON2D,
           4326,    -- SRID for WGS 84 longitude/latitude
           NULL,
           SDO_ELEM_INFO_ARRAY(1,1003,3),
           SDO_ORDINATE_ARRAY(6,5, 10,10))
       ) = 'TRUE';
```

Example 6-1 produces the following output (assuming the data as defined in Example of Coordinate System Transformation):

```
NAME
--------------------------------
cola_c
cola_b
cola_d
```

The following considerations apply to the use of geodetic MBRs:

- Do not use a geodetic MBR with spatial objects stored in the database. Use it only to construct a query window.
- The lower-left Y coordinate (minY) must be less than the upper-right Y coordinate (maxY). If the lower-left X coordinate (minX) is greater than the upper-right X coordinate (maxX), the window is assumed to cross the date line meridian (that is, the meridian "opposite" the prime meridian, or both 180 and -180 longitude). For example, an MBR of (-10,10, -100, 20) with longitude/latitude data goes three-fourths of the way around the Earth (crossing the date line meridian), and goes from latitude lines 10 to 20.
- When Spatial uses the MBR internally for the query, the lines along the horizontal are treated as parallel lines to latitude and not as great circles. This might affect results for objects within a few meters of the edge of the MBR (especially objects in the middle latitudes in both hemispheres).
- When an optimized rectangle spans more than 119 degrees in longitude, it is internally divided into three rectangles; and as a result, these three rectangles share an edge that is the common boundary between them. If you validate the geometry of such an optimized rectangle, error code 13351 is returned because the internal rectangles have a shared edge. You can use such an optimized rectangle for queries with only the following: SDO_ANYINTERACT operator, SDO_RELATE operator with the ANYINTERACT mask, or SDO_GEOM.RELATE function with the ANYINTERACT mask. (Any other queries on such an optimized rectangle may return incorrect results.)

The following additional examples show special or unusual cases, to illustrate how a geodetic MBR is interpreted with longitude/latitude data:

- (10,0, -110,20) crosses the date line meridian and goes most of the way around the world, and goes from the equator to latitude 20.
- (10,-90, 40,90) is a band from the South Pole to the North Pole between longitudes 10 and 40.
- (10,-90, 40,50) is a band from the South Pole to latitude 50 between longitudes 10 and 40.
- (-180,-10, 180,5) is a band that wraps the equator from 10 degrees south to 5 degrees north.
- (-180,-90, 180,90) is the whole Earth.
- (-180,-90, 180,50) is the whole Earth below latitude 50.
- (-180,50, 180,90) is the whole Earth above latitude 50.

6.2.5 Distance: Spherical versus Ellipsoidal with Geodetic Data

When using a geodetic coordinate system, the distance between spatial objects can be computed as spherical or ellipsoidal.

The ellipsoidal distance is more accurate that the spherical distance, but it takes longer to compute. With previous releases (12.1 and earlier), with geodetic data, Spatial always used ellipsoidal distance for points and multipoints, but spherical distance for other geometry types.

Effective with Release 12.2, you have the option to specify ellipsoidal distance regardless of geometry type. The default distance measurement behavior is still as it was for Release 12.1. However, for spatial operators and functions that determine the distance between geometries, the “nearest neighbor” geometries, or whether geometries are within a given distance, you can specify whether ellipsoidal distance is needed, through the use of a keyword or parameter named `ellipsoidal`: `true` causes ellipsoidal distance to be returned regardless of the geometry type; `false` (the default) causes the pre-Release 12.2 behavior to be applied (ellipsoidal distance for points and multipoints, but spherical distance for other geometry types).

The default value of `false` prevents applications from returning different distance results after upgrading from Release 12.1 to 12.2, if that is a concern to you.

6.2.6 Other Considerations and Requirements with Geodetic Data

The following geometries are not permitted if a geodetic coordinate system is used or if any transformation is being performed (even if the transformation is from one projected coordinate system to another projected coordinate system):

- Circles
- Circular arcs

Geodetic coordinate system support is provided only for geometries that consist of points or geodesics (lines on the ellipsoid). If you have geometries containing circles or circular arcs in a projected coordinate system, you can densify them using the SDO_GEOM.SDO_ARC_DENSIFY function (documented in SDO_GEOM Package (Geometry)) before transforming them to geodetic coordinates, and then perform spatial operations on the resulting geometries.

The following size limits apply with geodetic data:

- In general, no polygon element can have an area larger than or equal to one-half the surface of the Earth. Moreover, if the result of a union of two polygons is greater than one-half the surface of the Earth, the operation will not produce a correct result. For example, if A union B results in a polygon that is greater than one-half of the area of the Earth, the operations A difference B, A intersection B, and A XOR B are not supported, and only a relate operation with the ANYINTERACT mask is supported between those two polygons.
- In a line, the distance between two adjacent coordinates cannot be greater than or equal to one-half the perimeter (a great circle) of the Earth.

Note:

If the SPATIAL_VECTOR_ACCELERATION database system parameter value is `TRUE`, polygon elements that can have area larger than one-half the surface of the Earth are supported with some restrictions. Running SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT on such a geometry will result in the warning code 13367, indicating that the ring has the wrong orientation.

The warning in this case means that the ring is has an area larger than half the area of the Earth. Such geometries can be used in most operations except XOR and CONVEXHULL; however, such geometries are supported only if both the North and South poles are not contained in the polygons. That is, these large polygons may contain either the North Pole or the South Pole, but not both.

If you need to work with larger elements, first break these elements into multiple smaller elements and work with them. For example, you cannot create a geometry representing the entire ocean surface of the Earth; however, you can create multiple geometries, each representing part of the overall ocean surface. To work with a line string that is greater than or equal to one-half the perimeter of the Earth, you can add one or more intermediate points on the line so that all adjacent coordinates are less than one-half the perimeter of the Earth.

Tolerance is specified as meters for geodetic layers. If you use tolerance values that are typical for non-geodetic data, these values are interpreted as meters for geodetic data. For example, if you specify a tolerance value of 0.05 for geodetic data, this is interpreted as precise to 5 centimeters. If this value is more precise than your applications need, performance may be affected because of the internal computational steps taken to implement the specified precision. (For more information about tolerance, see Tolerance.)

For geodetic layers, you must specify the dimensional extents in the index metadata as -180,180 for longitude and -90,90 for latitude. The following statement (from Example of Coordinate System Transformation) specifies these extents (with a 10-meter tolerance value in each dimension) for a geodetic data layer:

```
INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'cola_markets_cs',
  'shape',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),  -- 10 meters tolerance
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10)  -- 10 meters tolerance
     ),
  4326   -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);
```

See Notes and Restrictions with Coordinate Systems Support for additional notes and restrictions relating to geodetic data.

6.3 Local Coordinate Support

Spatial provides a level of support for local coordinate systems.

Local coordinate systems are often used in CAD systems, and they can also be used in local surveys where the relationship between the surveyed site and the rest of the world is not important.

Several local coordinate systems are predefined and included with Spatial in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table). These supplied local coordinate systems, whose names start with *Non-Earth*, define non-Earth Cartesian coordinate systems based on different units of measurement (*Meter*, *Millimeter*, *Inch*, and so on).

In the current release, you cannot perform coordinate system transformation between local and Earth-based coordinate systems; and when transforming a geometry or layer of geometries between local coordinate systems, you can only to convert coordinates in a local coordinate system from one unit of measurement to another (for example, inches to millimeters). However, you can perform all other spatial operations (for example, using SDO_RELATE, SDO_WITHIN_DISTANCE, and other operators) with local coordinate systems.

6.4 EPSG Model and Spatial

The Oracle Spatial coordinate system support is based on, but is not always identical to, the European Petroleum Survey Group (EPSG) data model and dataset.

These are described in detail at https://epsg.org, and the download for the EPSG geodetic parameter dataset includes a "Readme" that contains an entity-relationship (E-R) diagram. The approach taken by Oracle Spatial provides the benefits of standardization, expanded support, and flexibility:

- The EPSG model is a comprehensive and widely accepted standard for data representation, so users familiar with it can more easily understand Spatial storage and operations.
- Support is provided for more coordinate systems and their associated datums, ellipsoids, and projections. For example, some of the EPSG geographic and projected coordinate systems had no counterpart among coordinate systems supported for previous Spatial releases. Their addition results in an expanded set of supported coordinate systems.
- Data transformations are more flexible. Instead of there being only one possible Oracle-defined transformation path between a given source and target coordinate system, you can specify alternative paths to be used for a specific area of applicability (that is, use case) or as the systemwide default.

  The rest of this section describes this flexibility.

For data transformations (that is, transforming data from one coordinate system to another), you can now control which transformation rules are to be applied. In previous releases, and in the current release by default, Spatial performs transformations based only on the specified source and target coordinate systems, using predetermined intermediate transformation steps. The assumption behind that default approach is that there is a single correct or preferable transformation chain.

By default, then, Spatial applies certain transformation methods for each supported transformation between specific pairs of source and target coordinate systems. For example, there are over 500 supported transformations from specific coordinate systems to the WGS 84 (longitude/latitude) coordinate system, which has the EPSG SRID value of 4326. As one example, for a transformation from SRID 4605 to SRID 4326, Spatial can use the transformation method with the COORD_OP_ID value 1445, as indicated in the SDO_COORD_OPS table (described in SDO_COORD_OPS Table), which contains one row for each transformation operation between coordinate systems.

However, you can override the default transformation by specifying a different method (from the set of Oracle-supplied methods) for the transformation for any given source and target SRID combination. You can specify a transformation as the new systemwide default, or you can associate the transformation with a named use case that can be specified when transforming a layer of spatial geometries. (A **use case** is simply a name given to a usage scenario or area of applicability, such as *Project XYZ* or *Mike's Favorite Transformations*; there is no relationship between use cases and database users or schemas.)

To specify a transformation as either the systemwide default or associated with a use case, use the SDO_CS.ADD_PREFERENCE_FOR_OP procedure. To remove a previously specified preference, use the SDO_CS.REVOKE_PREFERENCE_FOR_OP procedure.

When it performs a coordinate system transformation, Spatial follows these general steps to determine the specific transformation to use:

1. If a use case has been specified, the transformation associated with that use case is applied.
2. If no use case has been specified and if a user-defined systemwide transformation has been created for the specified source and target coordinate system pair, that transformation is applied.
3. If no use case has been specified and if no user-defined transformation exists for the specified source and target coordinate system pair, the behavior depends on whether or not EPSG rules have been created, such as by the SDO_CS.CREATE_OBVIOUS_EPSG_RULES procedure:

  - If the EPSG rules have been created and if an EPSG rule is defined for this transformation, the EPSG transformation is applied.
  - If the EPSG rules have not been created, or if they have been created but no EPSG rule is defined for this transformation, the Oracle Spatial default transformation is applied.

To return the version number of the EPSG dataset used by Spatial, use the SDO_CS.GET_EPSG_DATA_VERSION function.

6.5 Three-Dimensional Coordinate Reference System Support

The Oracle Spatial support for three-dimensional coordinate reference systems complies with the EPSG model.

> **Note:**
>
> Three-dimensional coordinate reference systems are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The EPSG model (described in EPSG Model and Spatial) provides the following types of coordinate reference systems:

- Geographic 2D
- Projected 2D
- Geographic 3D, which consists of Geographic 2D plus ellipsoidal height, with longitude, latitude, and height based on the same ellipsoid and datum
- Compound, which consists of either Geographic 2D plus gravity-related height or Projected 2D plus gravity-related height

Thus, there are two categories of three-dimensional coordinate reference systems: those based on ellipsoidal height (geographic 3D, described in Geographic 3D Coordinate Reference Systems) and those based on gravity-related height (compound, described in Compound Coordinate Reference Systems).

Three-dimensional computations are more accurate than their two-dimensional equivalents, particularly when they are chained: For example, datum transformations internally always are performed in three dimensions, regardless of the dimensionality of the source and target CRS and geometries. When two-dimensional geometries are involved, one or more of the following can occur:

1. When the input or output geometries and CRS are two-dimensional, the (unspecified) input height defaults to zero (above the ellipsoid, depending on the CRS) for any internal three-dimensional computations. This is a potential source of inaccuracy, unless the height was intended to be exactly zero. (Data can be two-dimensional because height values were originally either unavailable or not considered important; this is different from representing data in two dimensions because heights are known to be exactly zero.
2. The transformation might then internally result in a non-zero height. Since the two-dimensional target CRS cannot accommodate the height value, the height value must be truncated, resulting in further inaccuracy.

3. If further transformations are chained, the repeated truncation of height values can result in increasing inaccuracies. Note that an inaccurate input height can affect not only the output height of a transformation, but also the longitude and latitude.

However, if the source and target CRS are three-dimensional, there is no repeated truncation of heights. Consequently, accuracy is increased, particularly for transformation chains.

For an introduction to support in Spatial for three-dimensional geometries, see Three-Dimensional Spatial Objects.

- Geographic 3D Coordinate Reference Systems
- Compound Coordinate Reference Systems
- Three-Dimensional Transformations
- Cross-Dimensionality Transformations
- 3D Equivalent for WGS 84?

6.5.1 Geographic 3D Coordinate Reference Systems

A geographic three-dimensional coordinate reference system is based on longitude and latitude, plus ellipsoidal height. The **ellipsoidal height** is the height relative to a reference ellipsoid, which is an approximation of the real Earth. All three dimensions of the CRS are based on the same ellipsoid.

Using ellipsoidal heights enables Spatial to perform internal operations with great mathematical regularity and efficiency. Compound coordinate reference systems, on the other hand, require more complex transformations, often based on offset matrixes. Some of these matrixes have to be downloaded and configured. Furthermore, they might have a significant footprint, on disk and in main memory.

The supported geographic 3D coordinate reference systems are listed in the SDO_CRS_GEOGRAPHIC3D view.

6.5.2 Compound Coordinate Reference Systems

A compound three-dimensional coordinate reference system is based on a geographic or projected two-dimensional system, plus gravity-related height. **Gravity-related** height is the height as influenced by the Earth's gravitational force, where the base height (zero) is often an equipotential surface, and might be defined as above or below "sea level."

Gravity-related height is a more complex representation than ellipsoidal height, because of gravitational irregularities such as the following:

- Orthometric height

  Orthometric height is also referred to as the height above the geoid. The geoid is an equipotential surface that most closely (but not exactly) matches mean sea level. An equipotential surface is a surface on which each point is at the same gravitational potential level. Such a surface tends to undulate slightly, because the Earth has regions of varying density. There are multiple equipotential surfaces, and these might not be parallel to each other due to the irregular density of the Earth.

- Height relative to mean sea level, to sea level at a specific location, or to a vertical network warped to fit multiple tidal stations (for example, NGVD 29)

  Sea level is close to, but not identical to, the geoid. The sea level at a given location is often defined based on the "average sea level" at a specific port.

The supported compound coordinate reference systems are listed in the SDO_CRS_COMPOUND view, described in SDO_CRS_COMPOUND View.

You can create a customized compound coordinate reference system, which combines a horizontal CRS with a vertical CRS. (The *horizontal* CRS contains two dimensions, such as X and Y or longitude and latitude, and the *vertical* CRS contains the third dimension, such as Z or height or altitude.) Creating a Compound CRS explains how to create a compound CRS.

6.5.3 Three-Dimensional Transformations

Spatial supports three-dimensional coordinate transformations for SDO_GEOMETRY objects directly, and indirectly for point clouds and TINs. (For example, a point cloud must be transformed to a table with an SDO_GEOMETRY column.) The supported transformations include the following:

- Three-dimensional datum transformations
- Transformations between ellipsoidal and gravity-related height

For three-dimensional datum transformations, the datum transformation between the two ellipsoids is essentially the same as for two-dimensional coordinate reference systems, except that the third dimension is considered instead of ignored. Because height values are not ignored, the accuracy of the results increases, especially for transformation chains.

For transformations between ellipsoidal and gravity-related height, computations are complicated by the fact that equipotential and other gravity-related surfaces tend to undulate, compared to any ellipsoid and to each other. Transformations might be based on higher-degree polynomial functions or bilinear interpolation. In either case, a significant parameter matrix is required to define the transformation.

For transforming between gravity-related and ellipsoidal height, the process usually involves a transformation, based on an offset matrix, between geoidal and ellipsoidal height. Depending on the source or target definition of the offset matrix, a common datum transformation might have to be appended or prefixed.

Example 6-2 Three-Dimensional Datum Transformation

Example 6-2 shows a three-dimensional datum transformation.

```
set numwidth 9

CREATE TABLE source_geoms (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  GEOMETRY SDO_GEOMETRY);

INSERT INTO source_geoms VALUES(
  1,
  'reference geom',
  SDO_GEOMETRY(
  SDO_POINT3D,
  4985,
  SDO_POINT_TYPE(
     4.0,
    55.0,
    1.0),
  NULL,
  NULL));

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',   -1000,1000, 10)),
  4985);

commit;

--------------------------------------------------------------------------------

CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_4979',
  4979);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'GEO_CS_4979',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',   -1000,1000, 10)),
  4979);

set lines 210;

--------------------------------------------------------------------------------

CALL SDO_CS.TRANSFORM_LAYER(
  'GEO_CS_4979',
  'GEOMETRY',
  'source_geoms2',
  4985);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms2',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',   -1000,1000, 10)),
  4985);

--------------------------------------------------------------------------------

DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'GEO_CS_4979';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS2';

drop table GEO_CS_4979;
drop table source_geoms;
drop table source_geoms2;
```

As a result of the transformation in Example 6-2, (4, 55, 1) is transformed to (4.0001539, 55.0000249, 4.218).

Example 6-3 Transformation Between Geoidal And Ellipsoidal Height

Example 6-3 configures a transformation between geoidal and ellipsoidal height, using a Hawaii offset grid. Note that without the initial creation of a rule (using the SDO_CS.CREATE_PREF_CONCATENATED_OP procedure), the grid would not be used.

```
-- Create Sample operation:
insert into mdsys.sdo_coord_ops (
  COORD_OP_ID,
  COORD_OP_NAME,
  COORD_OP_TYPE,
  SOURCE_SRID,
  TARGET_SRID,
  COORD_TFM_VERSION,
  COORD_OP_VARIANT,
  COORD_OP_METHOD_ID,
  UOM_ID_SOURCE_OFFSETS,
  UOM_ID_TARGET_OFFSETS,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  SHOW_OPERATION,
  IS_LEGACY,
  LEGACY_CODE,
  REVERSE_OP,
  IS_IMPLEMENTED_FORWARD,
  IS_IMPLEMENTED_REVERSE)
values (
  1000000005,
  'Test Bi-linear Interpolation',
  'CONVERSION',
  null,
  null,
  null,
  null,
  9635,
  null,
  null,
  'Oracle',
  'Oracle',
  1,
  'FALSE',
  null,
  1,
  1,
  1);

--Create sample parameters, pointing to the offset file
--(in this case reusing values from an existing operation):
insert into mdsys.sdo_coord_op_param_vals (
    coord_op_id,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    PARAM_VALUE_FILE,
    PARAM_VALUE_XML,
    UOM_ID) (
  select
    1000000005,
    9635,
    8666,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    PARAM_VALUE_FILE,
    PARAM_VALUE_XML,
    UOM_ID
  from
    mdsys.sdo_coord_op_param_vals
  where
    coord_op_id = 999998 and
    parameter_id = 8666);

--Create a rule to use this operation between SRIDs 7406 and 4359:
call sdo_cs.create_pref_concatenated_op(
    300,
    'CONCATENATED OPERATION',
    TFM_PLAN(SDO_TFM_CHAIN(7406, 1000000005, 4359)),
    NULL);


-- Now, actually perform the transformation:
set numformat 999999.99999999

-- Create the source table
CREATE TABLE source_geoms (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  GEOMETRY SDO_GEOMETRY);

INSERT INTO source_geoms VALUES(
  1,
  'reference geom',
  SDO_GEOMETRY(
  SDO_POINT3D,
  7406,
  SDO_POINT_TYPE(
    -161,
      18,
     0),
  NULL,
  NULL));

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',    -100, 100, 10)),
  7406);

commit;

SELECT GEOMETRY "Source" FROM source_geoms;

--------------------------------------------------------------------------------

--Perform the transformation:
CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_4359',
  4359);
```

```
INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'GEO_CS_4359',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',    -100, 100, 10)),
  4359);

set lines 210;

SELECT GEOMETRY "Target" FROM GEO_CS_4359;

--------------------------------------------------------------------------------

--Transform back:
CALL SDO_CS.TRANSFORM_LAYER(
  'GEO_CS_4359',
  'GEOMETRY',
  'source_geoms2',
  7406);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms2',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',    -100, 100, 10)),
  7406);

SELECT GEOMETRY "Source2" FROM source_geoms2;

--------------------------------------------------------------------------------

--Clean up (regarding the transformation):
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'GEO_CS_4359';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS2';

drop table GEO_CS_4359;
drop table source_geoms;
drop table source_geoms2;


--Clean up (regarding the rule):
CALL sdo_cs.delete_op(300);

delete from mdsys.sdo_coord_op_param_vals where coord_op_id = 1000000005;

delete from mdsys.sdo_coord_ops where coord_op_id = 1000000005;

COMMIT;
```

With the configuration in Example 6-3:

- Without the rule, (-161.00000000, 18.00000000, .00000000) is transformed to (-161.00127699, 18.00043360, 62.03196364), based simply on a datum transformation.
- With the rule, (-161.00000000, 18.00000000, .00000000) is transformed to (-161.00000000, 18.00000000, 6.33070000).

6.5.4 Cross-Dimensionality Transformations

You cannot directly perform a cross-dimensionality transformation (for example, from a two-dimensional geometry to a three-dimensional geometry) using the SDO_CS.TRANSFORM function or the SDO_CS.TRANSFORM_LAYER procedure. However, you can use the SDO_CS.MAKE_3D function to convert a two-dimensional geometry to a three-dimensional geometry, or the SDO_CS.MAKE_2D function to convert a three-dimensional geometry to a two-dimensional geometry; and you can use the resulting geometry to perform a transformation into a geometry with the desired number of dimensions.

For example, transforming a two-dimensional geometry into a three-dimensional geometry involves using the SDO_CS.MAKE_3D function. This function does not itself perform any coordinate transformation, but simply adds a height value and sets the target SRID. You must choose an appropriate target SRID, which should be the three-dimensional equivalent of the source SRID. For example, three-dimensional WGS 84 (4327) is the equivalent of two-dimensional WGS 84 (4326). If necessary, modify height values of vertices in the returned geometry.

There are many options for how to use the SDO_CS.MAKE_3D function, but the simplest is the following:

1. Transform from the two-dimensional source SRID to two-dimensional WGS 84 (4326).
2. Call SDO_CS.MAKE_3D to convert the geometry to three-dimensional WGS 84 (4327)
3. Transform from three-dimensional WGS 84 (4327) to the three-dimensional target SRID.

Example 6-4 transforms a two-dimensional point from SRID 27700 to two-dimensional SRID 4326, converts the result of the transformation to a three-dimensional point with SRID 4327, and transforms the converted point to three-dimensional SRID 4327.

Example 6-4   Cross-Dimensionality Transformation

```
SELECT
  SDO_CS.TRANSFORM(
    SDO_CS.MAKE_3D(
      SDO_CS.TRANSFORM(
        SDO_GEOMETRY(
          SDO_POINT2D,
          27700,
          SDO_POINT_TYPE(577274.984, 69740.4923, NULL),
          NULL,
          NULL),
        4326),
      height => 0,
      target_srid => 4327),
    4327) "27700 > 4326 > 4327 > 4327"
FROM DUAL;

27700 > 4326 > 4327 > 4327(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INF
--------------------------------------------------------------------------------
SDO_GEOMETRY(3001, 4327, SDO_POINT_TYPE(.498364058, 50.5006366, 0), NULL, NULL)
```

6.5.5 3D Equivalent for WGS 84?

There are two possible answers to the question *What is 3D equivalent for the WGS 84 coordinate system?* (that is, 2D EPSG SRID 4326):

- 4979 (in many or most cases), or

- It depends on what you mean by *height* (for example, above ground level, above or below sea level, or something else).

There are many different height datums. Height can be relative to:

- The ellipsoid, which requires the use of a coordinate system of type GEOGRAPHIC3d, for which SRID values 4327, 43229, and 4979 are predefined in Oracle Spatial.
- A non-ellipsoidal height datum, which requires the use of a coordinate system of type COMPOUND, for which a custom SRID must usually be defined. The non-ellipsoidal height may be specified in relation to the geoid, to some local or mean sea level (or a network of local sea levels), or to some other definition of *height* (such as above ground surface).

To define a compound coordinate system (see Compound Coordinate Reference Systems) based on the two dimensions of the WGS 84 coordinate system, you must first select a predefined or custom vertical coordinate reference system (see Creating a Vertical CRS). To find the available vertical coordinate reference systems, enter the following statement:

```
SELECT srid, COORD_REF_SYS_NAME from sdo_coord_ref_sys
  WHERE COORD_REF_SYS_KIND = 'VERTICAL' order by srid;

      SRID COORD_REF_SYS_NAME
---------- --------------------------------------------------------------------
      3855 EGM2008 geoid height
      3886 Fao 1979 height
      4440 NZVD2009 height
      4458 Dunedin-Bluff 1960 height
      5600 NGPF height
      5601 IGN 1966 height
      5602 Moorea SAU 1981 height
      . . .
      5795 Guadeloupe 1951 height
      5796 Lagos 1955 height
      5797 AIOC95 height
      5798 EGM84 geoid height
      5799 DVR90 height

123 rows selected.
```

After selecting a vertical coordinate reference system, create the compound SRID by entering a statement in the following form:

```
INSERT INTO sdo_coord_ref_system (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS,
  IS_VALID,
  SUPPORTS_SDO_GEOMETRY)
values (
  custom-SRID,
  'custom-name',
  'COMPOUND',
  NULL,
  NULL,
  6326,
  NULL,
  NULL,
  4326,
  vertical-SRID,
  'custom-information-source',
  'custom-data-source',
  'FALSE',
  NULL,
  NULL,
  NULL,
  'TRUE',
  'TRUE');
```

You can check the definition, based on the generated WKT, by entering a statement in the following form:

```
SELECT wktext3d FROM cs_srs WHERE srid = custom-SRID;

WKTEXT3D
------------------------------------------------------------------------------
COMPD_CS[
  "NTF (Paris) + NGF IGN69",
  GEOGCS["NTF (Paris)",
    DATUM["Nouvelle Triangulation Francaise (Paris)",
      SPHEROID[
        "Clarke 1880 (IGN)",
        6378249.2,
        293.4660212936293951,
        AUTHORITY["EPSG", "7011"]],
      TOWGS84[-168.0, -60.0, 320.0, 0.0, 0.0, 0.0, 0.0],
      AUTHORITY["EPSG", "6807"]],
    PRIMEM["Paris", 2.337229, AUTHORITY["EPSG","8903"]],
    UNIT["grad", 0.015707963267949, AUTHORITY["EPSG", "9105"]],
    AXIS["Lat", NORTH],
    AXIS["Long", EAST],
    AUTHORITY["EPSG", "4807"]],
  VERT_CS["NGF IGN69",
    VERT_DATUM["Nivellement general de la France - IGN69", 2005,
      AUTHORITY["EPSG", "5119"]],
    UNIT["metre", 1.0, AUTHORITY["EPSG", "9001"]],
    AXIS["H", UP],
    AUTHORITY["EPSG", "5720"]],
  AUTHORITY["EPSG","7400"]]
```

When transforming between different height datums, you might use a VERTCON matrix. For example, between the WGS 84 ellipsoid and geoid, there is an offset matrix that allows height transformation. For more information, see the following:

- Example 6-3 in Three-Dimensional Transformations
- Creating a Transformation Operation
- Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)

6.6 TFM_PLAN Object Type

The object type TFM_PLAN is used is by several SDO_CS package subprograms to specify a transformation plan.

For example, to create a concatenated operation that consists of two operations specified by a parameter of type TFM_PLAN, use the SDO_CS.CREATE_CONCATENATED_OP procedure.

Oracle Spatial defines the object type TFM_PLAN as:

```
CREATE TYPE tfm_plan AS OBJECT (
 THE_PLAN SDO_TFM_CHAIN);
```

The SDO_TFM_CHAIN type is defined as `VARRAY(1048576) OF NUMBER`.

Within the SDO_TFM_CHAIN array:

- The first element specifies the SRID of the source coordinate system.
- Each pair of elements after the first element specifies an operation ID and the SRID of a target coordinate system.

6.7 Coordinate Systems Data Structures

The coordinate systems functions and procedures use information provided in the tables and views supplied with Oracle Spatial. The tables and views are part of the MDSYS schema; however, public synonyms are defined, so you do not need to specify *MDSYS.* before the table or view name.

The definitions and data in these tables and views are based on the EPSG data model and dataset, as explained in EPSG Model and Spatial.

The coordinate system tables fit into several general categories:

- Coordinate system general information: SDO_COORD_SYS, SDO_COORD_REF_SYS
- Elements or aspects of a coordinate system definition: SDO_DATUMS, SDO_ELLIPSOIDS, SDO_PRIME_MERIDIANS
- Datum transformation support: SDO_COORD_OPS, SDO_COORD_OP_METHODS, SDO_COORD_OP_PARAM_USE, SDO_COORD_OP_PARAM_VALS, SDO_COORD_OP_PARAMS, SDO_COORD_OP_PATHS, SDO_PREFERRED_OPS_SYSTEM, SDO_PREFERRED_OPS_USER
- Others related to coordinate system definition: SDO_COORD_AXES, SDO_COORD_AXIS_NAMES, SDO_UNITS_OF_MEASURE

Several views are provided that are identical to or subsets of coordinate system tables:

- SDO_COORD_REF_SYSTEM, which contains the same columns as the SDO_COORD_REF_SYS table. Use the SDO_COORD_REF_SYSTEM view instead of the COORD_REF_SYS table for any insert, update, or delete operations.
- Subsets of SDO_DATUMS, selected according to the value in the DATUM_TYPE column: SDO_DATUM_ENGINEERING, SDO_DATUM_GEODETIC, SDO_DATUM_VERTICAL.
- Subsets of SDO_COORD_REF_SYS, selected according to the value in the COORD_REF_SYS_KIND column: SDO_CRS_COMPOUND, SDO_CRS_ENGINEERING, SDO_CRS_GEOCENTRIC, SDO_CRS_GEOGRAPHIC2D, SDO_CRS_GEOGRAPHIC3D, SDO_CRS_PROJECTED, SDO_CRS_VERTICAL.

Most of the rest of this section explains these tables and views, in alphabetical order. (Many column descriptions are adapted or taken from EPSG descriptions.) Relationships Among Coordinate System Tables and Views describes relationships among the tables and views, and it lists EPSG table names and their corresponding Oracle Spatial names. Finding Information About EPSG-Based Coordinate Systems describes how to find information about EPSG-based coordinate systems, and it provides several examples.

In addition to the tables and views in this section, Spatial provides several legacy tables whose definitions and data match those of certain Spatial system tables used in previous releases. Legacy Tables and Views describes the legacy tables.

> **Note:**
>
> You should not modify or delete any Oracle-supplied information in any of the tables or views that are used for coordinate system support.
>
> If you want to create a user-defined coordinate system, see Creating a User-Defined Coordinate Reference System.

- SDO_COORD_AXES Table
- SDO_COORD_AXIS_NAMES Table
- SDO_COORD_OP_METHODS Table
- SDO_COORD_OP_PARAM_USE Table
- SDO_COORD_OP_PARAM_VALS Table
- SDO_COORD_OP_PARAMS Table
- SDO_COORD_OP_PATHS Table
- SDO_COORD_OPS Table
- SDO_COORD_REF_SYS Table
- SDO_COORD_REF_SYSTEM View
- SDO_COORD_SYS Table
- SDO_CRS_COMPOUND View
- SDO_CRS_ENGINEERING View
- SDO_CRS_GEOCENTRIC View
- SDO_CRS_GEOGRAPHIC2D View
- SDO_CRS_GEOGRAPHIC3D View
- SDO_CRS_PROJECTED View
- SDO_CRS_VERTICAL View
- SDO_DATUM_ENGINEERING View
- SDO_DATUM_GEODETIC View
- SDO_DATUM_VERTICAL View
- SDO_DATUMS Table
- SDO_ELLIPSOIDS Table
- SDO_PREFERRED_OPS_SYSTEM Table

- SDO_PREFERRED_OPS_USER Table
- SDO_PRIME_MERIDIANS Table
- SDO_UNITS_OF_MEASURE Table
- Relationships Among Coordinate System Tables and Views
- Finding Information About EPSG-Based Coordinate Systems

6.7.1 SDO_COORD_AXES Table

The SDO_COORD_AXES table contains one row for each coordinate system axis definition. This table contains the columns shown in Table 6-1.

Table 6-1 SDO_COORD_AXES Table

Column Name	Data Type	Description
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system to which this axis applies.
COORD_AXIS_NAME_ID	NUMBER(10)	ID number of a coordinate system axis name. Matches a value in the COORD_AXIS_NAME_ID column of the SDO_COORD_AXIS_NAMES table (described in SDO_COORD_AXIS_NAMES Table). Example: `9901` (for `Geodetic latitude`)
COORD_AXIS_ORIENTATION	VARCHAR2(24)	The direction of orientation for the coordinate system axis. Example: `east`
COORD_AXIS_ABBREVIATION	VARCHAR2(24)	The abbreviation for the coordinate system axis orientation. Example: `E`
UOM_ID	NUMBER(10)	ID number of the unit of measurement associated with the axis. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table).
ORDER	NUMBER(5)	Position of this axis within the coordinate system (1, 2, or 3).

6.7.2 SDO_COORD_AXIS_NAMES Table

The SDO_COORD_AXIS_NAMES table contains one row for each axis that can be used in a coordinate system definition. This table contains the columns shown in Table 6-2.

Table 6-2 SDO_COORD_AXIS_NAMES Table

Column Name	Data Type	Description
COORD_AXIS_NAME_ID	NUMBER(10)	ID number of the coordinate axis name. Example: `9926`
COORD_AXIS_NAME	VARCHAR2(80)	Name of the coordinate axis. Example: `Spherical latitude`

6.7.3 SDO_COORD_OP_METHODS Table

The SDO_COORD_OP_METHODS table contains one row for each coordinate systems transformation method. This table contains the columns shown in Table 6-3.

Table 6-3 SDO_COORD_OP_METHODS Table

Column Name	Data Type	Description
COORD_OP_METHOD_ID	NUMBER(10)	ID number of the coordinate system transformation method. Example: `9613`
COORD_OP_METHOD_NAME	VARCHAR2(50)	Name of the method. Example: `NADCON`
LEGACY_NAME	VARCHAR2(50)	Name for this transformation method in the legacy WKT strings. This name might differ syntactically from the name used by EPSG.
REVERSE_OP	NUMBER(1)	Contains `1` if reversal of the transformation (from the current target coordinate system to the source coordinate system) can be achieved by reversing the sign of each parameter value; contains `0` if a separate operation must be defined for reversal of the transformation.
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `US Coast and geodetic Survey - http://www.ngs.noaa.gov`
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: `EPSG`
IS_IMPLEMENTED_FORWARD	NUMBER(1)	Contains `1` if the forward operation is implemented; contains `0` if the forward operation is not implemented.
IS_IMPLEMENTED_REVERSE	NUMBER(1)	Contains `1` if the reverse operation is implemented; contains `0` if the reverse operation is not implemented.

6.7.4 SDO_COORD_OP_PARAM_USE Table

The SDO_COORD_OP_PARAM_USE table contains one row for each combination of transformation method and transformation operation parameter that is available for use. This table contains the columns shown in Table 6-4.

Table 6-4 SDO_COORD_OP_PARAM_USE Table

Column Name	Data Type	Description
COORD_OP_METHOD_ID	NUMBER(10)	ID number of the coordinate system transformation method. Matches a value in the COORD_OP_METHOD_ID column of the COORD_OP_METHODS table (described in SDO_COORD_OP_METHODS Table).
PARAMETER_ID	NUMBER(10)	ID number of the parameter for transformation operations. Matches a value in the PARAMETER_ID column of the SDO_COORD_OP_PARAMS table (described in SDO_COORD_OP_PARAMS Table).
LEGACY_PARAM_NAME	VARCHAR2(80)	Open GeoSpatial Consortium (OGC) name for the parameter.
SORT_ORDER	NUMBER(5)	A number indicating the position of this parameter in the sequence of parameters for this method. Example: `2` for the second parameter

Table 6-4 (Cont.) SDO_COORD_OP_PARAM_USE Table

Column Name	Data Type	Description
PARAM_SIGN_REVERSAL	VARCHAR2(3)	`Yes` if reversal of the transformation (from the current target coordinate system to the source coordinate system) can be achieved by reversing the sign of each parameter value; `No` if a separate operation must be defined for reversal of the transformation.

6.7.5 SDO_COORD_OP_PARAM_VALS Table

The SDO_COORD_OP_PARAM_VALS table contains information about parameter values for each coordinate system transformation method. This table contains the columns shown in Table 6-5.

Table 6-5 SDO_COORD_OP_PARAM_VALS Table

Column Name	Data Type	Description
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in SDO_COORD_OPS Table).
COORD_OP_METHOD_ID	NUMBER(10)	Coordinate operation method ID. Must match a COORD_OP_METHOD_ID value in the SDO_COORD_OP_METHODS table (see SDO_COORD_OP_METHODS Table).
PARAMETER_ID	NUMBER(10)	ID number of the parameter for transformation operations. Matches a value in the PARAMETER_ID column of the SDO_COORD_OP_PARAMS table (described in SDO_COORD_OP_PARAMS Table).
PARAMETER_VALUE	FLOAT(49)	Value of the parameter for this operation.
PARAM_VALUE_FILE_REF	VARCHAR2(254)	Name of the file (as specified in the original EPSG database) containing the value data, if a single value for the parameter is not sufficient.
PARAM_VALUE_FILE	CLOB	The ASCII content of the file specified in the PARAM_VALUE_FILE_REF column. Used only for grid file parameters (for NADCON, NTv2, and height transformations "Geographic3D to Geographic2D+GravityRelatedHeight").
PARAM_VALUE_XML	XMLTYPE	An XML representation of the content of the file specified in the PARAM_VALUE_FILE_REF column. (Optional, and currently only used for documentation.)
UOM_ID	NUMBER(10)	ID number of the unit of measurement associated with the operation. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table).

6.7.6 SDO_COORD_OP_PARAMS Table

The SDO_COORD_OP_PARAMS table contains one row for each available parameter for transformation operations. This table contains the columns shown in Table 6-6.

Table 6-6 SDO_COORD_OP_PARAMS Table

Column Name	Data Type	Description
PARAMETER_ID	NUMBER(10)	ID number of the parameter. Example: `8608`
PARAMETER_NAME	VARCHAR2(80)	Name of the operation. Example: `X-axis rotation`
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `EPSG guidance note number 7.`
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: `EPSG`

6.7.7 SDO_COORD_OP_PATHS Table

The SDO_COORD_OP_PATHS table contains one row for each atomic step in a concatenated operation. This table contains the columns shown in Table 6-7.

Table 6-7 SDO_COORD_OP_PATHS Table

Column Name	Data Type	Description
CONCAT_OPERATION_ID	NUMBER(10)	ID number of the concatenation operation. Must match a COORD_OP_ID value in the SDO_COORD_OPS table (described in SDO_COORD_OPS Table) for which the COORD_OP_TYPE value is `CONCATENATION`.
SINGLE_OPERATION_ID	NUMBER(10)	ID number of the single coordinate operation for this step (atomic operation) in a concatenated operation. Must match a COORD_OP_ID value in the SDO_COORD_OPS table (described in SDO_COORD_OPS Table).
SINGLE_OP_SOURCE_ID	NUMBER(10)	ID number of source coordinate reference system for the single coordinate operation for this step. Must match an SRID value in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).
SINGLE_OP_TARGET_ID	NUMBER(10)	ID number of target coordinate reference system for the single coordinate operation for this step. Must match an SRID value in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).
OP_PATH_STEP	NUMBER(5)	Sequence number of this step (atomic operation) within this concatenated operation.

6.7.8 SDO_COORD_OPS Table

The SDO_COORD_OPS table contains one row for each transformation operation between coordinate systems. This table contains the columns shown in Table 6-8.

Table 6-8 SDO_COORD_OPS Table

Column Name	Data Type	Description
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Example: `101`
COORD_OP_NAME	VARCHAR2(80)	Name of the operation. Example: `ED50 to WGS 84 (14)`

Table 6-8 (Cont.) SDO_COORD_OPS Table

Column Name	Data Type	Description
COORD_OP_TYPE	VARCHAR2(24)	Type of operation. One of the following: `CONCATENATED OPERATION`, `CONVERSION`, or `TRANSFORMATION`
SOURCE_SRID	NUMBER(10)	SRID of the coordinate system from which to perform the transformation. Example: `4230`
TARGET_SRID	NUMBER(10)	SRID of the coordinate system into which to perform the transformation. Example: `4326`
COORD_TFM_VERSION	VARCHAR2(24)	Name assigned by EPSG to the coordinate transformation. Example: `5Nat-NSea90`
COORD_OP_VARIANT	NUMBER(5)	A variant of the more generic method specified in COORD_OP_METHOD_ID. Example: `14`
COORD_OP_METHOD_ID	NUMBER(10)	Coordinate operation method ID. Must match a COORD_OP_METHOD_ID value in the SDO_COORD_OP_METHODS table (see SDO_COORD_OP_METHODS Table). Several operations can use a method. Example: `9617`
UOM_ID_SOURCE_OFFSETS	NUMBER(10)	ID number of the unit of measurement for offsets in the source coordinate system. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table).
UOM_ID_TARGET_OFFSETS	NUMBER(10)	ID number of the unit of measurement for offsets in the target coordinate system. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table).
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `Institut de Geomatica; Barcelona`
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: `EPSG`
SHOW_OPERATION	NUMBER(3)	(Not currently used.)
IS_LEGACY	VARCHAR2(5)	TRUE if the operation was included in Oracle Spatial before release 10.2; FALSE if the operation was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG coordinate transformation operation that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the COORD_OP_ID value of the legacy coordinate transformation operation.
REVERSE_OP	NUMBER(1)	Contains `1` if reversal of the transformation (from the current target coordinate system to the source coordinate system) is defined as achievable by reversing the sign of each parameter value; contains `0` if a separate operation must be defined for reversal of the transformation. If REVERSE_OP contains `1`, the operations that are actually implemented are indicated by the values for IS_IMPLEMENTED_FORWARD and IS_IMPLEMENTED_REVERSE.
IS_IMPLEMENTED_FORWARD	NUMBER(1)	Contains `1` if the forward operation is implemented; contains `0` if the forward operation is not implemented.
IS_IMPLEMENTED_REVERSE	NUMBER(1)	Contains `1` if the reverse operation is implemented; contains `0` if the reverse operation is not implemented.

6.7.9 SDO_COORD_REF_SYS Table

The SDO_COORD_REF_SYS table contains one row for each coordinate reference system. This table contains the columns shown in Table 6-9. (The SDO_COORD_REF_SYS table is roughly patterned after the EPSG Coordinate Reference System table.)

> **Note:**
>
> If you need to perform an insert, update, or delete operation, you *must* perform it on the SDO_COORD_REF_SYSTEM view, which contains the same columns as the SDO_COORD_REF_SYS table. The SDO_COORD_REF_SYSTEM view is described in SDO_COORD_REF_SYSTEM View.

Table 6-9 SDO_COORD_REF_SYS Table

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system. Example: `4326`
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system. Example: `Longitude / Latitude (WGS 84)`
COORD_REF_SYS_KIND	VARCHAR2(24)	Category for the coordinate system. Example: `GEOGRAPHIC2D`
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Null for a projected coordinate system. For a geodetic coordinate system, must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table). Example: `10115`
GEOG_CRS_DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. For a projected coordinate system, must match the DATUM_ID value (in the SDO_DATUMS table, described in SDO_DATUMS Table) of the geodetic coordinate system on which the projected coordinate system is based. For a geodetic coordinate system, must match the DATUM_ID value. Example: `10115`
SOURCE_GEOG_SRID	NUMBER(10)	For a projected coordinate reference system, the ID number for the associated geodetic coordinate system.
PROJECTION_CONV_ID	NUMBER(10)	For a projected coordinate reference system, the COORD_OP_ID value of the conversion operation used to convert the projected coordinated system to and from the source geographic coordinate system.
CMPD_HORIZ_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial. The EPSG description is: "For compound CRS only, the code of the horizontal component of the Compound CRS.")
CMPD_VERT_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial. The EPSG description is: "For compound CRS only, the code of the vertical component of the Compound CRS.")

Table 6-9 (Cont.) SDO_COORD_REF_SYS Table

Column Name	Data Type	Description
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
IS_LEGACY	VARCHAR2(5)	`TRUE` if the coordinate system definition was included in Oracle Spatial before release 10.2; `FALSE` if the coordinate system definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG coordinate reference system that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the SRID value of the legacy coordinate system.
LEGACY_WKTEXT	VARCHAR2(2046)	If IS_LEGACY is `TRUE`, contains the well-known text description of the coordinate system. Example: `GEOGCS [ "Longitude / Latitude (WGS 84)", DATUM ["WGS 84", SPHEROID ["WGS 84", 6378137, 298.257223563]], PRIMEM [ "Greenwich", 0.000000 ], UNIT ["Decimal Degree", 0.01745329251994330]]`
LEGACY_CS_BOUNDS	SDO_GEOMETRY	For a legacy coordinate system, the dimensional boundary (if any).
IS_VALID	VARCHAR2(5)	`TRUE` if the EPSG record for the coordinate reference system is completely defined; `FALSE` if the EPSG record for the coordinate reference system is not completely defined.
SUPPORTS_SDO_GEOMETRY	VARCHAR2(5)	`TRUE` if the COORD_REF_SYS_KIND column contains `ENGINEERING`, `GEOGRAPHIC2D`, or `PROJECTED CRS`; `FALSE` if the COORD_REF_SYS_KIND column contains any other value.

See also the information about the following views that are defined based on the value of the COORD_REF_SYS_KIND column:

- SDO_CRS_COMPOUND (SDO_CRS_COMPOUND View)
- SDO_CRS_ENGINEERING (SDO_CRS_ENGINEERING View)
- SDO_CRS_GEOCENTRIC (SDO_CRS_GEOCENTRIC View)
- SDO_CRS_GEOGRAPHIC2D (SDO_CRS_GEOGRAPHIC2D View)
- SDO_CRS_GEOGRAPHIC3D (SDO_CRS_GEOGRAPHIC3D View)
- SDO_CRS_PROJECTED (SDO_CRS_PROJECTED View)
- SDO_CRS_VERTICAL (SDO_CRS_VERTICAL View)

6.7.10 SDO_COORD_REF_SYSTEM View

The SDO_COORD_REF_SYSTEM view contains the same columns as the SDO_COORD_REF_SYS table, which is described in SDO_COORD_REF_SYS Table. However, the SDO_COORD_REF_SYSTEM view has a trigger defined on it, so that any insert, update, or delete operations performed on the view cause all relevant Spatial system tables to have the appropriate operations performed on them.

Therefore, if you need to perform an insert, update, or delete operation, you *must* perform it on the SDO_COORD_REF_SYSTEM view, *not* the SDO_COORD_REF_SYS table.

6.7.11 SDO_COORD_SYS Table

The SDO_COORD_SYS table contains rows with information about coordinate systems. This table contains the columns shown in Table 6-10. (The SDO_COORD_SYS table is roughly patterned after the EPSG Coordinate System table, where a coordinate system is described as "a pair of reusable axes.")

Table 6-10   SDO_COORD_SYS Table

Column Name	Data Type	Description
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system. Example: `6405`
COORD_SYS_NAME	VARCHAR2(254)	Name of the coordinate system. Example: `Ellipsoidal 2D CS. Axes: latitude, longitude. Orientations: north, east. UoM: dec deg`
COORD_SYS_TYPE	VARCHAR2(24)	Type of coordinate system. Example: `ellipsoidal`
DIMENSION	NUMBER(5)	Number of dimensions represented by the coordinate system.
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information.
DATA_SOURCE	VARCHAR2(50)	Organization providing the data for this record.

6.7.12 SDO_CRS_COMPOUND View

The SDO_CRS_COMPOUND view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `COMPOUND`. (For an explanation of compound coordinate reference systems, see Compound Coordinate Reference Systems.) This view contains the columns shown in Table 6-11.

Table 6-11   SDO_CRS_COMPOUND View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
CMPD_HORIZ_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial. The EPSG description is: "For compound CRS only, the code of the horizontal component of the Compound CRS.")
CMPD_VERT_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial. The EPSG description is: "For compound CRS only, the code of the vertical component of the Compound CRS.")
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).

Table 6-11 (Cont.) SDO_CRS_COMPOUND View

Column Name	Data Type	Description
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.13 SDO_CRS_ENGINEERING View

The SDO_CRS_ENGINEERING view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `ENGINEERING`. This view contains the columns shown in Table 6-12.

Table 6-12 SDO_CRS_ENGINEERING View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.14 SDO_CRS_GEOCENTRIC View

The SDO_CRS_GEOCENTRIC view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `GEOCENTRIC`. This view contains the columns shown in Table 6-13.

Table 6-13 SDO_CRS_GEOCENTRIC View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).

Table 6-13 (Cont.) SDO_CRS_GEOCENTRIC View

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.15 SDO_CRS_GEOGRAPHIC2D View

The SDO_CRS_GEOGRAPHIC2D view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `GEOGRAPHIC2D`. This view contains the columns shown in Table 6-14.

Table 6-14 SDO_CRS_GEOGRAPHIC2D View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.16 SDO_CRS_GEOGRAPHIC3D View

The SDO_CRS_GEOGRAPHIC3D view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `GEOGRAPHIC3D`. (For an explanation of geographic 3D coordinate reference systems, see Geographic 3D Coordinate Reference Systems.)

Note:

The SDO_CRS_GEOGRAPHIC3D view is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This view contains the columns shown in Table 6-15.

Table 6-15 SDO_CRS_GEOGRAPHIC3D View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.17 SDO_CRS_PROJECTED View

The SDO_CRS_PROJECTED view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `PROJECTED`. This view contains the columns shown in Table 6-16.

Table 6-16 SDO_CRS_PROJECTED View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
SOURCE_GEOG_SRID	NUMBER(10)	ID number for the associated geodetic coordinate system.
PROJECTION_CONV_ID	NUMBER(10)	COORD_OP_ID value of the conversion operation used to convert the projected coordinated system to and from the source geographic coordinate system.

Table 6-16 (Cont.) SDO_CRS_PROJECTED View

Column Name	Data Type	Description
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.18 SDO_CRS_VERTICAL View

The SDO_CRS_VERTICAL view contains selected information from the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table) where the COORD_REF_SYS_KIND column value is `VERTICAL`. This view contains the columns shown in Table 6-17.

Table 6-17 SDO_CRS_VERTICAL View

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see SDO_COORD_SYS Table).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see SDO_DATUMS Table).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (`Oracle` for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

6.7.19 SDO_DATUM_ENGINEERING View

The SDO_DATUM_ENGINEERING view contains selected information from the SDO_DATUMS table (described in SDO_DATUMS Table) where the DATUM_TYPE column value is `ENGINEERING`. This view contains the columns shown in Table 6-18.

Table 6-18 SDO_DATUM_ENGINEERING View

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see SDO_ELLIPSOIDS Table). Example: `8045`

Table 6-18 (Cont.) SDO_DATUM_ENGINEERING View

Column Name	Data Type	Description
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see SDO_PRIME_MERIDIANS Table). Example: `8950`
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: `Ordnance Survey of Great Britain.`
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: 1.0 + (SCALE_ADJUST * 10^{-6})

6.7.20 SDO_DATUM_GEODETIC View

The SDO_DATUM_GEODETIC view contains selected information from the SDO_DATUMS table (described in SDO_DATUMS Table) where the DATUM_TYPE column value is `GEODETIC`. This view contains the columns shown in Table 6-19.

Table 6-19 SDO_DATUM_GEODETIC View

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see SDO_ELLIPSOIDS Table). Example: `8045`
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see SDO_PRIME_MERIDIANS Table). Example: `8950`
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: `Ordnance Survey of Great Britain.`
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.

Table 6-19 (Cont.) SDO_DATUM_GEODETIC View

Column Name	Data Type	Description
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: 1.0 + (SCALE_ADJUST * 10^{-6})

6.7.21 SDO_DATUM_VERTICAL View

The SDO_DATUM_VERTICAL view contains selected information from the SDO_DATUMS table (described in SDO_DATUMS Table) where the DATUM_TYPE column value is `VERTICAL`. This view contains the columns shown in Table 6-20.

Table 6-20 SDO_DATUM_VERTICAL View

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see SDO_ELLIPSOIDS Table). Example: `8045`
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see SDO_PRIME_MERIDIANS Table). Example: `8950`
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: `Ordnance Survey of Great Britain`.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.

Table 6-20 (Cont.) SDO_DATUM_VERTICAL View

Column Name	Data Type	Description
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: 1.0 + (SCALE_ADJUST * 10^{-6})

6.7.22 SDO_DATUMS Table

The SDO_DATUMS table contains one row for each datum. This table contains the columns shown in Table 6-21.

Table 6-21 SDO_DATUMS Table

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum. Example: `10115`
DATUM_NAME	VARCHAR2(80)	Name of the datum. Example: `WGS 84`
DATUM_TYPE	VARCHAR2(24)	Type of the datum. Example: `GEODETIC`
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see SDO_ELLIPSOIDS Table). Example: `8045`
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see SDO_PRIME_MERIDIANS Table). Example: `8950`
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: `Ordnance Survey of Great Britain.`
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle). Example: `EPSG`
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: 1.0 + (SCALE_ADJUST * 10^{-6})
IS_LEGACY	VARCHAR2(5)	`TRUE` if the datum definition was included in Oracle Spatial before release 10.2; `FALSE` if the datum definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG datum that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the DATUM_ID value of the legacy datum.

See also the information about the following views that are defined based on the value of the DATUM_TYPE column: SDO_DATUM_ENGINEERING (SDO_DATUM_ENGINEERING View), SDO_DATUM_GEODETIC (SDO_DATUM_GEODETIC View), and SDO_DATUM_VERTICAL (SDO_DATUM_VERTICAL View).

6.7.23 SDO_ELLIPSOIDS Table

The SDO_ELLIPSOIDS table contains one row for each ellipsoid. This table contains the columns shown in Table 6-22.

Table 6-22 SDO_ELLIPSOIDS Table

Column Name	Data Type	Description
ELLIPSOID_ID	NUMBER	ID number of the ellipsoid (spheroid). Example: `8045`
ELLIPSOID_NAME	VARCHAR2(80)	Name of the ellipsoid. Example: `WGS 84`
SEMI_MAJOR_AXIS	NUMBER	Radius in meters along the semi-major axis (one-half of the long axis of the ellipsoid).
UOM_ID	NUMBER	ID number of the unit of measurement for the ellipsoid. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table). Example: `9001`
INV_FLATTENING	NUMBER	Inverse flattening of the ellipsoid. That is, `1/f`, where `f = (a-b)/a`, and `a` is the semi-major axis and `b` is the semi-minor axis.
SEMI_MINOR_AXIS	NUMBER	Radius in meters along the semi-minor axis (one-half of the short axis of the ellipsoid).
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `Kort og Matrikelstyrelsen (KMS), Copenhagen.`
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle). Example: `EPSG`
IS_LEGACY	VARCHAR2(5)	`TRUE` if the ellipsoid definition was included in Oracle Spatial before release 10.2; `FALSE` if the ellipsoid definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER	For any EPSG ellipsoid that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the ELLIPSOID_ID value of the legacy ellipsoid.

6.7.24 SDO_PREFERRED_OPS_SYSTEM Table

The SDO_PREFERRED_OPS_SYSTEM table contains one row for each specification of the user-defined default preferred coordinate transformation operation for a source and target SRID combination. If you insert a row into the SDO_PREFERRED_OPS_SYSTEM table, you are overriding the Oracle default operation for transformations between the specified source and target coordinate systems. The SDO_CS.CREATE_OBVIOUS_EPSG_RULES procedure inserts many rows into this table. The SDO_CS.DELETE_ALL_EPSG_RULES procedure deletes all rows from this table if the `use_case` parameter is null. This table contains the columns shown in Table 6-23.

Table 6-23 SDO_PREFERRED_OPS_SYSTEM Table

Column Name	Data Type	Description
SOURCE_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) from which to perform coordinate transformation, using the operation specified by COORD_OP_ID as the default preferred method for transforming to the specified target SRID.
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in SDO_COORD_OPS Table).
TARGET_SRID	NUMBER(10)	ID number of coordinate system (spatial reference system) into which to perform coordinate transformation using the operation specified by COORD_OP_ID.

6.7.25 SDO_PREFERRED_OPS_USER Table

The SDO_PREFERRED_OPS_USER table contains one row for each specification of a user-defined source and target SRID and coordinate transformation operation. If you insert a row into the SDO_PREFERRED_OPS_USER table, you create a custom transformation between the source and target coordinate systems, and you can specify the name (the USE_CASE column value) of the transformation operation as the `use_case` parameter value with several SDO_CS functions and procedures. If you specify a use case with the SDO_CS.DELETE_ALL_EPSG_RULES procedure, rows associated with that use case are deleted from this table. This table contains the columns shown in Table 6-24.

Table 6-24 SDO_PREFERRED_OPS_USER Table

Column Name	Data Type	Description
USE_CASE	VARCHAR2(32)	Name of this specification of a source and target SRID and coordinate transformation operation.
SOURCE_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) from which to perform the transformation.
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in SDO_COORD_OPS Table).
TARGET_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) into which to perform the transformation.

6.7.26 SDO_PRIME_MERIDIANS Table

The SDO_PRIME_MERIDIANS table contains one row for each prime meridian that can be used in a datum specification. This table contains the columns shown in Table 6-25.

Table 6-25 SDO_PRIME_MERIDIANS Table

Column Name	Data Type	Description
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian. Example: `8907`

Table 6-25 (Cont.) SDO_PRIME_MERIDIANS Table

Column Name	Data Type	Description
PRIME_MERIDIAN_NAME	VARCHAR2(80)	Name of the prime meridian. Example: `Bern`
GREENWICH_LONGITUDE	FLOAT(49)	Longitude of the prime meridian as an offset from the Greenwich meridian. Example: `7.26225`
UOM_ID	NUMBER(10)	ID number of the unit of measurement for the prime meridian. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table). Example: `9110` for sexagesimal degree
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `Bundesamt fur Landestopographie`
DATA_SOURCE	VARCHAR2(254)	Organization that supplied the data for this record (if not Oracle). Example: `EPSG`

6.7.27 SDO_UNITS_OF_MEASURE Table

The SDO_UNITS_OF_MEASURE table contains one row for each unit of measurement. This table contains the columns shown in Table 6-26.

Table 6-26 SDO_UNITS_OF_MEASURE Table

Column Name	Data Type	Description
UOM_ID	NUMBER(10)	ID number of the unit of measurement. Example: `10032`
UNIT_OF_MEAS_NAME	VARCHAR2(2083)	Name of the unit of measurement; can also be a URL or URI. Example: `Meter`
SHORT_NAME	VARCHAR2(80)	Short name (if any) of the unit of measurement. Example: `METER`
UNIT_OF_MEAS_TYPE	VARCHAR2(50)	Type of measure for which the unit is used: `angle` for angle unit, `area` for area unit, `length` for distance unit, `scale` for scale unit, or `volume` for volume unit.
TARGET_UOM_ID	NUMBER(10)	ID number of a target unit of measurement. Corresponds to the TARGET_UOM_CODE column in the EPSG Unit of Measure table, which has the following description: "Other UOM of the same type into which the current UOM can be converted using the formula (POSC); POSC factors A and D always equal zero for EPSG supplied units of measure."
FACTOR_B	NUMBER	Corresponds to the FACTOR_B column in the EPSG Unit of Measure table, which has the following description: "A quantity in the target UOM (y) is obtained from a quantity in the current UOM (x) through the conversion: y = (B/C).x" In a user-defined unit of measurement, FACTOR_B is usually the number of square meters or meters equal to one of the unit. For information about user-defined units, see Creating a User-Defined Unit of Measurement.

Table 6-26 (Cont.) SDO_UNITS_OF_MEASURE Table

Column Name	Data Type	Description
FACTOR_C	NUMBER	Corresponds to the FACTOR_C column in the EPSG Unit of Measure table. For FACTOR_C in a user-defined unit of measurement, see Creating a User-Defined Unit of Measurement.
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: `ISO 1000`.
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: `EPSG`
IS_LEGACY	VARCHAR2(5)	TRUE if the unit of measurement definition was included in Oracle Spatial before release 10.2; FALSE if the unit of measurement definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG unit of measure that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the UOM_ID value of the legacy unit of measure.

6.7.28 Relationships Among Coordinate System Tables and Views

Although Spatial system tables and views are based on the EPSG data model and dataset, Oracle Spatial changes the names of some tables to conform to its own naming conventions, and it does not use some tables, as shown in Table 6-27

Table 6-27 EPSG Table Names and Oracle Spatial Names

EPSG Name	Oracle Name
Coordinate System	SDO_COORD_SYS
Coordinate Axis	SDO_COORD_AXES
Coordinate Reference System	SDO_COORD_REF_SYSTEM
Area Of Use	(Not used)
Datum	SDO_DATUMS
Prime Meridian	SDO_PRIME_MERIDIANS
Ellipsoid	SDO_ELLIPSOIDS
Unit Of Measure	SDO_UNITS_OF_MEASURE
Coordinate Operation	SDO_COORD_OPS
Coord. Operation Parameter ValueCoord	SDO_COORD_OP_PARAM_VALS
Operation Parameter UsageCoord.	SDO_COORD_OP_PARAM_USE
Operation Parameter	SDO_COORD_OP_PARAMS
Coordinate Operation Path	SDO_COORD_OP_PATHS
Coordinate Operation Method	SDO_COORD_OP_METHODS
Change	(Not used)
Deprecation	(Not used)
Supersession	(Not used)

Table 6-27 (Cont.) EPSG Table Names and Oracle Spatial Names

EPSG Name	Oracle Name
Naming System	(Not used)
Alias	(Not used)
Any Entity	(Not used)

6.7.29 Finding Information About EPSG-Based Coordinate Systems

This section explains how to query the Oracle Spatial coordinate systems data structures for information about geodetic and projected EPSG-based coordinate systems.

- Geodetic Coordinate Systems
- Projected Coordinate Systems

6.7.29.1 Geodetic Coordinate Systems

A human-readable summary of a CRS is the WKT string. For example:

```
SQL> select wktext from cs_srs where srid = 4326;

WKTEXT
--------------------------------------------------------------------------------
GEOGCS [ "WGS 84", DATUM ["World Geodetic System 1984 (EPSG ID 6326)", SPHEROID
["WGS 84 (EPSG ID 7030)", 6378137, 298.257223563]], PRIMEM [ "Greenwich", 0.0000
00 ], UNIT ["Decimal Degree", 0.01745329251994328]]
```

EPSG WKTs have been automatically generated by Spatial, for backward compatibility. Note that EPSG WKTs also contain numeric ID values (such as EPSG ID 6326 in the preceding example) for convenience. However, for more detailed information you should access the EPSG data stored in the coordinate systems data structures. The following example returns information about the ellipsoid, datum shift, rotation, and scale adjustment for SRID 4123:

```
SQL> select
  ell.semi_major_axis,
  ell.inv_flattening,
  ell.semi_minor_axis,
  ell.uom_id,
  dat.shift_x,
  dat.shift_y,
  dat.shift_z,
  dat.rotate_x,
  dat.rotate_y,
  dat.rotate_z,
  dat.scale_adjust
from
  sdo_coord_ref_system crs,
  sdo_datums dat,
  sdo_ellipsoids ell
where
  crs.srid = 4123 and
  dat.datum_id = crs.datum_id and
  ell.ellipsoid_id = dat.ellipsoid_id;

SEMI_MAJOR_AXIS INV_FLATTENING SEMI_MINOR_AXIS     UOM_ID    SHIFT_X    SHIFT_Y
SHIFT_Z    ROTATE_X    ROTATE_Y    ROTATE_Z SCALE_ADJUST
```

```
--------------- -------------- --------------- ---------- ---------- ----------
---------- ---------- ---------- ---------- ------------
        6378388            297      6356911.95       9001      -90.7     -106.1
-119.2       4.09       .218      -1.05         1.37
```

In the preceding example, the UOM_ID represents the unit of measure for SEMI_MAJOR_AXIS (`a`) and SEMI_MINOR_AXIS (`b`). INV_FLATTENING is `a/(a-b)` and has no associated unit. Shifts are in meters, rotation angles are given in arc seconds, and scale adjustment in parts per million.

To interpret the UOM_ID, you can query the units table, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME from sdo_units_of_measure where UOM_ID = 9001;

UNIT_OF_MEAS_NAME
--------------------------------------------------------------------------------
metre
```

Conversion factors for units of length are given relative to meters, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME, FACTOR_B/FACTOR_C from sdo_units_of_measure where UOM_ID
= 9002;

UNIT_OF_MEAS_NAME
--------------------------------------------------------------------------------
FACTOR_B/FACTOR_C
-----------------
foot
            .3048
```

Conversion factors for units of angle are given relative to radians, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME, FACTOR_B/FACTOR_C from sdo_units_of_measure where UOM_ID
= 9102;

UNIT_OF_MEAS_NAME
--------------------------------------------------------------------------------
FACTOR_B/FACTOR_C
-----------------
degree
       .017453293
```

6.7.29.2 Projected Coordinate Systems

As mentioned in Geodetic Coordinate Systems, the WKT is a human-readable summary of a CRS, but the actual EPSG data is stored in the Spatial coordinate systems data structures. The following example shows the WKT string for a projected coordinate system:

```
SQL> select wktext from cs_srs where srid = 32040;

WKTEXT
--------------------------------------------------------------------------------
PROJCS["NAD27 / Texas South Central", GEOGCS [ "NAD27", DATUM ["North American D
atum 1927 (EPSG ID 6267)", SPHEROID ["Clarke 1866 (EPSG ID 7008)", 6378206.4, 29
4.978698213905820761610537123195175418]], PRIMEM [ "Greenwich", 0.000000 ], UNIT
 ["Decimal Degree", 0.01745329251994328]], PROJECTION ["Texas CS27 South Central
 zone (EPSG OP 14204)"], PARAMETER ["Latitude_Of_Origin", 27.8333333333333333333
3333333333333333333], PARAMETER ["Central_Meridian", -98.99999999999999999999999
999999999999987], PARAMETER ["Standard_Parallel_1", 28.3833333333333333333333333
3333333333333], PARAMETER ["Standard_Parallel_2", 30.283333333333333333333333333
33333333333], PARAMETER ["False_Easting", 2000000], PARAMETER ["False_Northing",
 0], UNIT ["U.S. Foot", .3048006096012192024384048768097536195072]]
```

To determine the base geographic CRS for a projected CRS, you can query the SDO_COORD_REF_SYSTEM table, as in the following example:

```
SQL> select SOURCE_GEOG_SRID from sdo_coord_ref_system where srid = 32040;

SOURCE_GEOG_SRID
----------------
            4267
```

The following example returns the projection method for the projected CRS 32040:

```
SQL> select
  m.coord_op_method_name
from
  sdo_coord_ref_sys crs,
  sdo_coord_ops ops,
  sdo_coord_op_methods m
where
  crs.srid = 32040 and
  ops.coord_op_id = crs.projection_conv_id and
  m.coord_op_method_id = ops.coord_op_method_id;

COORD_OP_METHOD_NAME
--------------------------------------------------
Lambert Conic Conformal (2SP)
```

The following example returns the projection parameters for the projected CRS 32040:

```
SQL> select
  params.parameter_name || ' = ' ||
  vals.parameter_value || ' ' ||
  uom.unit_of_meas_name "Projection parameters"
from
  sdo_coord_ref_sys crs,
  sdo_coord_op_param_vals vals,
  sdo_units_of_measure uom,
  sdo_coord_op_params params
where
  crs.srid = 32040 and
  vals.coord_op_id = crs.projection_conv_id and
  uom.uom_id = vals.uom_id and
  params.parameter_id = vals.parameter_id;

Projection parameters
--------------------------------------------------------------------------------
Latitude of false origin = 27.5 sexagesimal DMS
Longitude of false origin = -99 sexagesimal DMS
Latitude of 1st standard parallel = 28.23 sexagesimal DMS
Latitude of 2nd standard parallel = 30.17 sexagesimal DMS
Easting at false origin = 2000000 US survey foot
Northing at false origin = 0 US survey foot
```

The following example is essentially the same query as the preceding example, but it also converts the values to the base unit:

```
SQL> select
  params.parameter_name || ' = ' ||
  vals.parameter_value || ' ' ||
  uom.unit_of_meas_name || ' = ' ||
  sdo_cs.transform_to_base_unit(vals.parameter_value, vals.uom_id) || ' ' ||
  decode(
    uom.unit_of_meas_type,
    'area', 'square meters',
    'angle', 'radians',
    'length', 'meters',
    'scale', '', '') "Projection parameters"
from
  sdo_coord_ref_sys crs,
  sdo_coord_op_param_vals vals,
  sdo_units_of_measure uom,
  sdo_coord_op_params params
where
  crs.srid = 32040 and
  vals.coord_op_id = crs.projection_conv_id and
  uom.uom_id = vals.uom_id and
  params.parameter_id = vals.parameter_id;

Projection parameters
-----------------------------------------------------------------------------------------
---------------------------------------------------------------------------------
Latitude of false origin = 27.5 sexagesimal DMS
= .485783308471754564814814814814814815 radians
Longitude of false origin = -99 sexagesimal DMS = -1.7278759594743845 radians
Latitude of 1st standard parallel = 28.23 sexagesimal DMS
= .495382619357723367592592592592592593 radians
Latitude of 2nd standard parallel = 30.17 sexagesimal DMS
= .528543875145615595370370370370370371 radians
Easting at false origin = 2000000 US survey foot =
609601.219202438404876809753619507239014 meters
Northing at false origin = 0 US survey foot = 0 meters
```

The following example returns the projection unit of measure for the projected CRS 32040. (The projection unit might be different from the length unit used for the projection parameters.)

```
SQL> select
  axes.coord_axis_abbreviation || ': ' ||
  uom.unit_of_meas_name "Projection units"
from
  sdo_coord_ref_sys crs,
  sdo_coord_axes axes,
  sdo_units_of_measure uom
where
  crs.srid = 32040 and
  axes.coord_sys_id = crs.coord_sys_id and
  uom.uom_id = axes.uom_id;

Projection units
------------------------------------------------------------------------------
X: US survey foot
Y: US survey foot
```

6.8 Legacy Tables and Views

In releases of Spatial before 10.2, the coordinate systems functions and procedures used information provided in the following tables, some of which have new names or are now views instead of tables.

- MDSYS.CS_SRS defines the valid coordinate systems. It associates each coordinate system with its well-known text description, which is in conformance with the standard published by the Open Geospatial Consortium (`http://www.opengeospatial.org`).

- MDSYS.SDO_ANGLE_UNITS defines the valid angle units.
- MDSYS.SDO_AREA_UNITS defines the valid area units.
- MDSYS.SDO_DIST_UNITS defines the valid distance units.
- MDSYS.SDO_DATUMS_OLD_FORMAT and MDSYS.SDO_DATUMS_OLD_SNAPSHOT are based on the MDSYS.SDO_DATUMS table before release 10.2, which defined valid datums.
- MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT and MDSYS.SDO_ELLIPSOIDS_OLD_SNAPSHOT are based on the MDSYS.SDO_ELLIPSOIDS table before release 10.2, which defined valid ellipsoids.
- MDSYS.SDO_PROJECTIONS_OLD_FORMAT and MDSYS.SDO_PROJECTIONS_OLD_SNAPSHOT are based on the MDSYS.SDO_PROJECTIONS table before release 10.2, which defined the valid map projections.

> **Note:**
>
> You should not modify or delete any Oracle-supplied information in these legacy tables.
>
> If you refer to a legacy table in a SQL statement, you must include the *MDSYS.* before the table name.

- MDSYS.CS_SRS Table
- MDSYS.SDO_ANGLE_UNITS View
- MDSYS.SDO_AREA_UNITS View
- MDSYS.SDO_DATUMS_OLD_FORMAT and SDO_DATUMS_OLD_SNAPSHOT Tables
- MDSYS.SDO_DIST_UNITS View
- MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT and SDO_ELLIPSOIDS_OLD_SNAPSHOT Tables
- MDSYS.SDO_PROJECTIONS_OLD_FORMAT and SDO_PROJECTIONS_OLD_SNAPSHOT Tables

6.8.1 MDSYS.CS_SRS Table

The MDSYS.CS_SRS reference table contains over 4000 rows, one for each valid coordinate system. This table contains the columns shown in Table 6-28.

Table 6-28 MDSYS.CS_SRS Table

Column Name	Data Type	Description
CS_NAME	VARCHAR2(68)	A well-known name, often mnemonic, by which a user can refer to the coordinate system.
SRID	NUMBER(38)	The unique ID number (Spatial Reference ID) for a coordinate system. All SRID values are reserved for use by Oracle Spatial except for values 5000000 to 6000000 (5 million to 6 million) which are available for user-defined coordinate systems.

Table 6-28 (Cont.) MDSYS.CS_SRS Table

Column Name	Data Type	Description
AUTH_SRID	NUMBER(38)	An optional ID number that can be used to indicate how the entry was derived; it might be a foreign key into another coordinate table, for example.
AUTH_NAME	VARCHAR2(256)	An authority name for the coordinate system. Contains `Oracle` in the supplied table. Users can specify any value in any rows that they add.
WKTEXT	VARCHAR2(2046)	The well-known text (WKT) description of the SRS, as defined by the Open Geospatial Consortium. For more information, see Well-Known Text (WKT).
CS_BOUNDS	SDO_GEOMETRY	An optional SDO_GEOMETRY object that is a polygon with WGS 84 longitude and latitude vertices, representing the spheroidal polygon description of the zone of validity for a projected coordinate system. Must be null for a geographic or non-Earth coordinate system. Is null in all supplied rows.

- Well-Known Text (WKT)
- US-American and European Notations for Datum Parameters
- Procedures for Updating the Well-Known Text

6.8.1.1 Well-Known Text (WKT)

The WKTEXT column of the MDSYS.CS_SRS table contains the well-known text (WKT) description of the SRS, as defined by the Open Geospatial Consortium. The following is the WKT EBNF syntax.

```
<coordinate system> ::=
     <horz cs> | <local cs>

<horz cs> ::=
     <geographic cs> | <projected cs>


<projected cs> ::=
     PROJCS [ "<name>", <geographic cs>, <projection>,
           {<parameter>,}* <linear unit> ]

<projection> ::=
     PROJECTION [ "<name>" ]

<parameter> ::=
     PARAMETER [ "<name>", <number> ]

<geographic cs> ::=
     GEOGCS [ "<name>", <datum>, <prime meridian>, <angular unit> ]

<datum> ::=
     DATUM [ "<name>", <spheroid>
     {, <shift-x>, <shift-y>, <shift-z>
       , <rot-x>, <rot-y>, <rot-z>, <scale_adjust>}
     ]

<spheroid> ::=
     SPHEROID ["<name>", <semi major axis>, <inverse flattening> ]
```

```
<prime meridian> ::=
     PRIMEM ["<name>", <longitude> ]

<longitude> ::=
     <number>

<semi-major axis> ::=
     <number>

<inverse flattening> ::=
     <number>

<angular unit> ::= <unit>

<linear unit> ::= <unit>

<unit> ::=
     UNIT [ "<name>", <conversion factor> ]

<local cs> ::=
     LOCAL_CS [ "<name>", <local datum>, <linear unit>,
          <axis> {, <axis>}* ]

<local datum> ::=
     LOCAL_DATUM [ "<name>", <datum type>
          {, <shift-x>, <shift-y>, <shift-z>
           , <rot-x>, <rot-y>, <rot-z>, <scale_adjust>}
          ]

<datum type> ::=
     <number>

<axis> ::=
     AXIS [ "<name>", NORTH | SOUTH | EAST |
           WEST | UP | DOWN | OTHER ]
```

Each `<parameter>` specification is one of the following:

- `Standard_Parallel_1` (in decimal degrees)
- `Standard_Parallel_2` (in decimal degrees)
- `Central_Meridian` (in decimal degrees)
- `Latitude_of_Origin` (in decimal degrees)
- `Azimuth` (in decimal degrees)
- `False_Easting` (in the unit of the coordinate system; for example, meters)
- `False_Northing` (in the unit of the coordinate system; for example, meters)
- `Perspective_Point_Height` (in the unit of the coordinate system; for example, meters)
- `Landsat_Number` (must be 1, 2, 3, 4, or 5)
- `Path_Number`
- `Scale_Factor`

> **Note:**
>
> If the WKT uses European rather than US-American notation for datum rotation parameters, or if the transformation results do not seem correct, see US-American and European Notations for Datum Parameters.

The default value for each `<parameter>` specification is 0 (zero). That is, if a specification is needed for a projection but no value is specified in the WKT, Spatial uses a value of 0.

The prime meridian (`PRIMEM`) is specified in decimal degrees of longitude.

An example of the WKT for a geodetic (geographic) coordinate system is:

```
'GEOGCS [ "Longitude / Latitude (Old Hawaiian)", DATUM ["Old Hawaiian", SPHEROID
["Clarke 1866", 6378206.400000, 294.978698]], PRIMEM [ "Greenwich", 0.000000 ],
UNIT ["Decimal Degree", 0.01745329251994330]]'
```

The WKT definition of the coordinate system is hierarchically nested. The Old Hawaiian geographic coordinate system (GEOGCS) is composed of a named datum (DATUM), a prime meridian (PRIMEM), and a unit definition (UNIT). The datum is in turn composed of a named spheroid and its parameters of semi-major axis and inverse flattening.

An example of the WKT for a projected coordinate system (a Wyoming State Plane) is:

```
'PROJCS["Wyoming 4901, Eastern Zone (1983, meters)", GEOGCS [ "GRS 80", DATUM
["GRS 80", SPHEROID ["GRS 80", 6378137.000000, 298.257222]], PRIMEM [
"Greenwich", 0.000000 ], UNIT ["Decimal Degree", 0.01745329251994330]],
PROJECTION ["Transverse Mercator"], PARAMETER ["Scale_Factor", 0.999938],
PARAMETER ["Central_Meridian", -105.166667], PARAMETER ["Latitude_Of_Origin",
40.500000], PARAMETER ["False_Easting", 200000.000000], UNIT ["Meter",
1.000000000000]]'
```

The projected coordinate system contains a nested geographic coordinate system as its basis, as well as parameters that control the projection.

Oracle Spatial supports all common geodetic datums and map projections.

An example of the WKT for a local coordinate system is:

```
LOCAL_CS [ "Non-Earth (Meter)", LOCAL_DATUM ["Local Datum", 0], UNIT ["Meter", 1.0],
AXIS ["X", EAST], AXIS["Y", NORTH]]
```

For more information about local coordinate systems, see Local Coordinate Support.

You can use the SDO_CS.VALIDATE_WKT function, described in SDO_CS Package (Coordinate System Transformation) , to validate the WKT of any coordinate system defined in the MDSYS.CS_SRS table.

6.8.1.2 US-American and European Notations for Datum Parameters

The datum-related WKT parameters are a list of up to seven Bursa Wolf transformation parameters. Rotation parameters specify arc seconds, and shift parameters specify meters.

Two different notations, US-American and European, are used for the three rotation parameters that are in general use, and these two notations use opposite signs. Spatial uses and expects the US-American notation. Therefore, if your WKT uses the European notation, you must convert it to the US-American notation by inverting the signs of the rotation parameters.

If you do not know if a parameter set uses the US-American or European notation, perform the following test:

1. Select a single point for which you know the correct result.
2. Perform the transformation using the current WKT.
3. If the computed result does not match the known correct result, invert signs of the rotation parameters, perform the transformation, and check if the computed result matches the known correct result.

6.8.1.3 Procedures for Updating the Well-Known Text

If you insert or delete a row in the SDO_COORD_REF_SYSTEM view (described in SDO_COORD_REF_SYSTEM View), Spatial automatically updates the WKTEXT column in the MDSYS.CS_SRS table. (The format of the WKTEXT column is described in Well-Known Text (WKT).) However, if you update an existing row in the SDO_COORD_REF_SYSTEM view, the well-known text (WKT) value is not automatically updated.

In addition, information relating to coordinate reference systems is also stored in several other system tables, including SDO_DATUMS (described in SDO_DATUMS Table), SDO_ELLIPSOIDS (described in SDO_ELLIPSOIDS Table), and SDO_PRIME_MERIDIANS (described in SDO_PRIME_MERIDIANS Table). If you add, delete, or modify information in these tables, the WKTEXT values in the MDSYS.CS_SRS table are not automatically updated. For example, if you update an ellipsoid flattening value in the SDO_ELLIPSOIDS table, the well-known text string for the associated coordinate system is not updated.

However, you can manually update the WKTEXT values in the in the MDSYS.CS_SRS table by using any of several procedures whose names start with *UPDATE_WKTS_FOR* (for example, SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS and SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM). If the display of SERVEROUTPUT information is enabled, these procedures display a message identifying the SRID value for each row in the MDSYS.CS_SRS table whose WKTEXT value is being updated. These procedures are described in SDO_CS Package (Coordinate System Transformation) .

6.8.2 MDSYS.SDO_ANGLE_UNITS View

The MDSYS.SDO_ANGLE_UNITS reference view contains one row for each valid angle UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in Well-Known Text (WKT).

The MDSYS.SDO_ANGLE_UNITS view is based on the SDO_UNITS_OF MEASURE table (described in SDO_UNITS_OF_MEASURE Table), and it contains the columns shown in Table 6-29.

Table 6-29 MDSYS.SDO_ANGLE_UNITS View

Column Name	Data Type	Description
SDO_UNIT	VARCHAR2(32)	Name of the angle unit (often a shortened form of the UNIT_NAME value). Use the SDO_UNIT value with the `from_unit` and `to_unit` parameters of the SDO_UTIL.CONVERT_UNIT function.
UNIT_NAME	VARCHAR2(100)	Name of the angle unit. Specify a value from this column in the UNIT specification of the WKT for any user-defined coordinate system. Examples: `Decimal Degree`, `Radian`, `Decimal Second`, `Decimal Minute`, `Gon`, `Grad`.

Table 6-29 (Cont.) MDSYS.SDO_ANGLE_UNITS View

Column Name	Data Type	Description
CONVERSION_FACTOR	NUMBER	The ratio of the specified unit to one radian. For example, the ratio of `Decimal Degree` to `Radian` is 0.017453293.

6.8.3 MDSYS.SDO_AREA_UNITS View

The MDSYS.SDO_AREA_UNITS reference view contains one row for each valid area UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in Well-Known Text (WKT).

The MDSYS.SDO_AREA_UNITS view is based on the SDO_UNITS_OF MEASURE table (described in SDO_UNITS_OF_MEASURE Table), and it contains the columns shown in Table 6-30.

Table 6-30 SDO_AREA_UNITS View

Column Name	Data Type	Purpose
SDO_UNIT	VARCHAR2	Values are taken from the SHORT_NAME column of the SDO_UNITS_OF MEASURE table.
UNIT_NAME	VARCHAR2	Values are taken from the UNIT_OF_MEAS_NAME column of the SDO_UNITS_OF MEASURE table.
CONVERSION_FACTOR	NUMBER	Ratio of the unit to 1 square meter. For example, the conversion factor for a square meter is 1.0, and the conversion factor for a square mile is 2589988.

6.8.4 MDSYS.SDO_DATUMS_OLD_FORMAT and SDO_DATUMS_OLD_SNAPSHOT Tables

The MDSYS.SDO_DATUMS_OLD_FORMAT and MDSYS.SDO_DATUMS_OLD_SNAPSHOT reference tables contain one row for each valid DATUM specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in Well-Known Text (WKT).)

- MDSYS.SDO_DATUMS_OLD_FORMAT contains the new data in the old format (that is, EPSG-based datum specifications in a table using the format from before release 10.2).
- MDSYS.SDO_DATUMS_OLD_SNAPSHOT contains the old data in the old format (that is, datum specifications and table format from before release 10.2).

These tables contain the columns shown in the following table.

Table 6-31 MDSYS.SDO_DATUMS_OLD_FORMAT and SDO_DATUMS_OLD_SNAPSHOT Tables

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the datum. Specify a value (Oracle-supplied or user-defined) from this column in the DATUM specification of the WKT for any user-defined coordinate system. Examples: `Adindan, Afgooye, Ain el Abd 1970, Anna 1 Astro 1965, Arc 1950, Arc 1960, Ascension Island 1958.`
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: 1.0 + (SCALE_ADJUST * 10^{-6})

To see the names of the datums in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_DATUMS_OLD_FORMAT ORDER BY name;
```

6.8.5 MDSYS.SDO_DIST_UNITS View

The MDSYS.SDO_DIST_UNITS reference view contains one row for each valid distance UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in Well-Known Text (WKT).

The MDSYS.SDO_DIST_UNITS view is based on the SDO_UNITS_OF MEASURE table (described in SDO_UNITS_OF_MEASURE Table), and it contains the columns shown in Table 6-32.

Table 6-32 MDSYS.SDO_DIST_UNITS View

Column Name	Data Type	Description
SDO_UNIT	VARCHAR2	Values are taken from the SHORT_NAME column of the SDO_UNITS_OF MEASURE table.
UNIT_NAME	VARCHAR2	Values are taken from the UNIT_OF_MEAS_NAME column of the SDO_UNITS_OF MEASURE table.
CONVERSION_FACTOR	NUMBER	Ratio of the unit to 1 meter. For example, the conversion factor for a meter is 1.0, and the conversion factor for a mile is 1609.344.

6.8.6 MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT and SDO_ELLIPSOIDS_OLD_SNAPSHOT Tables

The MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT and MDSYS.SDO_ELLIPSOIDS_OLD_SNAPSHOT reference tables contain one row for each valid SPHEROID specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in Well-Known Text (WKT).)

- MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT contains the new data in the old format (that is, EPSG-based ellipsoid specifications in a table using the format from before release 10.2).
- MDSYS.SDO_ELLIPSOIDS_OLD_SNAPSHOT contains the old data in the old format (that is, ellipsoid specifications and table format from before release 10.2).

These tables contain the columns shown in the following table.

Table 6-33 MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT and SDO_ELLIPSOIDS_OLD_SNAPSHOT Tables

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the ellipsoid (spheroid). Specify a value from this column in the SPHEROID specification of the WKT for any user-defined coordinate system. Examples: `Clarke 1866`, `WGS 72`, `Australian`, `Krassovsky`, `International 1924`.
SEMI_MAJOR_AXIS	NUMBER	Radius in meters along the semi-major axis (one-half of the long axis of the ellipsoid).
INVERSE_FLATTENING	NUMBER	Inverse flattening of the ellipsoid. That is, `1/f`, where `f = (a-b)/a`, and `a` is the semi-major axis and `b` is the semi-minor axis.

To see the names of the ellipsoids in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT ORDER BY name;
```

6.8.7 MDSYS.SDO_PROJECTIONS_OLD_FORMAT and SDO_PROJECTIONS_OLD_SNAPSHOT Tables

The MDSYS.SDO_PROJECTIONS_OLD_FORMAT and MDSYS.SDO_PROJECTIONS_OLD_SNAPSHOT reference tables contain one row for each valid PROJECTION specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in Well-Known Text (WKT).)

- MDSYS.SDO_PROJECTIONS_OLD_FORMAT contains the new data in the old format (that is, EPSG-based projection specifications in a table using the format from before release 10.2).
- MDSYS.SDO_PROJECTIONS_OLD_SNAPSHOT contains the old data in the old format (that is, projection specifications and table format from before release 10.2).

These tables contains the column shown in the following table.

Table 6-34 MDSYS.SDO_PROJECTIONS_OLD_FORMAT and SDO_PROJECTIONS_OLD_SNAPSHOT Tables

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the map projection. Specify a value from this column in the PROJECTION specification of the WKT for any user-defined coordinate system. Examples: `Geographic (Lat/Long)`, `Universal Transverse Mercator`, `State Plane Coordinates`, `Albers Conical Equal Area`.

To see the names of the projections in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_PROJECTIONS_OLD_FORMAT ORDER BY name;
```

6.9 Creating a User-Defined Coordinate Reference System

If the coordinate systems supplied by Oracle are not sufficient for your needs, you can create user-defined coordinate reference systems.

> **Note:**
>
> As mentioned in Coordinate System (Spatial Reference System) , the terms *coordinate system* and *coordinate reference system* (CRS) are often used interchangeably, although coordinate reference systems must be Earth-based.

The exact steps for creating a user-defined CRS depend on whether it is geodetic or projected. In both cases, supply information about the coordinate system (coordinate axes, axis names, unit of measurement, and so on). For a geodetic CRS, supply information about the datum (ellipsoid, prime meridian, and so on), as explained in Creating a Geodetic CRS. For a projected CRS, supply information about the source (geodetic) CRS and the projection (operation and parameters), as explained in Creating a Projected CRS.

For any user-defined coordinate system, the SRID value should be 5000000 to 6000000 (5 million to 6 million) which are available for user-defined coordinate systems.

- Creating a Geodetic CRS
- Creating a Projected CRS
- Creating a Vertical CRS
- Creating a Compound CRS
- Creating a Geographic 3D CRS
- Creating a Transformation Operation
- Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)

6.9.1 Creating a Geodetic CRS

If the necessary unit of measurement, coordinate axes, SDO_COORD_SYS table row, ellipsoid, prime meridian, and datum are already defined, insert a row into the SDO_COORD_REF_SYSTEM view (described in SDO_COORD_REF_SYSTEM View) to define the new geodetic CRS.

Example 6-5 inserts the definition for a hypothetical geodetic CRS named `My Own NAD27` (which, except for its SRID and name, is the same as the `NAD27` CRS supplied by Oracle).

If the necessary information for the definition does not already exist, follow these steps, as needed, to define the information before you insert the row into the SDO_COORD_REF_SYSTEM view:

1. If the unit of measurement is not already defined in the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table), insert a row into that table to define the new unit of measurement.
2. If the coordinate axes are not already defined in the SDO_COORD_AXES table (described in SDO_COORD_AXES Table), insert one row into that table for each new coordinate axis.
3. If an appropriate entry for the coordinate system does not already exist in the SDO_COORD_SYS table (described in SDO_COORD_SYS Table), insert a row into that table. Example 6-6 inserts the definition for a fictitious coordinate system.
4. If the ellipsoid is not already defined in the SDO_ELLIPSOIDS table (described in SDO_ELLIPSOIDS Table), insert a row into that table to define the new ellipsoid.
5. If the prime meridian is not already defined in the SDO_PRIME_MERIDIANS table (described in SDO_PRIME_MERIDIANS Table), insert a row into that table to define the new prime meridian.
6. If the datum is not already defined in the SDO_DATUMS table (described in SDO_DATUMS Table), insert a row into that table to define the new datum.

Example 6-5 Creating a User-Defined Geodetic Coordinate Reference System

```
INSERT INTO SDO_COORD_REF_SYSTEM (
        SRID,
        COORD_REF_SYS_NAME,
        COORD_REF_SYS_KIND,
        COORD_SYS_ID,
        DATUM_ID,
        GEOG_CRS_DATUM_ID,
        SOURCE_GEOG_SRID,
        PROJECTION_CONV_ID,
        CMPD_HORIZ_SRID,
        CMPD_VERT_SRID,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        IS_LEGACY,
        LEGACY_CODE,
        LEGACY_WKTEXT,
        LEGACY_CS_BOUNDS,
        IS_VALID,
        SUPPORTS_SDO_GEOMETRY)
  VALUES (
        9994267,
        'My Own NAD27',
        'GEOGRAPHIC2D',
        6422,
        6267,
        6267,
        NULL,
        NULL,
        NULL,
        NULL,
        NULL,
        'EPSG',
        'FALSE',
        NULL,
        NULL,
        NULL,
        'TRUE',
        'TRUE');
```

Example 6-6 Inserting a Row into the SDO_COORD_SYS Table

```
INSERT INTO SDO_COORD_SYS (
        COORD_SYS_ID,
        COORD_SYS_NAME,
        COORD_SYS_TYPE,
        DIMENSION,
        INFORMATION_SOURCE,
        DATA_SOURCE)
  VALUES (
        9876543,
        'My custom CS. Axes: lat, long. Orientations: north, east. UoM: deg',
        'ellipsoidal',
        2,
        'Myself',
        'Myself');
```

6.9.2 Creating a Projected CRS

If the necessary unit of measurement, coordinate axes, SDO_COORD_SYS table row, source coordinate system, projection operation, and projection parameters are already defined, insert a row into the SDO_COORD_REF_SYSTEM view (described in SDO_COORD_REF_SYSTEM View) to define the new projected CRS.

Example 6-7 inserts the definition for a hypothetical projected CRS named `My Own NAD27 / Cuba Norte` (which, except for its SRID and name, is the same as the `NAD27 / Cuba Norte` CRS supplied by Oracle).

If the necessary information for the definition does not already exist, follow these steps, as needed, to define the information before you insert the row into the SDO_COORD_REF_SYSTEM view:

1. If the unit of measurement is not already defined in the SDO_UNITS_OF_MEASURE table (described in SDO_UNITS_OF_MEASURE Table), insert a row into that table to define the new unit of measurement.
2. If the coordinate axes are not already defined in the SDO_COORD_AXES table (described in SDO_COORD_AXES Table), insert one row into that table for each new coordinate axis.
3. If an appropriate entry for the coordinate system does not already exist in SDO_COORD_SYS table (described in SDO_COORD_SYS Table), insert a row into that table. (See Example 6-6 in Creating a Geodetic CRS).
4. If the projection operation is not already defined in the SDO_COORD_OPS table (described in SDO_COORD_OPS Table), insert a row into that table to define the new

projection operation. Example 6-8 shows the statement used to insert information about coordinate operation ID 18061, which is supplied by Oracle.

5. If the parameters for the projection operation are not already defined in the SDO_COORD_OP_PARAM_VALS table (described in SDO_COORD_OP_PARAM_VALS Table), insert one row into that table for each new parameter. Example 6-9 shows the statement used to insert information about parameters with ID values 8801, 8802, 8805, 8806, and 8807, which are supplied by Oracle.

Example 6-7 Creating a User-Defined Projected Coordinate Reference System

```
INSERT INTO SDO_COORD_REF_SYSTEM (
        SRID,
        COORD_REF_SYS_NAME,
        COORD_REF_SYS_KIND,
        COORD_SYS_ID,
        DATUM_ID,
        GEOG_CRS_DATUM_ID,
        SOURCE_GEOG_SRID,
        PROJECTION_CONV_ID,
        CMPD_HORIZ_SRID,
        CMPD_VERT_SRID,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        IS_LEGACY,
        LEGACY_CODE,
        LEGACY_WKTEXT,
        LEGACY_CS_BOUNDS,
        IS_VALID,
        SUPPORTS_SDO_GEOMETRY)
  VALUES (
        9992085,
        'My Own NAD27 / Cuba Norte',
        'PROJECTED',
        4532,
        NULL,
        6267,
        4267,
        18061,
        NULL,
        NULL,
        'Institut Cubano di Hidrografia (ICH)',
        'EPSG',
        'FALSE',
        NULL,
        NULL,
        NULL,
        'TRUE',
        'TRUE');
```

Example 6-8 Inserting a Row into the SDO_COORD_OPS Table

```
INSERT INTO SDO_COORD_OPS (
        COORD_OP_ID,
        COORD_OP_NAME,
        COORD_OP_TYPE,
        SOURCE_SRID,
        TARGET_SRID,
        COORD_TFM_VERSION,
        COORD_OP_VARIANT,
        COORD_OP_METHOD_ID,
        UOM_ID_SOURCE_OFFSETS,
        UOM_ID_TARGET_OFFSETS,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        SHOW_OPERATION,
        IS_LEGACY,
        LEGACY_CODE,
        REVERSE_OP,
        IS_IMPLEMENTED_FORWARD,
        IS_IMPLEMENTED_REVERSE)
  VALUES (
        18061,
        'Cuba Norte',
        'CONVERSION',
        NULL,
        NULL,
        NULL,
        NULL,
        9801,
        NULL,
        NULL,
        NULL,
        'EPSG',
        1,
        'FALSE',
        NULL,
        1,
        1,
        1);
```

Example 6-9 Inserting a Row into the SDO_COORD_OP_PARAM_VALS Table

```
INSERT INTO SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
  VALUES (
        18061,
        9801,
        8801,
        22.21,
        NULL,
        9110);

 INSERT INTO SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
  VALUES (
        18061,
        9801,
        8802,
        -81,
        NULL,
        9110);

 INSERT INTO SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
  VALUES (
        18061,
        9801,
        8805,
        .99993602,
        NULL,
        9201);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
  VALUES (
        18061,
        9801,
        8806,
        500000,
        NULL,
        9001);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
  VALUES (
        18061,
        9801,
        8807,
        280296.016,
        NULL,
        9001);
```

Example 6-10 Creating a User-Defined Projected CRS: Extended Example

```
-- Create an EPSG equivalent for the following CRS:
--
-- CS_NAME:    VDOT_LAMBERT
-- SRID:       51000000
-- AUTH_SRID:  51000000
-- AUTH_NAME:  VDOT Custom Lambert Conformal Conic
-- WKTEXT:
--
-- PROJCS[
--   "VDOT_Lambert",
--   GEOGCS[
--     "GCS_North_American_1983",
--     DATUM[
--       "D_North_American_1983",
--       SPHEROID["GRS_1980", 6378137.0, 298.257222101]],
--     PRIMEM["Greenwich", 0.0],
--     UNIT["Decimal Degree",0.0174532925199433]],
--   PROJECTION["Lambert_Conformal_Conic"],
--   PARAMETER["False_Easting", 0.0],
--   PARAMETER["False_Northing", 0.0],
--   PARAMETER["Central_Meridian", -79.5],
--   PARAMETER["Standard_Parallel_1", 37.0],
--   PARAMETER["Standard_Parallel_2", 39.5],
--   PARAMETER["Scale_Factor", 1.0],
--   PARAMETER["Latitude_Of_Origin", 36.0],
--   UNIT["Meter", 1.0]]

-- First, the base geographic CRS (GCS_North_American_1983) already exists in EPSG.
-- It is 4269:
-- Next, find the EPSG equivalent for PROJECTION["Lambert_Conformal_Conic"]:
select
  coord_op_method_id,
  legacy_name
from
  sdo_coord_op_methods
where
  not legacy_name is null
order by
  coord_op_method_id;

-- Result:
-- COORD_OP_METHOD_ID LEGACY_NAME
-- ------------------ --------------------------------------------------
--               9802 Lambert Conformal Conic
--               9803 Lambert Conformal Conic (Belgium 1972)
--               9805 Mercator
--               9806 Cassini
--               9807 Transverse Mercator
--               9829 Polar Stereographic
--
-- 6 rows selected.
--
-- It is EPSG method 9802. Create a projection operation 510000001, based on it:

insert into MDSYS.SDO_COORD_OPS (
        COORD_OP_ID,
        COORD_OP_NAME,
        COORD_OP_TYPE,
        SOURCE_SRID,
        TARGET_SRID,
        COORD_TFM_VERSION,
        COORD_OP_VARIANT,
        COORD_OP_METHOD_ID,
        UOM_ID_SOURCE_OFFSETS,
        UOM_ID_TARGET_OFFSETS,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        SHOW_OPERATION,
        IS_LEGACY,
        LEGACY_CODE,
        REVERSE_OP,
        IS_IMPLEMENTED_FORWARD,
        IS_IMPLEMENTED_REVERSE)
VALUES (
        510000001,
        'VDOT_Lambert',
        'CONVERSION',
        NULL,
        NULL,
        NULL,
        NULL,
        9802,
        NULL,
        NULL,
        NULL,
        NULL,
        1,
        'FALSE',
        NULL,
        1,
        1,
        1);

-- Now, set the parameters. See which are required:

select
  use.parameter_id || ': ' ||
  use.legacy_param_name
from
  sdo_coord_op_param_use use
where
  use.coord_op_method_id = 9802;

-- result:
-- 8821: Latitude_Of_Origin
-- 8822: Central_Meridian
-- 8823: Standard_Parallel_1
-- 8824: Standard_Parallel_2
-- 8826: False_Easting
-- 8827: False_Northing
--
-- 6 rows selected.

-- Also check the most common units we will need:

select
  UOM_ID || ': ' ||
  UNIT_OF_MEAS_NAME
from
  sdo_units_of_measure
where
  uom_id in (9001, 9101, 9102, 9201)
order by
  uom_id;

-- result:
-- 9001: metre
-- 9101: radian
-- 9102: degree
-- 9201: unity

-- Now, configure the projection parameters:

-- 8821: Latitude_Of_Origin

    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8821,
        36.0,
        NULL,
        9102);

-- 8822: Central_Meridian

    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8822,
        -79.5,
        NULL,
        9102);

-- 8823: Standard_Parallel_1

    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8823,
        37.0,
        NULL,
        9102);

-- 8824: Standard_Parallel_2

    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8824,
        39.5,
        NULL,
        9102);

-- 8826: False_Easting
```

```
    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8826,
        0.0,
        NULL,
        9001);

-- 8827: False_Northing

    insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
        COORD_OP_ID,
        COORD_OP_METHOD_ID,
        PARAMETER_ID,
        PARAMETER_VALUE,
        PARAM_VALUE_FILE_REF,
        UOM_ID)
      VALUES (
        510000001,
        9802,
        8827,
        0.0,
        NULL,
        9001);

-- Now, create the actual projected CRS.Look at the GEOG_CRS_DATUM_ID
-- and COORD_SYS_ID first. The GEOG_CRS_DATUM_ID is the datum of
-- the base geog_crs (4269):

select datum_id from sdo_coord_ref_sys where srid = 4269;

--   DATUM_ID
-- ----------
--       6269

-- And the COORD_SYS_ID is the Cartesian CS used for the projected CRS.
-- We can use 4400, if meters will be the unit:

select COORD_SYS_NAME from sdo_coord_sys where COORD_SYS_ID = 4400;

-- Cartesian 2D CS. Axes: easting, northing (E,N). Orientations: east, north.
-- UoM: m.

-- Now create the projected CRS:

insert into MDSYS.SDO_COORD_REF_SYSTEM (
        SRID,
        COORD_REF_SYS_NAME,
        COORD_REF_SYS_KIND,
        COORD_SYS_ID,
        DATUM_ID,
        SOURCE_GEOG_SRID,
        PROJECTION_CONV_ID,
        CMPD_HORIZ_SRID,
        CMPD_VERT_SRID,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        IS_LEGACY,
        LEGACY_CODE,
        LEGACY_WKTEXT,
        LEGACY_CS_BOUNDS,
        GEOG_CRS_DATUM_ID)
VALUES (
        51000000,
        'VDOT_LAMBERT',
        'PROJECTED',
        4400,
        NULL,
        4269,
        510000001,
        NULL,
        NULL,
        NULL,
        NULL,
        'FALSE',
        NULL,
        NULL,
        NULL,
        6269);

-- To see the result:

select srid, wktext from cs_srs where srid = 51000000;

--  51000000
-- PROJCS[
--   "VDOT_LAMBERT",
--   GEOGCS [
--     "NAD83",
--     DATUM [
--       "North American Datum 1983 (EPSG ID 6269)",
--       SPHEROID [
--         "GRS 1980 (EPSG ID 7019)",
--         6378137,
--         298.257222101]],
--     PRIMEM [ "Greenwich", 0.000000 ],
--     UNIT ["Decimal Degree", 0.01745329251994328]],
--   PROJECTION ["VDOT_Lambert"],
--   PARAMETER ["Latitude_Of_Origin", 36],
--   PARAMETER ["Central_Meridian", -79.500000000000000000000000000000000028],
--   PARAMETER ["Standard_Parallel_1", 37],
--   PARAMETER ["Standard_Parallel_2", 39.5],
--   PARAMETER ["False_Easting", 0],
--   PARAMETER ["False_Northing", 0],
--   UNIT ["Meter", 1]]
```

Example 6-10 provides an extended, annotated example of creating a user-defined projected coordinate system

6.9.3 Creating a Vertical CRS

A vertical CRS has only one dimension, usually height. On its own, a vertical CRS is of little use, but it can be combined with a two-dimensional CRS (geodetic or projected), to result in a compound CRS. Example 6-11 shows the statement that created the vertical CRS with SRID 5701, which is included with Spatial. This definition refers to an existing (one-dimensional) coordinate system (ID 6499; see SDO_COORD_SYS Table) and vertical datum (ID 5101; see SDO_DATUMS Table).

Example 6-11 Creating a Vertical Coordinate Reference System

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS)
  VALUES (
    5701,
    'Newlyn',
    'VERTICAL',
    6499,
    5101,
    NULL,
    NULL,
    NULL,
    NULL,
    NULL,
    'EPSG',
    'FALSE',
    NULL,
    NULL,
    NULL);
```

A vertical CRS might define some undulating equipotential surface. The shape of that surface, and its offset from some ellipsoid, is not actually defined in the vertical CRS record itself (other than textually). Instead, that definition is included in an operation between the vertical CRS and another CRS. Consequently, you can define several alternative operations between the same pair of geoidal and WGS 84-ellipsoidal heights. For example, there are geoid offset matrixes GEOID90, GEOID93, GEOID96, GEOID99, GEOID03, GEOID06, and others, and for each of these variants there can be a separate operation. Creating a Transformation Operation describes such an operation.

6.9.4 Creating a Compound CRS

A compound CRS combines an existing horizontal (two-dimensional) CRS and a vertical (one-dimensional) CRS. The horizontal CRS can be geodetic or projected. Example 6-12 shows the statement that created the compound CRS with SRID 7405, which is included with Spatial. This definition refers to an existing projected CRS and vertical CRS (IDs 27700 and 5701, respectively; see SDO_COORD_REF_SYS Table).

Example 6-12 Creating a Compound Coordinate Reference System

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS)
  VALUES (
    7405,
    'OSGB36 / British National Grid + ODN',
    'COMPOUND',
    NULL,
    NULL,
    NULL,
    NULL,
    27700,
    5701,
    NULL,
    'EPSG',
    'FALSE',
    NULL,
    NULL,
    NULL);
```

6.9.5 Creating a Geographic 3D CRS

A geographic 3D CRS is the combination of a geographic 2D CRS with ellipsoidal height.

> **Note:**
>
> Creating a 3D CRS is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

Example 6-13 shows the statement that created the geographic 3D CRS with SRID 4327, which is included with Spatial. This definition refers to an existing projected coordinate system (ID 6401; see SDO_COORD_SYS Table) and datum (ID 6326; see SDO_DATUMS Table).

Example 6-13 Creating a Geographic 3D Coordinate Reference System

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
   SRID,
   COORD_REF_SYS_NAME,
   COORD_REF_SYS_KIND,
   COORD_SYS_ID,
   DATUM_ID,
   GEOG_CRS_DATUM_ID,
   SOURCE_GEOG_SRID,
   PROJECTION_CONV_ID,
   CMPD_HORIZ_SRID,
   CMPD_VERT_SRID,
   INFORMATION_SOURCE,
   DATA_SOURCE,
   IS_LEGACY,
   LEGACY_CODE,
   LEGACY_WKTEXT,
   LEGACY_CS_BOUNDS,
   IS_VALID,
   SUPPORTS_SDO_GEOMETRY)
 VALUES (
   4327,
   'WGS 84 (geographic 3D)',
   'GEOGRAPHIC3D',
   6401,
   6326,
   6326,
   NULL,
   NULL,
   NULL,
   NULL,
   'NIMA TR8350.2 January 2000 revision. http://164.214.2.59/GandG/tr8350_2.html',
   'EPSG',
   'FALSE',
   NULL,
   NULL,
   NULL,
   'TRUE',
   'TRUE');
```

6.9.6 Creating a Transformation Operation

Creating a Projected CRS described the creation of a projection operation, for the purpose of then creating a projected CRS. A similar requirement can arise when using a compound CRS based on orthometric height: you may want to transform from and to ellipsoidal height. The offset between the two heights is undulating and irregular.

By default, Spatial transforms between ellipsoidal and orthometric height using an identity transformation. (Between different ellipsoids, the default would instead be a datum transformation.) The identity transformation is a reasonable approximation; however, a more accurate approach involves an EPSG type 9635 operation, involving an offset matrix. Example 6-14 is a declaration of such an operation:

Example 6-14   Creating a Transformation Operation

```
INSERT INTO MDSYS.SDO_COORD_OPS (
   COORD_OP_ID,
   COORD_OP_NAME,
   COORD_OP_TYPE,
   SOURCE_SRID,
   TARGET_SRID,
   COORD_TFM_VERSION,
   COORD_OP_VARIANT,
   COORD_OP_METHOD_ID,
   UOM_ID_SOURCE_OFFSETS,
   UOM_ID_TARGET_OFFSETS,
   INFORMATION_SOURCE,
   DATA_SOURCE,
   SHOW_OPERATION,
   IS_LEGACY,
   LEGACY_CODE,
   REVERSE_OP,
   IS_IMPLEMENTED_FORWARD,
   IS_IMPLEMENTED_REVERSE)
 VALUES (
   999998,
   'Test operation, based on GEOID03 model, using Hawaii grid',
   'TRANSFORMATION',
   NULL,
   NULL,
   NULL,
   NULL,
   9635,
   NULL,
   NULL,
   'NGS',
   'NGS',
   1,
   'FALSE',
   NULL,
   1,
   1,
   1);

INSERT INTO MDSYS.SDO_COORD_OP_PARAM_VALS (
   COORD_OP_ID,
   COORD_OP_METHOD_ID,
   PARAMETER_ID,
   PARAMETER_VALUE,
   PARAM_VALUE_FILE_REF,
   UOM_ID)
 VALUES (
   999998,
   9635,
   8666,
   NULL,
   'g2003h01.asc',
   NULL);
```

The second INSERT statement in Example 6-14 specifies the file name `g2003h01.asc`, but not yet its actual CLOB content with the offset matrix. As with NADCON and NTv2 matrixes, geoid matrixes have to be loaded into the PARAM_VALUE_FILE column. Due to space and copyright considerations, Oracle does not supply most of these matrixes; however, they are usually available for download on the Web. Good sources are the relevant government websites, and you can search by file name (such as `g2003h01` in this example). Although some of these files are available in both binary format (such as .gsb) and ASCII format (such as .gsa or .asc), only the ASCII variant can be used with Spatial. The existing EPSG operations include file names in standard use.

Example 6-15 Loading Offset Matrixes

```
DECLARE
  ORCL_HOME_DIR VARCHAR2(128);
  ORCL_WORK_DIR VARCHAR2(128);
  Src_loc       BFILE;
  Dest_loc      CLOB;
  CURSOR PARAM_FILES IS
    SELECT
      COORD_OP_ID,
      PARAMETER_ID,
      PARAM_VALUE_FILE_REF
    FROM
      MDSYS.SDO_COORD_OP_PARAM_VALS
    WHERE
      PARAMETER_ID IN (8656, 8657, 8658, 8666);
  PARAM_FILE PARAM_FILES%ROWTYPE;
  ACTUAL_FILE_NAME VARCHAR2(128);
  platform NUMBER;
  dest_offset  number := 1;
  src_offset   number := 1;
  lang_context number := 0;
  warning      number;
BEGIN
  EXECUTE IMMEDIATE 'CREATE OR REPLACE DIRECTORY work_dir AS
''define_your_source_directory_here''';

  FOR PARAM_FILE IN PARAM_FILES LOOP
    CASE UPPER(PARAM_FILE.PARAM_VALUE_FILE_REF)
      /* NTv2, fill in your files here */
      WHEN 'NTV2_0.GSB'   THEN ACTUAL_FILE_NAME := 'ntv20.gsa';
      /* GEOID03, fill in your files here */
      WHEN 'G2003H01.ASC' THEN ACTUAL_FILE_NAME := 'g2003h01.asc';
      ELSE                     ACTUAL_FILE_NAME := NULL;
    END CASE;

    IF(NOT (ACTUAL_FILE_NAME IS NULL)) THEN
      BEGIN
        dbms_output.put_line('Loading file ' || actual_file_name || '...');
        Src_loc := BFILENAME('WORK_DIR', ACTUAL_FILE_NAME);
        DBMS_LOB.OPEN(Src_loc, DBMS_LOB.LOB_READONLY);
      END;

      UPDATE
        MDSYS.SDO_COORD_OP_PARAM_VALS
      SET
        PARAM_VALUE_FILE = EMPTY_CLOB()
      WHERE
        COORD_OP_ID = PARAM_FILE.COORD_OP_ID AND
        PARAMETER_ID = PARAM_FILE.PARAMETER_ID
      RETURNING
        PARAM_VALUE_FILE INTO Dest_loc;

      DBMS_LOB.OPEN(Dest_loc, DBMS_LOB.LOB_READWRITE);

      -- DBMS_LOB.LOADCLOBFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE);
      declare
        src_offset number := 1 ;
        dst_offset number := 1 ;
        lang_ctx   number := dbms_lob.default_lang_ctx;
        warning    number;
      begin
        DBMS_LOB.LOADCLOBFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE,
          dst_offset,
          src_offset,
          dbms_lob.default_csid,
          lang_ctx,
          warning) ;
        if (warning = dbms_lob.warn_inconvertible_char) then
          dbms_output.put_line('Warning: Inconvertible character');
        end if;
      end;

      DBMS_LOB.CLOSE(Dest_loc);
      DBMS_LOB.CLOSE(Src_loc);
      DBMS_LOB.FILECLOSE(Src_loc);
    END IF;
  END LOOP;
END;
/
```

Example 6-15 is a script for loading a set of such matrixes. It loads specified physical files (such as `ntv20.gsa`) into database CLOBs, based on the official file name reference (such as `NTV2_0.GSB`).

6.9.7 Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)

To use British Grid Transformation OSTN02/OSGM02 (EPSG method 9633) in a projected coordinate reference system, you must first insert a modified version of the `OSTN02_OSGM02_GB.txt` grid file into the PARAM_VALUE_FILE column (type CLOB) of the SDO_COORD_OP_PARAM_VALS table (described in SDO_COORD_OP_PARAM_VALS Table). The `OSTN02_OSGM02_GB.txt` file contains the offset matrix on which EPSG transformation method 9633 is based.

Follow these steps:

1. Download the following file: `http://www.ordnancesurvey.co.uk/docs/gps/ostn02-osgm02-files.zip`
2. From this .zip file, extract the following file: `OSTN02_OSGM02_GB.txt`
3. Edit your copy of `OSTN02_OSGM02_GB.txt`, and insert the following lines before the first line of the current file:

   ```
   SDO Header
   x: 0.0 - 700000.0
   y: 0.0 - 1250000.0
   x-intervals: 1000.0
   y-intervals: 1000.0
   End of SDO Header
   ```

   The is, after the editing operation, the contents of the file will look like this:

   ```
   SDO Header
   x: 0.0 - 700000.0
   y: 0.0 - 1250000.0
   x-intervals: 1000.0
   y-intervals: 1000.0
   End of SDO Header
   1,0,0,0.000,0.000,0.000,0
   2,1000,0,0.000,0.000,0.000,0
   3,2000,0,0.000,0.000,0.000,0
   4,3000,0,0.000,0.000,0.000,0
   5,4000,0,0.000,0.000,0.000,0
   . . .
   876949,698000,1250000,0.000,0.000,0.000,0
   876950,699000,1250000,0.000,0.000,0.000,0
   876951,700000,1250000,0.000,0.000,0.000,0
   ```

4. Save the edited file, perhaps using a different name (for example, `my_OSTN02_OSGM02_GB.txt`).
5. In the SDO_COORD_OP_PARAM_VALS table, for each operation of EPSG method 9633 that has PARAM_VALUE_FILE_REF value `OSTN02_OSGM02_GB.TXT`, update the PARAM_VALUE_FILE column to be the contents of the saved file (for example, the contents of `my_OSTN02_OSGM02_GB.txt`). You can use coding similar to that in Example 6-16.

Example 6-16 Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)

```
DECLARE
  ORCL_HOME_DIR VARCHAR2(128);
  ORCL_WORK_DIR VARCHAR2(128);
  Src_loc       BFILE;
  Dest_loc      CLOB;
  CURSOR PARAM_FILES IS
    SELECT
      COORD_OP_ID,
      PARAMETER_ID,
      PARAM_VALUE_FILE_REF
    FROM
      MDSYS.SDO_COORD_OP_PARAM_VALS
    WHERE
      PARAMETER_ID IN (8656, 8657, 8658, 8664, 8666)
    order by
      COORD_OP_ID,
      PARAMETER_ID;
  PARAM_FILE PARAM_FILES%ROWTYPE;
  ACTUAL_FILE_NAME VARCHAR2(128);
  platform NUMBER;
BEGIN
  EXECUTE IMMEDIATE 'CREATE OR REPLACE DIRECTORY work_dir AS ''' || system.geor_dir ||
'''';

  FOR PARAM_FILE IN PARAM_FILES LOOP
    CASE UPPER(PARAM_FILE.PARAM_VALUE_FILE_REF)
      /* NTv2 */
      WHEN 'NTV2_0.GSB'   THEN ACTUAL_FILE_NAME := 'ntv20.gsa';
      /* GEOID03 */
      WHEN 'G2003H01.ASC' THEN ACTUAL_FILE_NAME := 'g2003h01.asc';
      /* British Ordnance Survey (9633) */
      WHEN 'OSTN02_OSGM02_GB.TXT'
                          THEN ACTUAL_FILE_NAME := 'my_OSTN02_OSGM02_GB.txt';
      ELSE                ACTUAL_FILE_NAME := NULL;
    END CASE;

    IF(NOT (ACTUAL_FILE_NAME IS NULL)) THEN
      BEGIN
        dbms_output.put_line('Loading file ' || actual_file_name || '...');
        Src_loc := BFILENAME('WORK_DIR', ACTUAL_FILE_NAME);
        DBMS_LOB.OPEN(Src_loc, DBMS_LOB.LOB_READONLY);
      END;

      UPDATE
        MDSYS.SDO_COORD_OP_PARAM_VALS
      SET
        PARAM_VALUE_FILE = EMPTY_CLOB()
      WHERE
        COORD_OP_ID = PARAM_FILE.COORD_OP_ID AND
        PARAMETER_ID = PARAM_FILE.PARAMETER_ID
      RETURNING
        PARAM_VALUE_FILE INTO Dest_loc;

      DBMS_LOB.OPEN(Dest_loc, DBMS_LOB.LOB_READWRITE);
--    DBMS_LOB.LOADCLOBFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE);
      declare
        src_offset number := 1 ;
        dst_offset number := 1 ;
        lang_ctx   number := dbms_lob.default_lang_ctx;
```

```
          warning    number;
        begin
          DBMS_LOB.LOADCLOBFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE,
            dst_offset,
            src_offset,
            dbms_lob.default_csid,
            lang_ctx,
            warning) ;
          if (warning = dbms_lob.warn_inconvertible_char) then
            dbms_output.put_line('Warning: Inconvertible character');
          end if;
        end;
        DBMS_LOB.CLOSE(Dest_loc);
        DBMS_LOB.CLOSE(Src_loc);
        DBMS_LOB.FILECLOSE(Src_loc);
      END IF;
    END LOOP;
  END;
  /
```

Note that adding "header" information to a grid file is required only for British Grid Transformation OSTN02/OSGM02. It is not required for NADCON, NTv2, or VERTCON matrixes, because they already have headers of varying formats.

See also the following for related information:

- Creating a Projected CRS
- Creating a Transformation Operation

6.10 Notes and Restrictions with Coordinate Systems Support

The following notes and restrictions apply to coordinate systems support in the current release of Oracle Spatial.

If you have geodetic data, see Geodetic Coordinate Support for additional considerations, guidelines, and restrictions.

- Different Coordinate Systems for Geometries with Operators and Functions
- 3D LRS Functions Not Supported with Geodetic Data
- Functions Supported by Approximations with Geodetic Data
- Unknown CRS and NaC Coordinate Reference Systems

6.10.1 Different Coordinate Systems for Geometries with Operators and Functions

For spatial operators (described in Spatial Operators) that take two geometries as input parameters, if the geometries are based on different coordinate systems, the query window (the second geometry) is transformed to the coordinate system of the first geometry before the operation is performed. This transformation is a temporary internal operation performed by Spatial; it does not affect any stored query-window geometry.

For SDO_GEOM package geometry functions (described in SDO_GEOM Package (Geometry)) that take two geometries as input parameters, both geometries must be based on the same coordinate system.

6.10.2 3D LRS Functions Not Supported with Geodetic Data

In the current release, the *3D* formats of LRS functions (explained in 3D Formats of LRS Functions) are not supported with geodetic data.

6.10.3 Functions Supported by Approximations with Geodetic Data

In the current release, the following functions are supported by approximations with geodetic data:

- SDO_GEOM.SDO_BUFFER
- SDO_GEOM.SDO_CENTROID
- SDO_GEOM.SDO_CONVEXHULL

When these functions are used on data with geodetic coordinates, they internally perform the operations in an implicitly generated local-tangent-plane Cartesian coordinate system and then transform the results to the geodetic coordinate system. For SDO_GEOM.SDO_BUFFER, generated arcs are approximated by line segments before the back-transform.

6.10.4 Unknown CRS and NaC Coordinate Reference Systems

The following coordinate reference systems are provided for Oracle internal use and for other possible special uses:

- `unknown CRS` (SRID 999999) means that the coordinate system is unknown, and its space could be geodetic or Cartesian. Contrast this with specifying a null coordinate reference system, which indicates an unknown coordinate system with a Cartesian space.
- `NaC` (SRID 999998) means *Not-a-CRS*. Its name is patterned after the `NaN` (*Not-a-Number*) value in Java. It is intended for potential use with nonspatial geometries.

The following restrictions apply to geometries based on the `unknown CRS` and `NaC` coordinate reference systems:

- You cannot perform coordinate system transformations on these geometries.
- Operations that require a coordinate system will return a null value when performed on these geometries. These operations include finding the area or perimeter of a geometry, creating a buffer, densifying an arc, and computing the aggregate centroid.

6.11 U.S. National Grid Support

The U.S. National Grid is a point coordinate representation using a single alphanumeric coordinate (for example, 18SUJ2348316806479498).

This approach contrasts with the use of numeric coordinates to represent the location of a point, as is done with Oracle Spatial and with EPSG. A good description of the U.S. National Grid is available at `http://www.ngs.noaa.gov/TOOLS/usng.html`.

To support the U.S. National Grid in Spatial, the SDO_GEOMETRY type cannot be used because it is based on numeric coordinates. Instead, a point in U.S. National Grid format is represented as a single string of type VARCHAR2. To allow conversion between the SDO_GEOMETRY format and the U.S. National grid format, the SDO_CS package (documented in SDO_CS Package (Coordinate System Transformation)) contains the following functions:

- SDO_CS.FROM_USNG
- SDO_CS.TO_USNG

6.12 Geohash Support

A **geohash** is a standard String encoding of a longitude/latitude point.

Some third-party software without advanced geospatial capabilities may be compatible with geohashes, since they support some types of simple, limited analysis of geographic data. For example, the approximate distance between objects can be guessed, based on the length of common prefix of the geohashes.

For more information about geohash, see `https://en.wikipedia.org/wiki/Geohash`.

To support geohashes, the SDO_GEOMETRY type cannot be used directly. Instead, you can use the SDO_CS package (documented in SDO_CS Package (Coordinate System Transformation)) to convert between SDO_GEOMETRY and gaohash format, and to perform other geohash-related operations. That package contains the following subprograms related to geohash support:

- SDO_CS.FROM_GEOHASH
- SDO_CS.GET_GEOHASH_CELL_HEIGHT
- SDO_CS.GET_GEOHASH_CELL_WIDTH
- SDO_CS.TO_GEOHASH

6.13 Google Maps Considerations

Google Maps uses spherical math in its projections, as opposed to the ellipsoidal math used by Oracle Spatial. This difference can lead to inconsistencies in applications, such as when overlaying a map based on Google Maps with a map based on an Oracle Spatial ellipsoidal projection.

For example, an Oracle Spatial transformation from the ellipsoidal SRID 4326 to the spherical SRID 3785 accounts, by default, for the different ellipsoidal shapes, whereas Google Maps does not consider ellipsoidal shapes.

If you want Oracle Spatial to accommodate the Google Maps results, consider the following options:

- Use the spherical SRID 4055 instead of the ellipsoidal SRID 4326. This may be the simplest approach; however, if you need to accommodate SRID 4326-based data (such as from a third-party tool) as if it were spherical, you must use another option.
- Use SRID 3857 instead of SRID 3785. This more convenient than the next two options, because using SRID 3857 does not require that you declare an EPSG rule or that you specify the `USE_SPHERICAL` use case name in order to produce Google-compatible results.
- Declare an EPSG rule between the ellipsoidal and spherical coordinate systems. For example, declare an EPSG rule between SRIDs 4326 and 3785, ignoring the ellipsoidal shape of SRID 4326, as in the following example:

```
CALL sdo_cs.create_pref_concatenated_op(
  302,
  'CONCATENATED OPERATION',
  TFM_PLAN(SDO_TFM_CHAIN(4326, 1000000000, 4055, 19847, 3785)),
  NULL);
```

In this example, operation `1000000000` represents *no-operation*, causing the datum transformation between ellipsoid and sphere to be ignored.

With this approach, you must declare a rule for each desired SRID pair (ellipsoidal and spherical).

- Specify a use case name of `USE_SPHERICAL` with the SDO_CS.TRANSFORM function or the SDO_CS.TRANSFORM_LAYER procedure, as in the following examples:

```
SELECT
  SDO_CS.TRANSFORM(
    sdo_geometry(1,1),
    'USE_SPHERICAL',
    3785)
FROM DUAL;

CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_3785_SPHERICAL',
  'USE_SPHERICAL',
  3785);
```

  If you specify a `use_case` parameter value of `USE_SPHERICAL` in such cases, the transformation defaults to using spherical math instead of ellipsoidal math, thereby accommodating Google Maps and some other third-party tools that use spherical math.

  If you use this approach (specifying `'USE_SPHERICAL'`) but you have also declared an EPSG rule requiring that ellipsoidal math be used in transformations between two specified SRIDs, then the declared EPSG rule takes precedence and ellipsoidal math is used for transformations between those two SRIDs.

6.14 Example of Coordinate System Transformation

This topic presents a simplified example that uses coordinate system transformation functions and procedures.

It refers to concepts that are explained in this chapter and uses functions documented in SDO_CS Package (Coordinate System Transformation) .

Example 6-17   Simplified Example of Coordinate System Transformation

Example 6-17 uses mostly the same geometry data (cola markets) as in Simple Example: Inserting_ Indexing_ and Querying Spatial Data, except that instead of null SDO_SRID values, the SDO_SRID value 4326 is used. That is, the geometries are defined as using the coordinate system whose SRID is 4326 and whose well-known name is "Longitude / Latitude (WGS 84)". This is probably the most widely used coordinate system, and it is the one used for global positioning system (GPS) devices. The geometries are then transformed using the coordinate system whose SRID is 8199 and whose well-known name is "Longitude / Latitude (Arc 1950)".

Example 6-17 uses the geometries illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data, except that `cola_d` is a rectangle (here, a square) instead of a circle, because arcs are not supported with geodetic coordinate systems.

Example 6-17 does the following:

- Creates a table (COLA_MARKETS_CS) to hold the spatial data
- Inserts rows for four areas of interest (`cola_a`, `cola_b`, `cola_c`, `cola_d`), using the SDO_SRID value 4326

- Updates the USER_SDO_GEOM_METADATA view to reflect the dimension of the areas, using the SDO_SRID value 4326
- Creates a spatial index (COLA_SPATIAL_IDX_CS)
- Performs some transformation operations (single geometry and entire layer)

```
-- Create a table for cola (soft drink) markets in a
-- given geography (such as city or state).

CREATE TABLE cola_markets_cs (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape SDO_GEOMETRY);

-- The next INSERT statement creates an area of interest for
-- Cola A. This area happens to be a rectangle.
-- The area could represent any user-defined criterion: for
-- example, where Cola A is the preferred drink, where
-- Cola A is under competitive pressure, where Cola A
-- has strong growth potential, and so on.

INSERT INTO cola_markets_cs VALUES(
  1,
  'cola_a',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,  -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    SDO_ORDINATE_ARRAY(1,1, 5,1, 5,7, 1,7, 1,1) -- All vertices must
              -- be defined for rectangle with geodetic data.
  )
);

-- The next two INSERT statements create areas of interest for
-- Cola B and Cola C. These areas are simple polygons (but not
-- rectangles).

INSERT INTO cola_markets_cs VALUES(
  2,
  'cola_b',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
  )
);

INSERT INTO cola_markets_cs VALUES(
  3,
  'cola_c',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), --one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
  )
);
```

```
-- Insert a rectangle (here, square) instead of a circle as in the original,
-- because arcs are not supported with geodetic coordinate systems.
INSERT INTO cola_markets_cs VALUES(
  4,
  'cola_d',
  SDO_GEOMETRY(
    SDO_POLYGON2D,  -- two-dimensional polygon
    4326,  -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    SDO_ORDINATE_ARRAY(10,9, 11,9, 11,10, 10,10, 10,9) -- All vertices must
              -- be defined for rectangle with geodetic data.
  )
);

---------------------------------------------------------------------------
-- UPDATE METADATA VIEW --
---------------------------------------------------------------------------
-- Update the USER_SDO_GEOM_METADATA view. This is required
-- before the spatial index can be created. Do this only once for each
-- layer (table-column combination; here: cola_markets_cs and shape).

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'cola_markets_cs',
  'shape',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),  -- 10 meters tolerance
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10)  -- 10 meters tolerance
     ),
  4326   -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);

-------------------------------------------------------------------
-- CREATE THE SPATIAL INDEX --
-------------------------------------------------------------------
CREATE INDEX cola_spatial_idx_cs
ON cola_markets_cs(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

-------------------------------------------------------------------
-- TEST COORDINATE SYSTEM TRANSFORMATION --
-------------------------------------------------------------------

-- Return the transformation of cola_c using to_srid 8199
-- ('Longitude / Latitude (Arc 1950)')
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

-- Same as preceding, but using to_srname parameter.
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
  FROM cola_markets_cs c  WHERE c.name = 'cola_c';

-- Transform the entire SHAPE layer and put results in the table
-- named cola_markets_cs_8199, which the procedure will create.
CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',8199);

-- Select all from the old (existing) table.
```

```
SELECT * from cola_markets_cs;

-- Select all from the new (layer transformed) table.
SELECT * from cola_markets_cs_8199;

-- Show metadata for the new (layer transformed) table.
DESCRIBE cola_markets_cs_8199;

-- Use a geodetic MBR with SDO_FILTER.
SELECT c.name FROM cola_markets_cs c WHERE
   SDO_FILTER(c.shape,
       SDO_GEOMETRY(
           2003,
           4326,    -- SRID for WGS 84 longitude/latitude
           NULL,
           SDO_ELEM_INFO_ARRAY(1,1003,3),
           SDO_ORDINATE_ARRAY(6,5, 10,10))
       ) = 'TRUE';
```

Example 6-18 shows the output of the SELECT statements in Example 6-17. Notice the slight differences between the coordinates in the original geometries (SRID 4326) and the transformed coordinates (SRID 8199) -- for example, (1, 1, 5, 1, 5, 7, 1, 7, 1, 1) and (1.00078604, 1.00274579, 5.00069354, 1.00274488, 5.0006986, 7.00323528, 1.00079179, 7.00324162, 1.00078604, 1.00274579) for `cola_a`.

Example 6-18 Output of SELECT Statements in Coordinate System Transformation Example

```
SQL> -- Return the transformation of cola_c using to_srid 8199
SQL> -- ('Longitude / Latitude (Arc 1950)')
SQL> SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
  2    FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_CS.TRANSFORM(C.SHAPE,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

SQL>
SQL> -- Same as preceding, but using to_srname parameter.
SQL> SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
  2    FROM cola_markets_cs c  WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_CS.TRANSFORM(C.SHAPE,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, SDO_SRID, SDO
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

SQL>
SQL> -- Transform the entire SHAPE layer and put results in the table
SQL> -- named cola_markets_cs_8199, which the procedure will create.
SQL> CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',8199);

Call completed.
```

```
SQL>
SQL> -- Select all from the old (existing) table.
SQL> SELECT * from cola_markets_cs;

    MKT_ID NAME
---------- --------------------------------
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
         1 cola_a
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 5, 1, 5, 7, 1, 7, 1, 1))

         2 cola_b
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

         3 cola_c

    MKT_ID NAME
---------- --------------------------------
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3, 3, 6, 3, 6, 5, 4, 5, 3, 3))

         4 cola_d
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(10, 9, 11, 9, 11, 10, 10, 10, 10, 9))


SQL>
SQL> -- Select all from the new (layer transformed) table.
SQL> SELECT * from cola_markets_cs_8199;

SDO_ROWID
------------------
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
AAABZzAABAAAOa6AAA
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1.00078604, 1.00274579, 5.00069354, 1.00274488, 5.0006986, 7.00323528, 1.0007
9179, 7.00324162, 1.00078604, 1.00274579))

AAABZzAABAAAOa6AAB
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5.00069354, 1.00274488, 8.00062191, 1.00274427, 8.00062522, 6.00315345, 5.000
6986, 7.00323528, 5.00069354, 1.00274488))

SDO_ROWID
------------------
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------

AAABZzAABAAAOa6AAC
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

AAABZzAABAAAOa6AAD
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(10.0005802, 9.00337775, 11.0005553, 9.00337621, 11.0005569, 10.0034478, 10.00
SDO_ROWID
------------------
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
05819, 10.0034495, 10.0005802, 9.00337775))


SQL>
SQL> -- Show metadata for the new (layer transformed) table.
SQL> DESCRIBE cola_markets_cs_8199;
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 SDO_ROWID                                          ROWID
 GEOMETRY                                           SDO_GEOMETRY

SQL>
SQL> -- Use a geodetic MBR with SDO_FILTER
SQL> SELECT c.name FROM cola_markets_cs c WHERE
  2     SDO_FILTER(c.shape,
  3         SDO_GEOMETRY(
  4             SDO_POLYGON2D,
  5             4326,    -- SRID for WGS 84 longitude/latitude
  6             NULL,
  7             SDO_ELEM_INFO_ARRAY(1,1003,3),
  8             SDO_ORDINATE_ARRAY(6,5, 10,10))
  9         ) = 'TRUE';

NAME
--------------------------------
cola_c
cola_b
cola_d
```

7

Linear Referencing System

Linear referencing is a natural and convenient means to associate attributes or events to locations or portions of a linear feature. It has been widely used in transportation applications (such as for highways, railroads, and transit routes) and utilities applications (such as for gas and oil pipelines).

The major advantage of linear referencing is its capability of locating attributes and events along a linear feature with only one parameter (usually known as *measure*) instead of two (such as *longitude/latitude* or *x/y* in Cartesian space). Sections of a linear feature can be referenced and created dynamically by indicating the start and end locations along the feature without explicitly storing them.

The linear referencing system (LRS) application programming interface (API) in Oracle Spatial provides server-side LRS capabilities at the cartographic level. The linear measure information is directly integrated into the Oracle Spatial geometry structure. The Oracle Spatial LRS API provides support for dynamic segmentation, and it serves as a groundwork for third-party or middle-tier application development for virtually any linear referencing methods and models in any coordinate system.

For an example of LRS, see Example of LRS Functions. However, you may want to read the rest of this chapter first, to understand the concepts that the example illustrates.

For reference information about LRS functions and procedures, see SDO_LRS Package (Linear Referencing System) .

- LRS Terms and Concepts
  This topic explains important terms and concepts related to linear referencing support in Oracle Spatial.
- LRS Data Model
  The Oracle Spatial LRS data model incorporates measure information into its geometry representation at the point level.
- Indexing of LRS Data
  If LRS data has four dimensions (three plus the M dimension) and if you need to index all three non-measure dimensions, you must use a spatial R-tree index to index the data.
- 3D Formats of LRS Functions
  Most LRS functions have formats that end in *_3D*: for example, DEFINE_GEOM_SEGMENT_3D, CLIP_GEOM_SEGMENT_3D, FIND_MEASURE_3D, and LOCATE_PT_3D. If a function has a *3D* format, it is identified in the Usage Notes for the function’s reference topic.
- LRS Operations
  This topic describes several linear referencing operations supported by the Oracle Spatial LRS API.
- Tolerance Values with LRS Functions
  Many LRS functions require that you specify a tolerance value or one or more dimensional arrays.
- Example of LRS Functions
  This section presents a simplified example that uses LRS functions.

7.1 LRS Terms and Concepts

This topic explains important terms and concepts related to linear referencing support in Oracle Spatial.

- Geometric Segments (LRS Segments)
- Shape Points
- Direction of a Geometric Segment
- Measure (Linear Measure)
- Offset
- Measure Populating
- Measure Range of a Geometric Segment
- Projection
- LRS Point
- Linear Features
- Measures with Multiline Strings and Polygons with Holes

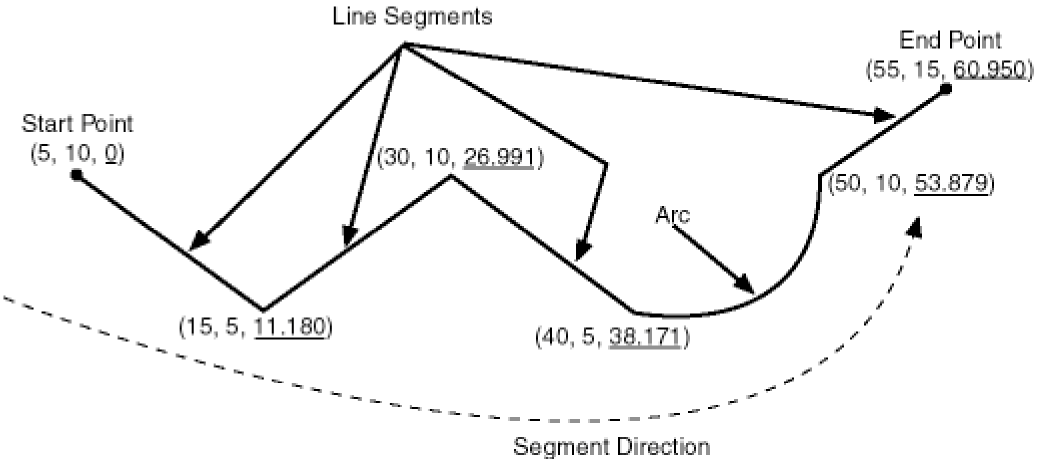
7.1.1 Geometric Segments (LRS Segments)

Geometric segments are basic LRS elements in Oracle Spatial. A geometric segment can be any of the following:

- Line string: an ordered, nonbranching, and continuous geometry (for example, a simple road)
- Multiline string: nonconnected line strings (for example, a highway with a gap caused by a lake or a bypass road)
- Polygon (for example, a racetrack or a scenic tour route that starts and ends at the same point)

A geometric segment must contain at least start and end measures for its start and end points. Measures of points of interest (such as highway exits) on the geometric segments can also be assigned. These measures are either assigned by users or derived from existing geometric segments. Figure 7-1 shows a geometric segment with four line segments and one arc. Points on the geometric segment are represented by triplets (x, y, m), where *x* and *y* describe the location and *m* denotes the measure (with each measure value underlined in Figure 7-1).

Figure 7-1 Geometric Segment



7.1.2 Shape Points

Shape points are points that are specified when an LRS segment is constructed, and that are assigned measure information. In Oracle Spatial, a line segment is represented by its start and end points, and an arc is represented by three points: start, middle, and end points of the arc. You must specify these points as shape points, but you can also specify other points as shape points if you need measure information stored for these points (for example, an exit in the middle of a straight part of the highway).

Thus, shape points can serve one or both of the following purposes: to indicate the direction of the segment (for example, a turn or curve), and to identify a point of interest for which measure information is to be stored.

Shape points might not directly relate to mileposts or reference posts in LRS; they are used as internal reference points. The measure information of shape points is automatically populated when you define the LRS segment using the SDO_LRS.DEFINE_GEOM_SEGMENT procedure, which is described in SDO_LRS Package (Linear Referencing System) .

7.1.3 Direction of a Geometric Segment

The **direction** of a geometric segment is indicated from the start point of the geometric segment to the end point. The direction is determined by the order of the vertices (from start point to end point) in the geometry definition. Measures of points on a geometric segment always either increase or decrease along the direction of the geometric segment.

7.1.4 Measure (Linear Measure)

The **measure** of a point along a geometric segment is the linear distance (in the measure dimension) to the point measured from the start point (for increasing values) or end point (for decreasing values) of the geometric segment. The measure information does not necessarily have to be of the same scale as the distance. However, the linear mapping relationship between measure and distance is always preserved.

Some LRS functions use *offset* instead of measure to represent measured distance along linear features. Although some other linear referencing systems might use offset to mean what the Oracle Spatial LRS refers to as measure, offset has a different meaning in Oracle Spatial from measure, as explained in Offset.

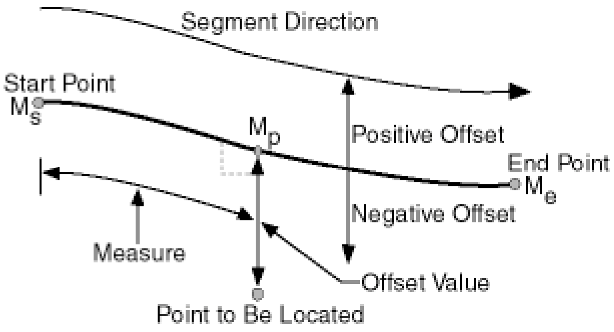
7.1.5 Offset

The **offset** of a point along a geometric segment is the perpendicular distance between the point and the geometric segment. Offsets are positive if the points are on the left side along the segment direction and are negative if they are on the right side. Points are on a geometric segment if their offsets to the segment are zero.

The unit of measurement for an offset is the same as for the coordinate system associated with the geometric segment. For geodetic data, the default unit of measurement is meters.

Figure 7-2 shows how a point can be located along a geometric segment with measure and offset information. By assigning an offset together with a measure, it is possible to locate not only points that are on the geometric segment, but also points that are perpendicular to the geometric segment.

Figure 7-2 Describing a Point Along a Segment with a Measure and an Offset



7.1.6 Measure Populating

Any unassigned measures of a geometric segment are automatically populated based upon their distance distribution. This is done before any LRS operations for geometric segments with unknown measures (NULL in Oracle Spatial). The resulting geometric segments from any LRS operations return the measure information associated with geometric segments. The measure of a point on the geometric segment can be obtained based upon a linear mapping relationship between its previous and next known measures or locations. See the algorithm representation in Figure 7-3 and the example in Figure 7-4.

Figure 7-3 Measures, Distances, and Their Mapping Relationship

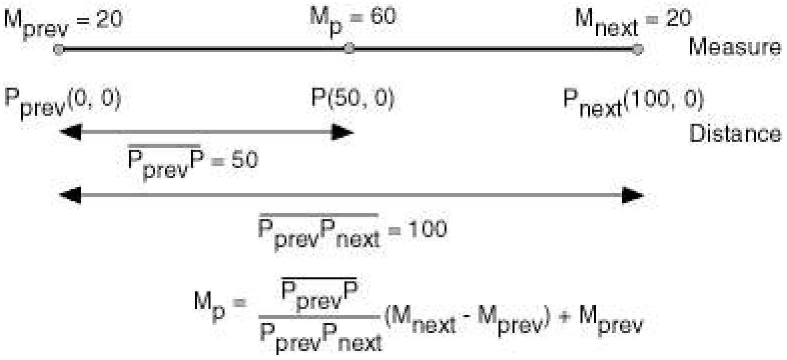
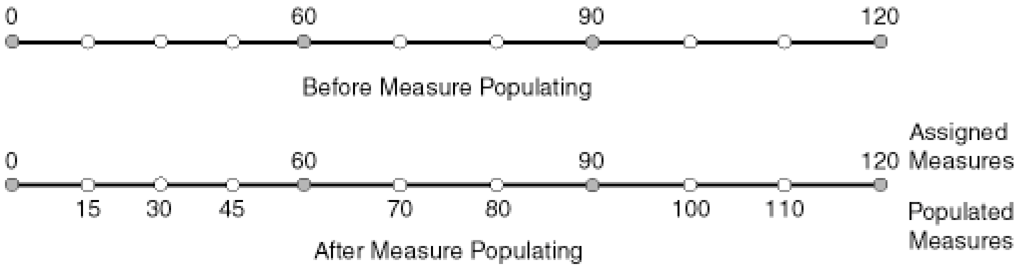

$M_{prev} = 20$
$M_p = 60$
$M_{next} = 20$
Measure
$P_{prev}(0, 0)$
P(50, 0)
$P_{next}(100, 0)$
Distance
$\overline{P_{prev}P} = 50$
$\overline{P_{prev}P_{next}} = 100$
$M_p = \frac{\overline{P_{prev}P}}{\overline{P_{prev}P_{next}}}(M_{next} - M_{prev}) + M_{prev}$

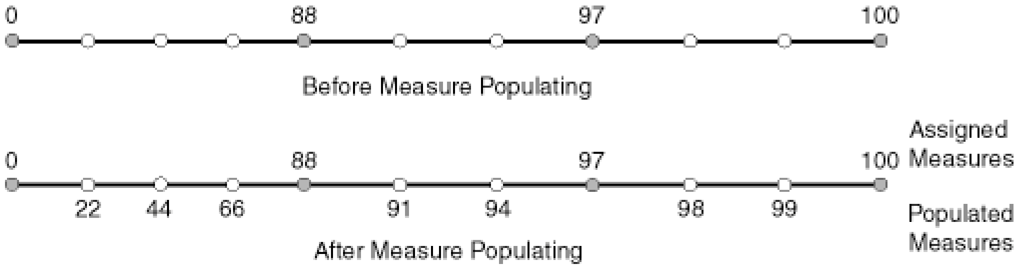
Figure 7-4   Measure Populating of a Geometric Segment



Measures are evenly spaced between assigned measures. However, the assigned measures for points of interest on a geometric segment do not need to be evenly spaced. This could eliminate the problem of error accumulation and account for inaccuracy of data source.

Moreover, the assigned measures do not even need to reflect actual distances (for example, they can reflect estimated driving time); they can be any valid values within the measure range. Figure 7-5 shows the measure population that results when assigned measure values are not proportional and reflect widely varying gaps.

Figure 7-5   Measure Populating with Disproportional Assigned Measures



In all cases, measure populating is done in an incremental fashion along the segment direction. This improves the performance of current and subsequent LRS operations.

7.1.7 Measure Range of a Geometric Segment

The start and end measures of a geometric segment define the linear **measure range** of the geometric segment. Any valid LRS measures of a geometric segment must fall within its linear measure range.

7.1.8 Projection

The **projection** of a point along a geometric segment is the point on the geometric segment with the minimum distance to the specified point. The measure information of the resulting point is also returned in the point geometry.

7.1.9 LRS Point

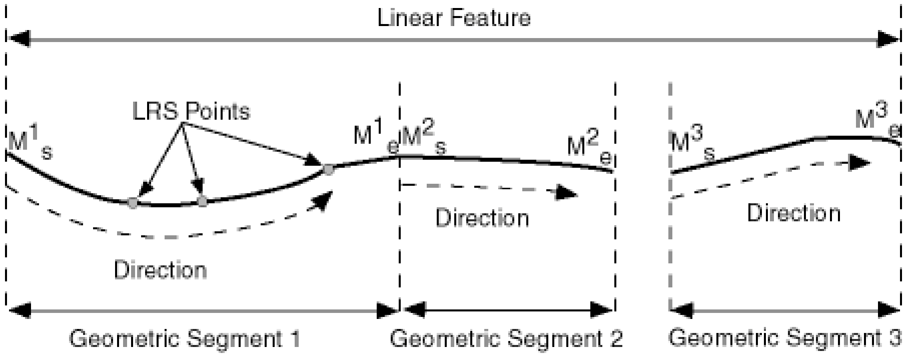
LRS points are points with linear measure information along a geometric segment. A valid LRS point is a point geometry with measure information.

All LRS point data must be stored in the SDO_ELEM_INFO_ARRAY and SDO_ORDINATE_ARRAY, and cannot be stored in the SDO_POINT field in the SDO_GEOMETRY definition of the point.

7.1.10 Linear Features

Linear features are any spatial objects that can be treated as a logical set of linear segments. Examples of linear features are highways in transportation applications and pipelines in utility industry applications. The relationship of linear features, geometric segments, and LRS points is shown in Figure 7-6, where a single linear feature consists of three geometric segments, and three LRS points are shown on the first segment.

Figure 7-6 Linear Feature, Geometric Segments, and LRS Points



7.1.11 Measures with Multiline Strings and Polygons with Holes

With a multiline string or polygon with hole LRS geometry, the SDO_LRS.DEFINE_GEOM_SEGMENT procedure and SDO_LRS.CONVERT_TO_LRS_GEOM function by default assign the same measure value to the end point of one segment and the start point (separated by a gap) of the next segment, although you can later assign different measure values to points. Thus, by default there will duplicate measure values in different segments for such geometries. In such cases, LRS subprograms use the first point with a specified measure, except when doing so would result in an invalid geometry.

For example, assume that in a multiline string LRS geometry, the first segment is from measures 0 through 100 and the second segment is from measures 100 through 150. If you use the SDO_LRS.LOCATE_PT function to find the point at measure 100, the returned point will be at measure 100 in the first segment. If you use the SDO_LRS.CLIP_GEOM_SEGMENT, SDO_LRS.DYNAMIC_SEGMENT, or SDO_LRS.OFFSET_GEOM_SEGMENT function to return the geometry object between measures 75 and 125, the result is a multiline string geometry consisting of two segments. If you use the same function to return the geometry object between measures 100 and 125, the point at measure 100 in the first segment is ignored, and the result is a line string along the second segment from measures 100 through 125.

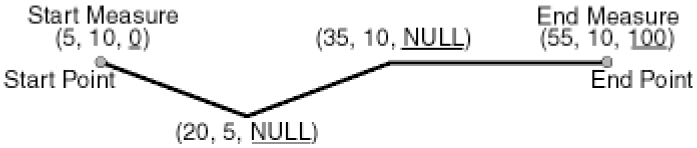
7.2 LRS Data Model

The Oracle Spatial LRS data model incorporates measure information into its geometry representation at the point level.

The measure information is directly integrated into the Oracle Spatial model. To accomplish this, an additional *measure* dimension must be added to the Oracle Spatial metadata.

Oracle Spatial LRS support affects the spatial metadata and data (the geometries). Example 7-1 shows how a measure dimension can be added to two-dimensional geometries in the spatial metadata. The measure dimension must be the last element of the SDO_DIM_ARRAY in a spatial object definition (shown in bold in Example 7-1).

Figure 7-7 Creating a Geometric Segment



In Figure 7-7, the geometric segment has the following definition (with measure values underlined):

```
SDO_GEOMETRY(3302, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1,2,1),
     SDO_ORDINATE_ARRAY(5,10,0, 20,5,NULL, 35,10,NULL, 55,10,100))
```

Whenever a geometric segment is defined, its start and end measures must be defined or derived from some existing geometric segment. The unsigned measures of all shape points on a geometric segment will be automatically populated.

The SDO_GTYPE of any point geometry used with an LRS function must be 3301.

Example 7-1 Including LRS Measure Dimension in Spatial Metadata

```
INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES(
  'LRS_ROUTES',
  'GEOMETRY',
  SDO_DIM_ARRAY (
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005),
    SDO_DIM_ELEMENT('M', 0, 100, 0.005)),
  NULL);
```

After adding the new measure dimension, geometries with measure information such as geometric segments and LRS points can be represented. An example of creating a geometric segment with three line segments is shown in Figure 7-7.

7.3 Indexing of LRS Data

If LRS data has four dimensions (three plus the M dimension) and if you need to index all three non-measure dimensions, you must use a spatial R-tree index to index the data.

You must also specify PARAMETERS('sdo_indx_dims=3') in the CREATE INDEX statement to ensure that the first three dimensions are indexed. Note, however, that if you specify an `sdo_indx_dims` value of 3 or higher, only those operators listed in Three-Dimensional Spatial Objects as considering all three dimensions can be used on the indexed geometries; the other operators described in Spatial Operators cannot be used. (The default value for the `sdo_indx_dims` keyword is 2, which would cause only the first two dimensions to be indexed.) For example, if the dimensions are X, Y, Z, and M, specify `sdo_indx_dims=3` to index the X, Y, and Z dimensions, but not the measure (M) dimension. Do not include the measure dimension in a spatial index, because this causes additional processing overhead and produces no benefit.

Information about the CREATE INDEX statement and its parameters and keywords is in SQL Statements for Indexing Spatial Data.

7.4 3D Formats of LRS Functions

Most LRS functions have formats that end in *_3D*: for example, DEFINE_GEOM_SEGMENT_3D, CLIP_GEOM_SEGMENT_3D, FIND_MEASURE_3D, and LOCATE_PT_3D. If a function has a *3D* format, it is identified in the Usage Notes for the function’s reference topic.

The *3D* formats are supported only for line string and multiline string geometries. (They are not supported for polygons, arcs, or circles.) The *3D* formats should be used only when the geometry object has four dimensions and the fourth dimension is the measure (for example, X, Y, Z, and M), and only when you want the function to consider the first three dimensions (for example, X, Y, and Z). If the standard format of a function (that is, without the *_3D*) is used on a geometry with four dimensions, the function considers only the first two dimensions (for example, X and Y).

For example, the following format considers the X, Y, and Z dimensions of the specified GEOM object in performing the clip operation:

```
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT_3D(a.geom, m.diminfo, 5, 10)
  FROM routes r, user_sdo_geom_metadata m
  WHERE m.table_name = 'ROUTES' AND m.column_name = 'GEOM'
    AND r.route_id = 1;
```

However, the following format considers only the X and Y dimensions, and ignores the Z dimension, of the specified GEOM object in performing the clip operation:

```
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(a.geom, m.diminfo, 5, 10)
  FROM routes r, user_sdo_geom_metadata m
  WHERE m.table_name = 'ROUTES' AND m.column_name = 'GEOM'
    AND r.route_id = 1;
```

The parameters for the standard and *3D* formats of any function are the same, and the Usage Notes apply to both formats.

If the parameters for an LRS function include both a line (or multiline) string and a point (LRS point), both the line string and the point must have the same number of dimensions. For example:

- For the SDO_LRS.PROJECT_PT function, the input `geom_segment` (line) must have two dimensions (X.Y) plus the measure dimension, and the the input `point` point must be a two-dimensional LRS point geometry with a measure dimension (SDO_GTYPE = 3301). (This is the case in the example for that function.)
- For the SDO_LRS.PROJECT_PT_3D function. the input `geom_segment` must have three dimensions (X,Y,Z) plus the measure dimension, and the input `point` point must be a three-dimensional LRS point geometry with a measure dimension (SDO_GTYPE = 3401).

7.5 LRS Operations

This topic describes several linear referencing operations supported by the Oracle Spatial LRS API.

- Defining a Geometric Segment
- Redefining a Geometric Segment
- Clipping a Geometric Segment (Dynamic Segmentation)
- Splitting a Geometric Segment
- Concatenating Geometric Segments
- Scaling a Geometric Segment
- Offsetting a Geometric Segment
- Locating a Point on a Geometric Segment
- Projecting a Point onto a Geometric Segment
- Converting LRS Geometries

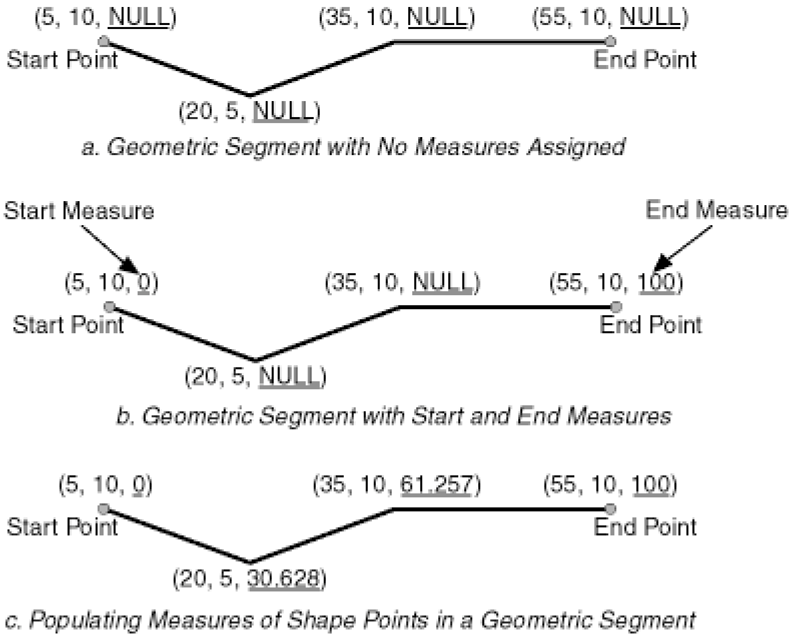
7.5.1 Defining a Geometric Segment

There are two ways to create a geometric segment with measure information:

- Construct a geometric segment and assign measures explicitly.
- Define a geometric segment with specified start and end, and any other measures, in an ascending or descending order. Measures of shape points with unknown (unassigned) measures (null values) in the geometric segment will be automatically populated according to their locations and distance distribution.

Figure 7-8 shows different ways of defining a geometric segment:

Figure 7-8   Defining a Geometric Segment



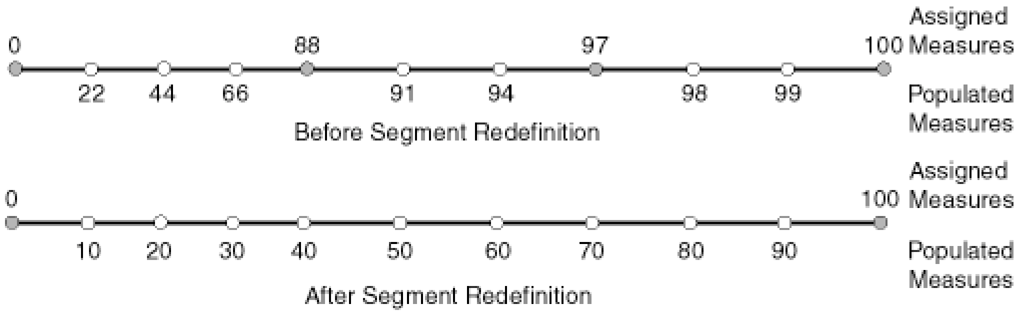
An LRS segment must be defined (or must already exist) before any LRS operations can proceed. That is, the start, end, and any other assigned measures must be present to derive the location from a specified measure. The measure information of intermediate shape points will automatically be populated if measure values are not assigned.

7.5.2 Redefining a Geometric Segment

You can redefine a geometric segment to replace the existing measures of all shape points between the start and end point with automatically calculated measures. Redefining a segment can be useful if errors have been made in one or more explicit measure assignments, and you want to start over with proportionally assigned measures.

Figure 7-9 shows the redefinition of a segment where the existing (before) assigned measure values are not proportional and reflect widely varying gaps.

Figure 7-9 Redefining a Geometric Segment

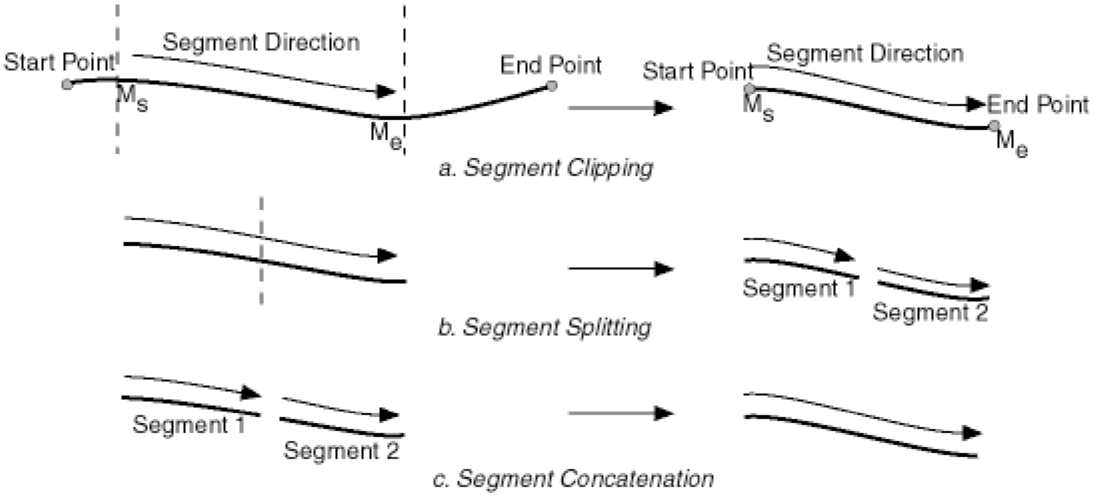


After the segment redefinition in Figure 7-9, the populated measures reflect proportional distances along the segment.

7.5.3 Clipping a Geometric Segment (Dynamic Segmentation)

You can clip a geometric segment to create a new geometric segment out of an existing geometric segment, as shown in Figure 7-10, part a.

Figure 7-10 Clipping, Splitting, and Concatenating Geometric Segments



In Figure 7-10, part a, a segment is created from part of a larger segment. The new segment has its own start and end points, and the direction is the same as in the original larger segment.

Clipping segments enables you to perform **dynamic segmentation**, where you clip the line at specific measure values. A scenario for such usage would be creating a table of road conditions, where for a given road, some segments are designated as in good condition and other segments are designated as in bad condition. For example, the segment between measures 100 and 120 might be in good condition, but the segment between measures 120 and 125 might be in poor condition. See the reference information for the synonymous functions SDO_LRS.CLIP_GEOM_SEGMENT and SDO_LRS.DYNAMIC_SEGMENT.

7.5.4 Splitting a Geometric Segment

You can create two new geometric segments by splitting a geometric segment, as shown in the figure in Clipping a Geometric Segment (Dynamic Segmentation), part b. The direction of each new segment is the same as in the original segment.

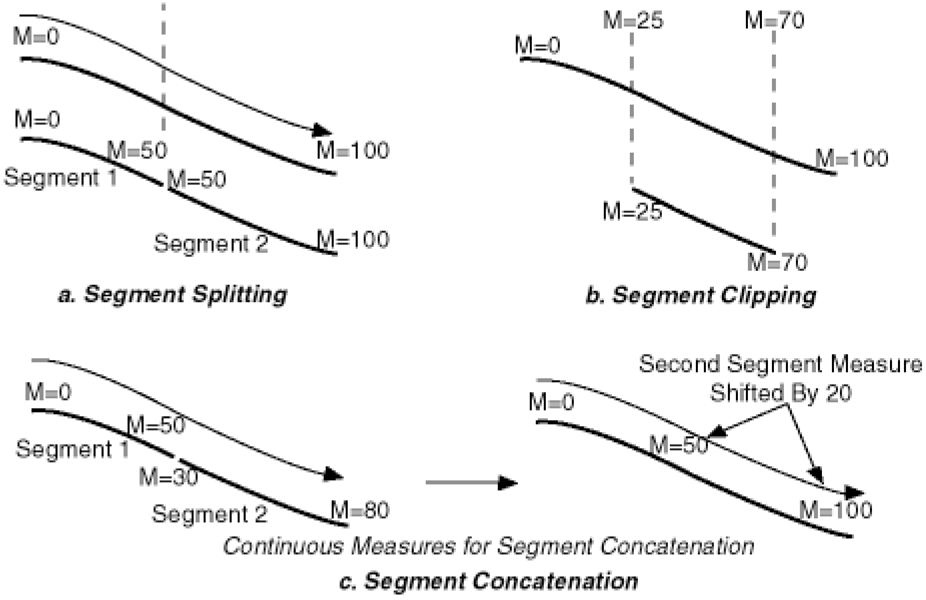
> **Note:**
>
> In Clipping a Geometric Segment (Dynamic Segmentation) and other topics, small gaps between segments are used in illutrations of segment splitting and concatenation. Each gap simply reinforces the fact that two different segments are involved. However, the two segments (such as segment 1 and segment 2 in Clipping a Geometric Segment (Dynamic Segmentation), parts b and c) are actually connected. The tolerance (see Tolerance) is considered in determining whether or not segments are connected.

7.5.5 Concatenating Geometric Segments

You can create a new geometric segment by concatenating two geometric segments, as shown in part c of the figure in Clipping a Geometric Segment (Dynamic Segmentation). The geometric segments do not need to be spatially connected, although they are connected in the illustration in part c of that figure. (If the segments are not spatially connected, the concatenated result is a multiline string.) The measures of the second geometric segment are shifted so that the end measure of the first segment is the same as the start measure of the second segment. The direction of the segment resulting from the concatenation is the same as in the two original segments.

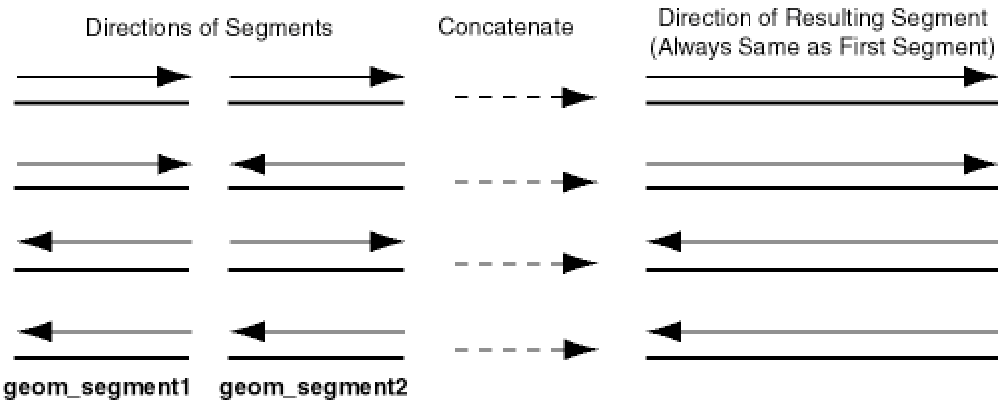
Measure assignments for the clipping, splitting, and concatenating operations in the figure in Clipping a Geometric Segment (Dynamic Segmentation) are shown in the following figure. Measure information and segment direction are preserved in a consistent manner. The assignment is done automatically when the operations have completed.

Figure 7-11 Measure Assignment in Geometric Segment Operations



The direction of the geometric segment resulting from concatenation is always the direction of the first segment (`geom_segment1` in the call to the SDO_LRS.CONCATENATE_GEOM_SEGMENTS function), as shown in the following figure.

Figure 7-12 Segment Direction with Concatenation

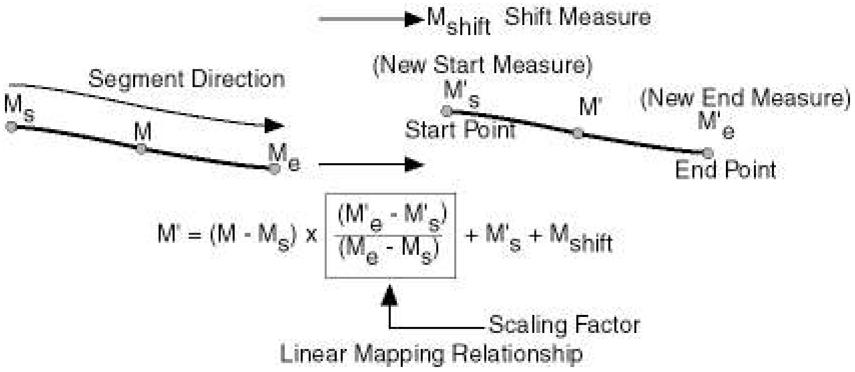

Directions of Segments
Concatenate
Direction of Resulting Segment
(Always Same as First Segment)
geom_segment1
geom_segment2

In addition to explicitly concatenating two connected segments using the SDO_LRS.CONCATENATE_GEOM_SEGMENTS function, you can perform aggregate concatenation: that is, you can concatenate all connected geometric segments in a column (layer) using the SDO_AGGR_LRS_CONCAT spatial aggregate function. (See the description and example of the SDO_AGGR_LRS_CONCAT spatial aggregate function in Spatial Aggregate Functions.)

7.5.6 Scaling a Geometric Segment

You can create a new geometric segment by performing a linear scaling operation on a geometric segment. Figure 7-13 shows the mapping relationship for geometric segment scaling.

Figure 7-13 Scaling a Geometric Segment


M_{shift} Shift Measure
Segment Direction
(New Start Measure)
M'_s
Start Point
M'
(New End Measure)
M'_e
End Point
M_s
M
M_e
$M' = (M - M_s) \times \boxed{\frac{(M'_e - M'_s)}{(M_e - M_s)}} + M'_s + M_{shift}$
Scaling Factor
Linear Mapping Relationship

In general, scaling a geometric segment only involves rearranging measures of the newly created geometric segment. However, if the scaling factor is negative, the order of the shape points needs to be reversed so that measures will increase along the geometric segment's direction (which is defined by the order of the shape points).

A scale operation can perform any combination of the following operations:

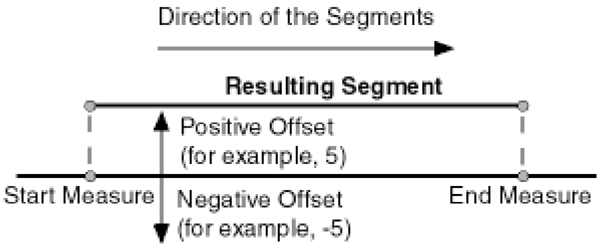
- Translating (shifting) measure information. (For example, add the same value to Ms and Me to get M's and M'e.)
- Reversing measure information. (Let M's = Me, M'e = Ms, and Mshift = 0.)
- Performing simple scaling of measure information. (Let Mshift = 0.)

For examples of these operations, see the Usage Notes and Examples for theSDO_LRS.SCALE_GEOM_SEGMENT, SDO_LRS.TRANSLATE_MEASURE, SDO_LRS.REVERSE_GEOMETRY, and SDO_LRS.REDEFINE_GEOM_SEGMENT subprograms in SDO_LRS Package (Linear Referencing System) .

7.5.7 Offsetting a Geometric Segment

You can create a new geometric segment by performing an offsetting operation on a geometric segment. Figure 7-14 shows the mapping relationship for geometric segment offsetting.

Figure 7-14 Offsetting a Geometric Segment



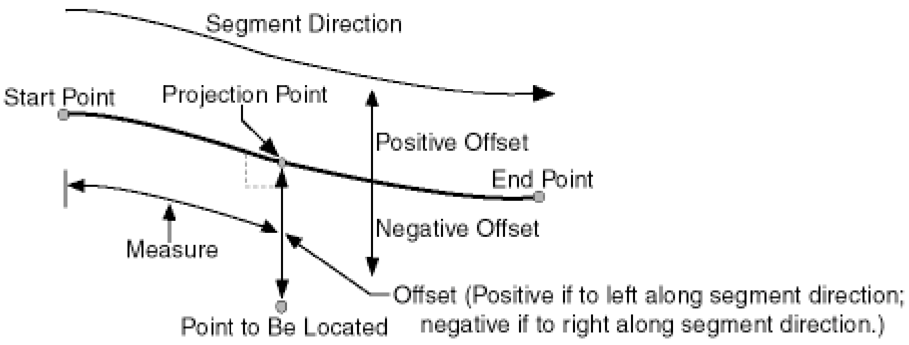
In the offsetting operation shown in Figure 7-14, the resulting geometric segment is offset by 5 units from the specified start and end measures of the original segment.

For more information, see the Usage Notes and Examples for the SDO_LRS.OFFSET_GEOM_SEGMENT function in SDO_LRS Package (Linear Referencing System) .

7.5.8 Locating a Point on a Geometric Segment

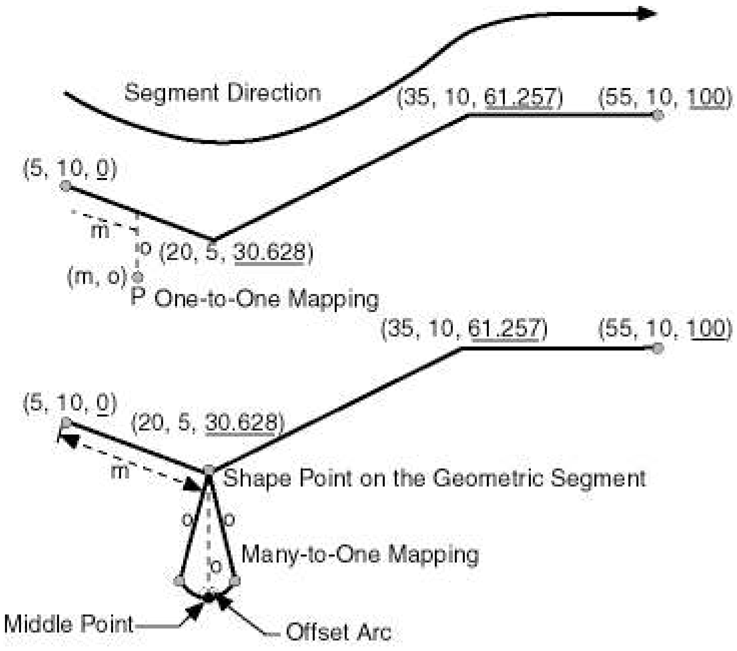
You can find the position of a point described by a measure and an offset on a geometric segment (see Figure 7-15).

Figure 7-15 Locating a Point Along a Segment with a Measure and an Offset



There is always a unique location with a specific measure on a geometric segment. Ambiguity arises when offsets are given and the points described by the measures fall on shape points of the geometric segment (see Figure 7-16).

Figure 7-16 Ambiguity in Location Referencing with Offsets



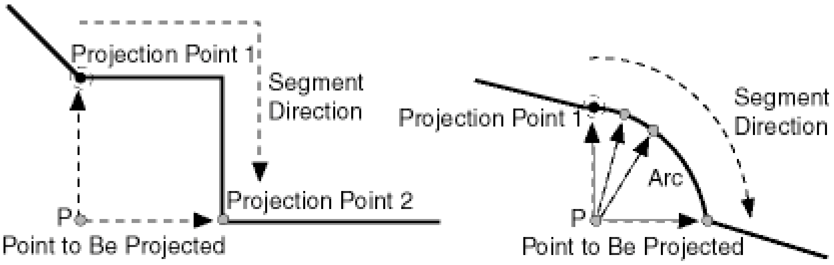
As shown in Figure 7-16, an offset arc of a shape point on a geometric segment is an arc on which all points have the same minimum distance to the shape point. As a result, all points on the offset arc are represented by the same (measure, offset) pair. To resolve this one-to-many mapping problem, the middle point on the offset arc is returned.

7.5.9 Projecting a Point onto a Geometric Segment

You can find the projection point of a point with respect to a geometric segment. The point to be projected can be on or off the segment. If the point is on the segment, the point and its projection point are the same.

Projection is a reverse operation of the point-locating operation shown in Figure 7-15. Similar to a point-locating operation, all points on the offset arc of a shape point will have the same projection point (that is, the shape point itself), measure, and offset (see Figure 7-16). If there are multiple projection points for a point, the first one from the start point is returned (Projection Point 1 in both illustrations in Figure 7-17).

Figure 7-17 Multiple Projection Points



7.5.10 Converting LRS Geometries

You can convert geometries from standard line string format to LRS format, and the reverse. The main use of conversion functions will probably occur if you have a large amount of existing line string data, in which case conversion is a convenient alternative to creating all of the LRS segments manually. However, if you need to convert LRS segments to standard line strings for certain applications, that capability is provided also.

Functions are provided to convert:

- Individual line strings or points

  For conversion from standard format to LRS format, a measure dimension (named *M* by default) is added, and measure information is provided for each point. For conversion from LRS format to standard format, the measure dimension and information are removed. In both cases, the dimensional information (DIMINFO) metadata in the USER_SDO_GEOM_METADATA view is not affected.

- Layers (all geometries in a column)

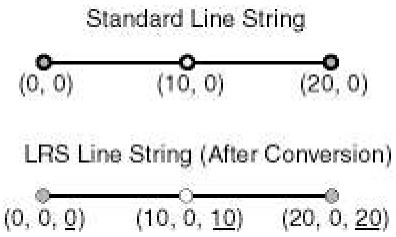
  For conversion from standard format to LRS format, a measure dimension (named *M* by default) is added, but no measure information is provided for each point. For conversion from LRS format to standard format, the measure dimension and information are removed. In both cases, the dimensional information (DIMINFO) metadata in the USER_SDO_GEOM_METADATA view is modified as needed.

- Dimensional information (DIMINFO)

The dimensional information (DIMINFO) metadata in the USER_SDO_GEOM_METADATA view is modified as needed. For example, converting a standard dimensional array with X and Y dimensions (SDO_DIM_ELEMENT) to an LRS dimensional array causes an M dimension (SDO_DIM_ELEMENT) to be added.

Figure 7-18 shows the addition of measure information when a standard line string is converted to an LRS line string (using the SDO_LRS.CONVERT_TO_LRS_GEOM function). The measure dimension values are underlined in Figure 7-18.

Figure 7-18   Conversion from Standard to LRS Line String



For conversions of point geometries, the SDO_POINT attribute (described in SDO_POINT) in the returned geometry is affected as follows:

- If a standard point is converted to an LRS point, the SDO_POINT attribute information in the input geometry is used to set the SDO_ELEM_INFO and SDO_ORDINATES attributes (described in SDO_ELEM_INFO and SDO_ORDINATES) in the resulting geometry, and the SDO_POINT attribute in the resulting geometry is set to null.
- If an LRS point is converted to a standard point, the information in the SDO_ELEM_INFO and SDO_ORDINATES attributes (described in SDO_ELEM_INFO and SDO_ORDINATES) in the input geometry is used to set the SDO_POINT attribute information in the resulting geometry, and the SDO_ELEM_INFO and SDO_ORDINATES attributes in the resulting geometry are set to null.

The conversion functions are listed in SDO_LRS Package (Linear Referencing System) . See also the reference information in SDO_LRS Package (Linear Referencing System) about each conversion function.

7.6 Tolerance Values with LRS Functions

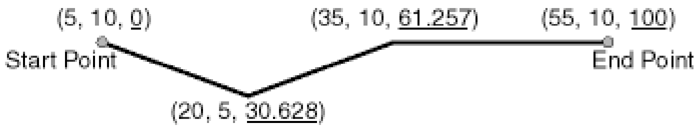
Many LRS functions require that you specify a tolerance value or one or more dimensional arrays.

Thus, you can control whether to specify a single tolerance value for all non-measure dimensions or to use the tolerance associated with each non-measure dimension in the dimensional array or arrays. The tolerance is applied only to the geometry portion of the data, not to the measure dimension. The tolerance value for geodetic data is in meters, and for non-geodetic data it is in the unit of measurement associated with the data. (For a detailed discussion of tolerance, see Tolerance.)

Be sure that the tolerance value used is appropriate to the data and your purpose. If the results of LRS functions seem imprecise or incorrect, you may need to specify a smaller tolerance value.

For clip operations (see Clipping a Geometric Segment) and offset operations (see Offsetting a Geometric Segment), if the returned segment has any shape points within the tolerance value of the input geometric segment from what would otherwise be the start point or end point of the returned segment, the shape point is used as the start point or end point of the returned segment. This is done to ensure that the resulting geometry does not contain any redundant vertices, which would cause the geometry to be invalid. For example, assume that the tolerance associated with the geometric segment (non-geodetic data) in Figure 7-19 is 0.5.

Figure 7-19 Segment for Clip Operation Affected by Tolerance



If you request a clip operation to return the segment between measure values 0 (the start point) and 61.5 in Figure 7-19, and if the distance between the points associated with measure values 61.5 and 61.257 is less than the 0.5 tolerance value, the end point of the returned segment is (35, 10, 61.257).

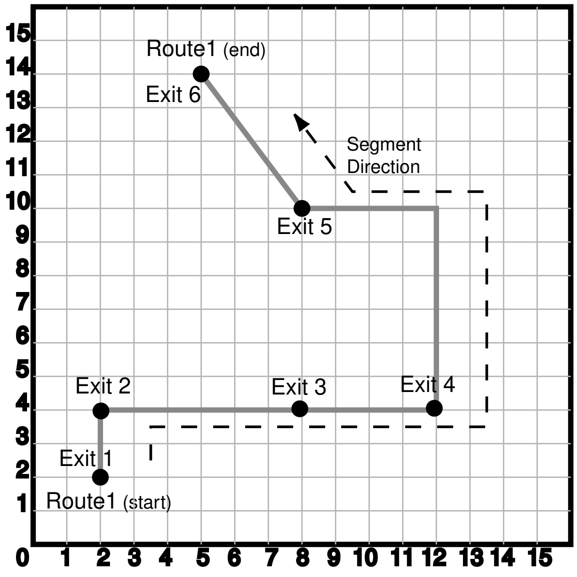
7.7 Example of LRS Functions

This section presents a simplified example that uses LRS functions.

It refers to concepts that are explained in this chapter and uses functions documented in SDO_LRS Package (Linear Referencing System) .

This example uses the road that is illustrated in Figure 7-20.

Figure 7-20 Simplified LRS Example: Highway



In Figure 7-20, the highway (Route 1) starts at point 2,2 and ends at point 5,14, follows the path shown, and has six entrance-exit points (Exit 1 through Exit 6). For simplicity, each unit on the graph represents one unit of measure, and thus the measure from start to end is 27 (the segment from Exit 5 to Exit 6 being the hypotenuse of a 3-4-5 right triangle).

Each row in Table 7-1 lists an actual highway-related feature and the LRS feature that corresponds to it or that can be used to represent it.

Table 7-1 Highway Features and LRS Counterparts

Highway Feature	LRS Feature
Named route, road, or street	LRS segment, or linear feature (logical set of segments)
Mile or kilometer marker	Measure
Accident reporting and location tracking	SDO_LRS.LOCATE_PT function
Construction zone (portion of a road)	SDO_LRS.CLIP_GEOM_SEGMENT function
Road extension (adding at the beginning or end) or combination (designating or renaming two roads that meet as one road)	SDO_LRS.CONCATENATE_GEOM_SEGMENTS function
Road reconstruction or splitting (resulting in two named roads from one named road)	SDO_LRS.SPLIT_GEOM_SEGMENT procedure
Finding the closest point on the road to a point off the road (such as a building)	SDO_LRS.PROJECT_PT function
Guard rail or fence alongside a road	SDO_LRS.OFFSET_GEOM_SEGMENT function

Example 7-2 does the following:

- Creates a table to hold the segment depicted in Figure 7-20
- Inserts the definition of the highway depicted in Figure 7-20 into the table
- Inserts the necessary metadata into the USER_SDO_GEOM_METADATA view
- Uses PL/SQL and SQL statements to define the segment and perform operations on it

Example 7-2 Simplified Example: Highway

```
-- Create a table for routes (highways).
CREATE TABLE lrs_routes (
  route_id  NUMBER PRIMARY KEY,
  route_name  VARCHAR2(32),
  route_geometry  SDO_GEOMETRY);

-- Populate table with just one route for this example.
INSERT INTO lrs_routes VALUES(
  1,
  'Route1',
  SDO_GEOMETRY(
    3302,  -- line string, 3 dimensions: X,Y,M
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    SDO_ORDINATE_ARRAY(
      2,2,0,   -- Start point - Exit1; 0 is measure from start.
      2,4,2,   -- Exit2; 2 is measure from start.
      8,4,8,   -- Exit3; 8 is measure from start.
      12,4,12,  -- Exit4; 12 is measure from start.
      12,10,NULL,  -- Not an exit; measure automatically calculated and filled.
      8,10,22,  -- Exit5; 22 is measure from start.
      5,14,27)  -- End point (Exit6); 27 is measure from start.
  )
);

-- Update the spatial metadata.
INSERT INTO user_sdo_geom_metadata
```

```
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'lrs_routes',
  'route_geometry',
  SDO_DIM_ARRAY(   -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005),
    SDO_DIM_ELEMENT('M', 0, 20, 0.005) -- Measure dimension
     ),
  NULL   -- SRID
);

-- Create the spatial index.
CREATE INDEX lrs_routes_idx ON lrs_routes(route_geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;

-- Test the LRS procedures.
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1. This will populate any null measures.
-- No need to specify start and end measures, because they are already defined
-- in the geometry.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment, dim_array);

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
   WHERE a.route_id = 1;

INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);

END;
/

-- First, display the data in the LRS table.
SELECT route_id, route_name, route_geometry FROM lrs_routes;

-- Are result_geom_1 and result_geom2 connected?
SELECT  SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
           b.route_geometry, 0.005)
  FROM lrs_routes a, lrs_routes b
  WHERE a.route_id = 11 AND b.route_id = 12;

-- Is the Route1 segment valid?
SELECT  SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- Is 50 a valid measure on Route1? (Should return FALSE; highest Route1 measure is 27.)
SELECT  SDO_LRS.VALID_MEASURE(route_geometry, 50)
  FROM lrs_routes WHERE route_id = 1;

-- Is the Route1 segment defined?
SELECT  SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- How long is Route1?
SELECT  SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- What is the start measure of Route1?
SELECT  SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- What is the end measure of Route1?
SELECT  SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- What is the start point of Route1?
SELECT  SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- What is the end point of Route1?
SELECT  SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

-- Translate (shift measure values) (+10).
-- First, display the original segment; then, translate.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;
SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

-- Redefine geometric segment to "convert" miles to kilometers
```

```
DECLARE
geom_segment SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0, -- Zero starting measure: LRS segment starts at start of route.
  43.443); -- End of LRS segment. 27 miles = 43.443 kilometers.

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
   WHERE a.route_id = 1;

END;/
-- Display the redefined segment, with all measures "converted."
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

-- Clip a piece of Route1.
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
  FROM lrs_routes WHERE route_id = 1;

-- Point (9,3,NULL) is off the road; should return (9,4,9).
SELECT  SDO_LRS.PROJECT_PT(route_geometry,
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(9, 3, NULL)) )
  FROM lrs_routes WHERE route_id = 1;

-- Return the measure of the projected point.
SELECT  SDO_LRS.GET_MEASURE(
 SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
 m.diminfo )
 FROM lrs_routes a, user_sdo_geom_metadata m
 WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
   AND a.route_id = 1;

-- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)
SELECT  SDO_LRS.VALID_LRS_PT(
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(9, 3, NULL)),
  m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

-- Locate the point on Route1 at measure 9, offset 0.
SELECT  SDO_LRS.LOCATE_PT(route_geometry, 9, 0)
  FROM lrs_routes WHERE route_id = 1;
```

Example 7-3 shows the output of the SELECT statements in Example 7-2.

Example 7-3 Simplified Example: Output of SELECT Statements

```
SQL> -- First, display the data in the LRS table.
SQL> SELECT route_id, route_name, route_geometry FROM lrs_routes;

  ROUTE_ID ROUTE_NAME
---------- --------------------------------
ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
         1 Route1
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

        11 result_geom_1
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 5, 4, 5))

        12 result_geom_2

  ROUTE_ID ROUTE_NAME
---------- --------------------------------
ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

        13 result_geom_3
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 5, 4, 5, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27)
)

SQL> -- Are result_geom_1 and result_geom2 connected?
SQL> SELECT  SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
  2           b.route_geometry, 0.005)
  3    FROM lrs_routes a, lrs_routes b
  4    WHERE a.route_id = 11 AND b.route_id = 12;

SDO_LRS.CONNECTED_GEOM_SEGMENTS(A.ROUTE_GEOMETRY,B.ROUTE_GEOMETRY,0.005)
--------------------------------------------------------------------------------
TRUE

SQL> -- Is the Route1 segment valid?
SQL> SELECT  SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.VALID_GEOM_SEGMENT(ROUTE_GEOMETRY)
--------------------------------------------------------------------------------
TRUE

SQL> -- Is 50 a valid measure on Route1? (Should return FALSE; highest Route1 measure is
27.)
SQL> SELECT  SDO_LRS.VALID_MEASURE(route_geometry, 50)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.VALID_MEASURE(ROUTE_GEOMETRY,50)
--------------------------------------------------------------------------------
FALSE

SQL> -- Is the Route1 segment defined?
SQL> SELECT  SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(ROUTE_GEOMETRY)
--------------------------------------------------------------------------------
TRUE

SQL> -- How long is Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_LENGTH(ROUTE_GEOMETRY)
-------------------------------------------
                                         27

SQL> -- What is the start measure of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_MEASURE(ROUTE_GEOMETRY)
--------------------------------------------------
                                                 0

SQL> -- What is the end measure of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_MEASURE(ROUTE_GEOMETRY)
------------------------------------------------
                                              27

SQL> -- What is the start point of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
2, 2, 0))

SQL> -- What is the end point of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
5, 14, 27))

SQL> -- Translate (shift measure values) (+10).
SQL> -- First, display the original segment; then, translate.
SQL> SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SQL> SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
  2    FROM lrs_routes a, user_sdo_geom_metadata m
  3    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
  4   AND a.route_id = 1;

SDO_LRS.TRANSLATE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,10)(SDO_GTYPE, SDO_SRID, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 10, 2, 4, 12, 8, 4, 18, 12, 4, 22, 12, 10, 28, 8, 10, 32, 5, 14, 37))


SQL> -- Redefine geometric segment to "convert" miles to kilometers
SQL> DECLARE
  2  geom_segment SDO_GEOMETRY;
  3  dim_array SDO_DIM_ARRAY;
  4
  5  BEGIN
  6
  7  SELECT a.route_geometry into geom_segment FROM lrs_routes a
  8    WHERE a.route_name = 'Route1';
  9  SELECT m.diminfo into dim_array from
 10    user_sdo_geom_metadata m
 11    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';
 12
 13  -- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
 14  SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
 15    dim_array,
 16    0, -- Zero starting measure: LRS segment starts at start of route.
 17    43.443); -- End of LRS segment. 27 miles = 43.443 kilometers.
 18
 19  -- Update and insert geometries into table, to display later.
 20  UPDATE lrs_routes a SET a.route_geometry = geom_segment
 21      WHERE a.route_id = 1;
 22
 23  END;
 24  /

PL/SQL procedure successfully completed.

SQL> -- Display the redefined segment, with all measures "converted."
SQL> SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 3.218, 8, 4, 12.872, 12, 4, 19.308, 12, 10, 28.962, 8, 10, 35.398
, 5, 14, 43.443))

SQL> -- Clip a piece of Route1.
SQL> SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.CLIP_GEOM_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))

SQL> -- Point (9,3,NULL) is off the road; should return (9,4,9).
SQL> SELECT  SDO_LRS.PROJECT_PT(route_geometry,
  2    SDO_GEOMETRY(3301, NULL, NULL,
  3    SDO_ELEM_INFO_ARRAY(1, 1, 1),
  4    SDO_ORDINATE_ARRAY(9, 3, NULL)) )
  5    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_EL
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

```
SQL> -- Return the measure of the projected point.
SQL> SELECT  SDO_LRS.GET_MEASURE(
  2   SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,
  3    SDO_GEOMETRY(3301, NULL, NULL,
  4    SDO_ELEM_INFO_ARRAY(1, 1, 1),
  5    SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
  6   m.diminfo )
  7   FROM lrs_routes a, user_sdo_geom_metadata m
  8   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
  9       AND a.route_id = 1;

SDO_LRS.GET_MEASURE(SDO_LRS.PROJECT_PT(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOM
--------------------------------------------------------------------------------
                                                                               9

SQL> -- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)
SQL> SELECT  SDO_LRS.VALID_LRS_PT(
  2    SDO_GEOMETRY(3301, NULL, NULL,
  3    SDO_ELEM_INFO_ARRAY(1, 1, 1),
  4    SDO_ORDINATE_ARRAY(9, 3, NULL)),
  5    m.diminfo)
  6    FROM lrs_routes a, user_sdo_geom_metadata m
  7    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
  8    AND a.route_id = 1;

SDO_LRS.VALID_LRS_PT(SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARRAY
------------------------------------------------------------------------------
TRUE

SQL> -- Locate the point on Route1 at measure 9, offset 0.
SQL> SELECT  SDO_LRS.LOCATE_PT(route_geometry, 9, 0)
  2    FROM lrs_routes WHERE route_id = 1;

SDO_LRS.LOCATE_PT(ROUTE_GEOMETRY,9,0)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), S
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

8

Location Tracking Server

The Oracle Spatial location tracking server enables you to define regions, track the movement of objects into or out of those regions, and receive notifications when certain movements occur.

For reference information about location tracking PL/SQL subprograms, see SDO_TRKR Package (Location Tracking).

- About the Location Tracking Server
  As location becomes an increasingly important aspect of our lives, and as location-sensing devices become ubiquitous, there is an increasing demand for applications to be able to monitor subscriber location data continuously. The monitoring of the location data may translate into alerts being generated in the system.
- Location Tracking Set
  The location tracking server tracks a set of moving objects against a known set of regions and generates notifications as required. In this framework, the set of objects and regions is referred to as a **tracking set**.
- Data Types for the Location Tracking Server
  The PL/SQL subprograms associated with location tracking have parameters of data types that are specific to the location tracking server.
- Data Structures for the Location Tracking Server
  The location tracking server requires the user to specify a tracking set name when the server is created. Based on this name, additional data structures are created.
- Workflow for the Location Tracking Server
  The typical location tracking workflow involves several operations, some required and others optional.

8.1 About the Location Tracking Server

As location becomes an increasingly important aspect of our lives, and as location-sensing devices become ubiquitous, there is an increasing demand for applications to be able to monitor subscriber location data continuously. The monitoring of the location data may translate into alerts being generated in the system.

For example, a trucking company may want to monitor its network of 10,000 trucks as they move along their specified routes towards their destinations. They may want to track the movement of trucks within a specified range of the route and expect notifications to be generated to detect undesirable deviations the vehicles from their desired routes. Proactive location-based services (LBSs) generalize such applications that track locations of subscribers inside or outside a specified region for various purposes, such as location-based advertising and notifications about friends nearby.

The Oracle Spatial location tracking server provides:

- A simple framework for setting up a *location tracking network* within the database through a PL/SQL interface
- An API for continuous location monitoring of objects within a tracking network

- A queuing mechanism for incoming location updates and tracking requests and for outgoing relevant notifications, using Oracle Advanced Queuing
- Efficient, continuous location monitoring for thousands of relevant objects within the database

8.2 Location Tracking Set

The location tracking server tracks a set of moving objects against a known set of regions and generates notifications as required. In this framework, the set of objects and regions is referred to as a **tracking set**.

In the database these are managed in a table with two columns:

```
region_id  NUMBER,
geometry   SDO_GEOMETRY
```

REGION_ID is the primary key for this table, and GEOMETRY is the geometry of the tracking region.

Several additional structures are created when you create a tracking set. You can create any number of tracking sets, and each tracking set can have thousands of regions. When a region is no longer of interest for tracking purposes, it should be deleted from the tracking regions table.

A set of objects to be tracked also needs to be created. Each object must specify an ID for the object and a region ID to specify the region in which this object is tracked. That is, each object can be tracked against one or more tracking regions. An object is created by inserting a tracker message, `TRACKER_MSG`, into a tracking queue.

A tracker message object specifies the `object_id`, `region_id`, and `operation`. The `operation` parameter has one of the following string values.

- `I`: A notification message is issued every time an object, defined by `object_id`, moves while **inside** the region, defined by `region_id`
- `O`: A notification message is issued every time an object, defined by `object_id`, moves while **outside** the region, defined by `region_id`.
- `T`: A notification message is issued only when the object, defined by `object_id`, **transitions** from inside to outside or from outside to inside the region defined by `region_id`.
- `D`: **Disables** the tracking of an object defined by `object_id` in the region defined by `region_id`. To enable tracking of this object again, another tracking message must be sent.

After the objects are created and tracking regions configured, new location messages for the objects can be sent. As objects move in space, their locations change. Every time a new location message is sent, it is inserted into the location message queue, to be processed by the location tracking server. Location messages are processed and notification messages are generated as required. Applications can monitor the notification queue and process the notification messages whenever new notifications are generated.

The following additional grants are required for a user to run the location tracking server.

```
GRANT aq_administrator_role, create job, manage scheduler to <USER>; grant
execute on dbms_aq to <USER>;
GRANT execute on dbms_aqadm to <USER>;
GRANT execute on dbms_lock to  <USER>;
GRANT execute on dbms_aqin to  <USER>;
GRANT execute on dbms_aqjms to <USER>;
```

8.3 Data Types for the Location Tracking Server

The PL/SQL subprograms associated with location tracking have parameters of data types that are specific to the location tracking server.

These subprograms are documented in the SDO_TRKR Package (Location Tracking). The specific data types have the following definitions:

- LOCATION_MSG

  ```
  (object_id INTEGER,
   time      TIMESTAMP,
   x         NUMBER,
   y         NUMBER)
  ```

- LOCATION_MSG_ARR

  ```
  VARRAY(1000) of location_msg
  ```

- LOCATION_MSG_PKD

  ```
  object(arr location_msg_arr)
  ```

- NOTIFICATION_MSG

  ```
  (object_id INTEGER,
   region_id INTEGER,
   time      TIMESTAMP,
   x         NUMBER,
   y         NUMBER,
   state     VARCHAR2(8))
  ```

- PROC_MSG

  ```
  (object_id  INTEGER,
   time       TIMESTAMP,
   x          NUMBER,
   y          NUMBER,
   region_id  INTEGER,
   alert_when VARCHAR2(2))
  ```

- PROC_MSG_ARR

  ```
  VARRAY(1000) of proc_msg
  ```

- PROC_MSG_PKD

  ```
  object(arr proc_msg_arr)
  ```

- TRACKER_MSG

  ```
  (object_id INTEGER,
   region_id INTEGER,
   operation VARCHAR2(2))
  ```

8.4 Data Structures for the Location Tracking Server

The location tracking server requires the user to specify a tracking set name when the server is created. Based on this name, additional data structures are created.

- ***<TS_NAME>*_TRACKING_REGIONS** (region_id NUMBER, geometry MDSYS.SDO_GEOMETRY) is a table containing the tracking region polygons defined in the tracking set <TS_NAME>. Users must insert the polygons into this table after the server is created. All of the polygons must be geodetic (using SRID 4326) and two dimensional. The table has a primary key defined on the REGION_ID column.
- ***<TS_NAME>*_TRACKER** (object_id NUMBER, region_id NUMBER, queue_no NUMBER, alert_when VARCHAR2(2)) is a table whose entries map the relationship between an object and a region in which the object is tracked. The table has a primary key defined on the OBJECT_ID and REGION_ID columns. This table is managed using the TRACKER_MSG type; users should not update this table directly.
- ***<TS_NAME>*_TRACKER_QUEUES**(num_loc_queues NUMBER, num_trkr_queues NUMBER) is a table that holds queue information needed by the server. The server populates and maintains this table; users should never modify this table.
- ***<TS_NAME>*_TRACKER_LOG** (message_level VARCHAR2(1), message VARCHAR2(512), ts TIMESTAMP WITH TIMEZONE) is a table containing log messages generated by the server. Message level 'I' indicates an informational message, and message level 'E' indicates an error message. This table is not dropped when the tracking set is dropped. However, if a tracking set of the same name is then created, this table is truncated and reused by the new tracking set.
- ***<TS_NAME>*_NOTIFICATIONS** (object_id NUMBER, region_id NUMBER, time TIMESTAMP, x NUMBER, y NUMBER, state VARCHAR2(8)) is an auxiliary table provided to users to store messages from the notifications queue. The layout of columns in this table match that of the NOTIFICATION_MSG type. The X and Y columns are the coordinate that prompted the notification for object_id in region_id at the time. The STATE column shows if the point INSIDE or OUTSIDE the region. For tracking types INSIDE and OUTSIDE this value never changes. For tracking type TRANSITION this column is the state of the object at the time it generated the notification.
- ***<TS_NAME>*_TRAJECTORY** is an auxiliary table not currently used by the location tracking server.

In addition to these tables, the location tracking server also creates a set of Advanced Queuing (AQ) objects for managing the location, tracking and notification messages. All of the queues have a prefix of <*TS_NAME*>, for example. <*TS_NAME*>_TRACKER_Q_1 and <*TS_NAME*>_LOCATION_Q_1.

8.5 Workflow for the Location Tracking Server

The typical location tracking workflow involves several operations, some required and others optional.

The typical workflow contains several steps:

1. Create a tracking set.
2. Optionally, show the tracking set tables that were created.
3. Start the tracking set.
4. Optionally, show the queues used by the tracking set.
5. Optionally, show the Scheduler jobs used by the tracking set.
6. Insert polygons for various regions.
7. Create object-region pairs to be tracked.
8. Optionally, show the object-region pairs in the tracking set.

9. Send location messages.
10. Optionally, show the location messages that have been sent.
11. Dequeue the notification messages into the notifications table.
12. Optionally, disable the tracking server's object-region pairs.
13. Stop the tracking set.
14. Drop the tracking set.

The following is a simple example of the location tracking server workflow.

Example 8-1 Location Tracking Server Workflow

```
-- Create a tracking set named sample with one tracker/process
-- queue pair and one location queue.
EXEC sdo_trkr.create_tracking_set('sample', 1, 1);

-- Optional: Show the tracking sets tables that were created
SELECT table_name
FROM user_tables
WHERE table_name LIKE ‘SAMPLE%’
ORDER BY table_name;

TABLE_NAME
----------------------
SAMPLE_LOCATION_QT_1     - AQ queue table for location queue
SAMPLE_NOTIFICATIONS     - Auxiliary table to store notification messages
SAMPLE_NOTIFICATION_QT   - AQ queue table for the notification queue
SAMPLE_PROC_QT_1         - AQ queue table for the process queue
SAMPLE_TRACKER           - Table, will contain object-region tracking pairs
SAMPLE_TRACKER_LOG       - Table, contains log messages from the server
SAMPLE_TRACKER_QT_1      - AQ queue table for the tracker queue
SAMPLE_TRACKER_QUEUES    - Table, contains tracking sets queue metadata
SAMPLE_TRACKING_REGIONS  - Table, will contain the regions geometry
SAMPLE_TRAJECTORY        - Table, currently unused

-- Start the tracking set
EXEC sdo_trkr.start_tracking_set(‘sample’);

-- Optional: Show the queues used by the tracking set
SELECT name
FROM user_queues
WHERE name LIKE 'SAMPLE%'
ORDER BY name;

NAME
---------------------
SAMPLE_LOCATION_Q_1
SAMPLE_NOTIFICATION_Q
SAMPLE_PROC_Q_1
SAMPLE_TRACKER_Q_1

-- Optional: Show the scheduler jobs used by the tracking set
SELECT job_name, state
FROM user_scheduler_jobs
WHERE job_name LIKE 'SAMPLE%'
```

```
ORDER BY job_name;

JOB_NAME        STATE
--------------------------
SAMPLE_LOC_JOB_1   RUNNING
SAMPLE_TRKR_JOB_1  RUNNING


-- Insert a polygon for region 1. This polygon must be geodetic (using SRID
4326)
-- and two dimensional. The region may also be a multi-polygon.
INSERT INTO SAMPLE_TRACKING_REGIONS VALUES (1,
  MDSYS.SDO_GEOMETRY(SDO_POLYGON2D, 4326, null,
    sdo_elem_info_array(1, 1003, 1),
    sdo_ordinate_array(0,0, 5,0, 5,5, 0,5, 0,0)));
-- Create two objects, object 1 and 2 that are tracked in region 1.
-- Object 1 sends notification messages when it is inside region 1.
-- Object 2 sends notification messages when it is outside region 1.
EXEC sdo_trkr.send_tracking_msg(
  'SAMPLE', mdsys.tracker_msg(1, 1, 'I'));
EXEC sdo_trkr.send_tracking_msg(
  'SAMPLE', mdsys.tracker_msg(2, 1, 'O'));
-- Optional: Show the object-region pairs used in the tracking set
SELECT object_id, region_id, alert_when  FROM sample_tracker;

OBJECT_ID  REGION_ID  ALERT_WHEN
---------- ---------- -----------
     1             1        I
     2             1        O

-- Send 2 location messages.
-- Object 1 moves to (1, 1).
-- Object 2 moves to (8, 8).
EXEC sdo_trkr.send_location_msgs('SAMPLE',
  mdsys.location_msg_arr(
    mdsys.location_msg(1, '01-AUG-16 01.01.46.000000 PM', 1, 1),
    mdsys.location_msg(2, '01-AUG-16 01.02.46.000000 PM', 8, 8)));

-- Optional: Show that 2 notification message were generated
SELECT a.name, b.ready
FROM user_queues a, v$aq b
WHERE a.name='SAMPLE_NOTIFICATION_Q' AND a.qid=b.qid
ORDER BY a.name;

NAME                    READY
----------------------- ------
SAMPLE_NOTIFICATION_Q    2

-- Dequeue the notification messages into the notifications table
DECLARE
  message       mdsys.notification_msg;
BEGIN
  LOOP
    sdo_trkr.get_notification_msg(
      tracking_set_name => 'SAMPLE',
      message => message,
      deq_wait =>2);    -- wait at most 2 seconds for a message

    IF (message IS NULL) THEN
      EXIT;
    END IF;

    INSERT INTO sample_notifications (
                  object_id, region_id, time, x, y, state)
      (SELECT message.object_id, message.region_id,
              message.time, message.x, message.y, message.state);
  END LOOP;
END;
-- Query the object id, region id, (x, y) coordinate and the objects
-- relationship to the region sorted by the time that was sent with
-- the objects location message.
SELECT object_id, region_id, x, y, state
FROM sample_notifications
ORDER BY time;
OBJECT_ID  REGION_ID    X   Y   STATE
---------- ---------- --- --- -------
  1          1            1   1   INSIDE
  2          1            8   8   OUTSIDE
-- Optional: Disable the tracking server's object-region pairs
EXEC sdo_trkr.send_tracking_msg('SAMPLE',
  mdsys.tracker_msg(1, 1, 'D'));
EXEC sdo_trkr.send_tracking_msg('SAMPLE',
  mdsys.tracker_msg(2, 1, 'D'));
-- Stop the tracking set. This stops the tracking sets
-- queues and its scheduler jobs. Running stop_tracking_set
-- does not delete the tables and queues used by the tracking
-- server so start_tracking_set can be rerun and all of the
-- object and region data is still available.
-- This must be done before dropping a tracking set
EXEC sdo_trkr.stop_tracking_set('sample');

-- Drop the tracking set. This completely deletes the tracking
-- sets queues and tables. Once completed all traces of the tracking
-- set are removed except for the log table which is left intact for
-- debugging purposes. If another tracking set of the same name is
-- created the log table is truncated.
EXEC sdo_trkr.drop_tracking_set('sample');
```

9

Spatial Analysis and Mining

This chapter describes the Oracle Spatial features that enable the use of spatial data in data mining applications.

> **Note:**
>
> To use the features described in this chapter, you must understand the main concepts and techniques explained in the documentation for Oracle Data Mining, a component of the Oracle Advanced Analytics Option.

For reference information about spatial analysis and mining functions and procedures in the SDO_SAM package, see SDO_SAM Package (Spatial Analysis and Mining).

> **Note:**
>
> SDO_SAM subprograms are supported for two-dimensional geometries only. They are not supported for three-dimensional geometries.

- Spatial Information and Data Mining Applications
  Oracle Data Mining allows automatic discovery of knowledge from a database. Its techniques include discovering hidden associations between different data attributes, classification of data based on some samples, and clustering to identify intrinsic patterns. Spatial data can be materialized for inclusion in data mining applications.
- Spatial Binning for Detection of Regional Patterns
  Spatial binning (spatial discretization) discretizes the location values into a small number of groups associated with geographical areas.
- Materializing Spatial Correlation
  Spatial correlation (or, *neighborhood influence*) refers to the phenomenon of the location of a specific object in an area affecting some nonspatial attribute of the object. For example, the value (nonspatial attribute) of a house at a given address (geocoded to give a spatial attribute) is largely determined by the value of other houses in the neighborhood.
- Colocation Mining
  Colocation is the presence of two or more spatial objects at the same location or at significantly close distances from each other. Colocation patterns can indicate interesting associations among spatial data objects with respect to their nonspatial attributes.
- Spatial Clustering
  Spatial clustering returns cluster geometries for a layer of data. An example of spatial clustering is the clustering of crime location data.
- Location Prospecting
  Location prospecting can be performed by using thematic layers to compute aggregates for a layer, and choosing the locations that have the maximum values for computed aggregates.

9.1 Spatial Information and Data Mining Applications

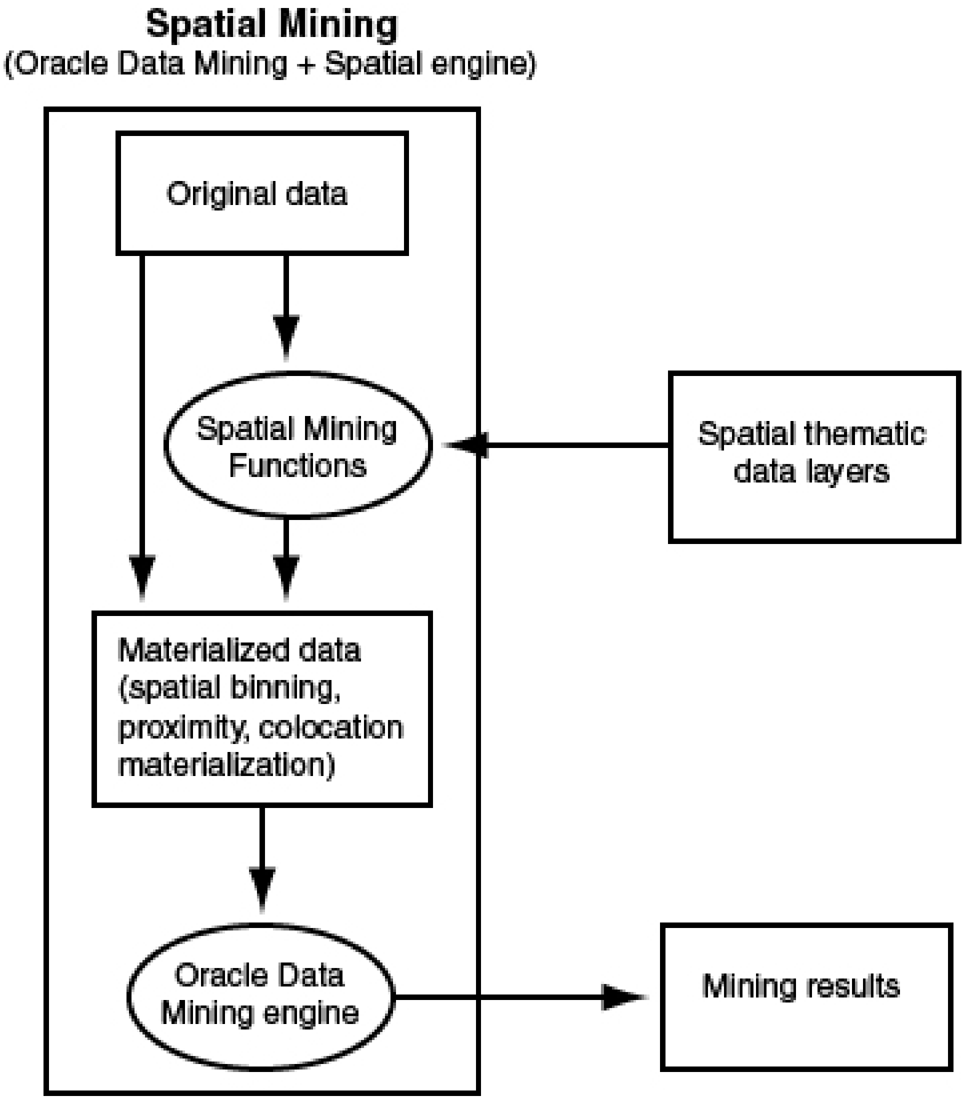
Oracle Data Mining allows automatic discovery of knowledge from a database. Its techniques include discovering hidden associations between different data attributes, classification of data based on some samples, and clustering to identify intrinsic patterns. Spatial data can be materialized for inclusion in data mining applications.

Thus, Oracle Data Mining might enable you to discover that sales prospects with addresses located in specific areas (neighborhoods, cities, or regions) are more likely to watch a particular television program or to respond favorably to a particular advertising solicitation. (The addresses are geocoded into longitude/latitude points and stored in an Oracle Spatial geometry object.)

In many applications, data at a specific location is influenced by data in the neighborhood. For example, the value of a house is largely determined by the value of other houses in the neighborhood. This phenomenon is called *spatial correlation* (or, neighborhood influence), and is discussed further in Materializing Spatial Correlation. The spatial analysis and mining features in Oracle Spatial let you exploit spatial correlation by using the location attributes of data items in several ways: for binning (discretizing) data into regions (such as categorizing data into northern, southern, eastern, and western regions), for materializing the influence of neighborhood (such as number of customers within a two-mile radius of each store), and for identifying colocated data items (such as video rental stores and pizza restaurants).

To perform spatial data mining, you materialize spatial predicates and relationships for a set of spatial data using thematic layers. Each layer contains data about a specific kind of spatial data (that is, having a specific "theme"), for example, parks and recreation areas, or demographic income data. The spatial materialization could be performed as a preprocessing step before the application of data mining techniques, or it could be performed as an intermediate step in spatial mining, as shown in Figure 9-1.

Figure 9-1   Spatial Mining and Oracle Data Mining


Spatial Mining
(Oracle Data Mining + Spatial engine)
Original data
Spatial Mining Functions
Spatial thematic data layers
Materialized data (spatial binning, proximity, colocation materialization)
Oracle Data Mining engine
Mining results

Notes on Figure 9-1:

- The original data, which included spatial and nonspatial data, is processed to produce materialized data.
- Spatial data in the original data is processed by spatial mining functions to produce materialized data. The processing includes such operations as spatial binning, proximity, and colocation materialization.
- The Oracle Data Mining engine processes materialized data (spatial and nonspatial) to generate mining results.

The following are examples of the kinds of data mining applications that could benefit from including spatial information in their processing:

- Business prospecting: Determine if colocation of a business with another franchise (such as colocation of a Pizza Hut restaurant with a Blockbuster video store) might improve its sales.

- Store prospecting: Find a good store location that is within 50 miles of a major city and inside a state with no sales tax. (Although 50 miles is probably too far to drive to avoid a sales tax, many customers may live near the edge of the 50-mile radius and thus be near the state with no sales tax.)
- Hospital prospecting: Identify the best locations for opening new hospitals based on the population of patients who live in each neighborhood.
- Spatial region-based classification or personalization: Determine if southeastern United States customers in a certain age or income category are more likely to prefer "soft" or "hard" rock music.
- Automobile insurance: Given a customer's home or work location, determine if it is in an area with high or low rates of accident claims or auto thefts.
- Property analysis: Use colocation rules to find hidden associations between proximity to a highway and either the price of a house or the sales volume of a store.
- Property assessment: In assessing the value of a house, examine the values of similar houses in a neighborhood, and derive an estimate based on variations and spatial correlation.

9.2 Spatial Binning for Detection of Regional Patterns

Spatial binning (spatial discretization) discretizes the location values into a small number of groups associated with geographical areas.

The assignment of a location to a group can be done by any of the following methods:

- Reverse geocoding the longitude/latitude coordinates to obtain an address that specifies (for United States locations) the ZIP code, city, state, and country
- Checking a spatial bin table to determine which bin this specific location belongs in

You can then apply Oracle Data Mining techniques to the discretized locations to identify interesting regional patterns or association rules. For example, you might discover that customers in area A prefer regular soda, while customers in area B prefer diet soda.

The following functions and procedures, documented in SDO_SAM Package (Spatial Analysis and Mining), perform operations related to spatial binning:

- SDO_SAM.BIN_GEOMETRY
- SDO_SAM.BIN_LAYER

9.3 Materializing Spatial Correlation

Spatial correlation (or, *neighborhood influence*) refers to the phenomenon of the location of a specific object in an area affecting some nonspatial attribute of the object. For example, the value (nonspatial attribute) of a house at a given address (geocoded to give a spatial attribute) is largely determined by the value of other houses in the neighborhood.

To use spatial correlation in a data mining application, you materialize the spatial correlation by adding attributes (columns) in a data mining table. You use associated thematic tables to add the appropriate attributes. You then perform mining tasks on the data mining table using Oracle Data Mining functions.

The following functions and procedures, documented in SDO_SAM Package (Spatial Analysis and Mining), perform operations related to materializing spatial correlation:

- SDO_SAM.SIMPLIFY_GEOMETRY

- SDO_SAM.SIMPLIFY_LAYER
- SDO_SAM.AGGREGATES_FOR_GEOMETRY
- SDO_SAM.AGGREGATES_FOR_LAYER

9.4 Colocation Mining

Colocation is the presence of two or more spatial objects at the same location or at significantly close distances from each other. Colocation patterns can indicate interesting associations among spatial data objects with respect to their nonspatial attributes.

For example, a data mining application could discover that sales at franchises of a specific pizza restaurant chain were higher at restaurants colocated with video stores than at restaurants not colocated with video stores.

Two types of colocation mining are supported:

- Colocation of items in a data mining table. Given a data layer, this approach identifies the colocation of multiple features. For example, predator and prey species could be colocated in animal habitats, and high-sales pizza restaurants could be colocated with high-sales video stores. You can use a reference-feature approach (using one feature as a reference and the other features as thematic attributes, and materializing all neighbors for the reference feature) or a buffer-based approach (materializing all items that are within all windows of a specified size).
- Colocation with thematic layers. Given several data layers, this approach identifies colocation across the layers. For example, given a lakes layer and a vegetation layer, lakes could be colocated with areas of high vegetation. You materialize the data, add categorical and numerical spatial relationships to the data mining table, and apply the Oracle Data Mining Association-Rule mechanisms.

The following functions and procedures, documented in SDO_SAM Package (Spatial Analysis and Mining), perform operations related to colocation mining:

- SDO_SAM.COLOCATED_REFERENCE_FEATURES
- SDO_SAM.BIN_GEOMETRY

9.5 Spatial Clustering

Spatial clustering returns cluster geometries for a layer of data. An example of spatial clustering is the clustering of crime location data.

The SDO_SAM.SPATIAL_CLUSTERS function, documented in SDO_SAM Package (Spatial Analysis and Mining), performs spatial clustering. This function requires a spatial R-tree index on the geometry column of the layer, and it returns a set of SDO_REGION objects where the geometry column specifies the boundary of each cluster and the `geometry_key` value is set to null.

You can use the SDO_SAM.BIN_GEOMETRY function, with the returned spatial clusters in the bin table, to identify the cluster to which a geometry belongs.

9.6 Location Prospecting

Location prospecting can be performed by using thematic layers to compute aggregates for a layer, and choosing the locations that have the maximum values for computed aggregates.

The following functions, documented in SDO_SAM Package (Spatial Analysis and Mining), perform operations related to location prospecting:

- SDO_SAM.AGGREGATES_FOR_GEOMETRY
- SDO_SAM.AGGREGATES_FOR_LAYER
- SDO_SAM.TILED_AGGREGATES

10

Extending Spatial Indexing Capabilities

This chapter shows how to create and use spatial indexes on objects other than a geometry column. In other chapters, the focus is on indexing and querying spatial data that is stored in a single column of type SDO_GEOMETRY.

This chapter shows how to:

- Embed an SDO_GEOMETRY object in a user-defined object type, and index the geometry attribute of that type
- Create and use a function-based index where the function returns an SDO_GEOMETRY object

The techniques in this chapter are intended for experienced and knowledgeable application developers. You should be familiar with the Spatial concepts and techniques described in other chapters. You should also be familiar with, or able to learn about, relevant Oracle database features, such as user-defined data types and function-based indexing.

- SDO_GEOMETRY Objects in User-Defined Type Definitions
  The SDO_GEOMETRY type can be embedded in a user-defined data type definition.
- SDO_GEOMETRY Objects in Function-Based Indexes
  A function-based spatial index facilitates queries that use location information (of type SDO_GEOMETRY) returned by a function or expression. In this case, the spatial index is created based on the precomputed values returned by the function or expression.

10.1 SDO_GEOMETRY Objects in User-Defined Type Definitions

The SDO_GEOMETRY type can be embedded in a user-defined data type definition.

The procedure is very similar to that for using the SDO_GEOMETRY type for a spatial data column:

1. Create the user-defined data type.
2. Create a table with a column based on that data type.
3. Insert data into the table.
4. Update the USER_SDO_GEOM_METADATA view.
5. Create the spatial index on the geometry attribute.
6. Perform queries on the data.

For example, assume that you want to follow the cola markets scenario in the simplified example in Simple Example: Inserting_ Indexing_ and Querying Spatial Data, but want to incorporate the market name attribute and the geometry attribute in a single type. First, create the user-defined data type, as in the following example that creates an object type named MARKET_TYPE:

```
CREATE OR REPLACE TYPE market_type AS OBJECT
  (name VARCHAR2(32), shape SDO_GEOMETRY);
/
```

Create a table that includes a column based on the user-defined type. The following example creates a table named COLA_MARKETS_2 that will contain the same information as the COLA_MARKETS table used in the example in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.

```
CREATE TABLE cola_markets_2 (
  mkt_id NUMBER PRIMARY KEY,
  market MARKET_TYPE);
```

Insert data into the table, using the object type name as a constructor. For example:

```
INSERT INTO cola_markets_2 VALUES(
  1,
  MARKET_TYPE('cola_a',
    SDO_GEOMETRY(
      SDO_POLYGON2D,  -- two-dimensional polygon
      NULL,
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
      SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
            -- define rectangle (lower left and upper right)
      )
  )
);
```

Update the USER_SDO_GEOM_METADATA view, using dot-notation to specify the column name and spatial attribute. The following example specifies MARKET.SHAPE as the COLUMN_NAME (explained in COLUMN_NAME) in the metadata view.

```
INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)
  VALUES (
  'cola_markets_2',
  'market.shape',
  SDO_DIM_ARRAY(   -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
     ),
  NULL   -- SRID
);
```

Create the spatial index, specifying the column name and spatial attribute using dot-notation. For example.

```
CREATE INDEX cola_spatial_idx_2
ON cola_markets_2(market.shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
```

Perform queries on the data, using dot-notation to refer to attributes of the user-defined type. The following simple query returns information associated with the cola market named `cola_a`.

```
SELECT c.mkt_id, c.market.name, c.market.shape
  FROM cola_markets_2 c
  WHERE c.market.name = 'cola_a';
```

The following query returns information associated with all geometries that have any spatial interaction with a specified query window, namely, the rectangle with lower-left coordinates (4,6) and upper-right coordinates (8,8).

```
SELECT c.mkt_id, c.market.name, c.market.shape
  FROM cola_markets_2 c
  WHERE SDO_RELATE(c.market.shape,
            SDO_GEOMETRY(SDO_POLYGON2D, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(4,6, 8,8)),
            'mask=anyinteract' = 'TRUE';
```

10.2 SDO_GEOMETRY Objects in Function-Based Indexes

A function-based spatial index facilitates queries that use location information (of type SDO_GEOMETRY) returned by a function or expression. In this case, the spatial index is created based on the precomputed values returned by the function or expression.

If you are not already familiar with function-based indexes, see the following for detailed explanations of their benefits, options, and requirements, as well as usage examples:

- *Oracle Database Development Guide*
- *Oracle Database Administrator's Guide*

The procedure for using an SDO_GEOMETRY object in a function-based index is as follows:

1. Create the function that returns an SDO_GEOMETRY object.

   The function must be declared as DETERMINISTIC.
2. If the spatial data table does not already exist, create it, and insert data into the table.
3. Update the USER_SDO_GEOM_METADATA view.
4. Create the spatial index.

   For a function-based spatial index, the number of parameters must not exceed 32.
5. Perform queries on the data.

The rest of this section describes two examples of using function-based indexes. In both examples, a function is created that returns an SDO_GEOMETRY object, and a spatial index is created on that function. In the first example, the input parameters to the function are a standard Oracle data type (NUMBER). In the second example, the input to the function is a user-defined object type.

- Example: Function with Standard Types
- Example: Function with a User-Defined Object Type

10.2.1 Example: Function with Standard Types

In the following example, the input parameters to the function used for the function-based index are standard numeric values (longitude and latitude).

Assume that you want to create a function that returns the longitude and latitude of a point and to use that function in a spatial index. First, create the function, as in the following example that creates a function named `get_long_lat_pt`:

```
-- Create a function to return a point geometry (SDO_GTYPE = SDO_POINT2D) with
-- input of 2 numbers: longitude and latitude (SDO_SRID = 4326, for
-- "Longitude / Latitude (WGS 84)",  probably the most widely used
--  coordinate system, and the one used for GPS devices.
-- Specify DETERMINISTIC for the function.
```

```
CREATE OR REPLACE FUNCTION get_long_lat_pt(longitude IN NUMBER,
                                           latitude IN NUMBER)
RETURN SDO_GEOMETRY DETERMINISTIC IS
BEGIN
     IF (longitude IS NULL) OR (latitude IS NULL) THEN
         RETURN NULL;
     END IF;
     RETURN SDO_GEOMETRY(longitude, latitude);
END;
/
```

If the spatial data table does not already exist, create the table and add data to it, as in the following example that creates a table named `long_lat_table`:

```
CREATE TABLE long_lat_table
(lon NUMBER, lat NUMBER, name VARCHAR2(32));

INSERT INTO long_lat_table VALUES (10,10, 'Place1');
INSERT INTO long_lat_table VALUES (20,20, 'Place2');
INSERT INTO long_lat_table VALUES (30,30, 'Place3');
```

Update the USER_SDO_GEOM_METADATA view, using dot-notation to specify the schema name and function name. The following example specifies `SCOTT.GET_LONG_LAT_PT(LON,LAT)` as the COLUMN_NAME (explained in COLUMN_NAME) in the metadata view.

```
-- Set up the metadata entry for this table.
-- The column name sets up the function on top
-- of the two columns used in this function,
-- along with the owner of the function.
INSERT INTO USER_SDO_GEOM_METADATA VALUES('LONG_LAT_TABLE',
 'scott.get_long_lat_pt(lon,lat)',
 SDO_DIM_ARRAY(
   SDO_DIM_ELEMENT('Longitude', -180, 180, 0.005),
   SDO_DIM_ELEMENT('Latitude', -90, 90, 0.005)), 4326);
```

Create the spatial index, specifying the function name with parameters. For example:

```
CREATE INDEX long_lat_table_idx ON
   long_lat_table(get_long_lat_pt(lon,lat))
   INDEXTYPE IS mdsys.spatial_index_v2;
```

Perform queries on the data. The following example specifies the user-defined function in a call to the SDO_FILTER operator.

```
SELECT NAME FROM long_lat_table a
  WHERE SDO_FILTER(
    get_long_lat_pt(a.lon,a.lat),
    SDO_GEOMETRY(10,10)
  )='TRUE';

NAME
--------------------------------
Place1
```

10.2.2 Example: Function with a User-Defined Object Type

In the following example, the input parameter to the function used for the function-based index is an object of a user-defined type that includes the longitude and latitude.

Assume that you want to create a function that returns the longitude and latitude of a point and to create a spatial index on that function. First, create the user-defined data type, as in the following example that creates an object type named `long_lat` and its member function `GetGeometry()`:

```
CREATE TYPE long_lat as object (
   longitude NUMBER,
   latitude NUMBER,
MEMBER FUNCTION GetGeometry(SELF IN long_lat)
RETURN SDO_GEOMETRY DETERMINISTIC)
/

CREATE OR REPLACE TYPE BODY long_lat AS
  MEMBER FUNCTION GetGeometry(SELF IN long_lat)
  RETURN SDO_GEOMETRY IS
    BEGIN
       IF (longitude IS NULL) OR (latitude IS NULL) THEN
         RETURN NULL;
       END IF;
       RETURN SDO_GEOMETRY(longitude, latitude);
    END;
END;
/
```

If the spatial data table does not already exist, create the table and add data to it, as in the following example that creates a table named `test_long_lat`:

```
CREATE TABLE test_long_lat
   (location long_lat, name VARCHAR2(32));

INSERT INTO test_long_lat VALUES (long_lat(10,10), 'Place1');
INSERT INTO test_long_lat VALUES (long_lat(20,20), 'Place2');
INSERT INTO test_long_lat VALUES (long_lat(30,30), 'Place3');
```

Update the USER_SDO_GEOM_METADATA view, using dot-notation to specify the schema name, table name, and function name and parameter value. The following example specifies SCOTT.LONG_LAT.GETGEOMETRY(LOCATION) as the COLUMN_NAME (explained in COLUMN_NAME) in the metadata view.

```
INSERT INTO USER_SDO_GEOM_METADATA VALUES('test_long_lat',
 'scott.long_lat.GetGeometry(location)',
 SDO_DIM_ARRAY(
   SDO_DIM_ELEMENT('Longitude', -180, 180, 0.005),
   SDO_DIM_ELEMENT('Latitude', -90, 90, 0.005)), 4326);
```

Create the spatial index, specifying the column name and function name using dot-notation. For example:

```
CREATE INDEX test_long_lat_idx ON test_long_lat(location.GetGeometry())
  INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
```

Perform queries on the data. The following query performs a primary filter operation, asking for the names of geometries that are likely to interact spatially with point (10,10).

```
SELECT a.name FROM test_long_lat a
  WHERE SDO_FILTER(a.location.GetGeometry(),
            SDO_GEOMETRY(10,10)
            ) = 'TRUE';
```

Part II

Spatial Web Services

This document has the following parts:

- Conceptual and Usage Information provides conceptual and usage information about Oracle Spatial.
- Part II provides conceptual and usage information about Oracle Spatial web services.
- Reference Information provides reference information about Oracle Spatial operators, functions, and procedures.
- Supplementary Information provides supplementary information (appendixes and a glossary).

Part II contains the following chapters.

- Introduction to Spatial Web Services
  This chapter introduces Oracle Spatial support for Spatial Web Services.
- Geocoding Address Data
  Geocoding is the process of associating spatial locations (longitude and latitude coordinates) with postal addresses.
- Business Directory (Yellow Pages) Support
  Oracle Spatial provides support for OpenLS business directory (Yellow Pages, or YP) services.
- Routing Engine
  The Spatial routing engine (often referred to as the routing engine) enables you to host an XML-based web service that provides the following features.
- OpenLS Support
  This chapter describes the Oracle Spatial support for web services based on the Open Location Services Initiative (OpenLS) of the Open GeoSpatial Consortium (OGC), versions 1.0 and 1.1.
- Web Feature Service (WFS) Support
  Oracle Spatial includes Web Feature Service (WFS) support.
- Web Coverage Service (WCS) Support
  This chapter describes the Oracle Spatial implementation of the Open GIS Consortium (OGC) standard for Web Coverage Service Interface Standard (WCS), which, supports retrieval of “coverages” (according to the OGC, “electronic encoding of geospatial data, that is, digital geospatial information representing space and time-varying phenomena”).
- Catalog Services for the Web (CSW) Support
  Oracle Spatial provides an implementation of version 2.0.2 of the Open GIS Consortium specification for catalog services for the web.

11

Introduction to Spatial Web Services

This chapter introduces Oracle Spatial support for Spatial Web Services.

> **Note:**
>
> You can deploy Oracle Spatial Web Services from Oracle Cloud Marketplace. This packaged application allows you to install Oracle Spatial web services (such as Web Feature Service (WFS), Web Coverage Services (WCS), and Catalog Services for the Web (CSW)) that are deployed in an Apache Tomcat web server instance on Oracle Cloud Infrastructure (OCI).

A web service enables developers of Oracle Spatial applications to provide feature data and metadata to their application users over the web.

> **Note:**
>
> If you are using Spatial WFS or CSW support, and if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes **before** the upgrade and re-create the indexes **after** the upgrade.
> For more information, see Index Maintenance Before and After an Upgrade (WFS and CSW).

- Types of Spatial Web Services
  Learn about the different types of web services provided by Oracle Spatial.
- Types of Users of Spatial Web Services
  Learn about the different users involved in configuring Spatial Web Services.
- Deploying and Configuring Spatial Web Services
  This topic describes actions that apply to deploying and configuring Oracle Spatial Web Services, and particularly WFS, WCS, CSW, and GeoRaster REST API.

11.1 Types of Spatial Web Services

Learn about the different types of web services provided by Oracle Spatial.

- **Geocoding**, which enables users to associate spatial locations (longitude and latitude coordinates) with postal addresses. See Geocoding Address Data for more information on Geocoding support.
- **Yellow Pages**, which enables users to find businesses by name or category based on their relationship to a location. See Business Directory (Yellow Pages) Support for more information on Yellow Pages support.

- **Routing**, which provides driving information and instructions for individual or multiple routes. See Routing Engine for more information on Routing support.
- **OpenLS**, which provides location-based services based on the Open Location Services Initiative (OpenLS) specification for geocoding, mapping, routing, and yellow pages. See OpenLS Support for more information on OpenLS support.
- **Web Feature Services (WFS)**, which enables users to find features (roads, rivers, and so on) based on their relationship to a location or a nonspatial attribute. See Web Feature Service (WFS) Support for more information on WFS versions 1.1.0 and 1.0.0 support.
- **Web Coverage Services (WCS)**, which provides access to coverage data in forms that are useful for client-side rendering, as input into scientific models, and for other clients.
  - See Web Coverage Service (WCS) Support for more information on WCS version 2.0.1 support.
  - See https://en.wikipedia.org/wiki/Web_Coverage_Service for an overview of WCS.
  - See http://gis.stackexchange.com/questions/80948/what-are-the-differences-between-wms-wfs-wcs-wps for an introductory comparison of WCS to related web services.
- **Catalog Services for the Web (CSW)**, which describes the Oracle Spatial implementation of the Open GIS Consortium specification for catalog services. According to this specification: "Catalog services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects." See Catalog Services for the Web (CSW) Support for more information on CSW version 2.0.2 support.
- **Web Map Service (WMS)**, which supports the rendering of spatial data. Specifically, the WMS 1.1.1 and 1.3.0 implementation specifications are implemented in the Map Visualization Component. See OGC WMS Support in the Map Visualization Component in *Oracle Spatial Map Visualization Developer's Guide* for more information.
- **GeoRaster REST API**, which supports access and management of GeoRaster data stored in Oracle Database through REST HTTP/S requests with JSON responses. See GeoRaster REST API in *Oracle Spatial GeoRaster Developer's Guide* for more information.

11.2 Types of Users of Spatial Web Services

Learn about the different users involved in configuring Spatial Web Services.

A "user" implementing any spatial web services application can be any one of the following:

- **Administrators** set up the web services infrastructure. Administrators might create database users, grant privileges and access rights to new and existing database users, and do other operations that affect multiple database users.
  - For web feature services, administrators can use the WFS Admin Console to register feature tables and publish feature types.
  - For catalog service for the web services, administrators can use CSW Admin Console to publish record types.
  - For web coverage services, administrators can use WCS Admin Console to publish coverages.

  For example, an administrator might set up the infrastructure to enable access to spatial features, such as roads and rivers.
- **Application developers** create and manage the spatial data and metadata. They create spatial data tables, create spatial indexes, insert rows into the

USER_SDO_GEOM_METADATA view, and use spatial functions and procedures to implement the application logic.

For example, an application developer might create tables of roads and rivers, and implement application logic that enables end users to find roads and rivers based on spatial query criteria.

- **End users** access the services through HTTP requests using KVP, POST, or SOAP protocol.

  For example, an end user might ask for all roads that are within one mile of a specific river or that intersect (cross) that river.

From the perspective of an administrator, application developers and end users are all "users" because database users must be created to accommodate their needs. Application developers will connect to the database as users with sufficient privileges to create and manage spatial tables and to use Oracle Spatial functions and procedures. End users will access the database through HTTP requests.

The chapters about Spatial web services are written for administrators and application developers, not for end users.

11.3 Deploying and Configuring Spatial Web Services

This topic describes actions that apply to deploying and configuring Oracle Spatial Web Services, and particularly WFS, WCS, CSW, and GeoRaster REST API.

These services are implemented as Java web applications and can be deployed to run on WebLogic 12.1.3 or later. The required Java version is JDK 8 or later.

> **Note:**
>
> Effective with Oracle Database Release 23ai, the Oracle Spatial Java APIs are compiled with JDK 11 as the OJVM in the database supports JDK11. However, the APIs will continue to be supported on JDK8 for backwards compatibility. When using the API, ensure that all the related JAR files are consistent with the JDK version (JDK 8 or JDK 11) that is being used. See RDBMS and JDK Version Compatibility for Oracle JDBC Drivers for more information on the JDBC drivers that are supported for the different JDK versions.

- WFS, WCS, and CSW are packaged in the `sdows.ear` file.
- The GeoRaster REST API is packaged in the `sdows.ear` file.
- The Geocoder service is packaged in the `geocoder.ear.zip` file.
- The Routing Engine is packaged in the `routeserver.ear.zip` file.

Geocoder and routing files can be found under the directory `$ORACLE_HOME/md/jlib` of your Oracle installation. In addition to the “general” instructions in this topic, refer to the respective chapters for each specific spatial web service that you plan to use for any additional deployment and configuration tasks.

WFS, WCS, CSW and GeoRaster REST API (`sdows.ear`) can be installed in the following ways:

- You can install *Oracle Spatial Web Services* application from Oracle Cloud Marketplace. This will install and configure `sdows.ear` in an Apache Tomcat Web Server instance and

GDAL on a new Oracle Cloud Infrastructure Compute under your Oracle Cloud Account. Once you complete the installation, you can continue to configure your spatial web service. Refer to Configuring Each Spatial Web Service for more information.

- On a WebLogic Server on your own Linux or Windows machine, you can deploy the `sdows.ear` package available in either one of the following two places:
  - Inside you Oracle Home Installation, under the directory:

    ```
    $ORACLE_HOME/md/jlib.
    ```

  - On My Oracle Support using the Doc Id 3019446.1.

  Once you have the deployment package, you can then continue to Preparing the WebLogic Server.

- Preparing the WebLogic Server
  You can deploy Spatial Web Services on any Oracle WebLogic Server version that support JDK 8 or JDK 11.
- Deploying Spatial Web Services in WebLogic Server
  This section describes how to deploy the services (such as WFS, WCS, CSW, and GeoRaster REST API) included in the `sdows.ear` file.
- Configuring Each Spatial Web Service
  Each spatial web service to be used must be configured independently.

11.3.1 Preparing the WebLogic Server

You can deploy Spatial Web Services on any Oracle WebLogic Server version that support JDK 8 or JDK 11.

However, it is recommended to use Oracle WebLogic Server version 14.1.1.0.0.

You can prepare the WebLogic environment by performing the following steps:

1. Install Oracle WebLogic Server version 14.1.1.0.0.

   See Installing the Oracle WebLogic Server for installation instructions.
2. Create and configure a WebLogic Domain. Note that it is recommend to create an Administration Server and a Node Manager.

   See Creating and Configuring the WebLogic Domain for more information.
3. Start the Node Manager and also Start the WebLogic Server.
4. Perform the following steps on the Oracle WebLogic Server Administration Console.
   a. Create and configure a Machine.
   b. Create a Managed Server
   c. Configure the **Machine** name on the **General** tab for the Managed Server's **Configuration**.
   d. Start the Managed Server.

11.3.2 Deploying Spatial Web Services in WebLogic Server

This section describes how to deploy the services (such as WFS, WCS, CSW, and GeoRaster REST API) included in the `sdows.ear` file.

For any other web services, follow the instructions in their respective chapters.

Also, note that if you want to configure WCS or GeoRaster REST API, then you need to setup GDAL prior to the deployment of `sdows.ear` file. If you are only interested in WFS or CSW, then you can skip the Setting up GDAL section.

To deploy `sdows.ear` file in the WebLogic Server, perform the following steps.

1. Create a folder that will contain the configuration and log files.
2. Create an environment variable `SDOWS_HOME` pointing to the folder created in the preceding step.
3. Deploy `<WLS_HOME>/wlserver/common/deployable-libraries/jax-rs-2.0.war` to Oracle WebLogic Server as a library. See Install an enterprise application for more information.
4. Optionally, set up GDAL (see Setting up GDAL) only if you are deploying WCS or the GeoRaster REST API.
5. Add the WebLogic data source (see Adding a WebLogic Data Source).
6. Optionally, if you are deploying GeoRaster REST API, then set up the necessary environment variables and Oracle Wallet.
7. Deploy `sdows.ear` as an application (see Install an enterprise application).

After completing the necessary steps for a spatial web service, check the **Deployments** page to ensure that the application is in the `Active` state. If it is in the `Prepared` state, then click **Start** to start the application. See Start and stop a deployed enterprise application for instructions.

- Setting up GDAL
  This section describes how to set up GDAL (Geospatial Data Abstraction Library).
- Adding a WebLogic Data Source
  You can configure database connectivity in a WebLogic Server by adding JDBC data sources to your WebLogic domain.
- Setting up the GeoRaster REST API
  Learn to set up the GeoRaster REST API.

11.3.2.1 Setting up GDAL

This section describes how to set up GDAL (Geospatial Data Abstraction Library).

You can download GDAL from My Oracle Support using the Patch ID listed in MOS note 2997919.1.

There are two GDAL zip files, one for Linux 64 operating system and the other for Windows 64 operating system.

The `README.txt` file inside the GDAL zip file contains the instructions to setup GDAL.

Ensure that GDAL is available to the running Oracle WebLogic Server by starting the server from a terminal where GDAL is set up or by invoking the `gdal_setup` script from the WebLogic server `setDomainEnv` script located in your WebLogic domain `bin` folder.

11.3.2.2 Adding a WebLogic Data Source

You can configure database connectivity in a WebLogic Server by adding JDBC data sources to your WebLogic domain.

You can create a generic data source by following the instructions provided in Create JDBC generic data sources.

However, you must consider the following aspects while choosing values during data source configuration:

1. JDBC data source name must only contain the characters *A-Z*, *a-z*, *0-9*. This value will be part of the service URL.
2. JNDI name must have the format `jdbc/<name>`, where <*name*> is the same as JDBC data source name.

11.3.2.3 Setting up the GeoRaster REST API

Learn to set up the GeoRaster REST API.

To set up the GeoRaster REST API in the WebLogic Server, perform the following steps.

1. Configure an Oracle Wallet and add the WebLogic data source connections.
    a. Create a new Oracle Wallet using the *mkstore* tool.

       See How to Create an External Password Store for the instructions.
    b. Store the credentials and connection string to the Oracle Wallet using a TNS Alias.

       See Using a TNS Alias instead of a DB Connect String for the instructions to add a TNS Alias to an Oracle Wallet.
       Add as many database connections to the Oracle Wallet as you need.
    c. Add a WebLogic data source using as JDBC data source name, the alias defined in the Oracle Wallet and JNDI name in the format `jdbc/<alias>` where `<alias>` is the alias defined in the Oracle Wallet.

       See Defining a WebLogic Server Data Source using the Wallet for instructions to define the WebLogic data source using the Oracle Wallet.
    d. Create a zip file with the Oracle Wallet files and add an environment variable `GEOR_WALLET_FILE` pointing to the zipped Oracle Wallet file.

       Ensure that the `GEOR_WALLET_FILE` environment variable is available to the WebLogic Server by starting the server from a terminal where `GEOR_WALLET_FILE` was previously setup or by adding the environment variable definition to the WebLogic Server `setDomainEnv` script located on you WebLogic domain `bin` folder.
2. Optionally, setup a folder for raster Import/Export temporary storage.

   This optional step is required only if you want to import and export raster files using the REST API.
    a. Add an environment variable with name GEOR_IMPORT_EXPORT_FOLDER and the value points to a folder that will be used as a temporary storage for import and export functionality.
    b. Ensure that the `GEOR_IMPORT_EXPORT_FOLDER` environment variable is available to the WebLogic Server by starting the server from a terminal where `GEOR_IMPORT_EXPORT_FOLDER` was previously setup or by adding the environment variable definition to the WebLogic Server `setDomainEnv` script located in your WebLogic domain `bin` folder.

11.3.3 Configuring Each Spatial Web Service

Each spatial web service to be used must be configured independently.

You must perform specific tasks that depend on which web services you will be supporting for use in your environment. You will probably need to create and grant privileges to database users. You may need to download and load special data (such as for geocoding), modify configuration files, or create data sources in WebLogic Server.

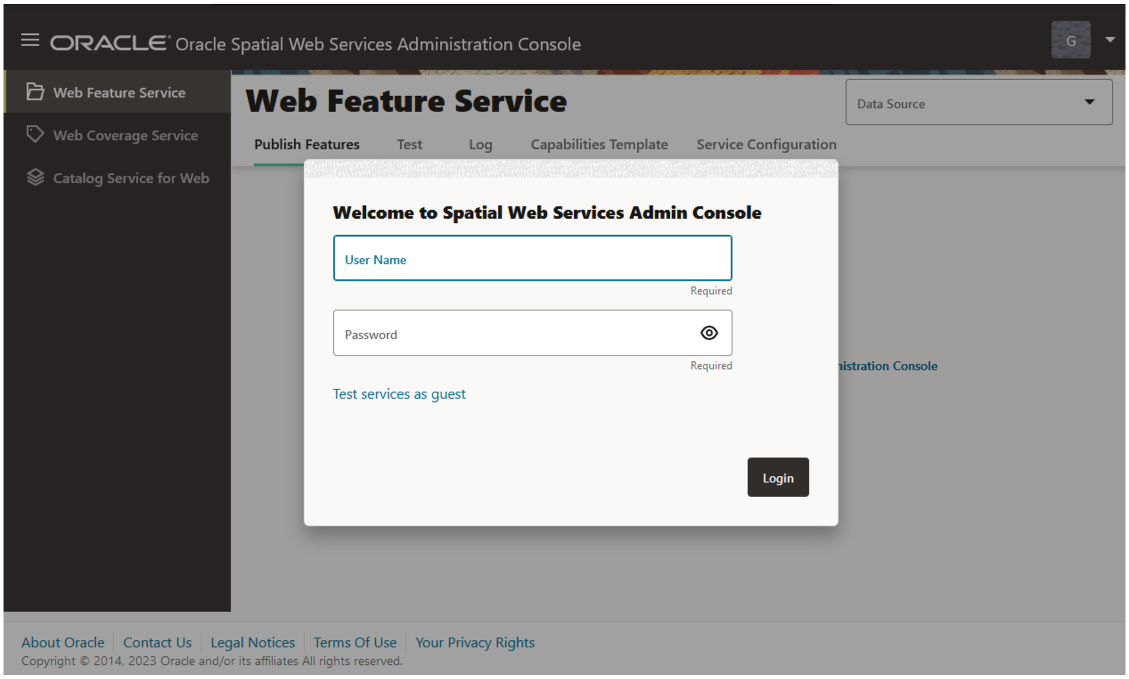
- Spatial Web Services Administration Console
  Oracle Spatial provides a web application to help configure the WFS, WCS, and CSW web service engines.

11.3.3.1 Spatial Web Services Administration Console

Oracle Spatial provides a web application to help configure the WFS, WCS, and CSW web service engines.

The following figure shows the user interface for the Oracle Spatial Web Services Administration Console:

Figure 11-1 Spatial Web Services Administration Console



The user interface for the administration console comprises the following pages:

- **Publish Features:** To add and remove the data that is included for each service
- **Test:** To test the request and response of each service
- **Log:** To display and download log file content for diagnosis
- **Service Configuration:** To configure each service

Use the following URL to launch the administration console in your browser.

```
http://<system-name>:<port>/oraclespatial/
```

As seen in the preceding figure, to login to the application, you can either provide the **User Name** and **Password** credentials for authentication or you can click the **Test service as guest** link which opens the test page. The test page allows you to create the OGC requests by showing all available service operation requests. Note that except the test page all other pages require you to be authenticated.

You can use the user menu on the top right of the page to **Login** or **Log out**. All users are configured in the Oracle WebLogic Server where the administration console is deployed.

The Services menu ☰ is located on the top left of the page.

The Services menu options are as follows:

- **Web Feature Service**
- **Web Coverage Service**
- **Catalog service for the Web**

You can click on any one of the service options to view all the available tabs for the selected service in the main page.

Select a configured data source from the **Data Source** drop-down on the top right of the page for the selected service. You can change the selected data source at any time. Multiple data sources can be configured in WebLogic server to access data from different schemas or databases.

The **Service Configuration** tab allows you to modify service parameters like logging level or service provider information displayed in the `GetCapabilities` response.

The **Test** tab allows you to create simple requests for different operations. You can edit, add, or modify parameters, and then send as HTTP POST/XML request. The responses are also displayed.

The **Log** tab displays the content of the log files to diagnose problems. You can download logs compressed in a zip file which you can use later to diagnose problems.

See Also:

- WFS Administration Console
- WCS Administration Console
- CSW Administration Console

12

Geocoding Address Data

Geocoding is the process of associating spatial locations (longitude and latitude coordinates) with postal addresses.

> **Note:**
>
> Geocoding using SQL that accesses an Oracle managed service is available on Oracle Autonomous Database. See SDO_GCDR.ELOC_GEOCODE and SDO_GCDR.ELOC_GEOCODE_AS_GEOM for more information.

- Concepts for Geocoding
  This topic describes concepts that you must understand before you use the Spatial geocoding capabilities.
- Data Types for Geocoding
  This topic describes the data types specific to geocoding functions and procedures.
- Using the Geocoding Capabilities
  To use the Oracle Spatial geocoding capabilities, you must use data provided by a geocoding vendor, and the data must be in the format supported by the Oracle Spatial geocoding feature.
- Geocoding from a Place Name
  If you know a place name (point of interest) but not its locality details, you can create a PL/SQL function to construct an SDO_GEO_ADDR object from `placename` and `country` input parameters.
- Data Structures for Geocoding
  Oracle uses the following tables for geocoding.
- Installing the Profile Tables
  The Oracle Geocoder profile tables are typically supplied by a data provider.
- Using the Geocoding Service (XML API)
  In addition to the SQL API, Oracle Spatial also provides an XML API for a geocoding service that enables you to geocode addresses.

12.1 Concepts for Geocoding

This topic describes concepts that you must understand before you use the Spatial geocoding capabilities.

- Address Representation
- Match Modes
- Match Codes
- Error Messages for Output Geocoded Addresses
- Match Vector for Output Geocoded Addresses

12.1.1 Address Representation

Addresses to be geocoded can be represented either as formatted addresses or unformatted addresses.

A **formatted address** is described by a set of attributes for various parts of the address, which can include some or all of those shown in Table 12-1.

Table 12-1 Attributes for Formal Address Representation

Address Attribute	Description
Name	Place name (optional).
Intersecting street	Intersecting street name (optional).
Street	Street address, including the house or building number, street name, street type (Street, Road, Blvd, and so on), and possibly other information. In the current release, the first four characters of the street name must match a street name in the geocoding data for there to be a potential street name match.
Settlement	The lowest-level administrative area to which the address belongs. In most cases it is the city. In some European countries, the settlement can be an area within a large city, in which case the large city is the municipality.
Municipality	The administrative area above settlement. Municipality is not used for United States addresses. In European countries where cities contain settlements, the municipality is the city.
Region	The administrative area above municipality (if applicable), or above settlement if municipality does not apply. In the United States, the region is the state; in some other countries, the region is the province.
Postal code	Postal code (optional if administrative area information is provided). In the United States, the postal code is the 5-digit ZIP code.
Postal add-on code	String appended to the postal code. In the United States, the postal add-on code is typically the last four numbers of a 9-digit ZIP code specified in "5-4" format.
Country	The country name or ISO country code.

Formatted addresses are specified using the SDO_GEO_ADDR data type, which is described in SDO_GEO_ADDR Type.

An **unformatted address** is described using lines with information in the postal address format for the relevant country. The address lines must contain information essential for geocoding, and they might also contain information that is not needed for geocoding (something that is common in unprocessed postal addresses). An unformatted address is stored as an array of strings. For example, an address might consist of the following strings: '22 Monument Square' and 'Concord, MA 01742'.

Unformatted addresses are specified using the SDO_KEYWORDARRAY data type, which is described in SDO_KEYWORDARRAY Type.

12.1.2 Match Modes

The match mode for a geocoding operation determines how closely the attributes of an input address must match the data being used for the geocoding. Input addresses can include different ways of representing the same thing (such as *Street* and the abbreviation *St*), and they can include minor errors (such as the wrong postal code, even though the street address and city are correct and the street address is unique within the city).

You can require an exact match between the input address and the data used for geocoding, or you can relax the requirements for some attributes so that geocoding can be performed despite certain discrepancies or errors in the input addresses. Table 12-2 lists the match modes and their meanings. Use a value from this table with the `MatchMode` attribute of the SDO_GEO_ADDR data type (described in SDO_GEO_ADDR Type) and for the `match_mode` parameter of a geocoding function or procedure.

Table 12-2 Match Modes for Geocoding Operations

Match Mode	Description
EXACT	All attributes of the input address must match the data used for geocoding. However, if the house or building number, base name (street name), street type, street prefix, and street suffix do not all match the geocoding data, a location in the first match found in the following is returned: postal code, city or town (settlement) within the state, and state. For example, if the street name is incorrect but a valid postal code is specified, a location in the postal code is returned.
RELAX_STREET_TYPE	The street type can be different from the data used for geocoding. For example, if *Main St* is in the data used for geocoding, *Main Street* would also match that, as would *Main Blvd* if there was no *Main Blvd* and no other street type named *Main* in the relevant area.
RELAX_POI_NAME	The name of the point of interest does not have to match the data used for geocoding. For example, if *Jones State Park* is in the data used for geocoding, *Jones State Pk* and *Jones Park* would also match as long as there were no ambiguities or other matches in the data.
RELAX_HOUSE_NUMBER	The house or building number and street type can be different from the data used for geocoding. For example, if *123 Main St* is in the data used for geocoding, *123 Main Lane* and *124 Main St* would also match as long as there were no ambiguities or other matches in the data.
RELAX_BASE_NAME	The base name of the street, the house or building number, and the street type can be different from the data used for geocoding. For example, if *Pleasant Valley* is the base name of a street in the data used for geocoding, *Pleasant Vale* would also match as long as there were no ambiguities or other matches in the data.
RELAX_POSTAL_CODE	The postal code (if provided), base name, house or building number, and street type can be different from the data used for geocoding.
RELAX_BUILTUP_AREA	The address can be outside the city specified as long as it is within the same county. Also includes the characteristics of RELAX_POSTAL_CODE.
RELAX_ALL	Equivalent to RELAX_BUILTUP_AREA.
DEFAULT	Equivalent to RELAX_POSTAL_CODE.

12.1.3 Match Codes

The match code is a number indicating which input address attributes matched the data used for geocoding. The match code is stored in the `MatchCode` attribute of the output SDO_GEO_ADDR object (described in SDO_GEO_ADDR Type).

Table 12-3 lists the possible match code values.

Table 12-3 Match Codes for Geocoding Operations

Match Code	Description
1	Exact match: the city name, postal code, street base name, street type (and suffix or prefix or both, if applicable), and house or building number match the data used for geocoding.
2	The city name, postal code, street base name, and house or building number match the data used for geocoding, but the street type, suffix, or prefix does not match.
3	The city name, postal code, and street base name match the data used for geocoding, but the house or building number does not match.
4	The city name and postal code match the data used for geocoding, but the street address does not match.
10	The city name matches the data used for geocoding, but the postal code does not match.
11	The postal code matches the data used for geocoding, but the city name does not match.
12	The region matches the data in the geocoder schema, but the city name and postal code do not match.

12.1.4 Error Messages for Output Geocoded Addresses

> **Note:**
>
> You are encouraged to use the `MatchVector` attribute (see Match Vector for Output Geocoded Addresses) instead of the `ErrorMessage` attribute, which is described in this section.

For an output geocoded address, the `ErrorMessage` attribute of the SDO_GEO_ADDR object (described in SDO_GEO_ADDR Type) contains a string that indicates which address attributes have been matched against the data used for geocoding. Before the geocoding operation begins, the string is set to the value `???????????281C??`; and the value is modified to reflect which attributes have been matched.

Table 12-4 lists the character positions in the string and the address attribute corresponding to each position. It also lists the character value that the position is set to if the attribute is matched.

Table 12-4 Geocoded Address Error Message Interpretation

Position	Attribute	Value If Matched
1-2	(Reserved for future use)	??
3	Address point	X

Table 12-4 (Cont.) Geocoded Address Error Message Interpretation

Position	Attribute	Value If Matched
4	POI name	O
5	House or building number	#
6	Street prefix	E
7	Street base name	N
8	Street suffix	U
9	Street type	T
10	Secondary unit	S
11	Built-up area or city	B
12-13	(Reserved)	(Ignore any values in these positions.)
14	Region	1
15	Country	C
16	Postal code	P
17	Postal add-on code	A

12.1.5 Match Vector for Output Geocoded Addresses

For an output geocoded address, the `MatchVector` attribute of the SDO_GEO_ADDR object (described in SDO_GEO_ADDR Type) contains a string that indicates how each address attribute has been matched against the data used for geocoding. It gives more accurate and detailed information about the match status of each address attribute than the `ErrorMessage` attribute (described in Error Messages for Output Geocoded Addresses). Before the geocoding operation begins, the string is set to the value `?????????????????`. Each character of this string indicates the match status of an address attribute.

Table 12-5 lists the character positions in the string and the address attribute corresponding to each position. Following the table is an explanation of what the value in each character position represents.

Table 12-5 Geocoded Address Match Vector Interpretation

Position	Attribute
1-2	(Reserved for future use)
3	Address point location (not interpolated)
4	POI name
5	House or building number
6	Street prefix
7	Street base name
8	Street suffix
9	Street type
10	Secondary unit
11	Built-up area or city

Table 12-5 (Cont.) Geocoded Address Match Vector Interpretation

Position	Attribute
14	Region
15	Country
16	Postal code
17	Postal add-on code

Each character position in Table 12-5 can have one of the following possible numeric values:

- 0: The input attribute is not null and is matched with a non-null value.
- 1: The input attribute is null and is matched with a null value.
- 2: The input attribute is not null and is replaced by a different non-null value.
- 3: The input attribute is not null and is replaced by a null value.
- 4: The input attribute is null and is replaced by a non-null value.

12.2 Data Types for Geocoding

This topic describes the data types specific to geocoding functions and procedures.

- SDO_GEO_ADDR Type
- SDO_ADDR_ARRAY Type
- SDO_KEYWORDARRAY Type

12.2.1 SDO_GEO_ADDR Type

The SDO_GEO_ADDR object type is used to describe an address. When a geocoded address is output by an SDO_GCDR function or procedure, it is stored as an object of type SDO_GEO_ADDR.

Table 12-6 lists the attributes of the SDO_GEO_ADDR type. Not all attributes will be relevant in any given case. The attributes used for a returned geocoded address depend on the geographical context of the input address, especially the country.

Table 12-6 SDO_GEO_ADDR Type Attributes

Attribute	Data Type	Description
Id	NUMBER	(Not used.)
AddressLines	SDO_KEYWORDARRAY	Address lines. (The SDO_KEYWORDARRAY type is described in SDO_KEYWORDARRAY Type.)
PlaceName	VARCHAR2(200)	Point of interest (POI) name. Example: *CALIFORNIA PACIFIC MEDICAL CTR*
StreetName	VARCHAR2(200)	Street name, including street type. Example: *MAIN ST*
IntersectStreet	VARCHAR2(200)	Intersecting street.
SecUnit	VARCHAR2(200)	Secondary unit, such as an apartment number or building number.

Table 12-6 (Cont.) SDO_GEO_ADDR Type Attributes

Attribute	Data Type	Description
Settlement	VARCHAR2(200)	Lowest-level administrative area to which the address belongs. (See Table 12-1.)
Municipality	VARCHAR2(200)	Administrative area above settlement. (See Table 12-1.)
Region	VARCHAR2(200)	Administrative area above municipality (if applicable), or above settlement if municipality does not apply. (See Table 12-1.)
Country	VARCHAR2(100)	Country name or ISO country code.
PostalCode	VARCHAR2(20)	Postal code (optional if administrative area information is provided). In the United States, the postal code is the 5-digit ZIP code.
PostalAddOnCode	VARCHAR2(20)	String appended to the postal code. In the United States, the postal add-on code is typically the last four numbers of a 9-digit ZIP code specified in "5-4" format.
FullPostalCode	VARCHAR2(20)	Full postal code, including the postal code and postal add-on code.
POBox	VARCHAR2(100)	Post Office box number.
HouseNumber	VARCHAR2(100)	House or building number. Example: *123* in *123 MAIN ST*
BaseName	VARCHAR2(200)	Base name of the street. Example: *MAIN* in *123 MAIN ST*
StreetType	VARCHAR2(20)	Type of the street. Example: ST in *123 MAIN ST*
StreetTypeBefore	VARCHAR2(1)	(Not used.)
StreetTypeAttached	VARCHAR2(1)	(Not used.)
StreetPrefix	VARCHAR2(20)	Prefix for the street. Example: *S* in *123 S MAIN ST*
StreetSuffix	VARCHAR2(20)	Suffix for the street. Example: *NE* in *123 MAIN ST NE*
Side	VARCHAR2(1)	Side of the street (`L` for left or `R` for right) that the house is on when you are traveling along the road segment following its orientation (that is, from its start node toward its end node). The house numbers may be increasing or decreasing.
Percent	NUMBER	Number from 0 to 1 (multiply by 100 to get a percentage value) indicating how far along the street you are when traveling following the road segment orientation.
EdgeID	NUMBER	Edge ID of the road segment.
ErrorMessage	VARCHAR2(20)	Error message (see Error Messages for Output Geocoded Addresses). Note: You are encouraged to use the `MatchVector` attribute instead of the `ErrorMessage` attribute.
MatchCode	NUMBER	Match code (see Match Codes).
MatchMode	VARCHAR2(30)	Match mode (see Match Modes).
Longitude	NUMBER	Longitude coordinate value.
Latitude	NUMBER	Latitude coordinate value.

Table 12-6 (Cont.) SDO_GEO_ADDR Type Attributes

Attribute	Data Type	Description
MatchVector	VARCHAR2(20)	A string that indicates how each address attribute has been matched against the data used for geocoding (see Match Vector for Output Geocoded Addresses).

You can return the entire SDO_GEO_ADDR object, or you can specify an attribute using standard "dot" notation. Example 12-1 contains statements that geocode the address of the San Francisco City Hall; the first statement returns the entire SDO_GEO_ADDR object, and the remaining statements return some specific attributes.

Example 12-1 Geocoding, Returning Address Object and Specific Attributes

```
SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
    'US', 'RELAX_BASE_NAME') FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'CARLTON B GOODLETT PL', NULL, NULL, '
SAN FRANCISCO', NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '1', 'CARLTON B
GOODLETT', 'PL', 'F', 'F', NULL, NULL, 'L', .01, 23614360, '????#ENUT?B281CP?',
1, 'RELAX_BASE_NAME', -122.41815, 37.7784183, '????0101010??000?')

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').StreetType  FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
PL

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').Side  RROM DUAL;

S
-
L

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').Percent  FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
                                                                             .01

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').EdgeID  FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
                                                                        23614360

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').MatchCode  FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
                                                                               1

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US', 'RELAX_BASE_NAME').MatchVector  FROM DUAL;

SDO_GCDR.GEOCODE('SC
--------------------
????0101010??000?
```

12.2.2 SDO_ADDR_ARRAY Type

The SDO_ADDR_ARRAY type is a VARRAY of SDO_GEO_ADDR objects (described in SDO_GEO_ADDR Type) used to store geocoded address results. Multiple address objects can be returned when multiple addresses are matched as a result of a geocoding operation.

The SDO_ADDR_ARRAY type is defined as follows:

```
CREATE TYPE sdo_addr_array AS VARRAY(1000) OF sdo_geo_addr;
```

12.2.3 SDO_KEYWORDARRAY Type

The SDO_KEYWORDARRAY type is a VARRAY of VARCHAR2 strings used to store address lines for unformatted addresses. (Formatted and unformatted addresses are described in Address Representation.)

The SDO_KEYWORDARRAY type is defined as follows:

```
CREATE TYPE sdo_keywordarray AS VARRAY(10000) OF VARCHAR2(9000);
```

12.3 Using the Geocoding Capabilities

To use the Oracle Spatial geocoding capabilities, you must use data provided by a geocoding vendor, and the data must be in the format supported by the Oracle Spatial geocoding feature.

To geocode an address using the geocoding data, use the SDO_GCDR PL/SQL package subprograms, which are documented in SDO_GCDR Package (Geocoding) :

- The SDO_GCDR.ELOC_GEOCODE function applies only if you are working on Oracle Autonomous Database. Depending on the input parameters, the function performs one of the following actions:
  - Geocodes a formatted (address parts in separate fields) address
  - Geocodes an unformatted (complete address in a single string field) address
  - Reverse geocodes the specified location

  The function returns the output address in JSON format.
- The SDO_GCDR.ELOC_GEOCODE_AS_GEOM function applies only if you are working on Oracle Autonomous Database. Depending on the input parameters, the function geocodes a formatted (address parts in separate fields) or an unformatted (complete address in a single string field) address and returns the output address as an SDO_GEOMETRY object.

- The SDO_GCDR.GEOCODE function geocodes an unformatted address to return an SDO_GEO_ADDR object.
- The SDO_GCDR.GEOCODE_ADDR function geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns the first matched address as an SDO_GEO_ADDR object.
- The SDO_GCDR.GEOCODE_ADDR_ALL function geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns matching addresses as an SDO_ADDR_ARRAY object.
- The SDO_GCDR.GEOCODE_AS_GEOMETRY function geocodes an unformatted address to return an SDO_GEOMETRY object.
- The SDO_GCDR.GEOCODE_ALL function geocodes all addresses associated with an unformatted address and returns the result as an SDO_ADDR_ARRAY object (an array of address objects).
- The SDO_GCDR.REVERSE_GEOCODE function reverse geocodes a location, specified by its spatial geometry object and country, and returns the result as an SDO_GEO_ADDR object.

12.4 Geocoding from a Place Name

If you know a place name (point of interest) but not its locality details, you can create a PL/SQL function to construct an SDO_GEO_ADDR object from `placename` and `country` input parameters.

This is shown in Example 12-2, which creates a function named `create_addr_from_placename`. The SELECT statement in this example uses the SDO_GCDR.GEOCODE_ADDR function to geocode the address constructed using the `create_addr_from_placename` function.

Example 12-2 Geocoding from a Place Name and Country

```
create or replace function create_addr_from_placename(
placename varchar2,
country varchar2)
return sdo_geo_addr
deterministic
as
  addr sdo_geo_addr ;
  begin
  addr := sdo_geo_addr() ;
  addr.country := country ;
  addr.placename := placename ;
  addr.matchmode := 'default' ;
  return addr ;
  end;
  /

SELECT sdo_gcdr.geocode_addr('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'))
FROM DUAL;
```

Example 12-3 Geocoding from a Place Name, Country, and Other Fields

If you know at least some of the locality information, such as settlement, region, and postal code, you can get better performance if you can provide such information. Example 12-3 provides an alternate version of the `create_addr_from_placename` function that accepts additional parameters. To call this version of the function, specify actual values for the placename and country parameters, and specify an actual value or a null value for each of the other input parameters.

```
create or replace function create_addr_from_placename(
placename varchar2,
city varchar2,
state varchar2,
postalcode varchar2,
country varchar2)
return sdo_geo_addr
deterministic
as
  addr sdo_geo_addr ;
  begin
  addr := sdo_geo_addr() ;
  addr.settlement := city ;
  addr.region := state ;
  addr.postalcode := postalcode ;
  addr.country := country ;
  addr.placename := placename ;
  addr.matchmode := 'default' ;
  return addr ;
  end;
  /

SELECT sdo_gcdr.geocode_addr('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR',
    'san francisco', 'ca', null, 'US')) FROM DUAL;
```

12.5 Data Structures for Geocoding

Oracle uses the following tables for geocoding.

- GC_PARSER_PROFILES
- GC_PARSER_PROFILEAFS
- GC_COUNTRY_PROFILE
- GC_AREA_<suffix>
- GC_POSTAL_CODE_<suffix>
- GC_ROAD_SEGMENT_<suffix>
- GC_ROAD_<suffix>
- GC_POI_<suffix>
- GC_INTERSECTION_<suffix>

The GC_PARSER_PROFILES and GC_PARSER_PROFILEAFS tables store address format definitions of all supported counties. These tables are used by the internal address parser in parsing postal addresses into addressing fields. The data for these two tables is provided by your data provider or by Oracle. (If these tables are not supplied by your data provider, you will need to install and populate them as explained in Installing the Profile Tables.) The remaining tables store geocoding data provided by data vendors.

Each user that owns the tables containing geocoding data (that is, each user that can be specified with the `username` parameter in a call to an SDO_GCDR subprogram) must have one GC_PARSER_PROFILES table, one GC_PARSER_PROFILEAFS table, and one GC_COUNTRY_PROFILE table. Each such user can have multiple sets of the other tables (GC_*xxx*_<suffix>). Each set of tables whose names end with the same suffix stores geocoding data of a country. For example, the following set of tables can be used to store geocoding data of the United States:

- GC_AREA_US
- GC_POSTAL_CODE_US
- GC_ROAD_SEGMENT_US
- GC_ROAD_US
- GC_POI_US
- GC_INTERSECTION_US

Geocoding data of one country cannot be stored in more than one set of those tables. The table suffix is defined by data venders and is specified in the GC_TABLE_SUFFIX column in the GC_COUNTRY_PROFILE table (described in GC_COUNTRY_PROFILE Table).

The following sections describe the vendor-supplied tables that store geocoding data, in alphabetical order by table name.

Indexes on Tables for Geocoding describes the indexes that you must create in order to use these tables for geocoding.

- GC_ADDRESS_POINT_<suffix> Table and Index
- GC_AREA_<suffix> Table
- GC_COUNTRY_PROFILE Table
- GC_INTERSECTION_<suffix> Table
- GC_PARSER_PROFILES Table
- GC_PARSER_PROFILEAFS Table
- GC_POI_<suffix> Table
- GC_POSTAL_CODE_<suffix> Table
- GC_ROAD_<suffix> Table
- GC_ROAD_SEGMENT_<suffix> Table
- Indexes on Tables for Geocoding

12.5.1 GC_ADDRESS_POINT_<suffix> Table and Index

The GC_ADDRESS_POINT_<suffix> table (for example, GC_ADDRESS_POINT_US) stores the geographic (latitude, longitude) coordinates for addresses in the country or group of countries associated with the table-name suffix. This table is *not* required for geocoding (although it is required for point-based geocoding); however, it enables the geocoder to provide more accurate location results. It is automatically used when present in the schema. This table contains one row for each address stored in the table, and it contains the columns shown in Table 12-7.

Table 12-7 GC_ADDRESS_POINT_<suffix> Table

Column Name	Data Type	Description
ADDRESS_POINT_ID	NUMBER(10)	ID number of the address point. (Required)
ROAD_ID	NUMBER	ID number of the road on which the address point is located. (Required)

Table 12-7 (Cont.) GC_ADDRESS_POINT_<suffix> Table

Column Name	Data Type	Description
ROAD_SEGMENT_ID	NUMBER(10)	ID number of the road segment on the road on which the address point is located. (Required)
SIDE	VARCHAR2(1)	Side of the road on which the address point is located. Possible values: `L` (left) or `R` (right). (Required)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the address point. (Required) point
HOUSE_NUMBER	VARCHAR2(600 CHAR)	House number of the address point; may contain non-numeric characters. (Required)
PERCENT	NUMBER	Decimal fraction of the length of the road segment on which the address point is located. It is computed by dividing the distance from the segment start point to the address point by the length of the road segment. (Required).
ADDR_LONG	NUMBER(10)	Longitude coordinate value of the address point. (Required)
ADDR_LAT	NUMBER(10)	Latitude coordinate value of the address point. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the address point belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

If you use the GC_ADDRESS_POINT_<suffix> table, you must create an index on the table using a statement in the following form:

```
CREATE INDEX idx_<suffix>_addrpt_addr ON gc_address_point_<suffix> (road_segment_id,
road_id, house_number, side);
```

12.5.2 GC_AREA_<suffix> Table

The GC_AREA_<suffix> table (for example, CG_AREA_US) stores administration area information for the country associated with the table name suffix. This table contains one row for each administration area, and it contains the columns shown in Table 12-8.

Table 12-8 GC_AREA_<suffix> Table

Column Name	Data Type	Description
AREA_ID	NUMBER(10)	Area ID number. (Required)
AREA_NAME	VARCHAR2(64)	Area name. (Required)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the area. (Required)
ADMIN_LEVEL	NUMBER(1)	Administration hierarchy level for the area. (Required)
LEVEL1_AREA_ID	NUMBER(10)	ID of the level-1 area to which the area belongs. In the administration hierarchy, the level-1 area is the country. (Required)
LEVEL2_AREA_ID	NUMBER(10)	ID of the level-2 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)

Table 12-8 (Cont.) GC_AREA_<suffix> Table

Column Name	Data Type	Description
LEVEL3_AREA_ID	NUMBER(10)	ID of the level-3 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL4_AREA_ID	NUMBER(10)	ID of the level-4 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL5_AREA_ID	NUMBER(10)	ID of the level-5 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL6_AREA_ID	NUMBER(10)	ID of the level-6 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL7_AREA_ID	NUMBER(10)	ID of the level-7 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
CENTER_LONG	NUMBER	Longitude value of the center of the area. The center is set to the closest road segment to the center longitude and latitude values. Oracle recommends that these two attributes be set properly. If these values are not set, the longitude and latitude coordinates of the geocoded result of an area will be (0,0). (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (See the explanation for the CENTER_LONG column.) (Optional)
ROAD_SEGMENT_ID	NUMBER(10)	ID of the road segment to which the area center is set. This value must be set correctly if the geocoder is intended to work with the Oracle Spatial routing engine (described in Routing Engine); otherwise, it can be set to any nonzero value, but it cannot be null. (Required)
POSTAL_CODE	VARCHAR2(16)	Postal code for the center of the area. Oracle recommends that this attribute be set correctly. If this value is null, the postal code attribute of the geocoded result of an area will be null. (Optional)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the area belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

Table 12-8 (Cont.) GC_AREA_<suffix> Table

Column Name	Data Type	Description
REAL_NAME	VARCHAR2(64)	The real name of the area, as spelled using the local language. This column is useful for area names that are not in English. For example, the German name of city `MUNICH` is `MÜNCHEN`. It is allowed to be spelled as `MUNCHEN`, but its REAL_NAME value should be `MÜNCHEN`. In the area table for Germany, areas with name `MÜNCHEN` and `MUNCHEN` both refer to the same area, and they both have the same real name `MÜNCHEN`. If the area name does not have any non-English characters, set REAL_NAME to be the same as AREA_NAME. (Required)
IS_ALIAS	VARCHAR2(1)	Contains `T` if this area is an alias of another area that is an officially recognized administrative area; contains `F` if this area is not an alias of another area that is an officially recognized administrative area. For example, Manhattan is not an officially recognized administrative area, but it is used by the public to refer to a part of New York City. In this case, `Manhattan` is an alias of `New York City`. (Required)
NUM_STREETS	NUMBER	The number of streets inside this area. (Optional)

12.5.3 GC_COUNTRY_PROFILE Table

The GC_COUNTRY_PROFILE table stores country profile information used by the geocoder. This information includes administrative-area hierarchy definitions, the national languages, and the table-name suffix used by the data tables and their indexes. This table contains one row for each supported country, and it contains the columns shown in Table 12-9.

Table 12-9 GC_COUNTRY_PROFILE Table

Column Name	Data Type	Description
COUNTRY_NAME	VARCHAR2(60)	Country name. (Required)
COUNTRY_CODE_3	VARCHAR2(3)	3- letter ISO country code. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code. (Required)
LANG_CODE_1	VARCHAR2(3)	3-letter ISO national language code. Some countries might have multiple national languages, in which case LANG_CODE_2 and perhaps other LANG_CODE_*n* columns should contain values. (Required)
LANG_CODE_2	VARCHAR2(3)	3-letter ISO national language code. (Optional)
LANG_CODE_3	VARCHAR2(3)	3-letter ISO national language code. (Optional)
LANG_CODE_4	VARCHAR2(3)	3-letter ISO national language code. (Optional)
NUMBER_ADMIN_LEVELS	NUMBER(1)	Number of administration hierarchy levels. A country can have up to 7 administration area levels, numbered from 1 to 7 (largest to smallest). The top level area (country) is level 1. For the United States, the administration hierarchy is as follows: level 1 = country, level 2 = state, level 3 = county, level 4 = city. (Required)

Table 12-9 (Cont.) GC_COUNTRY_PROFILE Table

Column Name	Data Type	Description
SETTLEMENT_LEVEL	NUMBER(1)	Administration hierarchy level for a settlement, which is the lowest area level used in addressing. In the United States, this is the city level; in Europe, this is generally a subdivision of a city (level 5). (Required)
MUNICIPALITY_LEVEL	NUMBER(1)	Administration hierarchy level for a municipality, which is the second-lowest area level used in addressing. In the United States, this is the county (level 3); in Europe, this is generally a city (level 4). (Optional)
REGION_LEVEL	NUMBER(1)	Administrative level for the region, which is above the municipality level. In the United States, this is the state or third-lowest area level used in addressing (level 2); in Europe, this is a recognized subdivision of the country (level 2 or level 3). (Optional)
SETTLEMENT_IS_OPTIONAL	VARCHAR2(1)	Contains `T` if settlement information is optional in the address data; contains `F` if settlement information is not optional (that is, is required) in the address data. (Required)
MUNICIPALITY_IS_OPTIONAL	VARCHAR2(1)	Contains `T` if municipality information is optional in the address data; contains `F` if municipality information is not optional (that is, is required) in the address data. (Required)
REGION_IS_OPTIONAL	VARCHAR2(1)	Contains `T` if region information is optional in the address data; contains `F` if region information is not optional (that is, is required) in the address data. (Required)
POSTCODE_IN_SETTLEMENT	VARCHAR(1)	Contains `T` if each postal code must be completely within a settlement area; contains `F` if a postal code can include areas from multiple settlements. (Required)
SETTLEMENT_AS_CITY	VARCHAR(1)	Contains `T` if a city name can identify both a municipality and a settlement; contains `F` if a city name can identify only a settlement. For example, in the United Kingdom, London can be both the name of a municipality area and the name of a settlement area, which is inside the municipality of London. This is common in large cities in some European countries, such as the UK and Belgium. (Required)
CACHED_ADMIN_AREA_LEVEL	NUMBER	(Reserved for future use.)
GC_TABLE_SUFFIX	VARCHAR2(5)	Table name suffix identifying the country for the GC_* data tables. For example, if the value of GC_TABLE_SUFFIX is `US`, the names of tables with geocoding data for this country end with `_US` (for example, CG_AREA_US). (Required)
CENTER_LONG	NUMBER	Longitude value of the center of the area. (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (Optional)
SEPARATE_PREFIX	VARCHAR2(1)	Contains `T` if the street name prefix is a separate word from the street name; contains `F` if the street name prefix is in the same word with the street name. For example, in an American street address of `123 N Main St`, the prefix is `N`, and it is separate from the street name, which is `Main`. (Optional; not currently used by Oracle)

Table 12-9 (Cont.) GC_COUNTRY_PROFILE Table

Column Name	Data Type	Description
SEPARATE_SUFFIX	VARCHAR2(1)	Contains `T` if the street name suffix is a separate word from the street name; contains `F` if the street name suffix is in the same word with the street name. For example, in an American street address of `123 Main St NW`, the suffix is `NW`, and it is separate from the street name, which is `Main`, and from the street type, which is `St`. (Optional; not currently used by Oracle)
SEPARATE_STYPE	VARCHAR2(1)	Contains `T` if the street type is a separate word from the street name; contains `F` if the street type is in the same word with the street name. For example, in a German street address of `123 Beethovenstrass`, the type is `strass`, and it is in the same word with the street name, which is `Beethoven`. (Optional; not currently used by Oracle)
AREA_ID	NUMBER	Not currently used by Oracle. (Optional)
VERSION	VARCHAR2(10)	Version of the data. The first version should be `1.0`. (Required)

12.5.4 GC_INTERSECTION_<suffix> Table

The GC_INTERSECTION_<suffix> table (for example, GC_INTERSECTION_US) stores information on road intersections for the country or group of countries associated with the table-name suffix. An intersection occurs when roads meet or cross each other. This table contains the columns shown in Table 12-10.

Table 12-10 GC_INTERSECTION_<suffix> Table

Column Name	Data Type	Description
ROAD_ID_1	NUMBER	ID number of the first road on which the intersection is located. (Required)
ROAD_SEGMENT_ID_1	NUMBER	ID number of the road segment on the first road on which the intersection is located. (Required)
ROAD_ID_2	NUMBER	ID number of the second road on which the intersection is located. (Required)
ROAD_SEGMENT_ID_2	NUMBER	ID number of the road segment on the second road on which the intersection is located. (Required)
INTS_LONG	NUMBER	Longitude coordinate value of the intersection. (Required)
INTS_LAT	NUMBER	Latitude coordinate value of the intersection. (Required)
HOUSE_NUMBER	NUMBER	The leading numerical part of the house number at the intersection. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) (Required)
HOUSE_NUMBER_2	VARCHAR2(10)	The second part of the house number at the intersection. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) (Required)
SIDE	VARCHAR2(1)	Side of the street on which the house at the intersection is located. Possible values: `L` (left) or `R` (right). (Required)

Table 12-10 (Cont.) GC_INTERSECTION_<suffix> Table

Column Name	Data Type	Description
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the house at the intersection belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

12.5.5 GC_PARSER_PROFILES Table

The GC_PARSER_PROFILES table stores information about keywords typically found in postal addresses. The geocoder uses keywords to identify address fields, such as house number, road name, city name, state name, and postal code. A keyword can be the type of street (such as road, street, drive, or avenue) or the prefix or suffix of a street (such as north, south, east, or west). This table contains the columns shown in Table 12-11.

Table 12-11 GC_PARSER_PROFILES Table

Column Name	Data Type	Description
COUNTRY_CODE	VARCHAR2(2)	2- letter ISO country code of the country for the keyword. (Required)

KEYWORDS	SDO_KEYWORDARRAY	A single array of keywords for a specific address field. The array may contain a single word, or a group of words and abbreviations that can be used with the same meaning; for example, *United States of America*, *USA*, and *United States* all refer to the US. The first word of this array should be the official full name of the keyword, if there is any. The US uses over 400 keywords in parsing addresses. The following are some examples of keyword arrays and keywords from the US data set; however, only a single SDO_KEYWORDARRAY object is stored in each row:
		SDO_KEYWORDARRAY('UNITED STATES OF AMERICA','US', 'USA', 'UNITED STATES', 'U.S.A.', 'U.S.')
		SDO_KEYWORDARRAY('AVENUE','AV', 'AVE', 'AVEN', 'AVENU', 'AVN', 'AVNUE', 'AV.','AVE.')
		SDO_KEYWORDARRAY('40TH', 'FORTIETH')
		SDO_KEYWORDARRAY('NEW YORK','NY')
		SDO_KEYWORDARRAY('LIBRARY')

Table 12-11 (Cont.) GC_PARSER_PROFILES Table

Column Name	Data Type	Description

OUTPUT_KEYWORD	VARCHAR2(2000)	A keyword used in the geocoder data to represent an address field. It must be the same as one of the keywords used in the keyword array. The output keyword is used to match the addresses stored in the geocoding data tables to the user's input, for example, if the output keyword `AV` is used for street type `Avenue` in the GC_ROAD_US table, wherever a user enters an address containing any of the keywords (*AVENUE*, *AV*, *AVE*, *AVEN*, *AVENU*, *AVN*, *AVNUE*, *AV.*, *AVE.*), the keyword will be interpreted and matched to the output keyword `AV` to help find the address in the database The following are some examples of output keywords; however, only a single output keyword is stored in each row:
		`US`
		`AV`
		`40TH`
		`NY`
		`LIBRARY`

Table 12-11 (Cont.) GC_PARSER_PROFILES Table

Column Name	Data Type	Description
SECTION_LABEL	VARCHAR2(30)	A label used to identify the type of keyword represented in the KEYWORDS and OUTPUT_KEYWORD columns. There are the multiple different section labels; however, only a single section label for each row is used in identifying the type of keywords: COUNTRY_NAME: Identifies keywords that are used to represent country names. LOCALITY_KEYWORD_DICTIONARY: Identifies keywords that are used to replace words in a locality (city, state, province, and so on) with a standardized form of the word. For example, *Saint* is replaced by *St*; and by doing so, the city names *Saint Thomas* and *St. Thomas* will be standardized to *St Thomas*, which is stored in the database. PLACE_NAME_KEYWORD: Identifies a point of interest (POI) name keyword, such as for a restaurant or a hotel. REGION_LIST: Identifies keywords that are known names of regions, such as *NY*, *New York*, *NH*, and *New Hampshire*. The regions identified must be administrative areas that belong to the third-lowest area level or third-smallest area used in addressing. In the US this is the state level (the lowest area level or smallest area is the city level). SECOND_UNIT_KEYWORD: Identifies keywords used in second-unit descriptions, such as *Floor*, *#*, *Suite*, and *Apartment*. STREET_KEYWORD_DICTIONARY: Identifies keywords used to replace non-street-type keywords in street names (such as *40TH* and *Fortieth*) with a standardized form. STREET_PREFIX_KEYWORD: Identifies street name prefix keywords, such as *South*, *North*, *West*, and *East*. STREET_TYPE_KEYWORD: Identifies street type keywords, such as *Road*, *Street*, and *Drive*. IN_LINE_STREET_TYPE_KEYWORD: Identifies street type keywords that are attached to street names, such as *strasse* in the German street name *Steinstrasse*.
POSITION	VARCHAR2(1)	The position of the keyword relative to a street name. It indicates whether the keyword can precede (`P`) or follow (`F`) the actual street name, or both (`B`). Thus, `P`, `F`, and `B` are the only valid entries. In the US, most street type keywords follow the street names, for example, the street type `Blvd` in *Hollywood Blvd*. In France, however, street type keywords usually precede the street names, for example, the street type `Avenue` in *Avenue De Paris*.
SEPARATENESS	VARCHAR2(1)	Indicates whether the keyword is separate from a street name. Keywords are either separable (`S`) or non-separable (`N`). Thus, `S` and `N` are the only valid entries. In the US, all street-type keywords are separate words from the street name, for example, the street type `Blvd` in *Hollywood Blvd*. In Germany, however, the street-type keywords are not separate from the street name, for example, the street type `strasse` in *Augustenstrasse*.

12.5.6 GC_PARSER_PROFILEAFS Table

The GC_PARSER_PROFILEAFS table stores the XML definition of postal-address formats. An XML string describes each address format for a specific country. In the Oracle Geocoder 10g and earlier, the J2EE geocoder uses a country_name.ppr file instead of this table. The content of the country_name.ppr file is equivalent to the content of the ADDRESS_FORMAT_STRING attribute. This table contains the columns shown in Table 12-12.

Table 12-12 GC_PARSER_PROFILEAFS Table

Column Name	Data Type	Description
COUNTRY_CODE	VARCHAR2(2)	2- letter ISO country code of the country. (Required)
ADDRESS_FORMAT_STRING	CLOB	XML string describing the address format for the country specified in the COUNTRY_CODE column. (Example 12-4 shows the XML definition for the US address format, and ADDRESS_FORMAT_STRING Description explains the elements used in the US address format definition.).

Example 12-4 shows the ADDRESS_FORMAT_STRING definition for the US address format.

Example 12-4 XML Definition for the US Address Format

```
<address_format unit_separator="," replace_hyphen="true">
 <address_line>
   <place_name />
 </address_line>
 <address_line>
   <street_address>
     <house_number>
       <format form="0*" effective="0-1" output="$" />
       <format form="0*1*" effective="0-1" output="$">
         <exception form="0*TH" />
         <exception form="0*ST" />
         <exception form="0*2ND" />
         <exception form="0*3RD" />
       </format>
       <format form="0*10*" effective="0-1" output="$" />
       <format form="0*-0*" effective="0-1" output="$" />
       <format form="0*.0*" effective="0-1" output="$" />
       <format form="0* 0*/0*" effective="0-1" output="$" />
     </house_number>
     <street_name>
       <prefix />
       <base_name />
        <suffix />
       <street_type />
       <special_format>
   <format form="1* HWY 0*" effective="7-8" addon_effective="0-1" addon_output="$ HWY"/>
   <format form="1* HIGHWAY 0*" effective="11-12" addon_effective="0-1" addon_output="$
HWY"/>
   <format form="1* HWY-0*" effective="7-8" addon_effective="0-1" addon_output="$ HWY"/>
   <format form="1* HIGHWAY-0*" effective="11-12" addon_effective="0-1" addon_output="$
HWY"/>
         <format form="HWY 0*" effective="4-5" addon_output="HWY" />
         <format form="HIGHWAY 0*" effective="8-9" addon_output="HWY" />
         <format form="ROUTE 0*" effective="6-7" addon_output="RT" />
         <format form="I 0*" effective="2-3" addon_output="I" />
         <format form="11 0*" effective="3-4" addon_effective="0-1" />
         <format form="I0*" effective="1-2" addon_output="I" />
         <format form="I-0*" effective="2-3" addon_output="I" />
         <format form="11-0*" effective="3-4" addon_effective="0-1" />
         <format form="ROUTE-0*" effective="6-7" addon_output="RT" />
         <format form="US0*" effective="2-3" addon_output="US" />
         <format form="HWY-0*" effective="2-3" addon_output="US" />
         <format form="HIGHWAY-0*" effective="8-9" addon_output="HWY" />
       </special_format>
     </street_name>
     <second_unit>
       <special_format>
         <format form="# 0*" effective="2-3" output="APT $" />
         <format form="#0*" effective="1-2" output="APT $" />
       </special_format>
     </second_unit>
   </street_address>
 </address_line>
 <address_line>
   <po_box>
     <format form="PO BOX 0*" effective="7-8" />
     <format form="P.O. BOX 0*" effective="9-10" />
     <format form="PO 0*" effective="3-4" />
     <format form="P.O. 0*" effective="5-6" />
     <format form="POBOX 0*" effective="6-7" />
   </po_box>
 </address_line>
 <address_line>
   <city optional="no" />
   <region optional="no" order="1" />
   <postal_code>
     <format form="00000" effective="0-4" />
     <format form="00000-0000" effective="0-4" addon_effective="6-9" />
     <format form="00000 0000" effective="0-4" addon_effective="6-9" />
   </postal_code>
 </address_line>
</address_format>
```

- ADDRESS_FORMAT_STRING Description

12.5.6.1 ADDRESS_FORMAT_STRING Description

The ADDRESS_FORMAT_STRING column of the GC_PARSER_PROFILEAFS table describes the format of address fields and their positioning in valid postal addresses. The address format string is organized by address lines, because postal addresses are typically written in multiple address lines.

The address parser uses the format description defined in the XML address format, combined with the keyword definition for each address field defined in the GC_PARSER_PROFILES table, to parse the input address and identify individual address fields.

<address_format> Element

The `<address_format>` element includes the `unit_separator` and `replace_hyphen` attributes. The `unit_separator` attribute is used to separate fields in the stored data. By default it is a comma (`unit_separator=","`). The `replace_hyphen` attribute specifies whether to replace all hyphens in the user's input with a space. By default it is set to true (`replace_hyphen="true"`), that is, it is expected that all names in the data tables will contain a space instead of a hyphen.

If `replace_hyphen="true"`, administrative-area names in the data tables containing hyphens will not be matched during geocoding if `replace_hyphen="true"`; however, these area names with hyphens can be placed in the REAL_NAME column of the GC_AREA table to be returned as the administrative-area name in the geocoded result. Road names in the NAME column of the GC_ROAD table containing hyphens will, however, be matched during geocoding, but the matching performance will be degraded

<address_line> Elements

Each `<address_line>` element in the XML address format string describes the format of an address line. Each `<address_line>` element can have one or more child elements describing the individual address fields, such as street address, city, state (region or province), and postal code. These address field elements are listed in the order that the address fields appear in valid postal addresses. The `optional` attribute of the address field element is set to `"no"` if the address field is mandatory. By default, address field elements are optional.

<format> Elements

The format descriptions for house number, special street name, post box, and postal code elements are specified with a single or multiple `<format>` elements. Each `<format>` element specifies a valid layout and range of values for a particular address field. The following example illustrates the format used to define a special street name:

```
<format
     form="1* HWY 0*"
     effective="7-8"
     output="$"
     addon_effective="0-1"
     addon_output="$ HIGHWAY" />
```

The `form` attribute uses a regular expression-like string to describe the format: `1` stands for any alphabetic letter; `0` stands for any numerical digit; `2` stands for any alphabetic letter or any numerical digit; `1*` specifies a sting consisting of all alphabetic letters; `0*` specifies a string consisting of all numerical digits; `2*` specifies a string consisting of any combination of numerical digits and alphabetic letters. All other symbols represent themselves.

Any string matching the pattern specified by the `form` attribute is considered to be a valid string for its (parent) address field. A valid string can then be broken down into segments specified by the attributes `effective` and `addon_effective`. The effective attribute specifies the more important, primary piece of the address string; the addon_effective attribute specifies the secondary piece of the address string.

- The `effective` attribute specifies a substring of the full pattern using the start and end positions for the end descriptor of the `form` attribute. In the preceding example, `effective="7-8"` retrieves the substring (counting from position 0) starting at position 7 and ending at position 8, which is the substring defined by `0*`, at the end of the `form` attribute.
- The `addon_effective` attribute specifies a substring of the full pattern using the start and end positions for the start descriptor of the `form` attribute. In the preceding example, `addon_effective="0-1"` retrieves the substring, (counting from position 0) starting at position 0 and ending at position 1, which is the substring defined by `1*`, at the beginning of the `form` attribute.

The `output` and `addon_output` attributes specify the output form of the address string for segments specified by the `effective` and `addon_effective` attributes, respectively. These output forms are used during address matching. The symbol `$` stands for the matched string, and other symbols represent themselves. In the preceding example:

- In `output="$"`, the `$` stands for the substring that was matched in the `effective` attribute.

- In `addon_output="$ HIGHWAY"`, the `$ HIGHWAY` stands for the substring that was matched in the `addon_effective` attribute, followed by a space, followed by the word *HIGHWAY*.

Using the `<format>` element in the preceding example, with `form="1* HWY 0*"`, the input string *'STATE HWY 580'* will have `effective=580`, `output=580`, `addon_effective=STATE`, and `addon_output=STATE HIGHWAY`.

The `<format>` element may also contain an `<exception>` element. The `<exception>` element specifies a string that has a valid form, but must be excluded from the address field. For example, in a `<house_number>` element with valid numbers `0*1*` (that is, any numeric digits followed by any alphabetic letters), specifying `<exception form="0*TH" />` means that any house number with (or without) numeric digits and ending with "TH" must be excluded.

12.5.7 GC_POI_<suffix> Table

The GC_POI_<suffix> table (for example, GC_POI_US) stores point of interest (POI) information for the country or group of countries associated with the table name suffix. POIs include features such as airports, monuments, and parks. This table contains one or more rows for each point of interest. (For example, it can contain multiple rows for a POI if the POI is associated with multiple settlements.) The GC_POI_<suffix> table contains the columns shown in Table 12-13.

Table 12-13 GC_POI_<suffix> Table

Column Name	Data Type	Description
POI_ID	NUMBER	ID number of the POI. (Required)
NAME	VARCHAR2(64)	Name of the POI. (Required)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language for the POI name. (Required)
FEATURE_CODE	NUMBER	Feature code for the POI, if the data vendor classifies POIs by category. (Optional)
HOUSE_NUMBER	VARCHAR2(10)	House number of the POI; may contain non-numeric characters. (Required)
STREET_NAME	VARCHAR2(80)	Road name of the POI. (Required)
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the POI belongs. (Required if the POI is associated with a settlement)
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the POI belongs. (Required if the POI is associated with a municipality)
REGION_ID	NUMBER(10)	ID number of the region to which the POI belongs. (Required if the POI is associated with a region)
SETTLEMENT_NAME	VARCHAR2(64)	Name of the settlement to which the POI belongs. (Required if the POI is associated with a settlement)
MUNICIPALITY_NAME	VARCHAR2(64)	Name of the municipality to which the POI belongs. (Required if the POI is associated with a municipality)
REGION_NAME	VARCHAR2(64)	Name of the region to which the POI belongs. (Required if the POI is associated with a region)
POSTAL_CODE	VARCHAR2(16)	Postal code of the POI. (Required)

Table 12-13 (Cont.) GC_POI_<suffix> Table

Column Name	Data Type	Description
VANITY_CITY	VARCHAR2(35)	Name of the city popularly associated with the POI, if it is different from the actual city containing the POI. For example, the London Heathrow Airport is actually located in a town named Hayes, which is part of greater London, but people tend to associate the airport only with London. In this case, the VANITY_CITY value is `London`. (Optional)
ROAD_SEGMENT_ID	NUMBER	ID of the road segment on which the POI is located. (Required)
SIDE	VARCHAR2(1)	Side of the street on which the POI is located. Possible values: `L` (left) or `R` (right). (Required)
PERCENT	NUMBER	Percentage value at which the POI is located on the road. It is computed by dividing the distance from the street segment start point to the POI by the length of the street segment. (Required)
TELEPHONE_NUMBER	VARCHAR2(20)	Telephone number of the POI. (Optional)
LOC_LONG	NUMBER	Longitude coordinate value of the POI. (Required)
LOC_LAT	NUMBER	Latitude coordinate value of the POI. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the POI belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

12.5.8 GC_POSTAL_CODE_<suffix> Table

The GC_POSTAL_CODE_<suffix> table (for example, GC_POSTAL_CODE_US) stores postal code information for the country or group of countries associated with the table-name suffix, if postal codes are used in the address format. This table contains one or more rows for each postal code; it may contain multiple rows for a postal code when the postal code is associated with multiple settlements. The GC_POSTAL_CODE_<suffix> table contains the columns shown in Table 12-14.

Table 12-14 GC_POSTAL_CODE_<suffix> Table

Column Name	Data Type	Description
POSTAL_CODE	VARCHAR2(16)	Postal code for the postal code area. (Required)
SETTLEMENT_NAME	VARCHAR2(64)	Name of the settlement to which the postal code belongs. (Required if the postal code is associated with a settlement)
MUNICIPALITY_NAME	VARCHAR2(64)	Name of the municipality to which the postal code belongs. (Required if the postal code is associated with a municipality)
REGION_NAME	VARCHAR2(64)	Name of the region to which the postal code belongs. (Required if the postal code is associated with a region)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the area. (Required)

Table 12-14 (Cont.) GC_POSTAL_CODE_<suffix> Table

Column Name	Data Type	Description
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the postal code belongs. (Required if the postal code is associated with a settlement)
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the postal code belongs. (Required if the postal code is associated with a municipality)
REGION_ID	NUMBER(10)	ID number of the region to which the postal code belongs. (Required if the postal code is associated with a region)
CENTER_LONG	NUMBER	Longitude value of the center of the postal-code area. The center (longitude, latitude) value is set to the start- or end-point of the closest road segment to the center, depending on which point is closer. Oracle recommends that the CENTER_LONG and CENTER_LAT values be correctly set. If these values are not set, the longitude, latitude values of the geocoded result for an area will be (0,0). (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (See the explanation for the CENTER_LONG column.) (Optional)
ROAD_SEGMENT_ID	NUMBER(10)	ID of the road segment to which the area center is set. This value must be set correctly if the geocoder is intended to work with the Oracle Spatial routing engine (described in Routing Engine); otherwise, it can be set to any nonzero value, but it cannot be null. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the area belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
NUM_STREETS	NUMBER	The number of streets inside this postal code area. (Optional)

12.5.9 GC_ROAD_<suffix> Table

The GC_ROAD_<suffix> table (for example, GC_ROAD_US) stores road information for the country associated with the table name suffix. A road is a collection of road segments with the same name in the same settlement area; a road segment is defined in GC_ROAD_SEGMENT_<suffix> Table. The GC_ROAD_<suffix> table contains one or more rows for each road. (For example, it can contain multiple rows for a road if the road is associated with multiple settlements.) The GC_ROAD_<suffix> table contains the columns shown in Table 12-15.

Table 12-15 GC_ROAD_<suffix> Table

Column Name	Data Type	Description
ROAD_ID	NUMBER	ID number of the road. (Required)
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the road belongs. (Required if the road is associated with a settlement)
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the road belongs. (Required if the road is associated with a municipality)

Table 12-15 (Cont.) GC_ROAD_<suffix> Table

Column Name	Data Type	Description
PARENT_AREA_ID	NUMBER(10)	ID number of the parent area of the municipality to which the road belongs. (Required if the road is associated with a parent area)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language for the road name. (Required)
NAME	VARCHAR2(64)	Name of the road, including the type (if any), the prefix (if any), and the suffix (if any). For example, `N Main St` as NAME. (Required)
BASE_NAME	VARCHAR2(64)	Name of the road, excluding the type (if any), the prefix (if any), and the suffix (if any). For example, `N Main St` as NAME, with `Main` as BASE_NAME. (Required)
PREFIX	VARCHAR2(32)	Prefix of the road name. For example, `N Main St` as NAME, with `N` as PREFIX. (Required if the road name has a prefix)
SUFFIX	VARCHAR2(32)	Suffix of the road name. For example, `Main St NW` as NAME, with `NW` as SUFFIX. (Required if the road name has a suffix)
STYPE_BEFORE	VARCHAR2(32)	Street type that precedes the base name. For example, `Avenue Victor Hugo` as NAME, with `Avenue` as STYPE_BEFORE and `Victor Hugo` as BASE_NAME. (Required if the road type precedes the base name)
STYPE_AFTER	VARCHAR2(32)	Street type that follows the base name. For example, `Main St` as NAME, with `St` as STYPE_AFTER and `Main` as BASE_NAME. (Required if the road type follows the base name)
STYPE_ATTACHED	VARCHAR2(1)	Contains `T` if the street type is in the same word with the street name; contains `F` if the street type is a separate word from the street name. For example, in a German street address of `123 Beethovenstrass`, the street type is `strass`, and it is in the same word with the street name, which is `Beethoven`. (Required)
START_HN	NUMBER(5)	The lowest house number on the road. It is returned when a specified house number is lower than this value.
CENTER_HN	NUMBER(5)	Leading numerical part of the center house number. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) It is returned when no house number is specified in an input address. (Required)
END_HN	NUMBER(5)	The highest house number on the road. It is returned when a specified house number is higher than this value.
START_HN_SIDE	VARCHAR2(1)	Side of the road of the lowest house number: `L` for left or `R` for right.

Table 12-15 (Cont.) GC_ROAD_<suffix> Table

Column Name	Data Type	Description
CENTER_HN_SIDE	VARCHAR2(1)	Side of the road of the center house number: `L` for left or `R` for right. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) (Required if there are houses on the road)
END_HN_SIDE	VARCHAR2(1)	Side of the road of the highest house number: `L` for left or `R` for right.
START_LONG	NUMBER	Longitude value of the lowest house number.
START_LAT	NUMBER	Latitude value of the lowest house number.
CENTER_LONG	NUMBER	Longitude value of the center house number. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) (Required)
CENTER_LAT	NUMBER	Latitude value of the center house number. (See also the explanation of the CENTER_LONG column.) (Required)
END_LONG	NUMBER	Longitude value of the highest house number.
END_LAT	NUMBER	Latitude value of the highest house number.
START_ROAD_SEG_ID	NUMBER(5)	ID number of the road segment at the start of the road.
CENTER_ROAD_SEG_ID	NUMBER(5)	ID number of the road segment at the center point of the road. (Required)
END_ROAD_SEG_ID	NUMBER(5)	ID number of the road segment at the end of the road.
POSTAL_CODE	VARCHAR2(16)	Postal code for the road. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the road belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
CENTER_HN2	VARCHAR2(10)	The second part of the center house number. (See the explanation of house numbers after Table 12-16 in GC_ROAD_SEGMENT_<suffix> Table.) (Required)

12.5.10 GC_ROAD_SEGMENT_<suffix> Table

The GC_ROAD_SEGMENT_<suffix> table (for example, GC_ROAD_SEGMENT_US) stores road segment information for the country associated with the table name suffix. A road segment is the portion of a road between two continuous intersections along the road; an intersection occurs when roads meet or cross each other. A road segment can also be the portion of a road between the start (or end) of the road and its closest intersection along the road, or it can be the entire length of a road if there are no intersections along the road. The GC_ROAD_SEGMENT_<suffix> table contains one row for each road segment, and it contains the columns shown in Table 12-16.

Table 12-16 GC_ROAD_SEGMENT_<suffix> Table

Column Name	Data Type	Description
ROAD_SEGMENT_ID	NUMBER	ID number of the road segment. A positive value, as explained in Relationship between Routing Engine and Geocoder. (Required)
ROAD_ID	NUMBER	ID number of the road containing this road segment. (Required)
L_ADDR_FORMAT	VARCHAR2(1)	Left side address format. Specify `N` if there are one or more house numbers on the left side of the road segment; leave null if there is no house number on the left side of the road segment. (Required)
R_ADDR_FORMAT	VARCHAR2(1)	Right side address format. Specify `N` if there are one or more house numbers on the right side of the road segment; leave null if there is no house number on the right side of the road segment. (Required)
L_ADDR_SCHEME	VARCHAR2(1)	Numbering scheme for house numbers on the left side of the road segment: `O` (all odd numbers), `E` (all even numbers), or `M` (mixture of odd and even numbers). (Required)
R_ADDR_SCHEME	VARCHAR2(1)	Numbering scheme for house numbers on the right side of the road segment: `O` (all odd numbers), `E` (all even numbers), or `M` (mixture of odd and even numbers). (Required)
START_HN	NUMBER(5)	The lowest house number on this road segment. (Required)
END_HN	NUMBER(5)	The highest house number on this road segment. (Required)
L_START_HN	NUMBER(5)	The leading numerical part of the left side starting house number. (See the explanation of house numbers after this table.) (Required)
L_END_HN	NUMBER(5)	The leading numerical part of the left side ending house number. (See the explanation of house numbers after this table.) (Required)
R_START_HN	NUMBER(5)	The leading numerical part of the right side starting house number. (See the explanation of house numbers after this table.) (Required)
R_END_HN	NUMBER(5)	The leading numerical part of the right side ending house number. (See the explanation of house numbers after this table.) (Required)
POSTAL_CODE	VARCHAR2(16)	Postal code for the road segment. If the left side and right side of the road segment belong to two different postal codes, create two rows for the road segment with identical values in all columns except for POSTAL_CODE. (Required)
GEOMETRY	SDO_GEOMETRY	Spatial geometry object representing the road segment. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the road segment belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
L_START_HN2	VARCHAR2(10)	The second part of the left side starting house number. (See the explanation of house numbers after this table.) (Required if the left side starting house number has a second part)

Table 12-16 (Cont.) GC_ROAD_SEGMENT_<suffix> Table

Column Name	Data Type	Description
L_END_HN2	VARCHAR2(10)	The second part of the left side ending house number. (See the explanation of house numbers after this table.) (Required if the left side ending house number has a second part)
R_START_HN2	VARCHAR2(10)	The second part of the right side starting house number. (See the explanation of house numbers after this table.) (Required if the right side starting house number has a second part)
R_END_HN2	VARCHAR2(10)	The second part of the right side ending house number. (See the explanation of house numbers after this table.) (Required if the right side ending house number has a second part)

A house number is a descriptive part of an address that helps identify the location of a establishment along a road segment. A house number is divided into two parts: the leading numerical part and the second part, which is the rest of the house number. The leading numerical part is the numerical part of the house number that starts from the beginning of the complete house number string and ends just before the first non-numeric character (if present). If the house number contains non-numeric characters, the second part of the house number is the portion from the first non-numeric character through the last character of the string. For example, if the house number is `123`, the leading numerical part is `123` and the second part is null; however, if the house number is `123A23`, the leading numerical part is `123` and the second part is `A23`.

The starting house number is the house number at the start point of a road segment; the start point of the road segment is the first shape point of the road segment geometry. The ending house number is the house number at the end point of a road segment; the end point of the road segment is the last shape point of the road segment geometry. The left and right side starting house numbers do not need to be lower than the left and right side ending house numbers. The house number attributes in the data tables follow these conventions in locating establishments along road segments.

12.5.11 Indexes on Tables for Geocoding

To use the vendor-supplied tables for geocoding, indexes must be created on many of the tables, and the names of these indexes must follow certain requirements.

Example 12-5 lists the format of CREATE INDEX statements that create the required indexes. In each statement, you must use the index name, table name, column names, and (if multiple columns are indexed) sequence of column names as shown in Example 12-5, except that you must replace all occurrences of <*suffix*> with the appropriate string (for example, `US` for the United States). Note that the first index in the example is a spatial index. Optionally, you can also include other valid keywords and clauses in the CREATE INDEX statements.

Example 12-5 Required Indexes on Tables for Geocoding

```
CREATE INDEX idx_<suffix>_road_geom ON gc_road_segment_<suffix> (geometry) INDEXTYPE IS
mdsys.spatial_index_v2;
CREATE INDEX idx_<suffix>_road_seg_rid ON gc_road_segment_<suffix> (road_id, start_hn, end_hn);
CREATE INDEX idx_<suffix>_road_id ON gc_road_<suffix> (road_id);
CREATE INDEX idx_<suffix>_road_setbn ON gc_road_<suffix> (settlement_id, base_name);
CREATE INDEX idx_<suffix>_road_munbn ON gc_road_<suffix> (municipality_id, base_name);
CREATE INDEX idx_<suffix>_road_parbn ON gc_road_<suffix> (parent_area_id, country_code_2, base_name);
CREATE INDEX idx_<suffix>_road_setbnsd ON gc_road_<suffix> (settlement_id, soundex(base_name));
CREATE INDEX idx_<suffix>_road_munbnsd ON gc_road_<suffix> (municipality_id, soundex(base_name));
CREATE INDEX idx_<suffix>_road_parbnsd ON gc_road_<suffix> (parent_area_id, country_code_2,
soundex(base_name));
CREATE INDEX idx_<suffix>_inters ON gc_intersection_<suffix> (country_code_2, road_id_1, road_id_2);
CREATE INDEX idx_<suffix>_area_name_id ON gc_area_<suffix> (country_code_2, area_name, admin_level);
CREATE INDEX idx_<suffix>_area_id_name ON gc_area_<suffix> (area_id, area_name, country_code_2);
CREATE INDEX idx_<suffix>_poi_name ON gc_poi_<suffix> (country_code_2, name);
CREATE INDEX idx_<suffix>_poi_setnm ON gc_poi_<suffix> (country_code_2, settlement_id, name);
CREATE INDEX idx_<suffix>_poi_ munnm ON gc_poi_<suffix> (country_code_2, municipality_id, name);
CREATE INDEX idx_<suffix>_poi_ regnm ON gc_poi_<suffix> (country_code_2, region_id, name);
CREATE INDEX idx_<suffix>_ postcode ON gc_postal_code_<suffix> (country_code_2, postal_code);
CREATE INDEX idx_<suffix>_addrpt_addr ON gc_address_point_<suffix> (road_segment_id, road_id,
house_number, side);
```

12.6 Installing the Profile Tables

The Oracle Geocoder profile tables are typically supplied by a data provider.

Use the data provider's profile tables for geocoding whenever they are available. For users building their own geocoder schema, Oracle provides sample GC_COUNTRY_PROFILE, GC_PARSER_PROFILES, and GC_PARSER_PROFILEAFS tables; however, you should install these Oracle-supplied profile tables *only* if profile tables are *not* supplied with the data tables.

The Oracle-supplied tables contain parser profiles for a limited number of countries. If profiles for your country or group of countries of interest are not included, you will need to manually add them; and for a quick start, you can copy the parser profiles of a country with a similar address format to your country of interest, and edit these profiles where necessary. If your parser profiles of interest are included in the Oracle-supplied tables, you can use them directly or update them if necessary. No sample country profiles are provided, so you will need to add your own

To install and query the Oracle-supplied profile tables, perform the following steps:

1. Log on to your database as the geocoder user. The geocoder user is the user under whose schema the geocoder schema will be loaded.
2. Create the GC_COUNTRY_PROFILE, GC_PARSER_PROFILES, and GC_PARSER_PROFILEAFS tables by executing the SDO_GCDR.CREATE_PROFILE_TABLES procedure:

   ```
   SQL> EXECUTE SDO_GCDR.CREATE_PROFILE_TABLES;
   ```

3. Populate the GC_PARSER_PROFILES and GC_PARSER_PROFILEAFS tables by running the `sdogcprs.sql` script in the `$ORACLE_HOME/md/admin/` directory. For example:

   ```
   SQL> @$ORACLE_HOME/md/admin/sdogcprs.sql
   ```

4. Query the profile tables to determine if parser profiles for your country of interest are supplied, by checking if its country code is included in the output of the following statements:

   ```
   SQL> SELECT DISTINCT(country_code) FROM gc_parser_profiles ORDER BY country_code;
   SQL> SELECT DISTINCT(country_code) FROM gc_parser_profileafs ORDER BY country_code;
   ```

12.7 Using the Geocoding Service (XML API)

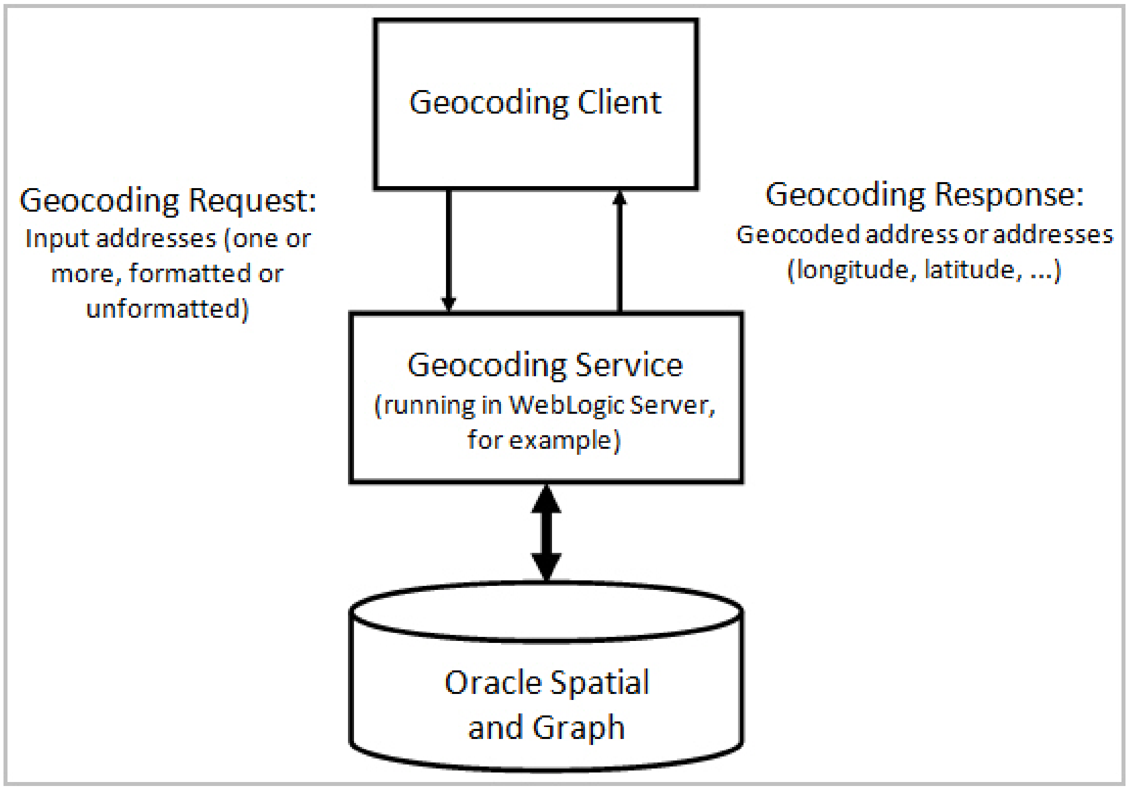
In addition to the SQL API, Oracle Spatial also provides an XML API for a geocoding service that enables you to geocode addresses.

A Java geocoder application engine performs international address standardization, geocoding, and POI matching, by querying geocoder data stored in the Oracle database. The support for unparsed addresses adds flexibility and convenience to customer applications.

This geocoding service is implemented as a Java 2 Enterprise Edition (J2EE) Web application that you can deploy in a WebLogic Server environment.

Figure 12-1 shows the basic flow of action with the geocoding service: a client locates a remote geocoding service instance, sends a geocoding request, and processes the response returned by the geocoding service instance.

Figure 12-1 Basic Flow of Action with the Spatial Geocoding Service


Geocoding Client
Geocoding Request:
Input addresses (one or more, formatted or unformatted)
Geocoding Response:
Geocoded address or addresses (longitude, latitude, ...)
Geocoding Service
(running in WebLogic Server, for example)
Oracle Spatial and Graph

As shown in Figure 12-1:

1. The client sends an XML geocoding request, containing one or more input addresses to be geocoded, to the geocoding service using the HTTP protocol.
2. The geocoding service parses the input request and looks up the input address in the database.
3. The geocoding service sends the geocoded result in XML format to the client using the HTTP protocol.

After you load the geocoder schema into the database, you must configure the J2EE geocoder before it can be used, as explained in Deploying and Configuring the J2EE Geocoder

- Deploying and Configuring the J2EE Geocoder
- Geocoding Request XML Schema Definition and Example
- Geocoding Response XML Schema Definition and Example

12.7.1 Deploying and Configuring the J2EE Geocoder

The J2EE geocoder processes geocoding requests and generates responses. To enable this geocoding service, a `geocoder.ear.zip` file must be deployed using Oracle WebLogic Server. To deploy and configure the geocoding service, follow these steps.

1. Deploy the geocoder using Oracle WebLogic Server:
   a. Unzip the `geocoder.ear.zip` file found in your `$ORACLE_HOME/md/jlib` directory into a suitable directory. Your resulting directory structure should be: `$geocoder.ear/web.war/....`
   b. Log on to the WebLogic Server console (for example, `http://<hostname>:7001/console`); and from **Deployments** install the `geocoder.ear` file, accepting the **Name** `geocoder` for the deployment and choosing the **Location** option `Make the deployment accessible from the following location`.
2. Launch the geocoder welcome page in a web browser using the URL `http://<hostname>:<port>/geocoder` . On the welcome page, select the **Administration** link and enter the administrator (`weblogic`) user name and password.

   > **Note:**
   >
   > If you are *not* using the default WebLogic administrator user name (`weblogic`) , you will need to edit the `weblogic.xml` file located in the `$geocoder.ear/web.war/WEB-INF/` directory. Replace `<principal-name>weblogic</principal-name>` with your WebLogic Server administrator user name, for example, `<principal-name>my_weblogic_admin</principal-name>`.
   >
   > If the welcome page was not displayed, ensure that the newly deployed geocoding service was successfully started. (It is assumed that you are running WebLogic Server 12.1 or later with an Oracle Database 12.2 or later `geocoder.ear.zip` file.)

3. Modify the geocoder configuration file (`geocodercfg.xml`). Uncomment at least one `<geocoder>` element, and change the `<database>` element attributes of that `<geocoder>` element to reflect the configuration of your database. For information about this file, see Configuring the geocodercfg.xml File.
4. Save the changes to the file, and restart the geocoder.
5. Test the database connection by going to the welcome page at URL `http://<hostname>:<port>/geocoder` and running the XML geocoding request page. (This demo requires geocoder data for the United States.)

   Examples are available to demonstrate various capabilities of the geocoding service. Reviewing the examples at URL `http://<hostname>:<port>/geocoder/gcxmlreq_exp_af.html` is a good way to learn the XML API, which is described in Geocoding Request XML Schema Definition and Example.

- Configuring the geocodercfg.xml File

12.7.1.1 Configuring the geocodercfg.xml File

You will need to edit the `<database>` element in the `geocodercfg.xml` file to specify the database and schema where the geocoding data is loaded. The `geocodercfg.xml` file is accessed through the Administrator link on the geocoder welcome page, and is stored in the `$geocoder.ear/web.war/WEB-INF/config` directory of the geocoder application

In the `geocodercfg.xml` file, each `<geocoder>` element defines the geocoder for the database in which the geocoder schema resides. The `<database>` element defines the database connection for the geocoder. In Oracle Database 12.2, the database connection is defined by providing the JNDI name (`container_ds`) of a predefined container data source. See the WebLogic Server documentation, Configuring and Managing WebLogic JDBC: *Creating a JDBC Data Source* for information about defining data sources.

Example 12-6 illustrates how a `<database>` element can be defined. The definition uses the JNDI name of a predefined container data source.

Example 12-6 <database> Element Definition

```
<database container_ds="jdbc/gc_usa"
          load_db_parser_profiles="true" />
```

The attributes of the `<database>` element are as follows

- `container_ds` specifies the JNDI name for a predefined data source.
- `load_db_parser_profiles` specifies whether to load the address parser profiles from the specified database connection. It is recommended that you set this parameter to `true` when parser profile tables are provided with the geocoder data. If the value is `true`, the address parser-profiles are loaded from the geocoder schema; otherwise, the parser profiles are loaded from the application at `../applications/geocoder/web/WEB-INF/parser_profiles/`*`<country-name>`*`.ppr` (for example, `usa.ppr`).

12.7.2 Geocoding Request XML Schema Definition and Example

For a geocoding request (HTTP GET or POST method), it is assumed the request has a parameter named `xml_request` whose value is a string containing the XML document for the request. The input XML document describes the input addresses that need to be geocoded. One XML request can contain one or more input addresses. Several internationalized address formats are available for describing the input addresses. (The input XML API also supports reverse geocoding, that is, a longitude/latitude point to a street address.)

The XML schema definition (XSD) for a geocoding request is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Schema for an XML geocoding request that takes one or more input_locations and
supports reverse geocoding using the input_location's attributes -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xsd:complexType name="address_lineType">
    <xsd:attribute name="value" type="xsd:string" use="required"/>
  </xsd:complexType>
  <xsd:complexType name="address_listType">
    <xsd:sequence>
      <xsd:element name="input_location" type="input_locationType"
         maxOccurs="unbounded"/>
    </xsd:sequence>
  </xsd:complexType>
  <xsd:complexType name="gdf_formType">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="builtup_area" type="xsd:string"/>
    <xsd:attribute name="order8_area" type="xsd:string"/>
    <xsd:attribute name="order2_area" type="xsd:string"/>
    <xsd:attribute name="order1_area" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="postal_code" type="xsd:string"/>
    <xsd:attribute name="postal_addon_code" type="xsd:string"/>
  </xsd:complexType>
  <xsd:complexType name="gen_formType">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="sub_area" type="xsd:string"/>
    <xsd:attribute name="city" type="xsd:string"/>
    <xsd:attribute name="region" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="postal_code" type="xsd:string"/>
    <xsd:attribute name="postal_addon_code" type="xsd:string"/>
  </xsd:complexType>
  <xsd:element name="geocode_request">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="address_list" type="address_listType"/>
      </xsd:sequence>
      <xsd:attribute name="vendor" type="xsd:string"/>
    </xsd:complexType>
  </xsd:element>
  <xsd:complexType name="input_addressType">
    <xsd:choice>
      <xsd:element name="us_form1" type="us_form1Type"/>
      <xsd:element name="us_form2" type="us_form2Type"/>
      <xsd:element name="gdf_form" type="gdf_formType"/>
      <xsd:element name="gen_form" type="gen_formType"/>
      <xsd:element name="unformatted" type="unformattedType"/>
    </xsd:choice>
    <xsd:attribute name="match_mode" default="relax_postal_code">
      <xsd:simpleType>
        <xsd:restriction base="xsd:NMTOKEN">
          <xsd:enumeration value="exact"/>
          <xsd:enumeration value="relax_street_type"/>
          <xsd:enumeration value="relax_poi_name"/>
          <xsd:enumeration value="relax_house_number"/>
          <xsd:enumeration value="relax_base_name"/>
          <xsd:enumeration value="relax_postal_code"/>
          <xsd:enumeration value="relax_builtup_area"/>
          <xsd:enumeration value="relax_all"/>
          <xsd:enumeration value="DEFAULT"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:attribute>
  </xsd:complexType>
  <xsd:complexType name="input_locationType">
    <xsd:sequence>
      <xsd:element name="input_address" type="input_addressType"
         minOccurs="0"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="longitude" type="xsd:string"/>
```

```
    <xsd:attribute name="latitude" type="xsd:string"/>
    <xsd:attribute name="x" type="xsd:string"/>
    <xsd:attribute name="y" type="xsd:string"/>
    <xsd:attribute name="srid" type="xsd:string"/>
    <xsd:attribute name="multimatch_number" type="xsd:string" default="1000"/>
  </xsd:complexType>
  <xsd:complexType name="unformattedType">
    <xsd:sequence>
      <xsd:element name="address_line" type="address_lineType"
         maxOccurs="unbounded"/>
    </xsd:sequence>
    <xsd:attribute name="country" type="xsd:string"/>
  </xsd:complexType>
  <xsd:complexType name="us_form1Type">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="lastline" type="xsd:string"/>
  </xsd:complexType>
  <xsd:complexType name="us_form2Type">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="city" type="xsd:string"/>
    <xsd:attribute name="state" type="xsd:string"/>
    <xsd:attribute name="zip_code" type="xsd:string"/>
  </xsd:complexType>
</xsd:schema>
```

Example 12-7 is a request to geocode several three addresses (representing two different actual physical addresses), using different address formats and an unformatted address.

Example 12-7 Geocoding Request (XML API)

```
<?xml version="1.0" encoding="UTF-8"?>
<geocode_request xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="../
geocode_request.xsd">
  <address_list>
    <input_location id="1">
      <input_address>
        <us_form2 name="Oracle" street="500 Oracle Parkway" city="Redwood City"
           state="CA" zip_code="94021"/>
      </input_address>
    </input_location>
    <input_location id="2">
      <input_address>
 <gdf_form street="1 Oracle Drive" builtup_area="Nashua" order1_area="NH"
        postal_code="03062" country="US"/>
      </input_address>
    </input_location>
    <input_location id="3">
      <input_address>
<gen_form street="1 Oracle Drive" city="Nashua" region="NH" postal_code="03062" country="US"/>
      </input_address>
    </input_location>
    <input_location id="4">
      <input_address>
        <unformatted country="UNITED STATES">
          <address_line value="Oracle NEDC"/>
          <address_line value="1 Oracle drive "/>
          <address_line value="Nashua "/>
          <address_line value="NH"/>
        </unformatted>
      </input_address>
    </input_location>
  </address_list>
</geocode_request>
```

12.7.3 Geocoding Response XML Schema Definition and Example

A geocoding response contains one or more standardized addresses including longitude/latitude points, the matching code, and possibly multiple match and no match indication and an error message.

The XML schema definition (XSD) for a geocoding response is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Schema for an XML geocoding response -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
  <xsd:complexType name="geocodeType">
    <xsd:sequence>
      <xsd:element name="match" type="matchType" minOccurs="0"
         maxOccurs="unbounded"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:string" use="required"/>
    <xsd:attribute name="match_count" type="xsd:string"/>
  </xsd:complexType>
  <xsd:element name="geocode_response">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="geocode" type="geocodeType" maxOccurs="unbounded"/>
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>
  <xsd:complexType name="matchType">
    <xsd:sequence>
      <xsd:element name="output_address" type="output_addressType"/>
    </xsd:sequence>
    <xsd:attribute name="sequence" type="xsd:string" use="required"/>
    <xsd:attribute name="longitude" type="xsd:string" use="required"/>
    <xsd:attribute name="latitude" type="xsd:string" use="required"/>
    <xsd:attribute name="match_code" use="required">
      <xsd:simpleType>
        <xsd:restriction base="xsd:NMTOKEN">
          <xsd:enumeration value="0"/>
          <xsd:enumeration value="1"/>
          <xsd:enumeration value="2"/>
          <xsd:enumeration value="3"/>
          <xsd:enumeration value="4"/>
          <xsd:enumeration value="10"/>
          <xsd:enumeration value="11"/>
          <xsd:enumeration value="12"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:attribute>
    <xsd:attribute name="error_message" type="xsd:string"/>
  </xsd:complexType>
  <xsd:complexType name="output_addressType">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="house_number" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="builtup_area" type="xsd:string"/>
    <xsd:attribute name="order1_area" type="xsd:string"/>
    <xsd:attribute name="order8_area" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="postal_code" type="xsd:string"/>
    <xsd:attribute name="postal_addon_code" type="xsd:string"/>
    <xsd:attribute name="side" type="xsd:string"/>
    <xsd:attribute name="percent" type="xsd:string"/>
    <xsd:attribute name="edge_id" type="xsd:string"/>
  </xsd:complexType>
</xsd:schema>
```

Example 12-8 is the response to the request in Example 12-7 in Geocoding Request XML Schema Definition and Example.

Example 12-8 Geocoding Response (XML API)

```
<?xml version="1.0" encoding="UTF-8"?>
<geocode_response xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xsi:noNamespaceSchemaLocation="../geocode_response.xsd">
 <geocode id="1" match_count="1">
    <match sequence="0"
         longitude="-122.26193971893862" latitude="37.53195483966782"
         match_code="10" error_message="????#ENUT?B281C??">
      <output_address name="" house_number="500" street="ORACLE PKY"
           builtup_area="REDWOOD CITY" order1_area="CA" order8_area=""
           country="US" postal_code="94065" postal_addon_code="" side="L"
           percent="0.3316666666666666667" edge_id="28503563"/>
    </match>
 </geocode>
 <geocode id="2" match_count="1">
   <match sequence="0"
        longitude="-71.45937299307225" latitude="42.70784494226865"
        match_code="1" error_message="????#ENUT?B281CP?">
      <output_address name="" house_number="1" street="ORACLE DR"
            builtup_area="NASHUA" order1_area="NH" order8_area=""
            country="US" postal_code="03062" postal_addon_code="" side="L"
            percent="0.01" edge_id="22325991"/>
   </match>
 </geocode>
 <geocode id="3" match_count="1">
   <match sequence="0"
         longitude="-71.45937299307225" latitude="42.70784494226865"
         match_code="1" error_message="????#ENUT?B281CP?">
      <output_address name="" house_number="1" street="ORACLE DR"
            builtup_area="NASHUA" order1_area="NH" order8_area=""
            country="US" postal_code="03062" postal_addon_code="" side="L"
            percent="0.01" edge_id="22325991"/>
   </match>
 </geocode>
 <geocode id="4" match_count="1">
   <match sequence="0"
         longitude="-71.45937299307225" latitude="42.70784494226865"
         match_code="1" error_message="????#ENUT?B281CP?">
     <output_address name="" house_number="1" street="ORACLE DR"
           builtup_area="NASHUA" order1_area="NH" order8_area=""
           country="US" postal_code="03062" postal_addon_code="" side="L"
           percent="0.01" edge_id="22325991"/>
   </match>
 </geocode>
</geocode_response>
```

13

Business Directory (Yellow Pages) Support

Oracle Spatial provides support for OpenLS business directory (Yellow Pages, or YP) services.

Note:

Spatial business directory services are not supported in Oracle Autonomous Database both in Serverless and Dedicated deployments.

- Business Directory Concepts
  Business directory services provide lists of businesses in a given area and matching a specified name or category.
- Using the Business Directory Capabilities
  To use the Oracle Spatial business directory capabilities, you must use data provided by a business directory (YP) vendor.
- Data Structures for Business Directory Support
  After you acquire the business directory data and invoke the appropriate procedure to load it into the database, the procedure populates the following tables, all owned by the MDSYS schema, which are used for business directory support.

13.1 Business Directory Concepts

Business directory services provide lists of businesses in a given area and matching a specified name or category.

Business directory data comes from third-party providers of such data. These providers probably have different business categories, and even different hierarchical structures. A unifying pattern in the various approaches is that businesses are categorized by subject and location. The location component is well understood; for example, for the United States, either a ZIP code or the combination of a city and state, and optionally a specific address, can be used to determine the location from which to start searching.

The categorization of businesses, on the other hand, is not uniformly implemented. Some providers offer a flat list of categories, user-selected by simple substring matching. Others offer a 3-level or 4-level hierarchical organization of subcategories, often with a fanout (maximum number of child categories at a level) of 20 to 50, and sometimes more than 100. A user might start the hierarchy traversal at the root of the hierarchy (by default). Alternatively, a user might enter a keyword that is matched to an appropriate starting point within the hierarchy. Such keyword matching might go beyond simple substring matching and result in more intelligent choices.

13.2 Using the Business Directory Capabilities

To use the Oracle Spatial business directory capabilities, you must use data provided by a business directory (YP) vendor.

The data must be in the format supported by the Oracle Spatial OpenLS support (see OPENLS_DIR_BUSINESSES Table).

To submit users' directory services requests and to return the responses, use the OpenLS web services API, which is introduced in OpenLS Application Programming Interfaces. For information about directory services requests and responses, with examples, see OpenLS Service Support and Examples.

13.3 Data Structures for Business Directory Support

After you acquire the business directory data and invoke the appropriate procedure to load it into the database, the procedure populates the following tables, all owned by the MDSYS schema, which are used for business directory support.

- OPENLS_DIR_BUSINESSES
- OPENLS_DIR_BUSINESS_CHAINS
- OPENLS_DIR_CATEGORIES
- OPENLS_DIR_CATEGORIZATIONS
- OPENLS_DIR_CATEGORY_TYPES
- OPENLS_DIR_SYNONYMS

In some tables, some rows have null values for some columns, because the information does not apply in this instance or because the data provider did not supply a value.

The following sections describe these tables, in alphabetical order by table name.

- OPENLS_DIR_BUSINESSES Table
- OPENLS_DIR_BUSINESS_CHAINS Table
- OPENLS_DIR_CATEGORIES Table
- OPENLS_DIR_CATEGORIZATIONS Table
- OPENLS_DIR_CATEGORY_TYPES Table
- OPENLS_DIR_SYNONYMS Table

13.3.1 OPENLS_DIR_BUSINESSES Table

The OPENLS_DIR_BUSINESSES table stores information about each business (that is, each business that has an address). If the business is part of a larger business chain, the CHAIN_ID column is a foreign key to the CHAIN_ID column in the OPENLS_DIR_BUSINESS_CHAINS table (described in OPENLS_DIR_BUSINESS_CHAINS Table).

The OPENLS_DIR_BUSINESSES table contains one row for each business, and it contains the columns shown in Table 13-1.

Table 13-1 OPENLS_DIR_BUSINESSES Table

Column Name	Data Type	Description
BUSINESS_ID	NUMBER	Business ID number. (Required)
BUSINESS_NAME	VARCHAR2(128)	Area name. (Required)

Table 13-1 (Cont.) OPENLS_DIR_BUSINESSES Table

Column Name	Data Type	Description
CHAIN_ID	NUMBER	ID number of the business chain (in the OPENLS_BIR_BUSINESS_CHAIN table), if the business is part of a chain.
DESCRIPTION	VARCHAR2(1024)	Description of the business.
PHONE	VARCHAR2(64)	Phone number, in an appropriate format for the location.
COUNTRY	VARCHAR2(64)	Country code or name. (Required)
COUNTRY_SUBDIVISION	VARCHAR2(128)	Subdivision of the country, if applicable.
COUNTRY_SECONDARY_SUBDIVISION	VARCHAR2(128)	Subdivision within COUNTRY_SUBDIVISION, if applicable.
MUNICIPALITY	VARCHAR2(128)	Municipality name.
MUNICIPALITY_SUBDIVISION	VARCHAR2(128)	Subdivision within MUNICIPALITY, if applicable.
POSTAL_CODE	VARCHAR2(32)	Postal code (for example, 5-digit ZIP code in the United Stated and Canada). (Required)
POSTAL_CODE_EXT	VARCHAR2(32)	Postal code extension (for example, 4-digit extension if the 5-4 ZIP code format is used).
STREET	VARCHAR2(128)	Street address, including house or unit number. (Required)
INTERSECTING_STREET	VARCHAR2(128)	Name of the street (if any) that intersects STREET at this address.
BUILDING	VARCHAR2(128)	Name of the building that includes this address.
PARAMETERS	XMLTYPE	XML document with additional information about the business.
GEOM	SDO_GEOMETRY	Point geometry representing the address of the business.

13.3.2 OPENLS_DIR_BUSINESS_CHAINS Table

The OPENLS_DIR_BUSINESS_CHAINS table stores information about each business chain. A business chain is a business that has multiple associated businesses; for example, a restaurant chain has multiple restaurants that have the same name and offer basically the same menu. If the business is part of a business chain, the row for that business in the OPENLS_DIR_BUSINESSES table (described in OPENLS_DIR_BUSINESSES Table) contains a CHAIN_ID column value that matches a value in the CHAIN_ID column in the OPENLS_DIR_BUSINESS_CHAINS table.

The OPENLS_DIR_BUSINESS_CHAINS table contains one row for each business chain, and it contains the columns shown in Table 13-2.

Table 13-2 OPENLS_DIR_BUSINESS_CHAINS Table

Column Name	Data Type	Description
CHAIN_ID	NUMBER	Business chain ID number. (Required)
CHAIN_NAME	VARCHAR2(128)	Business chain name.

13.3.3 OPENLS_DIR_CATEGORIES Table

The OPENLS_DIR_CATEGORIES table stores information about each category into which a business can be placed. If the data provider uses a category hierarchy, this table contains rows for categories at all levels of the hierarchy, using the PARENT_ID column to indicate the parent category of a child category. For example, a Restaurants category might be the parent of several child categories, one of which might be Chinese.

The OPENLS_DIR_CATEGORIES table contains one row for each category, and it contains the columns shown in Table 13-3.

Table 13-3 OPENLS_DIR_CATEGORIES Table

Column Name	Data Type	Description
CATEGORY_ID	VARCHAR2(32)	Category ID string. (Required)
CATEGORY_TYPE_ID	NUMBER	Category type ID number. Must match a value in the CATEGORY_TYPE_ID column of the OPENLS_DIR_CATEGORY_TYPES table (described in OPENLS_DIR_CATEGORY_TYPES Table). (Required)
CATEGORY_NAME	VARCHAR2(128)	Category name. (Required)
PARENT_ID	VARCHAR2(32)	CATEGORY_ID value of the parent category, if any, for this category.
PARAMETERS	XMLTYPE	XML document with additional information about the category.

13.3.4 OPENLS_DIR_CATEGORIZATIONS Table

The OPENLS_DIR_CATEGORIZATIONS table stores information about associations of businesses with categories. Each business can be in multiple categories; and the categories for a business can be independent of each other or in a parent-child relationship, or both. For example, a store that sells books and music CDs might be in the categories for Bookstores, Music, and its child category Music Stores, in which case there will be three rows for that business in this table.

The OPENLS_DIR_CATEGORIZATIONS table contains one row for each association of a business with a category, and it contains the columns shown in Table 13-4.

Table 13-4 OPENLS_DIR_CATEGORIZATIONS Table

Column Name	Data Type	Description
BUSINESS_ID	NUMBER	Business ID. Must match a value in the BUSINESS_ID column of the OPENLS_DIR_BUSNESSES table (described in OPENLS_DIR_BUSINESSES Table). (Required)
CATEGORY_ID	VARCHAR2(32)	Category ID string. The CATEGORY_ID and CATEGORY_TYPE_ID values must match corresponding column values in a single row in the OPENLS_DIR_CATEGORIES table (described in OPENLS_DIR_CATEGORIES Table). (Required)

Table 13-4 (Cont.) OPENLS_DIR_CATEGORIZATIONS Table

Column Name	Data Type	Description
CATEGORY_TYPE_ID	NUMBER	Category type ID number. The CATEGORY_ID and CATEGORY_TYPE_ID values must match corresponding column values in a single row in the OPENLS_DIR_CATEGORIES table (described in OPENLS_DIR_CATEGORIES Table). (Required)
CATEGORIZATION_TYPE	VARCHAR2(8)	`EXPLICIT` (the default) or `IMPLICIT`.
USER_SPECIFIC_CATEGORIZATION	VARCHAR2(32)	User-specified categorization, if any.
PARAMETERS	XMLTYPE	XML document with additional information about the association of the business with the category.

13.3.5 OPENLS_DIR_CATEGORY_TYPES Table

The OPENLS_DIR_CATEGORY_TYPES table stores information about category types. This table contains the columns shown in Table 13-5.

Table 13-5 OPENLS_DIR_CATEGORY_TYPES Table

Column Name	Data Type	Description
CATEGORY_TYPE_ID	NUMBER	Category type ID number. (Required)
CATEGORY_TYPE_NAME	VARCHAR2(128)	Name of the category type. (Required)
PARAMETERS	XMLTYPE	XML document with additional information about the category type.

13.3.6 OPENLS_DIR_SYNONYMS Table

The OPENLS_DIR_SYNONYMS table stores information about synonyms for categories. Synonyms can be created to expand the number of terms (strings) associated with a category, so that users get more complete and meaningful results from a search.

The OPENLS_DIR_SYNONYMS table contains one row for each synonym definition, and it contains the columns shown in Table 13-6.

Table 13-6 OPENLS_DIR_SYNONYMS Table

Column Name	Data Type	Description
STANDARD_NAME	VARCHAR2(128)	Standard name of a category, as the user might enter it.
CATEGORY	VARCHAR2(128)	Category name, as it appears in the OPENLS_DIR_CATEGORIES table (described in OPENLS_DIR_CATEGORIES Table).
AKA	VARCHAR2(128)	.Additional or alternate name for the category. ("AKA" stands for "also known as.")

14

Routing Engine

The Spatial routing engine (often referred to as the routing engine) enables you to host an XML-based web service that provides the following features.

> **Note:**
>
> Routing using SQL that accesses an Oracle managed service is available on Oracle Autonomous Database. Refer to the following subprograms for more information:
>
> - SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON
> - SDO_GCDR.ELOC_DRIVE_TIME_POLYGON
> - SDO_GCDR.ELOC_ROUTE
> - SDO_GCDR.ELOC_ROUTE_DISTANCE
> - SDO_GCDR.ELOC_ROUTE_GEOM
> - SDO_GCDR.ELOC_ROUTE_TIME

- Simple route requests return route information between the two locations.
- Simple multi-address route requests return route information between three or more locations. The ordering of the locations in the response is user specified and is not optimized.
- Traveling salesperson (TSP) route requests are a form of multi-address route request and also return route information between three or more locations. The ordering of some or all of the locations in the response can be reordered to optimize the overall route.
- Batched route requests are a batch of one or more simple or multi-address route requests. This can be a mix of simple, simple multi-address and TSP requests. Each individual request looks like a single request but is encapsulated in a <batch_route_request> element. The routing engine differentiates batched requests from batch mode requests when it finds a <route_request> element embedded in the <batch_route_request> element.
- Batch mode route requests return multiple responses, each with the same start location but different end locations.

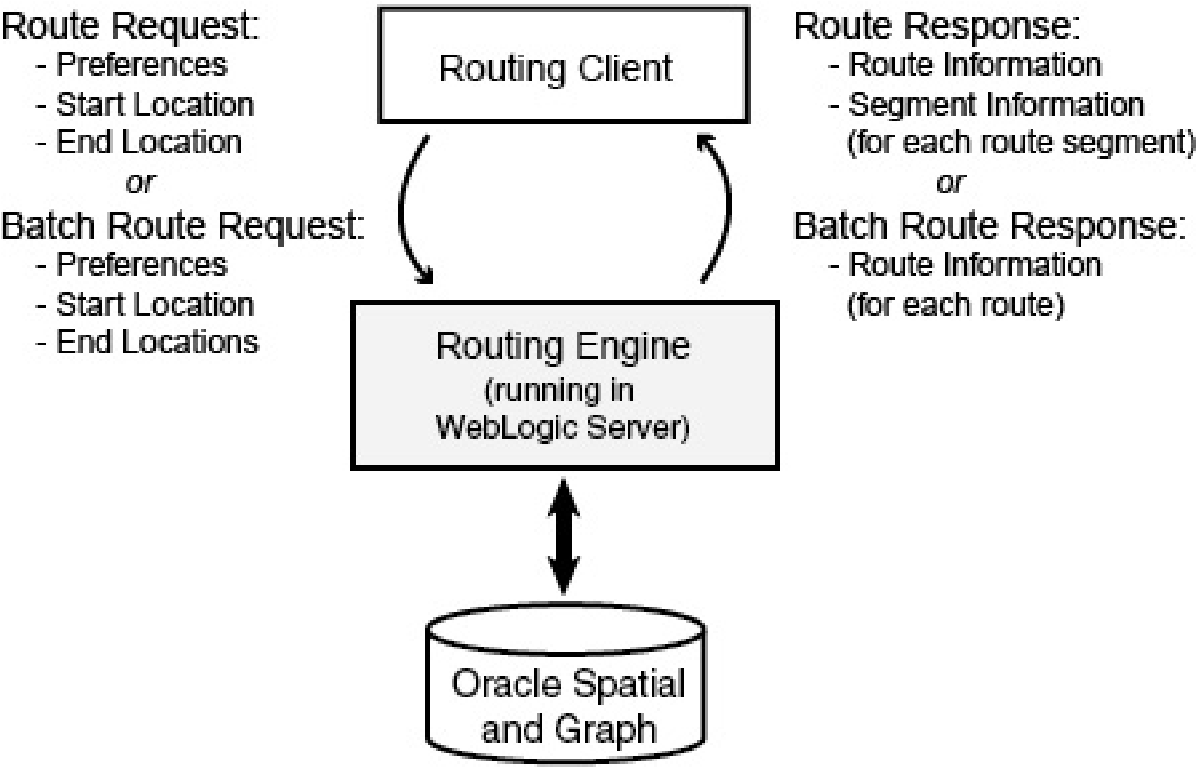
For all requests, the start, intermediate, and end locations are identified by addresses, pre-geocoded addresses, or longitude/latitude coordinates.

Multi-address routes are explained in Routing.

The Oracle Routing engine is implemented as a Java 2 Enterprise Edition (J2EE) Web application that can be deployed in an application server such as Oracle WebLogic Server.

Figure 14-1 shows the basic flow of action with the routing engine: a client locates a remote routing engine instance, sends a route request, and processes the route response returned by the routing engine instance.

Figure 14-1 Basic Flow of Action with the Spatial Routing Engine



This chapter does not include information about administering the routing engine. That information, which is for advanced users with specialized needs, is in Routing Engine Administration.

- Routing
  Routes are computed between location elements.
- Deploying the Routing Engine
  This topic provides an overview of deploying the routing engine.
- Routing Engine XML API
  This topic explains how to submit route requests in XML format to the routing engine, and it describes the XML Schema Definitions (XSDs) for the route requests (input) and responses (output).
- Location-Based Query Using the WSServlet XML API
  WSServlet is a routing engine servlet for performing lightweight location based queries related to speed limit and traffic speed.
- Data Structures Used by the Routing Engine
  Older versions of the routing engine (before Release 12.1) must have the following tables in their schema.
- User Data Structures Used by the Routing Engine
  The routing engine uses user data as well as routing engine data. Some user data, such as turn restriction user data, must be present in the routing engine schema. Other user data, such as trucking user data, is optional.

14.1 Routing

Routes are computed between location elements.

There are three types of location elements: `<start_location>`, `<location>` (intermediate locations or waypoints), and `<end_location>`. A location element can be specified as an address that is geocoded; as a pre-geocoded address, edge id/percentage pair; or as a latitude/longitude pair that is reverse geocoded.

The routing engine can incorporate a start time in its computations. For example, in an urban area, the estimated total driving time from your home to the airport on a weekday can be very different if you start at 8 am as opposed to 7 pm. The time computations are based on historical traffic pattern data, not on any real-time data gathering (for example, they do not factor in any current accidents or severe weather).

To include this optional feature, in the route request specify `start_time` and optionally `start_date` values, set `return_route_time` to `true` (that is, include the total estimated route time in the response), and make time zone user data available. If `return_route_time` is `true` but a start time is not specified, it is assumed to be when the route request is issued. (The relevant attributes are explained in Routing Engine XML API.)

This optional feature does not apply to batched route requests and batch mode requests.

- Simple Route Request
- Simple Multi-address Route Request
- Traveling Salesperson (TSP) Route Request
- Batched Route Request
- Batch Mode Route Request
- Relationship between Routing Engine and Geocoder

14.1.1 Simple Route Request

Simple route requests must contain both a `<start_location>` and `<end_location>` element. The response for a simple route request is a single route from the start location to the end location.

Several attributes in a simple route request control how the route is computed and what is returned in the route response. These attributes are discussed in Routing Engine XML API.

14.1.2 Simple Multi-address Route Request

Simple multi-address route requests must contain at least three locations, including a required `<start_location>` element. Multi-address route requests must also contain one or more `<location>` elements, and optionally an `<end_location>` element.

The result of a simple multi-address route request is a single route from the start location, through each intermediate location, to the end location. This single route consists of multiple subroutes. **Subroutes** are the routes between each of the individual locations.

In a simple multi-address route request, the `optimize_route` attribute must be absent or set to FALSE. In simple multi-address route requests, all locations are fixed. There is no attempt to optimize the order in which the locations are visited. The locations in the route are visited in the order in which they were specified in the request.

Simple multi-address route requests use the `route_type` attribute to classify the route as an open or closed tour:

- Open tour: The route ends at the final intermediate location or a specified end location.
- Closed tour: The route returns to the start location.

  If a simple multi-address closed tour route is requested, the `<start_location>` element specification also used as the end location during route computation. If an `<end_location>` element is specified in a simple multi-address closed tour route request, an error is returned.

Example: Simple Multi-address Open Tour Route Request

Assume you want to drive from your workplace to customer A, then to customer B, and then to customer C.

- The route request has your workplace as the start location, customers A and B as intermediate locations, and customer C as the end location.
- The returned route has three subroutes: (1) workplace to customer A, (2) customer A to customer B, and (3) customer B to customer C.
- Each subroute probably has multiple segments, each one associated with a specific driving direction step.

Example: Simple Multi-address Closed Tour Route Request

Assume you want to drive from your workplace to customer A, then to customer B, then to customer C, and then back to your workplace.

- The route request has your workplace as the start location, and customers A, B, and C as intermediate locations. Your workplace is also used as the end location. An `<end_location>` element .should not be specified in the route request. The routing engine adds the subroute from customer C to the workplace automatically when it sees a request for a closed tour.
- The returned route has four subroutes: (1) workplace to customer A, (2) customer A to customer B, (3) customer B to customer C, and (4) customer C back to the workplace.
- Each subroute probably has multiple segments, each one associated with a specific driving direction step.

Simple multi-address requests can contain several attributes specific to each subroute. These attributes include `return_subroutes`, `return_subroute_edge_ids`, and `return_subroute_geometry`. These attributes are explained in Route Request XML Schema Definition.

14.1.3 Traveling Salesperson (TSP) Route Request

A **traveling salesperson (TSP) route** request must have at least three locations. Unlike simple multi-address route requests, the `<start_location>` element is optional.

TSP route requests are multi-address requests that have the `optimize_route` attribute present and set to TRUE. TSP route requests attempt to reorder the unfixed locations in the request to optimize the overall route.

All the locations in a TSP request are classified as unfixed or fixed:

- **Unfixed** location: If a location is specified with the `<location>` element, it is considered an unfixed location and is subject to reordering during route computation.

- **Fixed** location: If the location is specified with a `<start_location>` or `<end_location>` element, it is considered a fixed location and is not subject to reordering during route computation.

  If intermediate locations need to be fixed, a simple multi-address route request should be used instead of a TSP route request.

TSP route requests use the `route_type` attribute to classify the route as an open or closed tour.:

- **Open** tour: The route does not return to the start location.
- **Closed** tour: The route returns to the start location.

  If a TSP closed tour route is requested, the `<start_location>` element must be specified. This start location is also used as the end location during route computation. If an `<end_location>` element is specified in a TSP closed tour route request, an error is returned. By definition, TSP closed tour routes use a single fixed start and end location but the intermediate locations are still subject to reordering.

Example: TSP Open Tour Route Request

To drive from your workplace, visiting customers A, B, and C:

- The route has the workplace as a fixed start location.
- The route has customers A, B, and C as unfixed intermediate locations. These locations are reordered to optimize the overall route.
- The returned route is an optimized open tour route from the workplace to the first reordered location, through the second reordered location, to the final location.

Example: TSP Closed Tour Route Request

To drive from your workplace, visiting customers A, B, and C, and then returning to your workplace:

- The route has the workplace as a fixed start location. The workplace is also used as a fixed end location. An `<end_location>` element should not be specified in the route request. The routing engine adds the subroute from last unfixed location to the workplace automatically when it sees a request for a closed tour.
- The route has customers A, B, and C as unfixed intermediate locations. These locations are reordered to optimize the overall route.
- The returned route is an optimized closed tour route from the workplace to the first reordered location, through the second and third reordered locations, and finally back to the start location.

TSP route requests can contain several attributes specific to each subroute. These attributes include `return_subroutes`, `return_subroute_edge_ids`, and `return_subroute_geometry`. These attributes are explained in Route Request XML Schema Definition.

14.1.4 Batched Route Request

Batched route requests are a hybrid of batch mode requests (explained in Batch Mode Route Request) and individual route requests. Batched route requests are a way to process multiple simple, simple multi-address, and TSP route requests in one request to the routing engine. Batching of batch mode requests is not allowed.

Like a batch mode request, the outermost element of a batched route request is `<batch_route_request>`. Unlike a batch mode request, batched route requests have one or more `<route_request>` elements nested inside the batch request.

In a batched route request, all attributes associated with the encompassing `<batch_route_request>` element are ignored. Instead, the attributes associated with the nested `<route_request>` elements are used when processing each individual route. This allows users to mix simple, simple multi-address, and TSP requests in a single batched individual route request.

The batched route request is useful for submitting multiple variations of a single route request with differing attributes and comparing the results, for example, for comparing the fastest route with the shortest route.

The individual route requests in a batched route request can use any of the attributes from simple route requests. They can also use any of the subroute-specific attributes of simple multi-address and TSP route requests.

All of the individual route requests in a batched route request are standalone; they have no effect on any other route request in the batch.

14.1.5 Batch Mode Route Request

A **batch mode route request** contains one `<start_location>` element and one or more `<end_location>` elements.

The result of a batch mode route request contains multiple routes. Each route is from the start location to one of the end locations. Each route in a batch mode request is completely separate from all the other routes except for the shared start location.

Batch mode route requests may contain several batch mode specific attributes. These attributes include `cutoff_distance` and `sort_by_distance`. These attributes are explained in Route Request XML Schema Definition.

14.1.6 Relationship between Routing Engine and Geocoder

The routing engine depends on the geocoder, and therefore the data used for routing and geocoding must be consistent (that is, must be of the same "vintage" from your data provider).

A geocoding request returns an SDO_GEO_ADDR object that includes the following for each road segment: (1) Percent and EdgeID, and (2) Longitude and Latitude. The routing engine considers only the Percent and EdgeID.

The route server edge ID values can be positive or negative, reflecting the direction of the segment. (Geocoding edge IDs are always positive, because direction is irrelevant for geocoding.) The same road segment identifier in the routing and geocoding tables might be different only in the sign.

Consider the following example where an address is geocoded and will be used later for routing:

```
SELECT SDO_GCDR.GEOCODE('ODF_NA_Q312',
  SDO_KEYWORDARRAY('5100 Geary Blvd', 'SAN FRANCISCO,CA 94118'),
  'US', 'RELAX_POSTAL_CODE')
  FROM dual;
```

The geocoder may return edgeid = 127806839 with percent = .86 (where EDGEID corresponds to the road_segment_id column of the geocoder GC_ROAD_SEGMENT table). However, the EDGE table used by the routing engine may have that same segment with edge_id -127806839 (different only in the negative sign). If a positive road_segment_id (from GC_ROAD_SEGMENT) matches only negative edge_id (from EDGE), the percent returned by the geocoder should be subtracted from 1 to get the corresponding percent to apply to the reversed edge(edge_id). In this example, 1 - .86 = .14.

14.2 Deploying the Routing Engine

This topic provides an overview of deploying the routing engine.

Before following steps in this topic, be sure you understand the information in Deploying and Configuring Spatial Web Services and performed any necessary operations.

Deploying the routing engine involves the following actions.

- Unpacking the routeserver.ear File
- Editing the web.xml File for Routing Engine Deployment
- Deploying the Routing Engine on WebLogic Server

14.2.1 Unpacking the routeserver.ear File

To unpack the routeserver.ear.zip file, follow these steps.

In examples in these steps, the following values are used:

- The WebLogic Server Home ($WLS_HOME) is `/scratch/software/Oracle/Middleware/user_projects/domains/spatial/`.
- The application deployment directory is `$WLS_HOME/applications/`.

However, use the values appropriate for your environment if they are different.

1. Copy `routeserver.ear.zip` to the application deployment directory:

   ```
   cp routeserver.ear.zip $WLS_HOME/applications/
   ```

2. Unzip `routeserver.ear.zip`:

   ```
   cd $WLS_HOME/applications/
   unzip routeserver.ear.zip
   ```

14.2.2 Editing the web.xml File for Routing Engine Deployment

This section describes changes to parameter values in the `web.xml` file that you must make for the routing engine to deploy properly. (There are also other parameters that you can change to alter how the routing engine operates.)

- Change the `container_ds` parameter to be the JNDI Name of the data source associated with the managed server. For example: `JNDI/NorthAmericanDS`
- Change the `routeserver_network_name` parameter to the name of the Network Data Model (NDM) network built on the routing engine road network data. For example: `NorthAmericanNetwork`
- If the WLS Managed Server has a Work Manager associated with it, change the `wl-dispatch-policy` parameter value to the name of the Work Manager. For example: `NorthAmericanWM`

- Check to be sure the `geocoder_type` parameter is set to `httpclient` or `None`. (`thinclient` is no longer supported.)
  - If set to httpclient, then also set `geocoder_http_url` to the URL of the Geocoder servlet. For example: `http://localhost:8888/geocoder/gcserver`
  - If an HTTP proxy is being used, then also specify `geocoder_http_proxy_host` and `geocoder_http_proxy_port`. If no proxy exists, these two parameters can be ignored
- If necessary, change the `logfile_name` parameter value. By default, the `logfile_name` parameter is set to `log/RouteServer.log`. This default relative path includes a subdirectory named `log`, relative to where the routing engine is installed. The `logfile_name` parameter can also be set to an absolute path, for example: `/scratch/logs/RouteServer.log`.
- If `start_time` and `start_date` are used in route requests, include the attributes `date_format`, `time_format`, and `output_time_format`. `date_format` and `time_format` must be ormats supported by `SimpleDateFormat` of Java. For example, `date_format` can be set to `dd-MMM-yyyy` and `time_format` can be set to `HH:mm`. The `start_time` in the route request will be parsed according to the format set by these parameters.
- If `return_route_time` or `return_subroute_time` is used in route requests, set `output_time_format` to a time format supported by `SimpleDateFormat` in Java. The start and end times in the router response are formatted according to the `output_time_format` value.
- Change the `partition_cache_size` parameter. The default value for this parameter is 70, but it will probably need to be changed depending on the amount of memory allocated to the heap on the managed server. The following formula can be used to get a good starting point for a cache size.

  ```
  partition_cache_size = (NodesPerGigabyte/AvgNodesPartition)*UsableMemory
  ```

  Where:

  - `NodesPerGigabyte` is the number of nodes per gigabyte. (This value should not change. In the data sets as of December 2013, this value is 15000000, that is, 1.5 million.)
  - `AvgNodesPartition` is the average number of nodes per local partition. This does not include the highway partition 0. The memory for the highway partition is accounted for in the 1 gigabyte subtracted from the allocated heap size. For the North American data set, the `AvgNodesPartition` value is around 26000. You can check the actual average nodes per partition by using the following query:

    ```
    SELECT AVG(COUNT(node_id))
         FROM node
         WHERE partition_id>0
         GROUP BY partition_id;
    ```

  - `UsableMemory` is the managed server allocated heap size in Gigabytes minus 1 Gigabyte.

  This formula generates a safe number for the `partition_cache_size` parameter. Depending on the types of user information being used and the average number of concurrent requests being processed, it may be possible to add another 15% to 20% to this number. Use the WLS console to monitor the heap usage before changing this number.

  The heap can then be monitored while the routing engine is running to tune this number up or down. However, setting this value too high may cause the managed server to run out of memory.

14.2.3 Deploying the Routing Engine on WebLogic Server

To deploy the routing engine on WebLogic Server, follow the steps under “Deploying Spatial Web Services on WebLogic Server and Editing the web.xml File” in Deploying and Configuring Spatial Web Services.

After the routing engine is deployed, you can test the deployment with a set of routing engine test queries. For example, if the managed server was set up to run on port 7003, the routing engine servlet can be tested from `http://localhost:7003/routeserver/`.

These queries can run a variety of different types of route requests. These queries contain North American addresses, but the addresses can easily be manipulated on the web page for other data sets.

14.3 Routing Engine XML API

This topic explains how to submit route requests in XML format to the routing engine, and it describes the XML Schema Definitions (XSDs) for the route requests (input) and responses (output).

XML is widely used for transmitting structured documents using the HTTP protocol. If an HTTP request (GET or POST method) is used, it is assumed the request has a parameter named `xml_request` whose value is a string containing the XML document for the request.

A request to the routing engine servlet has the following format:

```
http://hostname:port/route-server-servlet-path?xml_request=xml-request
```

In this format:

- *hostname* is the network path of the server on which the routing engine is running.
- *port* is the port on which the application server listens.
- *route-server-servlet-path* is the routing engine servlet path (for example, `routeserver/servlet/RouteServerServlet`).
- *xml-request* is the URL-encoded XML request submitted using the HTML GET or POST method.

The input XML is required for all requests. The output will be an XML document.

In a simple *route* request, you must specify a route ID, and you can specify one or more of the following attributes:

- `route_preference`: `fastest`, `traffic`, or `shortest` (default)
- `traffic_sampling_id` (if `route_preference` is `traffic`): `1` (travel times are available at 15-minute intervals) or `2` (the default: travel times are available at 1–hour intervals).
- `road_preference`: `highway` (default) or `local`
- `return_route_time` (whether to return start and end times): `true` or `false` (default)
- `return_driving_directions` (whether to return driving directions): `true` or `false` (default)
- `return_hierarchical_directions` (whether to return hierarchical directions): `true` or `false` (default)
- `return_locations` (return geocoded results for the start and end locations of the route and any subroutes): `true` or `false` (default)

- `return_subroutes` (whether to return subroutes): `true` (default if a multi-address route, ignored for a single-address route) or `false`
- `return_route_geometry` (whether to return the line string coordinates for the route): `true` or `false` (default)
- `return_subroute_geometry` (whether to return the line string coordinates for each subroute): `true` or `false` (default for multi-address routes)
- `return_segment_geometry` (whether to return the line string coordinates for each maneuver in the route): `true` or `false` (default)
- `return_detailed_geometry`: `true` (default; returns detailed geometries) or `false` (returns generalized geometries)
- `start_date`: the starting date of the route. Example:`05-Aug-2016`. Default is the date of the request.
- `start_time`: the starting time of the route. Example: `10:30` for 10:30 am. Default is the time of the request.
- `date_format`: the format used to parse the start date for the `start_date` attribute. Example: `dd-MMM_yyyy`. This can be set to any format supported by `SimpleDateFormat` of Java
- `time_format`: the format used to parse the start time for the `start_time` attribute. Example: `HH:mm`. This can be set to any format supported by `SimpleDateFormat` of Java
- `output_time_format`: the format used to display the start and end times in the route response, if `return_route_time` or `return_subroute_time` is set to `true`
- `language`: language used to generate driving directions (`ENGLISH` (default), `FRENCH`, `GERMAN`, `ITALIAN`, `PORTUGUESE`, or `SPANISH`)
- `distance_unit`: `kilometer`, `mile` (default), or `meter`
- `length_unit`: `us` for feet (default) or `metric` for meters
- `time_unit`: `hour`, `minute` (default), or `second`
- `weight_unit`: `us` for tons (default) or `metric` for metric tons
- `pre_geocoded_locations` (whether the start and end locations are input locations (address specifications or points) or previously geocoded locations): `true` (previously geocoded locations) or `false` (default; input locations)
- `driving_directions_detail`: `high`, `medium` (default) or `low`
- `optimize_route`: `true` or `false` (default)
- `route_type`: `open` (default) or `closed`
- `vehicle_type`: `auto` (default) or `truck`
- `truck_type`: `delivery`, `public`, `resident`, or `trailer`; (no default)
- `truck_height`: floating-point number in `length_units`
- `truck_length`: floating-point number in `length_units`
- `truck_per_axle_weight`: floating-point number in `weight_units`
- `truck_weight`: floating-point number in `weight_units`
- `truck_width`: floating-point number in `length_units`

Batched route requests are groups of one or more simple (single, multi-address, or TSP) requests encapsulated in a `<batch_route_request>` element. All attributes associated with the `<batch_route_request>` element are ignored. Because all encapsulated requests are simple requests, they use the preceding listed attributes.

In a *batch mode route* request, you must specify a request ID, a start location, and one or more end locations. Each location must have an ID attribute. Most of the attributes used for simple requests have no meaning for batch mode. You can use one or more of the following attributes in a batch mode route request, but using an attribute not in this list will cause an exception to be raised.

- `route_preference`: `fastest` or `shortest` (default)
- `road_preference`: `highway` (default) or `local`
- `distance_unit`: `kilometer`, `km`, `mile` (default), or `meter`
- `time_unit`: `hour`, `minute` (default), or `second`
- `sort_by_distance` (whether to sort the returned routes in ascending order by distance of the end location from the start location): `true` or `false` (default)
- `cutoff_distance` (returning only routes where the end location is less than or equal to a specified number of distance units from the start location): (number; default = no limit)
- `pre_geocoded_locations` (whether the start and end locations are input locations (address specifications or points) or previously geocoded locations): `true` (previously geocoded locations) or `false` (default; input locations)

- Route Request and Response Examples
- Route Request XML Schema Definition
- Route Response XML Schema Definition
- Batch Mode Route Request and Response Examples
- Batch Route Request XML Schema Definition
- Batch Route Response XML Schema

14.3.1 Route Request and Response Examples

This section contains XML examples of route requests and the responses generated by those requests. One request uses specified addresses, another uses points specified by longitude and latitude coordinates, and another uses previously geocoded locations. For reference information about the available elements and attributes, see Route Request XML Schema Definition for requests and Route Response XML Schema Definition for responses.

Example 14-1   Route Request with Specified Addresses

Example 14-1 shows a simple request for the fastest route, preferably using highways, between two offices at specified addresses (in Waltham, Massachusetts and Nashua, New Hampshire) in a 5.67 metric ton delivery truck. The response contains driving directions for each segment using kilometers for distances and minutes for times. This request also returns the geocode information for the start and end location.

```
<?xml version="1.0" standalone="yes"?>
<route_request
          id="8"
          route_preference="fastest"
          road_preference="highway"
          vehicle_type="truck"
```

```
        truck_type="delivery"
        truck_weight="5.67"
        return_driving_directions="true"
        return_locations="true"
        distance_unit="km"
        time_unit="minute"
        weight_unit="metric">
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="1000 Winter St"
          lastline="Waltham, MA" />
      </input_address>
    </input_location></start_location>
  <end_location>
    <input_location id="2">
      <input_address>
        <us_form1
          street="1 Oracle Dr"
          lastline="Nashua, NH" />
      </input_address>
    </input_location>
  </end_location>
</route_request>
```

Example 14-2   Response for Route Request with Specified Addresses

Example 14-2 shows the response generated by the request in Example 14-1. (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.1.0 (data version 11.1.0.7.1) -->
<route_response>
  <route id="8" step_count="12"
    distance="46.07216796875" distance_unit="km"
    time="31.133371988932293" time_unit="minute"
    start_location="1" end_location="2">
  <start_location>
    <location id="1"
      longitude="-71.25962" latitude="42.39741"
      house_number="399" street="WINTER ST"
      city="WALTHAM" state="MA" country="US"
      driving_side="R"
      postal_code="02451"
      edge_id="906810462" percent="0.0"/>
  </start_location>
  <segment sequence="1"
    instruction="Start out on Winter St (Going Southwest)"
    distance="0.0" time="0.0"/>
  <segment sequence="2"
    instruction="Turn RIGHT onto Wyman St (Going North)"
    distance="0.3453199939727783" time="0.3597083270549774"/>
  <segment sequence="3"
    instruction="Take RAMP toward Peabody"
    distance="0.43125000953674314" time="0.3478285253047943"/>
  <segment sequence="4"
    instruction="Merge onto I-95 N/RT-128 N (Going North)"
    distance="9.598520091056823" time="6.1528975268205"/>
  <segment sequence="5"
    instruction="Continue on toward Burlington"
    distance="0.0" time="0.0"/>
  <segment sequence="6"
    instruction="Stay STRAIGHT to go onto RAMP (Going East)"
    distance="0.22952000427246094" time="0.23908333778381347"/>
  <segment sequence="7"
    instruction="Continue on toward Lowell"
    distance="0.5157099990844727" time="0.5371979157129924"/>
  <segment  sequence="8"
    instruction="Stay STRAIGHT to go onto US-3 N (Going Northwest)"
    distance="33.26371000862122" time="21.322891048093638"/>
  <segment sequence="9"
    instruction="Take EXIT 1 toward S. Nashua"
    distance="0.6134100036621094" time="0.5454034169514974"/>
  <segment sequence="10"
    instruction="Continue on toward So. Nashua"
    distance="0.27333999633789063" time="0.41415150960286456"/>
  <segment sequence="11"
    instruction="Turn LEFT onto Spit Brook Rd (Going West)"
    distance="0.8013799934387207" time="1.2142121195793152"/>
  <segment sequence="12"
    instruction="Turn RIGHT onto Oracle Dr (Going North)"
    distance="0.0" time="0.0"/>
  <end_location>
    <location id="2"
      longitude="-71.45937" latitude="42.70783"
      house_number="1" street="ORACLE DR"
      city="NASHUA" state="NH" country="US"
      driving_side="R"
      postal_code="03062"
      edge_id="22325991" percent="0.0"/>
  </end_location>
  </route>
</route_response>
```

Example 14-3 Route Request with Locations Specified as Longitude/Latitude Points

Example 14-3 shows a request for a closed tour TSP shortest route, preferably using highways, between four locations specified as longitude/latitude points. (The points are associated with four locations in San Francisco, California: the World Trade Center, Golden Gate Park, 3001 Larkin Street, and 100 Flower Street.) The route starts and ends at a fixed location at the World Trade Center, but the other three locations are subject to reordering to produce an optimal route. The information from the geocoder is returned for all location in the route. The geometry is displayed at the subroute level, and edge IDs are displayed with the driving directions at the segment level.

```
<?xml version="1.0" standalone="yes"?>
<route_request id="8"
               route_preference="shortest"
               route_type="closed"
               optimize_route="true"
               road_preference="highway"
               return_locations="true"
               return_driving_directions="true"
               return_subroutes="true"
               return_route_geometry="false"
               return_subroute_geometry="true"
               return_segment_geometry= "false"
               return_segment_edge_ids= "true"
          >
  <start_location>
    <input_location id="1" longitude="-122.39436" latitude="37.79579"/>
  </start_location>
  <location>
    <input_location id="2" longitude="-122.45412" latitude="37.7714" />;
  </location>
  <location>
    <input_location id="3" longitude="-122.422" latitude="37.80551" />
  </location>
  <location>
    <input_location id="4" longitude="-122.40459" latitude="37.74211" />
  </location>
</route_request>
```

Example 14-4   Response for Route Request with Locations Specified as Longitude/ Latitude Points

Example 14-4 shows the response generated by the request in Example 14-3. (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<route_response>
  <route id="8" step_count="88"
    distance="15.105344411681319" distance_unit="mile"
    time="35.63843688964844" time_unit="minute"
    start_location="1" end_location="1">
    <subroute id="1" step_count="5"
      distance="1.8589950065634127" distance_unit="mile"
      time="4.305604044596354" time_unit="minute"
      start_location="1" end_location="3">
      <subroute_geometry>
        <LineString><coordinates>
          -122.39436,37.79579 -122.39436,37.79579 -122.39454,37.79601
          -122.39467,37.79614 -122.39486,37.79633 -122.39499,37.79647
          -122.39529,37.79678 -122.39558,37.79709 -122.39592,37.79747
          -122.3963,37.7979 -122.39646,37.79808 -122.3969,37.79858
          -122.39741,37.79916 -122.39755,37.79929 -122.39776,37.79918
          -122.39793,37.79907 -122.39811,37.79899 -122.39821,37.79896
          -122.39836,37.79892 -122.39867,37.79889 -122.39986,37.79874
          -122.40104,37.7986 -122.40223,37.79845 -122.40302,37.79835
          -122.40308,37.79834 -122.40349,37.79828 -122.40384,37.79824
          -122.40466,37.79813 -122.40545,37.79802 -122.40549,37.79802
          -122.4062,37.79794 -122.40622,37.79794 -122.40664,37.79789
          -122.40707,37.79816 -122.40789,37.79872 -122.40846,37.7991
          -122.40898,37.7995 -122.41017,37.80031 -122.41038,37.80045
          -122.41078,37.80073 -122.41089,37.8008 -122.41094,37.80084
          -122.41136,37.80112 -122.41143,37.80118 -122.41248,37.80188
          -122.41254,37.80193 -122.41289,37.80218 -122.41367,37.80274
          -122.41488,37.80355 -122.41547,37.80396 -122.41607,37.80441
          -122.41657,37.80475 -122.41681,37.80492 -122.4172,37.80519
          -122.4178,37.8056 -122.41837,37.80598 -122.41873,37.80593
          -122.42035,37.80573 -122.422,37.80551
          -122.42199999992847,37.805509999663826
        </coordinates></LineString>
      </subroute_geometry>
      <start_location>
        <location id="1"
          longitude="-122.39436" latitude="37.79579"
          house_number="" street="HERB CAEN WAY"
          city="SAN FRANCISCO" state="CA" country="US"
          driving_side="R"
          postal_code="94111"
          edge_id="724791174" percent="1.0"/>
      </start_location>
      <segment sequence="1"
        instruction="Start out on The Embarcadero (Going Northwest)"
        distance="0.29822904401544625" time="0.49993750055631003">
        <segment_edge_ids><edge_ids>
          724791174, 724791175, 733049363, 915793201, 915793202, 830932896,
          112011102, 112011103, 830934259, 830934260, 726169597, 112011105,
          37830229
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="2"
        instruction="Turn LEFT onto Broadway (Going Southwest)"
        distance="0.5093705394140182" time="1.2420151789983114">
        <segment_edge_ids><edge_ids>
          -24571168, -724946174, -724946173, -23598782, -23621077, -23598783,
          -23598784, -23598786, -23598787, -23598788, -23598789, -23598791,
          -23598792
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="3"
        instruction="Turn SLIGHT RIGHT onto Columbus Ave (Going Northwest)"
        distance="0.8505250718279074" time="2.07386361459891">
        <segment_edge_ids><edge_ids>
          23601001, 23601002, 23601003, 23601004, 830239101, 830239102,
          799420615, 23601006, 23601007, 23601008, 23737804, 23601009,
          23601010, 23601011, 23737805, 23601012, 754219681, 754219682,
          23622414, 754224948, 754224949
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="4"
        instruction="Turn SLIGHT LEFT onto North Point St (Going West)"
        distance="0.20086994241069608" time="0.48978787660598755">
        <segment_edge_ids><edge_ids>
          -23612405, -23612406, -23612407
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="5"
        instruction="Turn LEFT onto Larkin St (Going South)"
        distance="2.3560371803568745E-8" time="5.744803956986288">
        <segment_edge_ids><edge_ids>
          -23609029
        </edge_ids></segment_edge_ids>
      </segment>
      <end_location>
        <location id="3"
          longitude="-122.42199999966279" latitude="37.80551000007165"
          house_number="2999" street="LARKIN ST" city="SAN FRANCISCO"
          state="CA" country="US"
          driving_side="R"
          postal_code="94109"
          edge_id="23609029" percent="0.9999996412873026"/>
      </end_location>
    </subroute>
    <subroute id="2" step_count="32"
      distance="4.0150478493172495" distance_unit="mile"
      time="9.790025838216145" time_unit="minute"
      start_location="3" end_location="2">
      <subroute_geometry>
        <LineString><coordinates>
          -122.42199999992847,37.805509999663826 -122.422,37.80551
          -122.42364,37.8053 -122.42345,37.80436 -122.42327,37.80342
          -122.42482,37.80322 -122.42496,37.8032 -122.42545,37.80314
          -122.42656,37.803 -122.42638,37.80207 -122.4262,37.80111
          -122.42782,37.8009 -122.42947,37.80069 -122.43111,37.80048
          -122.43276,37.80026 -122.43439,37.80006 -122.43605,37.79985
          -122.43597,37.79943 -122.43588,37.79896 -122.43751,37.79874
          -122.43742,37.79828 -122.43733,37.79781 -122.43895,37.79759
          -122.43877,37.79667 -122.44041,37.79645 -122.44025,37.79554
          -122.4419,37.7953 -122.44173,37.79439 -122.44153,37.79343
          -122.44308,37.79323 -122.44317,37.79322 -122.44328,37.79321
          -122.44476,37.79302 -122.44487,37.79301 -122.44496,37.793
          -122.44643,37.7928 -122.4463,37.79188 -122.44614,37.79099
          -122.44595,37.79011 -122.44577,37.78924 -122.44559,37.78836
          -122.44697,37.78818 -122.44688,37.78775 -122.44687,37.78769
          -122.44678,37.78726 -122.44676,37.78705 -122.44671,37.78679
          -122.44675,37.78651 -122.4468,37.78635 -122.44689,37.78618
          -122.44697,37.78603 -122.44749,37.7855 -122.44766,37.78538
          -122.44792,37.78513 -122.448,37.78507 -122.44814,37.78496
          -122.44929,37.78468 -122.45012,37.78448 -122.45015,37.78432
          -122.4502,37.78418 -122.45034,37.78396 -122.45041,37.78383
          -122.45043,37.78369 -122.45012,37.78218 -122.45112,37.78205
          -122.45109,37.78192 -122.45082,37.78064 -122.45186,37.78049
          -122.45287,37.78037 -122.45385,37.78023 -122.45374,37.77943
          -122.45367,37.77905 -122.45349,37.77817 -122.45339,37.77781
          -122.45332,37.77763 -122.45318,37.77685 -122.45303,37.77596
          -122.45299,37.77574 -122.45283,37.77499 -122.45297,37.77497
          -122.45287,37.77443 -122.45279,37.77404 -122.45262,37.7731
          -122.45241,37.77215 -122.45276,37.77206 -122.45301,37.77195
          -122.45346,37.77172 -122.45387,37.77153 -122.45398,37.77148
          -122.45412868777395,37.77142244344235
        </coordinates></LineString>
      </subroute_geometry>
      <start_location>
        <location id="3"
          longitude="-122.42199999966279" latitude="37.80551000007165"
          house_number="2999" street="LARKIN ST" city="SAN FRANCISCO"
          state="CA" country="US"
          driving_side="R"
          postal_code="94109"
          edge_id="23609029" percent="0.9999996412873026"/>
      </start_location>
      <segment sequence="1"
        instruction="Start out on Larkin St (Going North)"
        distance="2.3560371803568745E-8" time="5.7448039569862884E-8">
        <segment_edge_ids><edge_ids>
          23609029
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="2"
        instruction="Turn LEFT onto North Point St (Going West)"
        distance="0.09072267445473188" time="0.22121211687723796">
        <segment_edge_ids><edge_ids>
          -23612408
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="3"
        instruction="Turn LEFT onto Polk St (Going South)"
        distance="0.1314981638707435" time="0.3206363519032796">
        <segment_edge_ids><edge_ids>
          -23614397, -23614396
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="4"
        instruction="Turn RIGHT onto Francisco St (Going West)"
        distance="0.1819921735430389" time="0.443757571776708">
        <segment_edge_ids><edge_ids>
          -23604420, -120906034, -916007650, -916007649
        </edge_ids></segment_edge_ids>
      </segment>
```

```
<segment sequence="5"
  instruction="Turn LEFT onto Franklin St (Going South)"
  distance="0.13209470069661014" time="0.32209091186523436">
  <segment_edge_ids><edge_ids>
    -23604500, -23604499
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="6"
  instruction="Turn RIGHT onto Lombard St (Going West)"
  distance="0.544926363604202"
  time="1.3287121295928954">
  <segment_edge_ids><edge_ids>
    -23609690, -23609691, -23609692, -23609693, -23609694,
    -23609695
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="7"
  instruction="Turn LEFT onto Fillmore St (Going South)"
  distance="0.06220717119887626"
  time="0.15168182055155435">
  <segment_edge_ids><edge_ids>
    -23604040, -23604039
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="8"
  instruction="Turn RIGHT onto Greenwich St (Going West)"
  distance="0.09030634551112576"
  time="0.22019697825113932">
  <segment_edge_ids><edge_ids>
    -23605619
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="9"
  instruction="Turn LEFT onto Steiner St (Going South)"
  distance="0.06502205890116725" t
  time="0.15854545434316">
  <segment_edge_ids><edge_ids>
    -23618095, -23618094
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="10"
  instruction="Turn RIGHT onto Filbert St (Going West)"
  distance="0.08977195129603127"
  time="0.21889394124348957">
  <segment_edge_ids><edge_ids>
    -23603994
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="11"
  instruction="Turn LEFT onto Pierce St (Going South)"
  distance="0.06433853285001388"
  time="0.15687878926595053">
  <segment_edge_ids><edge_ids>
    -23614117
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="12"
  instruction="Turn RIGHT onto Union St (Going West)"
  distance="0.09084695019464499"
  time="0.22151514689127605">
  <segment_edge_ids><edge_ids>
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      instruction="Turn LEFT onto Scott St (Going South)"
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      distance="0.3103461147339876"
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      distance="0.3103461147339876"
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      instruction="Turn RIGHT onto Sacramento St (Going West)"
      distance="0.07639346451339481"
      time="0.18627273241678874">
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  instruction="Turn SLIGHT RIGHT onto RAMP (Going South)"
  distance="0.054849932668282114"
  time="0.1337424119313558">
  <segment_edge_ids><edge_ids>
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  </edge_ids></segment_edge_ids>
</segment>
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  instruction="Turn SLIGHT RIGHT onto Masonic Ave (Going Southwest)"
  distance="0.09798048860074304"
  time="0.2389090855916341 2">
  <segment_edge_ids><edge_ids>
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      postal_code="94118"
      edge_id="728011751" percent="0.5203619908971352"/>
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      -122.4547,37.77107 -122.45447,37.77116 -122.45424,37.77124
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    city="SAN FRANCISCO" state="CA" country="US"
    driving_side="R"
    postal_code="94118"
    edge_id="728011751" percent="0.5203619908971352"/>
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  distance="0.04787796125753919"
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  </edge_ids></segment_edge_ids>
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  distance="0.08222829797036355"
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  distance="0.02978934855322748"
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</segment>
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  distance="0.06471136481056884"
  time="0.1577878793080648">
  <segment_edge_ids><edge_ids>
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  </edge_ids></segment_edge_ids>
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  distance="0.1948176204828599"
  time="0.4750302950541178">
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  distance="0.12885726410065712"
  time="0.3141969680786133">
  <segment_edge_ids><edge_ids>
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  distance="0.04533026592197986"
  time="0.11053029696146648">
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  instruction="Turn RIGHT onto Masonic Ave (Going South)"
  distance="0.2072702425733493"
  time="0.5053939501444499">
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    -814886921
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  instruction="Stay STRAIGHT to go onto Roosevelt Way (Going East)"
  distance="0.04439197258915798"
  time="0.1082424263159434">
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    -814886920, -799371986, -799371985
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</segment>
<segment sequence="15"
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  instruction="Turn RIGHT onto Levant St (Going Southwest)"
  distance="0.03410178286259032"
  time="0.0831515113512675">
  <segment_edge_ids><edge_ids>
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</segment>
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  distance="0.4172186714314114"
  time="1.0173182010650634">
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    932495103, 799475779
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    -905543897, -753950604, -753950603
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  distance="0.115211584951289"
  time="0.2809242566426595">
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  time="1.0132273137569427">
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  distance="0.10895420141545431"
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  distance="0.28101037926858485"
  time="0.6851969718933105">
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    23595021, 23595020
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  distance="0.10886099698092727"
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  instruction="Turn LEFT onto 24th St (Going East)"
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  time="0.3621212085088094">
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  instruction="Turn RIGHT onto Hampshire St (Going South)"
  distance="0.11043310832082466"
  time="0.26927274068196616">
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  distance="0.05257565439032596"
  time="0.1281969706217448">
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  instruction="Turn RIGHT onto Potrero Ave (Going South)"
  distance="0.050077673617465915"
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  distance="0.03984341188503202"
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    -915517048
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  instruction="Stay STRAIGHT to go onto Bayshore Blvd(Going Southeast)"
  distance="0.5910582184784158"
  time="1.0831619163354238">
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    -915517047, -120885637, -830210066, -776735343,
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    -23621037, -23621038, -23621034, -756635722,
    -756635721, -23597820, -756635724, -756635723
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  instruction="Turn LEFT onto Flower St (Going East)"
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  time="0.15581818421681723">
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</segment>
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      driving_side="R"
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      edge_id="23604155" percent="0.0"/>
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      -122.40254,37.75452 -122.40163,37.75458 -122.40178,37.75614
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      -122.40285,37.77086 -122.40226,37.77134 -122.40203,37.77153
      -122.40166,37.77183 -122.40131,37.77211 -122.40113,37.77226
      -122.39968,37.7734 -122.39956,37.7735 -122.39943,37.77361
      -122.39723,37.77535 -122.39539,37.77679 -122.39499,37.77711
      -122.39457,37.77743 -122.3943,37.77764 -122.3939,37.77795
      -122.39356,37.77823 -122.39344,37.77832 -122.3933,37.77843
      -122.39275,37.77886 -122.39259,37.77899 -122.39256,37.77902
      -122.39239,37.77915 -122.39222,37.77929 -122.39203,37.77944
      -122.39141,37.77994 -122.39108,37.7802 -122.39052,37.78062
      -122.38974,37.78123 -122.38923,37.78161 -122.38911,37.78166
      -122.38896,37.78173 -122.38863,37.78179 -122.38841,37.78181
      -122.38814,37.7818 -122.38813,37.78195 -122.38811,37.7823
      -122.38811,37.78254 -122.3881,37.78266 -122.38806,37.78316
      -122.38802,37.78335 -122.38791,37.78477 -122.38789,37.78504
      -122.3878,37.7861 -122.3878,37.78615 -122.38771,37.78707
      -122.3877,37.78722 -122.38769,37.78747 -122.3877,37.78766
      -122.38772,37.78791 -122.38779,37.78835 -122.38788,37.7888
      -122.38794,37.78896 -122.38816,37.78937 -122.38838,37.78965
      -122.38859,37.78984 -122.38935,37.79047 -122.38978,37.79082
      -122.38992,37.79095 -122.39013,37.7912 -122.39028,37.79141
      -122.39041,37.79166 -122.39049,37.79181 -122.39061,37.79205
      -122.39071,37.79226 -122.39093,37.79252 -122.39117,37.79276
      -122.3915,37.79303 -122.392,37.79344 -122.39233,37.79374
      -122.39246,37.79387 -122.39257,37.79397 -122.39275,37.79414
      -122.39303,37.7944 -122.39319,37.79455 -122.39335,37.79471
      -122.39357,37.79494 -122.39374,37.79511 -122.39382,37.79518
      -122.39407,37.79546 -122.39436,37.79579
    </coordinates></LineString>
  </subroute_geometry>
  <start_location>
    <location id="4"
      longitude="-122.40459" latitude="37.74211"
      house_number="99" street="FLOWER ST" city="SAN FRANCISCO"
      state="CA" country="US"
      driving_side="R"
      postal_code="94124"
      edge_id="23604155" percent="0.0"/>
  </start_location>
  <segment sequence="1"
    instruction="Start out on Flower St (Going East)"
    distance="0.0"
    time="0.0">
    <segment_edge_ids><edge_ids>
      -23604155
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="2"
    instruction="Turn LEFT onto Loomis St (Going Northeast)"
    distance="0.1399739006534103"
    time="0.341303030649821">
    <segment_edge_ids><edge_ids>
      23609757, 23609756
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="3"
    instruction="Turn SLIGHT LEFT onto Barneveld Ave (Going North)"
    distance="0.1780836365735976"
    time="0.43422727584838866">
    <segment_edge_ids><edge_ids>
      23597607
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="4"
    instruction="Turn SLIGHT LEFT onto Jerrold Ave (Going Northwest)"
    distance="0.06884359716369064"
    time="0.16786363919576008">
    <segment_edge_ids><edge_ids>
      127821131
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="5"
    instruction="Stay STRAIGHT to go onto RAMP (Going Northwest)"
    distance="0.04681538329577495"
    time="0.11415150960286459">
    <segment_edge_ids><edge_ids>
      127821133
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="6"
    instruction="Stay STRAIGHT to go onto Cesar Chavez (Going North)"
    distance="0.1321568397517706"
    time="0.22154166897137959">
    <segment_edge_ids><edge_ids>
      23621025, 830210057, 830210058, 120885622
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="7"
    instruction="Turn LEFT onto Vermont St (Going North)"
    distance="0.06916050646352936"
    time="0.16863636970520018">
    <segment_edge_ids><edge_ids>
      754243248, 754243249
    </edge_ids></segment_edge_ids>
  </segment>
```

```
<segment sequence="8"
  instruction="Turn SLIGHT RIGHT onto 26th St (Going East)"
  distance="0.036668115529443365"
  time="0.08940908908843995">
  <segment_edge_ids><edge_ids>
    23595258
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="9"
  instruction="Turn LEFT onto Kansas St (Going North)"
  distance="0.27153420476451817"
  time="0.6620909055074056">
  <segment_edge_ids><edge_ids>
    23608261, 23608260, 23608259
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="10"
  instruction="Turn RIGHT onto 23rd St (Going East)"
  distance="0.049897472846428766"
  time="0.12166666984558105">
  <segment_edge_ids><edge_ids>
    23595010
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="11"
  instruction="Turn LEFT onto Rhode Island St (Going North)"
  distance="1.0569688657972653"
  time="2.5772424399852754">
  <segment_edge_ids><edge_ids>
    933038005, 933038006, 933038001, 933038002,
    23615271, 23615270, 23615269, 23615268,
    23615267, 23615266, 23615265, 23615264,
    23615263
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="12"
  instruction="Turn LEFT onto Division St (Going West)"
  distance="0.043919717429223945"
  time="0.10709091226259868">
  <segment_edge_ids><edge_ids>
    -23602204, 829577422, 829577423
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="13"
  instruction="Stay STRAIGHT to go onto RAMP (Going Northwest)"
  distance="0.0055987076548075785"
  time="0.013651515046755472">
  <segment_edge_ids><edge_ids>
    24552756
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="14"
  instruction="Turn RIGHT onto Townsend St (Going Northeast)"
  distance="1.192965882328057"
  time="2.9088484485944113">
  <segment_edge_ids><edge_ids>
    916742043, 916742044, 916742041, 916742042,
    916637669, 916637670, 916637671, 916637672,
    23618959, 724706739, 724706740, 915025718,
    915025719, 915025717, 23618956, 915025720,
    915025721, 23618954, 916135978, 916135979,
    916135980, 916135981, 916135982, 799424055,
          23618951, 23618950, 799362044, 799362045,
          724686775, -23841533
        </edge_ids></segment_edge_ids>
      </segment>
      <segment sequence="15"
        instruction="Turn LEFT onto The Embarcadero (Going North)"
        distance="1.0898340975809355"
        time="1.8269479304552079">
        <segment_edge_ids><edge_ids>
          807424014, 807424015, 733049265, 830425790,
          830425791, 112011086, 799424653, 799424654,
          724665449, 830416191, 830416192, 120886507,
          120886508, 112011094, 112011097, 725001298,
          830434313, 830434314, 724945050, 724945051,
          830222369, 830222370, 23841522, 825450115,
          825450116, 127810052, 724791171, 724791172,
          799417573, 799417574, 724791173, 724791174
        </edge_ids></segment_edge_ids>
      </segment>
      <end_location>
        <location id="1"
          longitude="-122.39436" latitude="37.79579"
          house_number="" street="HERB CAEN WAY" city="SAN FRANCISCO"
          state="CA" country="US"
          driving_side="R" postal_code="94111"
          edge_id="724791174"percent="1.0"/>
      </end_location>
    </subroute>
  </route>
</route_response>
```

Example 14-5 Batched Route Request with Locations Specified as Addresses, Pre-geocoded Locations, and Longitude/Latitude Points

Example 14-5 shows a batched request for the a route between the same two points as an auto requesting the fastest route, an auto requesting the shortest route, a truck requesting the fastest route, and a truck requesting the shortest route. The locations in all the requests are the same, but they are specified in a mix of input addresses, pre-geocoded locations, and longitude/latitude points.

```
<?xml version="1.0" standalone="yes"?>
<batch_route_request id="1">
<route_request id="1"
        route_preference="fastest"
        road_preference="highway"
        return_locations="true"
        return_driving_directions="true"
        vehicle_type="auto"
        distance_unit="mile"
        time_unit="minute"
        >
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="875 ALMA ST"
          lastline="94301"/>
      </input_address>
    </input_location>
  </start_location>
  <end_location>
    <input_location id="2">
```

```
      <input_address>
        <us_form1
          street="660 BLOSSOM HILL RD"
          lastline="95123" />
      </input_address>
    </input_location>
  </end_location>
</route_request>
<route_request id="2"
        route_preference="shortest"
        road_preference="highway"
        pre_geocoded_locations="true"
        return_locations="true"
        return_driving_directions="true"
        vehicle_type="auto"
        distance_unit="mile"
        time_unit="minute"
        >
  <start_location>
    <pre_geocoded_location id="1">
      <edge_id>23694266</edge_id>
      <percent>0.0</percent>
      <side>R</side>
    </pre_geocoded_location>
  </start_location>
  <end_location>
    <pre_geocoded_location id="2">
      <edge_id>812218080</edge_id>
      <percent>0.0</percent>
      <side>R</side>
    </pre_geocoded_location>
  </end_location>
</route_request>
<route_request id="3"
        route_preference="fastest"
        road_preference="highway"
        return_locations="true"
        return_driving_directions="true"
        vehicle_type="truck"
        truck_height="13.6"
        truck_length="75"
        truck_weight="30"
        distance_unit="mile"
        time_unit="minute"
        >
  <start_location>
     <input_location id="1"
       longitude="-122.15901"
       latitude="37.4403" />
  </start_location>
  <end_location>
     <input_location id="2"
       longitude="-121.83459"
       latitude="37.25125" />
  </end_location>
</route_request>
<route_request id="4"
     route_preference="shortest"
     road_preference="highway"
     pre_geocoded_locations="true"
     vehicle_type="truck"
     truck_height="13.6"
     truck_length="75"
     truck_weight="30"
     return_driving_directions="true"
     distance_unit="mile"
     time_unit="minute"
     >
  <start_location>
    <pre_geocoded_location id="1">
      <edge_id>23694266</edge_id>
      <percent>0.0</percent>
      <side>R</side>
      </pre_geocoded_location>
  </start_location>
  <end_location>
    <pre_geocoded_location id="2">
      <edge_id>812218080</edge_id>
      <percent>0.0</percent>
      <side>R</side>
    </pre_geocoded_location>
  </end_location>
</route_request>
</batch_route_request>
```

Example 14-6 Response for Batched Route Request with Locations Specified as Addresses, Pre-geocoded Locations, and Longitude/Latitude Points

Example 14-6 shows the response to the request in Example 14-5. (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response>
<route_response>
  <route id="1" step_count="15"
    distance="26.103862121729946" distance_unit="mile"
    time="26.6184814453125" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="-122.15901" latitude="37.4403"
        house_number="898" street="ALMA ST" city="PALO ALTO"
        state="CA" country="US"
        driving_side="R"
        postal_code="94301"
        edge_id="23694266" percent="0.0"/>
    </start_location>
    <segment sequence="1"
      instruction="Start out on Alma St (Going Southeast)"
      distance="1.3587211956625542"
      time="2.504421416918437"/>
    <segment sequence="2"
      instruction="Take RAMP toward Oregon Expwy"
      distance="0.12862735113732848"
      time="0.2156249960263 57"/>
    <segment sequence="3"
      instruction="Stay STRAIGHT togo onto Oregon Expy (Going Northeast)"
      distance="1.3840054698278719"
      time="2.3200833360354105"/>
    <segment sequence="4"
      instruction="Take RAMP toward San Jose"
      distance="0.2647486517044605"
      time="0.44381250540415446"/>
    <segment sequence="5"
```

```
      instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
      distance="11.747225529883993"
      time="10.16387637803952"/>
    <segment sequence="6"
      instruction="Take RAMP toward Guadalupe Pkwy"
      distance="0.40232399596959373"
      time="0.6744375069936116"/>
    <segment sequence="7"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="2.6388802347934055"
      time="2.2831989218791326"/>
    <segment sequence="8"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="5.839967669586142"
      time="5.052827918032805"/>
    <segment sequence="9"
      instruction="Stay STRAIGHT to go onto RAMP (Going South)"
      distance="0.1527496425121632"
      time="0.15757692654927571"/>
    <segment sequence="10"
      instruction="Continue on toward Gilroy"
      distance="0.8405766344600814"
      time="0.8671410039067269"/>
    <segment sequence="11"
      instruction="Stay STRAIGHT to go onto CA-85 S (Going East)"
      distance="0.3956813619067624"
      time="0.34234946966171265"/>
    <segment sequence="12"
      instruction="Take RAMP toward Blossom Hill Road"
      distance="0.22891319287702547"
      time="0.38373958468437197"/>
    <segment sequence="13"
      instruction="Turn LEFT onto Blossom Hill Rd (Going East)"
      distance="0.49810476095097306"
      time="0.8349999914566676"/>
    <segment sequence="14"
      instruction="Turn LEFT onto Snell Ave (Going North)"
      distance="0.011060709151221367"
      time="0.01854166587193807"/>
    <segment sequence="15"
      instruction="Turn LEFT onto Blossom Hill Rd (Going West)"
      distance="0.21227241518009607"
      time="0.35584374765555066"/>
    <end_location>
      <location id="2"
        longitude="-121.83459" latitude="37.25125"
        house_number="499" street="BLOSSOM HILL RD" city="SAN JOSE"
        state="CA" country="US"
        driving_side="R"
        postal_code="95123"
        edge_id="812218080" percent="0.0"/>
    </end_location>
  </route>
</route_response>
<route_response>
  <route id="2" step_count="18"
    distance="24.879477393121235" distance_unit="mile"
    time="39.014546712239586" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="" latitude=""
        house_number="" street="" city=""
        state="" country=""
        driving_side="N"
        postal_code=""
        edge_id="23694266" percent="0.0"/>
    </start_location>
    <segment sequence="1"
      instruction="Start out on Alma St (Going Southeast)"
      distance="0.2592928618616754"
      time="0.6322424242893855"/>
    <segment sequence="2"
      instruction="Turn LEFT onto Kingsley Ave (Going Northeast)"
      distance="0.08879637204118493"
      time="0.2165151596069336"/>
    <segment sequence="3"
      instruction="Turn SLIGHT RIGHT onto Embarcadero Rd (Going East)"
      distance="0.6481327160471586"
      time="1.5803636133670806"/>
    <segment sequence="4"
      instruction="Turn RIGHT onto Middlefield Rd (Going Southeast)"
      distance="2.96746411421623"
      time="7.235666685303053"/>
    <segment sequence="5"
      instruction="Stay STRAIGHT to go onto Old Middlefield Way (Going East)"
      distance="0.8495432761786168"
      time="1.789845637480418"/>
    <segment sequence="6"
      instruction="Stay STRAIGHT to go onto RAMP (Going East)"
      distance="0.22642142849860966"
      time="0.37956250508626305"/>
    <segment sequence="7"
      instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
      distance="9.176685525492026"
      time="7.939806487659613"/>
    <segment sequence="8"
      instruction="Take RAMP toward Brokaw Road"
      distance="0.20942024511139234"
      time="0.3510625004768372"/>
    <segment sequence="9"
      instruction="Stay STRAIGHT to go onto Old Bayshore Hwy (Going East)"
      distance="0.1670850676627406"
      time="0.2800937493642171"/>
    <segment sequence="10"
      instruction="Turn SLIGHT RIGHT onto N 1st St (Going Southeast)"
      distance="1.9476604686858663"
      time="3.9989981204271317"/>
    <segment sequence="11"
      instruction="Turn LEFT onto Jackson St (Going Northeast)"
      distance="0.07099981550357595"
      time="0.17312120993932087"/>
    <segment sequence="12"
      instruction="Turn RIGHT onto 2nd St (Going Southeast)"
      distance="2.3224258991749434"
      time="5.6628484646479285"/>
    <segment sequence="13"
      instruction="Stay STRAIGHT to go onto S 1st St (Going Southeast)"
      distance="0.18884608205270126"
      time="0.31657291650772096"/>
    <segment sequence="14"
      instruction="Stay STRAIGHT to go onto Monterey Rd (Going Southeast)"
      distance="3.887951286200716"
      time="5.287046383817991"/>
```

```
    <segment sequence="15"
      instruction="Turn SLIGHT RIGHT onto RAMP (Going South)"
      distance="0.0414465897894999"
      time="0.1010606050491333"/>
    <segment sequence="16"
      instruction="Turn RIGHT onto Skyway Dr (Going Southwest)"
      distance="0.34504443027423093"
      time="0.5849081456661225"/>
    <segment sequence="17"
      instruction="Turn LEFT onto Snell Ave (Going East)"
      distance="1.279357478030909"
      time="2.1446562389532726"/>
    <segment sequence="18"
      instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
      distance="0.20292052293456395"
      time="0.34016666412353513"/>
    <end_location>
      <location id="2"
        longitude="" latitude=""
        house_number="" street="" city=""
        state="" country=""
        driving_side="N"
        postal_code=""
        edge_id="812218080" percent="0.0"/>
    </end_location>
  </route>
</route_response>
<route_response>
  <route id="3" step_count="14"
    distance="25.906590792580626" distance_unit="mile"
    time="29.140561930338542" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="-122.15901" latitude="37.4403"
        house_number="900" street="ALMA ST" city="PALO ALTO"
        state="CA" country="US"
        driving_side="R"
        postal_code="94301"
        edge_id="23694267" percent="1.0"/>
    </start_location>
    <segment sequence="1"
      instruction="Start out on Alma St (Going Northwest)"
      distance="0.0"
      time="0.0"/>
    <segment sequence="2"
      instruction="Turn RIGHT onto Channing Ave(Going Northeast)"
      distance="2.1771018293093087"
      time="5.30849996805191"/>
    <segment sequence="3"
      instruction="Turn RIGHT onto W Bayshore Rd (Going Southwest)"
      distance="0.12998197519156232"
      time="0.31693938573201497"/>
    <segment sequence="4"
      instruction="Turn LEFT onto Embarcadero Rd (Going Northeast)"
      distance="0.006878766976215882"
      time="0.016772727171579998"/>
    <segment sequence="5"
      instruction="Take RAMP toward San Jose"
      distance="0.4222705568230516"
      time="0.707875007390976"/>
    <segment sequence="6"
```

```
      instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
      distance="11.747225529883993"
      time="10.16387637803952"/>
    <segment sequence="7"
      instruction="Take RAMP toward Guadalupe Pkwy"
      distance="0.40232399596959373"
      time="0.6744375069936116"/>
    <segment sequence="8"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="2.6388802347934055"
      time="2.2831989218791326"/>
    <segment sequence="9"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="4.708519202974121"
      time="4.073881677289804"/>
    <segment sequence="10"
      instruction="Take EXIT 1D toward Capitol Expwy Auto Mall"
      distance="0.23860684637032842"
      time="0.3948361724615097"/>
    <segment sequence="11"
      instruction="Turn LEFT onto W Capitol Expy (Going East)"
      distance="1.2198347095111897"
      time="1.4871818164984385"/>
    <segment sequence="12"
      instruction="Turn SLIGHT RIGHT onto RAMP (Going East)"
      distance="0.029621573459855412"
      time="0.049656248092651366"/>
    <segment sequence="13"
      instruction="Turn SLIGHT RIGHT onto Snell Ave (Going Southeast)"
      distance="1.9824209209108623"
      time="3.3232395708560944"/>
    <segment sequence="14"
      instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
      distance="0.20292052293456395"
      time="0.34016666412353513"/>
    <end_location>
      <location id="2"
        longitude="-121.83459" latitude="37.25125"
        house_number="499" street="BLOSSOM HILL RD" city="SAN JOSE"
        state="CA" country="US"
        driving_side="R"
        postal_code="95123"
        edge_id="812218080" percent="0.0"/>
    </end_location>
  </route>
</route_response>
<route_response>
  <route id="4" step_count="28"
    distance="25.43010499518424" distance_unit="mile"
    time="41.812373860677084" time_unit="minute"
    start_location="1" end_location="2">
    <segment sequence="1"
    instruction="Start out on Alma St (Going Southeast)"
    distance="2.512197865475656"
    time="4.438056838512421"/>
    <segment sequence="2"
      instruction="Turn RIGHT onto W Meadow Dr (Going Southwest)"
      distance="0.259249367249032"
      time="0.6321363727251689"/>
    <segment sequence="3"
      instruction="Turn LEFT onto El Camino Way (Going Southeast)"
      distance="0.19732181646496028"
      time="0.48113636175791424"/>
    <segment sequence="4"
      instruction="Stay STRAIGHT to go onto RAMP (Going Southwest)"
      distance="0.009935996875112263"
      time="0.024227271477381390"/>
    <segment sequence="5"
      instruction="Turn LEFT onto El Camino Real (Going Southeast)"
      distance="0.7259305251035061"
      time="1.216916660467783 7"/>
    <segment sequence="6"
      instruction="Stay STRAIGHT to go onto El Camino Real (Going Southeast)"
      distance="10.18052570327847"
      time="17.06616668154796"/>
    <segment sequence="7"
      instruction="Turn RIGHT onto Madison St (Going Southeast)"
      distance="0.1341639244777912"
      time="0.32713637351989744"/>
    <segment sequence="8"
      instruction="Turn LEFT onto Harrison St (Going East)"
      distance="0.06893059350020074"
      time="0.16807576020558676"/>
    <segment sequence="9"
      instruction="Turn RIGHT onto Monroe St (Going Southeast)"
      distance="0.0705648403396469"
      time="0.1720606009165446"/>
    <segment sequence="10"
      instruction="Turn LEFT onto Fremont St (Going East)"
      distance="0.07203753203577691"
      time="0.17565151850382488"/>
    <segment sequence="11"
      instruction="Turn RIGHT onto Jackson St (Going Southeast)"
      distance="0.2098303612161659"
      time="0.5116363684336345"/>
    <segment sequence="12"
      instruction="Turn LEFT onto Homestead Rd (Going East)"
      distance="0.13950164667868017"
      time="0.3401515007019043"/>
    <segment sequence="13"
      instruction="Turn RIGHT onto Washington St (Going Southeast)"
      distance="0.14307462872056173"
      time="0.3488636334737142"/>
    <segment sequence="14"
      instruction="Turn LEFT onto Santa Clara St (Going East)"
      distance="0.06947120055412777"
      time="0.16939393679300943"/>
    <segment sequence="15"
      instruction="Turn RIGHT onto Lafayette St (Going Southeast)"
      distance="0.06759460559205673"
      time="0.16481818358103434"/>
    <segment sequence="16"
      instruction="Turn LEFT onto Market St (Going East)"
      distance="0.17456658015544202"
      time="0.4256515165170034"/>
    <segment sequence="17"
      instruction="Turn RIGHT onto The Alameda (Going Southeast)"
      distance="2.317572876182314"
      time="4.207776539524397"/>
    <segment sequence="18"
      instruction="Stay STRAIGHT to go onto W Santa Clara St (Going East)"
      distance="0.03303921082684557"
      time="0.05538541873296102"/>
    <segment sequence="19"
```

```
      instruction="Stay STRAIGHT to go onto CA-82 (Going East)"
      distance="0.05555210434715647"
      time="0.09312500158945719"/>
    <segment sequence="20"
      instruction="Stay STRAIGHT to go onto W Santa Clara St (Going East)"
      distance="0.17006772690279195"
      time="0.33163256843884786"/>
    <segment sequence="21"
      instruction="Turn RIGHT onto Delmas Ave (Going Southeast)"
      distance="0.49640216162493195"
      time="1.2103939274946849"/>
    <segment sequence="22"
      instruction="Take CA-87 RAMP toward Guadalupe Pky"
      distance="0.1178586975602079"
      time="0.197572918732961"/>
    <segment sequence="23"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="3.628403629205081"
      time="3.139349430302779"/>
    <segment sequence="24"
      instruction="Take EXIT 1D toward Capitol Expwy Auto Mall"
      distance="0.23860684637032842"
      time="0.3948361724615097"/>
    <segment sequence="25"
      instruction="Turn LEFT onto W Capitol Expy (Going East)"
      distance="0.9895544609762458"
      time="1.2064318120479585"/>
    <segment sequence="26"
      instruction="Turn SLIGHT RIGHT onto Rosenbaum Ave (Going East)"
      distance="0.49535202237807563"
      time="1.2078333616256713"/>
    <segment sequence="27"
      instruction="Turn RIGHT onto Snell Ave (Going Southeast)"
      distance="1.649872606747162"
      time="2.7657708187898"/>
    <segment sequence="28"
      instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
      distance="0.20292052293456395"
      time="0.34016666412353513"/>
  </route>
</route_response>
</batch_route_response>
```

Example 14-7   Route Request with Route Preference as Traffic

This example shows a route request with `route_preference` set to `traffic` and `return_route_time` set to `'true'`. The former instructs the router to use traffic, and the latter instructs the router to include the start and end times in the response.

```
<?xml version="1.0" standalone="yes"?>
<route_request id="2"
               route_preference="traffic"
               return_route_time="true"
               road_preference="highway"
               return_driving_directions="true"
               distance_unit="mile"
               time_unit="minute"
               return_route_geometry="false">
  <start_location>
     <input_location id="1">
       <input_address>
         <us_form1 street="1 Oracle Drive" lastline="Nashua, NH" />
```

```
      </input_address>
    </input_location>
  </start_location>
  <end_location>
    <input_location id="2">
      <input_address>
        <us_form1 street="77 Massachusetts Ave" lastline="cambridge, ma" />
      </input_address>
    </input_location>
  </end_location>
</route_request>
```

Example 14-8 Response for Route Request with Route Preference as Traffic

The following is the response to the preceding request.

```
<!--
 Oracle Routeserver version 12.2.0.1.2 (data version 12.1.0.2.0)
-->
<route_response>
<route id="2" step_count="24" distance="40.08" distance_unit="mile" time="44.92"
time_unit="minute" start_location="1" end_location="2" start_time="17-Aug-2016 11:04
EDT" end_time="17-Aug-2016 11:48 EDT">
<segment sequence="1" instruction="Start out on Oracle Dr (Going South)" distance="0.16"
time="0.79"/>
<segment sequence="2" instruction="Turn LEFT onto Spit Brook Rd (Going East)"
distance="0.38" time="1.01"/>
<segment sequence="3" instruction="Take RAMP toward Boston" distance="0.31" time="0.35"/>
<segment sequence="4" instruction="Stay STRAIGHT to go onto US-3 S (Going South)"
distance="9.28" time="9.58"/>
<segment sequence="5" instruction="Take EXIT 31-30B-A toward Lawrence" distance="1.38"
time="1.42"/>
<segment sequence="6" instruction="Stay STRAIGHT to go onto US-3 S (Going Southeast)"
distance="9.85" time="10.16"/>
<segment sequence="7" instruction="Continue on toward Boston" distance="0.35"
time="0.36"/>
<segment sequence="8" instruction="Stay STRAIGHT to go onto RAMP (Going West)"
distance="0.95" time="0.98"/>
<segment sequence="9" instruction="Merge onto I-95 N/RT-128 N (Going East)"
distance="4.82" time="4.97"/>
<segment sequence="10" instruction="Take EXIT 37A toward Boston" distance="0.44"
time="0.45"/>
<segment sequence="11" instruction="Stay STRAIGHT to go onto I-93 S (Going South)"
distance="8.64" time="8.21"/>
<segment sequence="12" instruction="Take EXIT 26 toward N. Station" distance="0.18"
time="0.19"/>
<segment sequence="13" instruction="Turn SLIGHT LEFT onto Leverett Circle Conn (Going
South)" distance="1.45" time="1.91"/>
<segment sequence="14" instruction="Take RAMP toward Leverett Cir" distance="0.03"
time="0.07"/>
<segment sequence="15" instruction="Turn LEFT onto Nashua St (Going Southwest)"
distance="0.04" time="0.10"/>
<segment sequence="16" instruction="Turn RIGHT onto Monsignor Obrien Hwy/RT-28 N (Going
Northwest)" distance="0.31" time="0.75"/>
<segment sequence="17" instruction="Turn LEFT onto RAMP (Going Southwest)"
distance="0.01" time="0.02"/>
<segment sequence="18" instruction="Stay STRAIGHT to go onto Edwin H Land Blvd (Going
Southwest)" distance="0.53" time="1.29"/>
<segment sequence="19" instruction="Stay STRAIGHT to go onto 1st St (Going South)"
distance="0.05" time="0.11"/>
<segment sequence="20" instruction="Stay STRAIGHT to go onto RT-3 N (Going South)"
distance="0.03" time="0.08"/>
<segment sequence="21" instruction="Take RAMP toward Boston" distance="0.07"
```

```
time="0.17"/>
<segment sequence="22" instruction="Stay STRAIGHT to go onto Memorial Dr (Going West)"
distance="0.59" time="1.10"/>
<segment sequence="23" instruction="Take RT-2A RAMP toward Mass. Ave. North"
distance="0.12" time="0.19"/>
<segment sequence="24" instruction="Turn RIGHT onto Massachusetts Ave/RT-2A (Going
Northwest)" distance="0.12" time="0.66"/>
</route>
</route_response>
```

Example 14-9   Route Request with Route Preference as Traffic and with Specified Start Date and Time

This example shows a request with a start date and a start time,

```
<?xml version="1.0" standalone="yes"?>
<route_request id="2"
               route_preference="traffic"
               return_route_time="true"
               start_time="16:30"
               start_date="19-Aug-2016"
               road_preference="highway"
               return_driving_directions="true"
               distance_unit="mile"
               time_unit="minute"
               return_route_geometry="false">
  <start_location>
     <input_location id="1">
       <input_address>
         <us_form1 street="1 Oracle Drive" lastline="Nashua, NH" />
       </input_address>
     </input_location>
  </start_location>
  <end_location>
     <input_location id="2">
       <input_address>
         <us_form1 street="77 Massachusetts Ave" lastline="cambridge, ma" />
       </input_address>
     </input_location>
  </end_location>
</route_request>
```

Example 14-10   Response for Route Request with Route Preference as Traffic and with Specified Start Date and Time

The following is the response to the preceding request.

```
<!--
 Oracle Routeserver version 12.2.0.1.2 (data version 12.1.0.2.0)
-->
<route_response>
<route id="2" step_count="24" distance="40.08" distance_unit="mile" time="44.96"
time_unit="minute" start_location="1" end_location="2" start_time="19-Aug-2016 16:30
EDT" end_time="19-Aug-2016 17:14 EDT">
<segment sequence="1" instruction="Start out on Oracle Dr (Going South)" distance="0.16"
time="0.79"/>
<segment sequence="2" instruction="Turn LEFT onto Spit Brook Rd (Going East)"
distance="0.38" time="1.03"/>
<segment sequence="3" instruction="Take RAMP toward Boston" distance="0.31" time="0.34"/>
<segment sequence="4" instruction="Stay STRAIGHT to go onto US-3 S (Going South)"
distance="9.28" time="9.58"/>
<segment sequence="5" instruction="Take EXIT 31-30B-A toward Lawrence" distance="1.38"
```

```
time="1.42"/>
<segment sequence="6" instruction="Stay STRAIGHT to go onto US-3 S (Going Southeast)"
distance="9.85" time="10.16"/>
<segment sequence="7" instruction="Continue on toward Boston" distance="0.35"
time="0.36"/>
<segment sequence="8" instruction="Stay STRAIGHT to go onto RAMP (Going West)"
distance="0.95" time="0.98"/>
<segment sequence="9" instruction="Merge onto I-95 N/RT-128 N (Going East)"
distance="4.82" time="4.97"/>
<segment sequence="10" instruction="Take EXIT 37A toward Boston" distance="0.44"
time="0.45"/>
<segment sequence="11" instruction="Stay STRAIGHT to go onto I-93 S (Going South)"
distance="8.64" time="8.21"/>
<segment sequence="12" instruction="Take EXIT 26 toward N. Station" distance="0.18"
time="0.19"/>
<segment sequence="13" instruction="Turn SLIGHT LEFT onto Leverett Circle Conn (Going
South)" distance="1.45" time="1.91"/>
<segment sequence="14" instruction="Take RAMP toward Leverett Cir" distance="0.03"
time="0.07"/>
<segment sequence="15" instruction="Turn LEFT onto Nashua St (Going Southwest)"
distance="0.04" time="0.10"/>
<segment sequence="16" instruction="Turn RIGHT onto Monsignor Obrien Hwy/RT-28 N (Going
Northwest)" distance="0.31" time="0.75"/>
<segment sequence="17" instruction="Turn LEFT onto RAMP (Going Southwest)"
distance="0.01" time="0.02"/>
<segment sequence="18" instruction="Stay STRAIGHT to go onto Edwin H Land Blvd (Going
Southwest)" distance="0.53" time="1.29"/>
<segment sequence="19" instruction="Stay STRAIGHT to go onto 1st St (Going South)"
distance="0.05" time="0.11"/>
<segment sequence="20" instruction="Stay STRAIGHT to go onto RT-3 N (Going South)"
distance="0.03" time="0.08"/>
<segment sequence="21" instruction="Take RAMP toward Boston" distance="0.07"
time="0.17"/>
<segment sequence="22" instruction="Stay STRAIGHT to go onto Memorial Dr (Going West)"
distance="0.59" time="1.10"/>
<segment sequence="23" instruction="Take RT-2A RAMP toward Mass. Ave. North"
distance="0.12" time="0.19"/>
<segment sequence="24" instruction="Turn RIGHT onto Massachusetts Ave/RT-2A (Going
Northwest)" distance="0.12" time="0.67"/>
</route>
</route_response>
```

Example 14-11 Route Request with Route Preference as Traffic and with Specified Start Date and Time (Non-Default Format)

This example shows a request with the input and output date and time formats different than the preceding request.

```
<?xml version="1.0" standalone="yes"?>
<route_request id="2"
               route_preference="traffic"
               return_route_time="true"
               date_format="yy/MM/dd"
               time_format="hh:mm a"
               output_time_format="yyyy-MM-dd hh:mm:ss a"
               start_time="4:30 pm"
               start_date="16/08/19"
               road_preference="highway"
               return_driving_directions="true"
               distance_unit="mile"
               time_unit="minute"
               return_route_geometry="false">
```

```
  <start_location>
     <input_location id="1">
       <input_address>
         <us_form1 street="1 Oracle Drive" lastline="Nashua, NH" />
       </input_address>
     </input_location>
  </start_location>
  <end_location>
     <input_location id="2">
       <input_address>
         <us_form1 street="77 Massachusetts Ave" lastline="cambridge, ma" />
       </input_address>
     </input_location>
  </end_location>
</route_request>
```

Example 14-12 Response for Route Request with Route Preference as Traffic and with Specified Start Date and Time (Non-Default Format)

The following is the response to the preceding request.

```
<!--
 Oracle Routeserver version 12.2.0.1.2 (data version 12.1.0.2.0)
-->
<route_response>
<route id="2" step_count="24" distance="40.08" distance_unit="mile" time="44.96"
time_unit="minute" start_location="1" end_location="2" start_time="2016-08-19 04:30:00
PM" end_time="2016-08-19 05:14:57 PM">
<segment sequence="1" instruction="Start out on Oracle Dr (Going South)" distance="0.16"
time="0.79"/>
<segment sequence="2" instruction="Turn LEFT onto Spit Brook Rd (Going East)"
distance="0.38" time="1.03"/>
<segment sequence="3" instruction="Take RAMP toward Boston" distance="0.31" time="0.34"/>
<segment sequence="4" instruction="Stay STRAIGHT to go onto US-3 S (Going South)"
distance="9.28" time="9.58"/>
<segment sequence="5" instruction="Take EXIT 31-30B-A toward Lawrence" distance="1.38"
time="1.42"/>
<segment sequence="6" instruction="Stay STRAIGHT to go onto US-3 S (Going Southeast)"
distance="9.85" time="10.16"/>
<segment sequence="7" instruction="Continue on toward Boston" distance="0.35"
time="0.36"/>
<segment sequence="8" instruction="Stay STRAIGHT to go onto RAMP (Going West)"
distance="0.95" time="0.98"/>
<segment sequence="9" instruction="Merge onto I-95 N/RT-128 N (Going East)"
distance="4.82" time="4.97"/>
<segment sequence="10" instruction="Take EXIT 37A toward Boston" distance="0.44"
time="0.45"/>
<segment sequence="11" instruction="Stay STRAIGHT to go onto I-93 S (Going South)"
distance="8.64" time="8.21"/>
<segment sequence="12" instruction="Take EXIT 26 toward N. Station" distance="0.18"
time="0.19"/>
<segment sequence="13" instruction="Turn SLIGHT LEFT onto Leverett Circle Conn (Going
South)" distance="1.45" time="1.91"/>
<segment sequence="14" instruction="Take RAMP toward Leverett Cir" distance="0.03"
time="0.07"/>
<segment sequence="15" instruction="Turn LEFT onto Nashua St (Going Southwest)"
distance="0.04" time="0.10"/>
<segment sequence="16" instruction="Turn RIGHT onto Monsignor Obrien Hwy/RT-28 N (Going
Northwest)" distance="0.31" time="0.75"/>
<segment sequence="17" instruction="Turn LEFT onto RAMP (Going Southwest)"
distance="0.01" time="0.02"/>
<segment sequence="18" instruction="Stay STRAIGHT to go onto Edwin H Land Blvd (Going
Southwest)" distance="0.53" time="1.29"/>
```

```
<segment sequence="19" instruction="Stay STRAIGHT to go onto 1st St (Going South)"
distance="0.05" time="0.11"/>
<segment sequence="20" instruction="Stay STRAIGHT to go onto RT-3 N (Going South)"
distance="0.03" time="0.08"/>
<segment sequence="21" instruction="Take RAMP toward Boston" distance="0.07"
time="0.17"/>
<segment sequence="22" instruction="Stay STRAIGHT to go onto Memorial Dr (Going West)"
distance="0.59" time="1.10"/>
<segment sequence="23" instruction="Take RT-2A RAMP toward Mass. Ave. North"
distance="0.12" time="0.19"/>
<segment sequence="24" instruction="Turn RIGHT onto Massachusetts Ave/RT-2A (Going
Northwest)" distance="0.12" time="0.67"/>
</route>
</route_response>
```

Example 14-13 Route Request with Route Preference for Shortest Path and Incorporating Time (return_route_time as true)

This example shows a request with `route_preference` as `shortest` (not `traffic`), and with `return_route_time` set to `true`,

```
<?xml version="1.0" standalone="yes"?>
<route_request id="1"
               route_preference="shortest"
               return_route_time="true"
               road_preference="highway"
               return_driving_directions="true"
               distance_unit="mile"
               time_unit="minute"
               return_route_geometry="false"
          >
  <start_location>
     <input_location id="1" country="us" longitude="-86.49826" latitude="41.464588" />
  </start_location>
  <end_location>
     <input_location id="2" country="us" longitude="-86.562759" latitude="41.476311" />
  </end_location>
</route_request>
```

Example 14-14 Response for Route Request with Route Preference for Shortest Path and Incorporating Time (return_route_time as true)

The following is the response to the preceding request. It illustrates a time zone change between the start location and the end location, and consequentially an arrival time at the end before the departure time at the start location

```
<!--
 Oracle Routeserver version 12.2.0.1.2 (data version 12.1.0.2.0)
-->
<route_response>
<route id="1" step_count="4" distance="4.11" distance_unit="mile" time="5.01"
time_unit="minute" start_location="1" end_location="2" start_time="17-Aug-2016 11:13
EDT" end_time="17-Aug-2016 10:18 CDT">
<segment sequence="1" instruction="Start out on Industrial Park Dr (Going East)"
distance="0.52" time="1.27"/>
<segment sequence="2" instruction="Turn LEFT onto US-6 (Going West)" distance="0.61"
time="0.67"/>
<segment sequence="3" instruction="Stay STRAIGHT to go onto Zietler Trl/US-6 (Going
Northwest)" distance="0.49" time="0.51"/>
<segment sequence="4" instruction="Stay STRAIGHT to go onto US-6 (Going West)"
distance="2.49" time="2.56"/>
```

```
</route>
</route_response>
```

Example 14-15 Multistop Route Request with Traffic Preference, Default Date and Time Formats, and Specified Time Format

This example shows a request for a multistop route that uses the default time and date format for input but a changed the output time format. By setting `return_subroute_time` to `true`, it instructs the router to display the time taken for each step in the route.

```
<?xml version="1.0" standalone="yes"?>
<route_request id="3"
              route_preference="traffic"
              return_route_time="true"
              return_subroute_time="true"
              output_time_format="yyyy-MM-dd hh:mm:ss a"
              start_time="23:40"
              start_date="25-Aug-2016"
              road_preference="highway"
              optimize_route="false"
              route_type="open"
              return_driving_directions="true"
              return_locations="true"
              return_subroutes="true"
              distance_unit="mile"
              time_unit="minute"
              return_route_geometry="false"
              return_subroute_geometry="false"
              return_segment_geometry="false">
 <start_location>
    <input_location id="1">
      <input_address>
        <us_form1 street="world trade center " lastline="san francisco, ca" />
      </input_address>
    </input_location>
 </start_location>
 <location>
    <input_location id="2">
      <input_address>
        <us_form1 street="golden gate park" lastline="san francisco, ca" />
      </input_address>
    </input_location>
 </location>
 <location>
    <input_location id="3">
      <input_address>
        <us_form1 street="3001 Larkin St" lastline="san francisco, ca" />
      </input_address>
    </input_location>
 </location>
 <end_location>
    <input_location id="4">
      <input_address>
        <us_form1 street="100 flower st" lastline="san francisco, ca" />
      </input_address>
    </input_location>
 </end_location>
</route_request>
```

Example 14-16 Response for Multistop Route Request with Traffic Preference, Default Date and Time Formats, and Specified Time Format

The following is the response to the preceding request. The response shows a date change because it goes past midnight during the route.

```
<!--
 Oracle Routeserver version 12.2.0.1.2 (data version 12.1.0.2.0)
-->
<route_response>
<route id="3" step_count="42" distance="15.25" distance_unit="mile" time="33.69"
time_unit="minute" start_location="1" end_location="4" start_time="2016-08-25 11:40:00
PM" end_time="2016-08-26 12:13:42 AM">
<start_location>
<location id="1" longitude="-122.39436" latitude="37.79579" house_number="161"
street="WORLD TRADE CTR" city="SAN FRANCISCO" state="CA" country="US" driving_side="R"
postal_code="94111" edge_id="724791175"percent="0.0"/>
</start_location>
<end_location>
<location id="4" longitude="-122.40459" latitude="37.74211" house_number="99"
street="FLOWER ST" city="SAN FRANCISCO BAY AREA" state="CA" country="US"
driving_side="R" postal_code="94124" edge_id="23604155"percent="0.0"/>
</end_location>
<subroute id="1" step_count="13" distance="5.42" distance_unit="mile" time="11.23"
time_unit="minute" start_location="1" end_location="2" start_time="2016-08-25 11:40:00
PM" end_time="2016-08-25 11:51:14 PM">
<start_location>
<location id="1" longitude="-122.39436" latitude="37.79579" house_number="161"
street="WORLD TRADE CTR" city="SAN FRANCISCO" state="CA" country="US" driving_side="R"
postal_code="94111"edge_id="724791175" percent="0.0"/>
</start_location>
<segment sequence="1" instruction="Start out on The Embarcadero (Going Northwest)"
distance="0.02" time="0.04"/>
<segment sequence="2" instruction="Turn SLIGHT LEFT onto RAMP (Going West)"
distance="0.03" time="0.08"/>
<segment sequence="3" instruction="Turn SLIGHT LEFT onto The Embarcadero (Going
Southeast)" distance="0.31" time="0.77"/>
<segment sequence="4" instruction="Turn RIGHT onto Howard St (Going Southwest)"
distance="0.89" time="2.61"/>
<segment sequence="5" instruction="Turn LEFT onto 4th St (Going Southeast)"
distance="0.24" time="0.59"/>
<segment sequence="6" instruction="Turn RIGHT onto RAMP (Going South)" distance="0.18"
time="0.21"/>
<segment sequence="7" instruction="Stay STRAIGHT to go onto I-80 W (Going Southwest)"
distance="0.70" time="0.85"/>
<segment sequence="8" instruction="Take EXIT 1B toward Golden Gate Bridge"
distance="0.35" time="0.43"/>
<segment sequence="9" instruction="Stay STRAIGHT to go onto Central Fwy/US-101 N (Going
West)" distance="0.76" time="0.93"/>
<segment sequence="10" instruction="Stay STRAIGHT to go onto Octavia Blvd (Going
Northwest)" distance="0.27" time="0.64"/>
<segment sequence="11" instruction="Turn LEFT onto Fell St (Going West)" distance="1.65"
time="4.01"/>
<segment sequence="12" instruction="Stay STRAIGHT to go onto Kezar Dr (Going Southwest)"
distance="0.01" time="0.02"/>
<segment sequence="13" instruction="Stay STRAIGHT to go onto John F Kennedy Dr (Going
West)" distance="0.02" time="0.05"/>
<end_location>
<location id="2" longitude="-122.45414" latitude="37.77144" house_number="7"
street="JOHN F KENNEDY DR" city="SAN FRANCISCO BAY AREA" state="CA" country="US"
driving_side="R" postal_code="94118"edge_id="728011751" percent="0.0"/>
</end_location>
```

```
</subroute>
<subroute id="2" step_count="13" distance="4.46" distance_unit="mile" time="10.61"
time_unit="minute" start_location="2" end_location="3" start_time="2016-08-25 11:51:14
PM" end_time="2016-08-26 12:01:51 AM">
<start_location>
<location id="2" longitude="-122.45414" latitude="37.77144" house_number="7"
street="JOHN F KENNEDY DR" city="SAN FRANCISCO BAY AREA" state="CA" country="US"
driving_side="R" postal_code="94118"edge_id="728011751" percent="0.0"/>
</start_location>
<segment sequence="1" instruction="Start out on John F Kennedy Dr (Going West)"
distance="0.02" time="0.05"/>
<segment sequence="2" instruction="Stay STRAIGHT to go onto Kezar Dr (Going Southwest)"
distance="0.15" time="0.38"/>
<segment sequence="3" instruction="Stay STRAIGHT to go onto John F Kennedy Dr (Going
East)" distance="0.04" time="0.11"/>
<segment sequence="4" instruction="Stay STRAIGHT to go onto Oak St (Going Northeast)"
distance="0.46" time="1.11"/>
<segment sequence="5" instruction="Turn LEFT onto Masonic Ave (Going North)"
distance="0.71" time="2.27"/>
<segment sequence="6" instruction="Turn RIGHT onto Geary Blvd (Going East)"
distance="1.26" time="2.12"/>
<segment sequence="7" instruction="Stay STRAIGHT to go onto Starr King Way (Going East)"
distance="0.10" time="0.23"/>
<segment sequence="8" instruction="Stay STRAIGHT to go onto O'Farrell St (Going East)"
distance="0.02" time="0.06"/>
<segment sequence="9" instruction="Turn LEFT onto Franklin St (Going North)"
distance="0.13" time="0.32"/>
<segment sequence="10" instruction="Turn RIGHT onto Post St (Going East)"
distance="0.09" time="0.23"/>
<segment sequence="11" instruction="Turn LEFT onto Van Ness Ave (Going North)"
distance="1.29" time="3.15"/>
<segment sequence="12" instruction="Turn RIGHT onto North Point St (Going East)"
distance="0.18" time="0.61"/>
<segment sequence="13" instruction="Turn LEFT onto Larkin St (Going North)"
distance="0.00" time="0.00"/>
<end_location>
<location id="3" longitude="-122.422" latitude="37.80551" house_number="3001"
street="LARKIN ST" city="SAN FRANCISCO" state="CA" country="US" driving_side="R"
postal_code="94109" edge_id="23609030"percent="0.0"/>
</end_location>
</subroute>
<subroute id="3" step_count="16" distance="5.38" distance_unit="mile" time="11.85"
time_unit="minute" start_location="3" end_location="4" start_time="2016-08-26 12:01:51
AM" end_time="2016-08-26 12:13:42 AM">
<start_location>
<location id="3" longitude="-122.422" latitude="37.80551" house_number="3001"
street="LARKIN ST" city="SAN FRANCISCO" state="CA" country="US" driving_side="R"
postal_code="94109" edge_id="23609030"percent="0.0"/>
</start_location>
<segment sequence="1" instruction="Start out on Larkin St (Going South)" distance="0.00"
time="0.00"/>
<segment sequence="2" instruction="Turn RIGHT onto North Point St (Going West)"
distance="0.19" time="0.66"/>
<segment sequence="3" instruction="Turn LEFT onto Van Ness Ave (Going South)"
distance="1.88" time="4.58"/>
<segment sequence="4" instruction="Turn LEFT onto Grove St (Going East)" distance="0.10"
time="0.56"/>
<segment sequence="5" instruction="Turn RIGHT onto Polk St (Going South)"
distance="0.15" time="0.35"/>
<segment sequence="6" instruction="Stay STRAIGHT to go onto 10th St (Going Southeast)"
distance="0.60" time="1.47"/>
<segment sequence="7" instruction="Take RAMP toward San Jose" distance="0.28"
```

```
time="0.34"/>
<segment sequence="8" instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
distance="1.14" time="1.39"/>
<segment sequence="9" instruction="Take EXIT 432 toward C Chavez St" distance="0.30"
time="0.37"/>
<segment sequence="10" instruction="Stay STRAIGHT to go onto Bayshore Blvd (Going
Southeast)" distance="0.21" time="0.45"/>
<segment sequence="11" instruction="Turn SLIGHT LEFT onto RAMP (Going East)"
distance="0.03" time="0.05"/>
<segment sequence="12" instruction="Turn LEFT onto Bayshore Blvd (Going North)"
distance="0.10" time="0.17"/>
<segment sequence="13" instruction="Turn RIGHT onto Jerrold Ave (Going Southeast)"
distance="0.09" time="0.33"/>
<segment sequence="14" instruction="Turn SLIGHT RIGHT onto Barneveld Ave (Going South)"
distance="0.18" time="0.61"/>
<segment sequence="15" instruction="Turn SLIGHT RIGHT onto Loomis St (Going Southwest)"
distance="0.14" time="0.53"/>
<segment sequence="16" instruction="Turn RIGHT onto Flower St (Going West)"
distance="0.00" time="0.00"/>
<end_location>
<location id="4" longitude="-122.40459" latitude="37.74211" house_number="99"
street="FLOWER ST" city="SAN FRANCISCO BAY AREA" state="CA" country="US"
driving_side="R" postal_code="94124"edge_id="23604155" percent="0.0"/>
</end_location>
</subroute>
</route>
</route_response>
```

14.3.2 Route Request XML Schema Definition

The following is the XML Schema Definition for a route request. The main elements and attributes of the Schema Definition are explained in sections that follow.

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
     elementFormDefault="qualified">
<xsd:include schemaLocation="geocoder_request.xsd"/>
<xsd:simpleType name="positiveDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minExclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="distanceUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="mile"/>
    <xsd:enumeration value="km"/>
    <xsd:enumeration value="kilometer"/>
    <xsd:enumeration value="meter"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="unitType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="us"/>
    <xsd:enumeration value="metric"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgePercentage">
  <xsd:restriction base="xsd:decimal">
    <xsd:minInclusive value="0.0"/>
    <xsd:maxInclusive value="1.0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="roadPreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="highway"/>
    <xsd:enumeration value="local"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="routePreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="shortest"/>
    <xsd:enumeration value="fastest"/>
    <xsd:enumeration value=”traffic”/>
  </xsd:restriction>
</xsd:simpleType>
<xsd:simpleType name="truckType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="delivery"/>
    <xsd:enumeration value="public"/>
    <xsd:enumeration value="resident"/>
    <xsd:enumeration value="trailer"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="vehicleType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="auto"/>
    <xsd:enumeration value="truck"/>
  </xsd:restriction>
</xsd:simpleType>
<xsd:complexType name="pregeocodedType">
  <xsd:all>
    <xsd:element name="edge_id" type="xsd:long" />
    <xsd:element name="percent" type="edgePercentage"/>
    <xsd:element name="side">
      <xsd:simpleType>
        <xsd:restriction base="xsd:string">
          <xsd:enumeration value="L"/>
          <xsd:enumeration value="R"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:element>
  </xsd:all>
</xsd:complexType>

<xsd:complexType name="routerInputLocation">
  <xsd:choice>
    <xsd:element name="router_input_location"  type="input_locationType"/>
    <xsd:element name="router_pregeocoded_location" type="pregeocodedType"/>
  </xsd:choice>
</xsd:complexType>
<xsd:element name="batch_route_request" type="batchRouteRequest" />
```

```
<xsd:complexType name="batchRouteRequest">
  <xsd:sequence>
    <xsd:element name="route_request" type="routeRequest"
                 minOccurs="1" maxOccurs="unbounded"/>
  </xsd:sequence>
  <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
</xsd:complexType>

<xsd:element name="route_request" type="routeRequest" />
<xsd:complexType name="routeRequest">
  <xsd:sequence>
    <xsd:element name="start_location" type="routerInputLocation"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="location" type="routerInputLocation"
                 minOccurs="0" maxOccurs="unbounded"/>
    <xsd:element name="end_location" type="routerInputLocation"
                 minOccurs="0" maxOccurs="1"/>
  </xsd:sequence>
  <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
  <xsd:attribute name="pre_geocoded_locations" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="route_preference" type="routePreference"
                 use="optional"/>
  <xsd:attribute name="road_preference" type="roadPreference"
                 use="optional"/>
  <xsd:attribute name="start_date" type="xsd:date"
                 use="optional"/>
  <xsd:attribute name="start_time" type="xsd:time"
                 use="optional"/>
  <xsd:attribute name="date_format" type="xsd:date"
                 use="optional"/>
  <xsd:attribute name="time_format" type="xsd:time"
                 use="optional"/>
  <xsd:attribute name="output_time_format" type="xsd:date"
                 use="optional"/>

  <xsd:attribute name="optimize_route" type="xsd:boolean" use="optional"/>
  <xsd:attribute name="route_type" use="optional">
    <xsd:simpleType>
      <xsd:restriction base="xsd:string">
        <xsd:enumeration value="open"/>
        <xsd:enumeration value="closed"/>
      </xsd:restriction>
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="driving_directions_detail" use="optional">
    <xsd:simpleType>
      <xsd:restriction base="xsd:string">
        <xsd:enumeration value="medium"/>
        <xsd:enumeration value="high"/>
        <xsd:enumeration value="low"/>
      </xsd:restriction>
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="language" use="optional">
    <xsd:simpleType>
      <xsd:restriction base="xsd:string">
        <xsd:enumeration value="English"/>
        <xsd:enumeration value="French"/>
        <xsd:enumeration value="German"/>
        <xsd:enumeration value="Italian"/>
        <xsd:enumeration value=”Portuguese”/>
        <xsd:enumeration value="Spanish"/>
              </xsd:restriction>
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="distance_unit" type="distanceUnit" use="optional"/>
  <xsd:attribute name="length_unit" type="unitType" use="optional"/>
  <xsd:attribute name="time_unit" type="timeUnit" use="optional"/>
  <xsd:attribute name="weight_unit" type="unitType" use="optional"/>
  <xsd:attribute name="return_locations" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_subroutes" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_route_time" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_subroute_time" type="xsd:boolean"
                 use="optional"/>

  <xsd:attribute name="return_driving_directions" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_hierarchical_directions" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_route_geometry" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_subroute_geometry" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_segment_geometry" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_detailed_geometry" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_route_edge_ids" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_subroute_edge_ids" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="return_segment_edge_ids" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="vehicle_type" type="vehicleType" use="optional"/>
  <xsd:attribute name="truck_type" type="truckType" use="optional"/>
  <xsd:attribute name="truck_height" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="truck_length" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="truck_per_axle_weight" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="truck_weight" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="truck_width" type="positiveDecimal" use="optional"/>
</xsd:complexType>
```

- route_request Element
- route_request Attributes
- input_location Element
- pre_geocoded_location Element

14.3.2.1 route_request Element

The `<route_request>` element has the following definition:

```
<xsd:element name="route_request" type="routeRequest" />
```

The root element of a route request is always named `route_request`.

The `<start_location>` child element specifies the start location for the route, as an address specification, a geocoded address, or longitude/latitude coordinates. Depending on the route request, there can be 0 or 1 `<start_location>` elements. A simple route request requires a `<start_location>` element, whereas an open tour TSP request does not.

The `<location>` child element specifies a location for a segment, as an address specification, a geocoded address, or longitude/latitude coordinates. In a simple route request there are no `<location>` elements; if there are one or more `<location>` elements, it is a multi-address route.

The `<end_location>` child element specifies the end location for the route, as an address specification, a geocoded address, or longitude/latitude coordinates. Depending on the route request, there can be 0 or 1 `<end_location>` elements. A simple route request requires an `<end_location>` element, whereas a closed tour multi-address or TSP tour must not contain an `<end_location>` element.

In a route request:

- If `<start_location>` is an address specification or longitude/latitude coordinates, each `<end_location>` and `<location>` element can be either an address specification or longitude/latitude coordinate; however, it cannot be a pre-geocoded address.
- If `<start_location>` is a pre-geocoded address, `<end_location>` and any `<location>` specifications must also be pre-geocoded addresses.

In a batched route request, each of the individual route requests must follow the preceding rules. However, within the batch, because the individual requests are independent, you can mix address, pre-geocoded, and longitude/latitude locations, as long as they are consistent within an individual request.

14.3.2.2 route_request Attributes

The root element `<route_request>` has a number of attributes, most of them optional. The attributes are defined as follows.

`vendor` is an optional attribute whose default value identifies the routing provider as Oracle.

`id` is a required attribute that specifies an identification number to be associated with the request.

`route_preference` is an optional attribute that specifies whether you want the route with the lowest estimated driving time (`FASTEST`), the route that considers historical traffic patterns in its computations (`TRAFFIC`), or the route with the shortest driving distance (`SHORTEST`, the default).

`road_preference` is an optional attribute that allows the routing process to have a preference for highways (`HIGHWAY`, the default) or local roads (`LOCAL`).

`return_driving_directions` is an optional attribute that specifies whether driving directions for the route are returned. `TRUE` returns driving directions; `FALSE` (the default) does not return driving directions.

`return_hierarchical_driving_directions` is an optional attribute that specifies whether driving directions for the route are returned in an expandable and collapsible hierarchy. `TRUE` returns driving directions in an expandable and collapsible hierarchy; `FALSE` (the default) returns driving directions in a list with no hierarchy.

`return_route_time` is an optional attribute that specifies whether time is returned at the route level. If the parameter is set to `TRUE`, the routing engine adds the start and end times to the route response, if the time zone user data is available.

`return_subroute_time` is an optional attribute that specifies whether time is returned at the subroute level. If the parameter is set to `TRUE`, the routing engine adds the start and end times to each of the subroutes in a multroute or TSP (traveling salesperson) request.

`return_locations` is an optional attribute that specifies whether to return the geocode information for all the locations in the route. `TRUE` returns the geocode information; `FALSE` (the default) does not.

`return_subroutes` is an optional attribute that specifies whether to return the subroutes in a multi-address route. `TRUE` (the default for multi-address routes) returns subroutes; `FALSE` does not return subroutes. (This attributed is ignored for simple routes.)

`return_route_geometry` is an optional attribute that specifies whether to return the coordinates of the line string that represents the route. `TRUE` returns the coordinates; `FALSE` (the default) does not return the coordinates.

`return_subroute_geometry` is an optional attribute that specifies whether to return the coordinates of the line strings that represent the subroutes within a route. `TRUE` returns the coordinates; `FALSE` (the default for multi-address routes) does not return the coordinates. (This attributed is ignored for simple routes.)

`return_segment_geometry` is an optional attribute that specifies whether to return the coordinates of the line strings that represent maneuvers of a route. `TRUE` returns the coordinates; `FALSE` (the default) does not return the coordinates. If `return_segment_geometry` is `TRUE`, driving directions for the route are returned regardless of the value of the `return_driving_directions` attribute.

`return_detailed_geometry` is an optional attribute that indicates the level of detail to be included in returned geometries. `TRUE` (the default) returns detailed geometries; `FALSE` returns generalized geometries (usually with fewer coordinates).

`return_route_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges in the route. `TRUE` returns the edge ID values; `FALSE` (the default) does not return the edge ID values.

`return_subroute_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges in the subroutes. `TRUE` returns the edge ID values; `FALSE` (the default for multi-address routes) does not return the edge ID values. (This attributed is ignored for simple routes.)

`return_segment_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges of all maneuvers in the route. `TRUE` returns the edge ID values; `FALSE` (the default) does not return the edge ID values. If `return_segment_edge_ids` is `TRUE`, driving directions for the route are returned regardless of the value of the `return_driving_directions` attribute.

`language` is an optional attribute that overrides the default language used to generate the driving directions. The default language for is set in the `web.xml` file; you can use this attribute to override the default on a per-request basis. The following attribute values are supported: `ENGLISH`, `FRENCH`, `GERMAN`, `ITALIAN`, `PORTUGUESE`, and `SPANISH`.

`distance_unit` is an optional attribute that specifies the unit of measure for distance values that are returned: `KILOMETER` or `KM` for kilometer, `MILE` (the default) for mile, or `METER` for meter.

`length_unit` is an optional attribute that specifies the length measurement system used for input length values: `US` for feet (the default) or `METRIC` for meters. This attribute is used to specify the height, length, and/or width of trucks.

`time_unit` is an optional attribute that specifies the unit for time values that are returned: `HOUR` for hour, `MINUTE` (the default) for minute, or `SECOND` for second.

`weight_unit` is an optional attribute that specifies the weight measurement system used for input weight values: `US` for tons (the default) or `METRIC` for metric tons. This attribute is used to specify the weight of trucks.

`pre_geocoded_locations` is an optional attribute that indicates how locations are specified. `TRUE` means that both are previously geocoded locations specified using the `<pre_geocoded_location>` element; `FALSE` (the default) means that both are addresses or longitude/latitude pairs specified using the `<input_location>` element.

`driving_directions_detail` is an optional attribute that influences the level of detail and the number of separate steps in driving instructions. The available values are `HIGH` (most details and steps), `MEDIUM` (the default), and `LOW` (fewest details and steps). For example, `LOW` might treat a segment as a single step even if it involves slight maneuvers to the right or left. The effect of a value for this attribute on the length of returned driving directions will vary, depending on the exact names of elements and maneuvers. This attribute is ignored if you do not specify `TRUE` for `return_driving_directions` or `return_hierarchical_driving_directions`.

`optimize_route` is an optional attribute that specifies whether a multi-address route request should have its unfixed locations reordered to optimize the overall route. `TRUE` reorders the locations to optimize the overall route (Traveling Salesperson); `FALSE` (the default) does not reorder the locations (multi-address). Since multi-address requests are not optimized, all locations are returned in the order specified in the request. In multi-address and TSP open tour requests, the START_LOCATION and END_LOCATION are optional. If they are specified they are fixed locations and are not subject to reordering in TSP requests. In multi-address and TSP requests, one or more intermediate locations (LOCATION) must be specified, and they are unfixed locations and are subject to reordering in a TSP request.

`route_type` is an optional attribute that specifies whether a multi-address route is an `OPEN` (the default) or `CLOSED` tour. An open tour routes from the START_LOCATION, or first LOCATION, to the END_LOCATION, or last LOCATION. In a closed tour the START_LOCATION is required and is used as both the starting and ending location. If an END_LOCATION is specified for a closed tour, an exception is raised.

`start_date` is an optional attribute that specifies the start date of the route request. If traffic patterns are included in route computations, the link costs vary with time, and this attribute is used to find the link cost at the time the link is traversed.

`start_time` is an optional attribute that specifies the start time of the route request, and is applicable when router includes traffic patterns in its computations. It uses historical traffic pattern data to fetch the travel time at the time the link is traversed.

`output_time_format` is an optional attribute that specifies the format in which the arrival times in the output route should be displayed. This format must be supported by `SimpleDateFormat` in Java.

`vehicle_type` is an optional attribute that specifies that the type of vehicle is an `AUTO` (the default) or a `TRUCK`. For the truck description subattributes to be used, the vehicle type must be set to `TRUCK`; if the vehicle type is `AUTO`, these subattributes are ignored.

`truck_type` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute describes a specific type of truck, allowing it to potentially override more generalized truck rules. The following attribute values are supported: `DELIVERY`, `PUBLIC`, `RESIDENT`, and `TRAILER`. The `DELIVERY`, `PUBLIC`, and `RESIDENT` truck types provide exceptions to truck rules for trucks of these types. Garbage and public utility trucks are examples of `PUBLIC` trucks. The

`RESIDENT` truck type describes trucks that are local to a neighborhood. The `TRAILER` truck type describes extra restrictions that semi-trailer trucks are subject to are that the other trucks are not.

`truck_height` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the height of a truck in `length_units`. This height is used to check against any height restrictions that may exist on an edge being considered as part of a route.

`truck_length` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the length of a truck in `length_units`. This length is used to check against any length restrictions that may exist on an edge being considered as part of a route.

`truck_per_axle_weight` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the per axle weight of a truck in `weight_units`. This weight is used to check against any per axle weight restrictions that may exist on an edge being considered as part of a route.

`truck_weight` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the weight of a truck in `weight_units`. This weight is used to check against weight restrictions that may exist on an edge being considered as part of a route.

`truck_width` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the width of a truck in `length_units`. This width is used to check against width restrictions that may exist on an edge being considered as part of a route.

14.3.2.3 input_location Element

The `<input_location>` element specifies an address in a format that satisfies the Oracle Spatial geocoding request XML Schema, which is described in Geocoding Request XML Schema Definition and Example. You can specify the input location using either a longitude/latitude pair or the `<input_address>` element. Example 14-1 in Route Request and Response Examples shows the start and end addresses specified using the `<input_location>` element and its child element `<input_address>`.

To use the `<input_location>` element, you must ensure that the value of the `pre_geocoded_locations` attribute is `FALSE` (the default) in the `<route_request>` element. You can use longitude/latitude pairs and `<input_address>` elements together in a request.

14.3.2.4 pre_geocoded_location Element

The `<pre_geocoded_location>` element specifies a geocoded location in terms of how far along a street (an edge) the address is and on which side of the street. Example 14-5 in Route Request and Response Examples shows the start and end addresses specified using the `<pre_geocoded_location>` element.

To use the `<pre_geocoded_location>` element, you must specify `pre_geocoded_locations="TRUE"` in the `<route_request>` element, and you must use the `<pre_geocoded_location>` element to specify all locations.

14.3.3 Route Response XML Schema Definition

The following is the XML Schema definition for a route response:

```
<!-- XML Schema definition for Route Response from the routing engine -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
     xmlns:gml="http://www.opengis.net/gml"
     elementFormDefault="qualified">

<xsd:simpleType name="nonNegativeDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minInclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="positiveDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minExclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="distanceUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="mile"/>
    <xsd:enumeration value="km"/>
    <xsd:enumeration value="kilometer"/>
    <xsd:enumeration value="meter"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgeIdElement">
  <xsd:restriction base="xsd:string">
    <xsd:pattern value="[-0-9,]+"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgeIdList">
  <xsd:list itemType="edgeIdElement"/>
</xsd:simpleType>

<xsd:simpleType name="emptyString">
  <xsd:restriction base="string">
    <xsd:maxLength value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="latitude">
  <xsd:restriction base="decimal">
    <xsd:minInclusive value="-90.0" />
    <xsd:maxInclusive value="90.0" />
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="longitude">
  <xsd:restriction base="decimal">
    <xsd:minInclusive value="-180.0"/>
    <xsd:maxInclusive value="180.0"/>
  </xsd:restriction>
```

```
</xsd:simpleType>

<xsd:complexType name="geometry">
  <xsd:sequence>
    <xsd:element ref="gml:LineString"/>
  </xsd:sequence>
</xsd:complexType>

<xsd:complexType name="outputLocation">
  <xsd:attribute name="id" type="xsd:positiveInteger" use="required"/>
  <xsd:attribute name="longitude" use="required">
    <xsd:simpleType>
      <xsd:union memberTypes="longitude emptyString" />
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="latitude" use="required">
    <xsd:simpleType>
      <xsd:union memberTypes="latitude emptyString" />
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="house_number" type="xsd:string" use="required"/>
  <xsd:attribute name="street" type="xsd:string" use="required"/>
  <xsd:attribute name="city" type="xsd:string" use="required"/>
  <xsd:attribute name="state" type="xsd:string" use="required"/>
  <xsd:attribute name="country" type="xsd:string" use="required"/>
  <xsd:attribute name="driving_side" use="required">
    <xsd:simpleType>
      <xsd:restriction base="xsd:string">
        <xsd:enumeration value="L"/>
        <xsd:enumeration value="N"/>
        <xsd:enumeration value="R"/>
      </xsd:restriction>
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="postal_code" type="xsd:string" use="required"/>
  <xsd:attribute name="edge_id" type="xsd:long" use="required"/>
  <xsd:attribute name="percent" type="edgePercentage" use="required"/>
</xsd:complexType>

<xsd:complexType name="segmentType">
  <xsd:sequence>
    <xsd:element name="segment_geometry" type="geometry"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="segment_edge_ids" type="edgeIdList"
                 minOccurs="0" maxOccurs="1"/>
  </xsd:sequence>
  <xsd:attribute name="sequence" type="xsd:positiveInteger" use="required"/>
  <xsd:attribute name="instruction" type="xsd:string" use="required"/>
  <xsd:attribute name="distance" type="nonNegativeDecimal" use="required"/>
  <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>
</xsd:complexType>

 <xsd:element name="route_response">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element name="route" minOccurs="1" maxOccurs="1">
        <xsd:simpleType>
          <xsd:union memberTypes="multiRouteType routeType"/>
        </xsd:simpleType>
      </xsd:element>
    </xsd:sequence>
  </xsd:complexType>
```

```
</xsd:element>

<xsd:complexType name="multiRouteType">
  <xsd:sequence>
    <xsd:element name="route_geometry" type="geometry"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="route_edge_ids" type="edgeIdList"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="start_location" type="outputLocation"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="end_location" type="outputLocation"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="subroute" minOccurs="1" maxOccurs="unbounded">
      <xsd:complexType>
        <xsd:sequence>
          <xsd:element name="subroute_geometry" type="geometry"
                       minOccurs="0" maxOccurs="1"/>
          <xsd:element name="subroute_edge_ids" type="edgeIdList"
                       minOccurs="0" maxOccurs="1"/>
          <xsd:element name="start_location" type="outputLocation"
                       minOccurs="0" maxOccurs="1"/>
          <xsd:element name="segment" type="segmentType"
                      minOccurs="0" maxOccurs="unbounded"/>
          <xsd:element name="end_location" type="outputLocation"
                       minOccurs="0" maxOccurs="1"/>
        </xsd:sequence>
        <xsd:attribute name="id" type="xsd:nonNegativeInteger"
                       use="required"/>
        <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
                       use="required"/>
        <xsd:attribute name="distance" type="nonNegativeDecimal"
                       use="required"/>
        <xsd:attribute name="distance_unit" type="distanceUnit"
                       use="required"/>
        <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>
        <xsd:attribute name="time_unit" type="timeUnit" use="required"/>
        <xsd:attribute name="start_location" type="xsd:positiveInteger"
                       use="required"/>
        <xsd:attribute name="end_location" type="xsd:positiveInteger"
                       use="required"/>
      </xsd:complexType>
    </xsd:element>
  </xsd:sequence>
</xsd:complexType>

<xsd:complexType name="routeType">
  <xsd:sequence>
    <xsd:element name="route_geometry" type="geometry"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="route_edge_ids" type="edgeIdList"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="start_location" type="outputLocation"
                 minOccurs="0" maxOccurs="1"/>
    <xsd:element name="segment" type="segmentType"
                 minOccurs="0" maxOccurs="unbounded"/>
    <xsd:element name="end_location" type="outputLocation"
                 minOccurs="0" maxOccurs="1"/>
  </xsd:sequence>
  <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
  <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
                 use="required"/>
  <xsd:attribute name="distance" type="nonNegativeDecimal" use="required"/>
  <xsd:attribute name="distance_unit" type="distanceUnit" use="required"/>
  <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>
  <xsd:attribute name="time_unit" type="timeUnit" use="required"/>
  <xsd:attribute name="start_location" type="xsd:positiveInteger"
                 use="required"/>
  <xsd:attribute name="end_location" type="xsd:positiveInteger"
                 use="required"/>
</xsd:complexType>
</xsd:schema>
```

14.3.4 Batch Mode Route Request and Response Examples

This section contains XML examples of batch mode route requests and the responses generated by those requests. One request uses specified addresses, and the other request uses previously geocoded locations. For reference information about the available elements and attributes, see Batch Route Request XML Schema Definition for requests and Batch Route Response XML Schema for responses.

Example 14-17 Batch Route Request with Specified Addresses

Example 14-17 shows a batch route request using specified addresses. The request is for the fastest routes, preferably using highways, between an office in Waltham, Massachusetts and three end locations (an Oracle office in Nashua, New Hampshire; the town offices in Concord, Massachusetts; and Boston City Hall), using miles for distances and minutes for times. The request calls for the returned routes to be sorted by distance between the start and end location, and for no routes over 35 miles to be returned.

```
<?xml version="1.0" standalone="yes"?>
<batch_route_request
          id="8"
          route_preference="fastest"
          road_preference="highway"
          return_driving_directions="false"
          sort_by_distance = "true"
          cutoff_distance="35"
          distance_unit="mile"
          time_unit="minute">
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="399 Winter St"
          lastline="Waltham, MA" />
      </input_address>
    </input_location>
  </start_location>
  <end_location>
    <input_location id="10">
      <input_address>
        <us_form1
          street="1 Oracle Dr"
          lastline="Nashua, NH" />
      </input_address>
    </input_location>
  </end_location>
  <end_location>
    <input_location id="11">
      <input_address>
        <us_form1
          street="2 Monument Sq"
          lastline="Concord, MA" />
      </input_address>
    </input_location>
  </end_location>
  <end_location>
    <input_location id="12">
      <input_address>
        <us_form1
          street="1 City Hall Plaza"
          lastline="Boston, MA" />
      </input_address>
    </input_location>
  </end_location>
</batch_route_request>
```

Example 14-18   Batch Route Response with Specified Addresses

Example 14-18 shows the response generated by the request in Example 14-17. (The output is reformatted for readability.) Note that because `sort_by_distance = "true"` was specified in the request, the routes returned are not in order by route IDs (11, 12, 10), but instead by route distances.

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response id="8">
  <route id="11" step_count="0"
         distance="7.796855460254458" distance_unit="mile"
         time="11.343014526367188" time_unit="minute"/>
  <route id="12" step_count="0"
         distance="17.201688768020258" distance_unit="mile"
         time="21.577909342447917" time_unit="minute"/>
  <route id="10" step_count="0"
          distance="28.628700657894736" distance_unit="mile"
          time="31.133371988932293" time_unit="minute"/>
</batch_route_response>
```

Example 14-19   Batch Route Request with Previously Geocoded Locations

Example 14-19 shows a batch route request using previously geocoded locations. The request is for the fastest routes, preferably using highways, between one location and three other locations, using miles for distances and minutes for times. The request calls for the returned routes to be sorted by distance between the start and end location, and for no routes over 28.5 miles to be returned.

```
<?xml version="1.0" standalone="yes"?>
<batch_route_request id="8"
                     route_preference="fastest"
                     road_preference="highway"
                     return_driving_directions="false"
                     distance_unit="mile"
                     time_unit="minute"
                     pre_geocoded_locations="true"
                     cutoff_distance="28.5"
                     sort_by_distance="true">
    <start_location>
        <pre_geocoded_location id="1">
            <edge_id>906810462</edge_id>
            <percent>0.0</percent>
            <side>R</side>
        </pre_geocoded_location>
    </start_location>
    <end_location>
        <pre_geocoded_location id="11">
            <edge_id>22325991</edge_id>
            <percent>0.0</percent>
            <side>R</side>
        </pre_geocoded_location>
    </end_location>
    <end_location>
        <pre_geocoded_location id="12">
            <edge_id>22027853</edge_id>
            <percent>0.0</percent>
            <side>R</side>
        </pre_geocoded_location>
    </end_location>
    <end_location>
        <pre_geocoded_location id="13">
            <edge_id>31102851</edge_id>
            <percent>0.0</percent>
            <side>R</side>
        </pre_geocoded_location>
    </end_location>
</batch_route_request>
```

Example 14-20 Batch Route Response with Previously Geocoded Locations

Example 14-20 shows the response to the request in Example 14-19. Only two routes are returned, because the third route is longer than the specified cutoff distance of 28.5 miles. (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response id="8">
  <route id="11" step_count="0"
          distance="7.796855460254458" distance_unit="mile"
          time="11.343014526367188" time_unit="minute"/>
  <route id="12" step_count="0"
         distance="17.201688768020258" distance_unit="mile"
         time="21.577909342447917" time_unit="minute"/>
</batch_route_response>
```

14.3.5 Batch Route Request XML Schema Definition

The following is the XML Schema definition for a batch route request. The main elements and attributes of the XML Schema Definition are explained in sections that follow.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- XML Schema definition for a Batch Route Request to the routing engine ->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
            elementFormDefault="qualified">
<xsd:include schemaLocation "geocoder_request.xsd" />

<xsd:simpleType name="positiveDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minExclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="distanceUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="mile"/>
    <xsd:enumeration value="km"/>
    <xsd:enumeration value="kilometer"/>
    <xsd:enumeration value="meter"/>
  </xsd:restriction>
</xsd:simpleType>
```

```
<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="unitType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="us"/>
    <xsd:enumeration value="metric"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="roadPreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="highway"/>
    <xsd:enumeration value="local"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="routePreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="shortest"/>
    <xsd:enumeration value="fastest"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="truckType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="delivery"/>
    <xsd:enumeration value="public"/>
    <xsd:enumeration value="resident"/>
    <xsd:enumeration value="trailer"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="vehicleType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="auto"/>
    <xsd:enumeration value="truck"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:complexType name="routerInputLocation">
  <xsd:choice>
    <xsd:element name="router_input_location"  type="input_locationType"/>
    <xsd:element name="router_pregeocoded_location" type="pregeocodedType"/>
  </xsd:choice>
</xsd:complexType>

<xsd:element name="batch_route_request" type="batch_route_requestType" />

<xsd:complexType name="batch_route_requestType">
  <xsd:sequence>
    <xsd:element name="start_location" type="routerInputLocation"
                 minOccurs="1" maxOccurs="1"/>
    <xsd:element name="end_location" type="routerInputLocation"
                 minOccurs="1" maxOccurs="unbounded"/>
  </xsd:sequence>
  <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
  <xsd:attribute name="pre_geocoded_locations" type="xsd:boolean"
                 use="optional"/>
  <xsd:attribute name="route_preference" type="routePreference"
                 use="optional"/>
  <xsd:attribute name="road_preference" type="roadPreference"
                 use="optional"/>
  <xsd:attribute name="distance_unit" type="distanceUnit" use="optional"/>
  <xsd:attribute name="length_unit" type="unitType" use="optional"/>
  <xsd:attribute name="time_unit" type="timeUnit" use="optional"/>
  <xsd:attribute name="weight_unit" type="unitType" use="optional"/>
  <xsd:attribute name="vehicle_type" type="vehicleType" use="optional">
  <xsd:attribute name="truck_type" type="truckType" use="optional"/>
  <xsd:attribute name="truck_height" type="positiveDecimal" use="optional"/>
  <xsd:attribute name="truck_length" type="positiveDecimal" use="optional"/>
  <xsd:attribute name="truck_per_axle_weight" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="truck_weight" type="positiveDecimal" use="optional"/>
  <xsd:attribute name="truck_width" type="positiveDecimal" use="optional"/>
  <xsd:attribute name="cutoff_distance" type="positiveDecimal"
                 use="optional"/>
  <xsd:attribute name="sort_by_distance" type="xsd:boolean" use="optional"/>
</xsd:complexType>
</xsd:schema>
```

- batch_route_request Element
- batch_route_request Attributes

14.3.5.1 batch_route_request Element

The root element of a batch mode route request is always named `batch_route_request`.

The `<start_location>` child element specifies the start location for the route, as an address specification, a pre-geocoded address, or longitude/latitude point.

Each of the one or more `<end_location>` child elements specifies the end location for the route, as an address specification, a geocoded address, or longitude/latitude point.

The `<location>` child element is never used in batch mode route requests.

14.3.5.2 batch_route_request Attributes

The root element `<batch_route_request>` has a number of attributes, most of them optional. The attributes are defined in this section.

The `<batch_route_request>` element shares a number of attributes with the `<route_request>` element. These attributes share the same meaning as their counterpart `<route_request>` attributes, which are explained in batch_route_request Attributes. In addition, the `sort_by_distance` and `cutoff_distance` attributes do not apply to single route requests.

`sort_by_distance` is an optional attribute that specifies whether you want the routes returned in ascending order by distance of the end location from the start location. `TRUE` sorts the returned routes by distance; `FALSE` (the default) does not sort the returned routes by distance.

`cutoff_distance` is an optional attribute that causes routes to be returned only where the end location is less than or equal to a specified distance from the start location. By default, all routes are returned.

Note:

If any route is within the batch generates a `<router_error>` element in the response (see Batch Route Response XML Schema), the route is removed from the response and not shown.

14.3.6 Batch Route Response XML Schema

The following is the XML Schema definition for a batch route response:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- XML Schema definition for a Batch Mode Route Request -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
     elementFormDefault="qualified">

<xsd:simpleType name="nonNegativeDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minInclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="distanceUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="mile"/>
    <xsd:enumeration value="km"/>
    <xsd:enumeration value="kilometer"/>
    <xsd:enumeration value="meter"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:element name="batch_route_response">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element name="route" maxOccurs="unbounded">
        <xsd:complexType>
          <xsd:attribute name="id" type="xsd:nonNegativeInteger"
                         use="required"/>
          <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
                         fixed="0" use="required"/>
          <xsd:attribute name="distance" type="nonNegativeDecimal"
                         use="required"/>
          <xsd:attribute name="distance_unit" type="distanceUnit"
                         use="required"/>
          <xsd:attribute name="time" type="nonNegativeDecimal"
                         use="required">
          <xsd:attribute name="time_unit" type="timeUnit" use="required"/>
        </xsd:complexType>
      </xsd:element>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
  </xsd:complexType>
</xsd:element>
</xsd:schema>
```

14.4 Location-Based Query Using the WSServlet XML API

WSServlet is a routing engine servlet for performing lightweight location based queries related to speed limit and traffic speed.

You submit requests in XML format using HTTP protocol. If an HTTP request (GET or POST method) is used, it is assumed the request has a parameter named xml_request whose value is a string containing the XML document for the request.

A request to the servlet has the following format:

```
http://hostname:port/routeserver/ws/WSServlet?xml_request=xml-request
```

In this format:

- *hostname* is the network path of the server on which the routing engine is running.
- *port* is the port on which the application server listens.
- `routeserver/ws/WSServlet` is the directory of the servlet.
- *xml-request* is the URL-encoded XML request submitted using the HTML GET or POST method.

The input XML is required for all requests. The output will be an XML document.

WSServlet takes the following different requests:

- Speed Limit: return speed limit of the nearest edge of the location.
- Traffic Speed: return average traffic speed of the nearest edge of the location.

Requests and responses in related topics are formatted, as needed, for readability.

- Specifying One or More Locations
- Speed Limit Support in WSServlet
- Traffic Speed Support in WSServlet
- WSServlet Exception Handling

14.4.1 Specifying One or More Locations

A request to the WSServlet servlet can specify a single location or multiple locations. A request specifying a single location has one `<location>` element; a request specifying multiple locations has multiple `<location>` elements and is called a **batch** request.

A request to the WSServlet servlet references the `locationType` type, an XML schema definition type that is used for specifying a single location or multiple locations, plus other related attributes. This type is defined as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
    <xsd:complexType name="locationType">
        <xsd:attribute name="id" type="xsd:string" use="required"/>
        <xsd:attribute name="longitude" type="xsd:string" use="required"/>
        <xsd:attribute name="latitude" type="xsd:string" use ="required"/>
        <xsd:attribute name="requestTime" type="xsd:string"/>
        <xsd:attribute name="timeFormat" type="xsd:string" default="dd MMM
yyyy HH:mm"/>
    </xsd:complexType>
</xsd:schema>
```

This type includes the following:

- `id`: a string containing the ID (identifier) value of the location (mandatory attribute).
- `longitude`: a string containing the longitude of the location (mandatory attribute).
- `latitude`: a string containing the latitude of the location (mandatory attribute).
- `requestTime`: a string containing the request time. It should be follow the default time format(`dd MMM yyyy HH:mm`) or a customized format.
- `timeFormat`: a string containing the request time format. The default value is`“dd MMM yyyy HH:mm”`; however, you can customize the time format, such as `“yyyy/mm/dd HH:mm”` or `“mm-dd-yyyy HH:mm”`.

14.4.2 Speed Limit Support in WSServlet

This topic provides examples of requests and responses related to speed limit, and schema definitions for the request and response. A request and its corresponding response can be for a single location or multiple locations.

- Speed Limit Request and Response Examples
- Speed Limit Request and Response Schema Definitions

14.4.2.1 Speed Limit Request and Response Examples

Example 14-21 Speed Limit Request (Single Location)

This example shows a speed limit request specifying a single location using a location ID (`location id="1291"`) and a longitude-latitude pair.

```
<speedLimitRequest requestId="0001">
    <location id="1291" longitude="-93.2857" latitude="45.1705"/>
</speedLimitRequest>
```

The response from this request might look like the following:

```
<speedLimitResponse requestId="0001" unit="mph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="24.9"/>
</speedLimitResponse>
```

Because the request did not specify a speed unit, the servlet uses the default unit of miles per hour (mph). In this case, although the speed limit is actually posted as 40 kilometers per hour (kmph), the servlet converts it to mph (24.9) in the response. In order to have the response indicate kilometers per hour, the request must include `unit="kmph"`.

Example 14-22 Speed Limit Request (Multiple Locatons)

This example is a batch request for speed limits at three locations, each with its own location ID and each specified by a longitude-latitude pair. The request specifies a unit of kilometers per hour (kmph)..

```
<speedLimitRequest requestId="0002" unit="kmph">
    <location id="1291" longitude="-93.2857" latitude="45.1705"/>
    <location id="211" longitude="-93.24049" latitude="46.69592"/>
    <location id="376" longitude="-71.46006" latitude="42.71004"/>
</speedLimitRequest>
```

The response from this request might look like the following:

```
<speedLimitResponse requestId="0002" unit="kmph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="40.0"/>
    <edgeResponse locationId="211" edgeId="125949436" speedLimit="95.0"/>
    <edgeResponse locationId="376" edgeId="22325991" speedLimit="20.0"/>
</speedLimitResponse>
```

The response includes an `<edgeResponse>` element for each requested location. That is, for each location, it returns the speed limit on the road or street at the point (longitude-latitude) associated with that location.

14.4.2.2 Speed Limit Request and Response Schema Definitions

The speed limit **request** XML schema definition (XSD) is as follows.

```
<?xml version="1.0"  ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
    <xs:element name="speedLimitRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" name="location" type="locationType"/>
            </xs:sequence>
            <xs:attribute name="requestId" type="xs:string" use="required"/>
            <xs:attribute name="requestType" type="xs:string" fixed="speedLimit"/>
            <xs:attribute name="unit" default="mph">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="mph"/>
                        <xs:enumeration value="kmph"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

In this definition, `<speedLimitRequest>` includes:

- `requestId`: a string containing the ID of the request (mandatory attribute).
- `requestType`: a string that has a fixed value `"speedLimit"` (optional attribute). This attribute does not need to be specified in the request, and is intended for possible later use with JSON parsing.
- `unit`: a string containing the speed unit, optional attribute. Only “`mph`”(miles per hour) and “`kmph`”(kilometers per hour) are supported.

- `location` elements: Can be a single location or a list of locations, as explained in Specifying One or More Locations.

The speed limit **response** XML schema definition (XSD) is as follows.

```
<?xml version="1.0"  ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
    <xs:element name="speedLimitResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" name="edgeResponse">
                    <xs:complexType>
                        <xs:attribute name="locationId" type="xs:string"/>
                        <xs:attribute name="edgeId" type="xs:long"/>
                        <xs:attribute name="speedLimit" type="xs:double"/>
                        <xs:attribute name="error" type="xs:string"/>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="requestId" use="required"/>
            <xs:attribute name="unit" default="mph">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="mph"/>
                        <xs:enumeration value="kmph"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

In this definition, `<speedLimitResponse>` includes:

- `requestId`: a string containing the ID of the request (mandatory attribute).
- `unit`: a string containing the speed unit (optional attribute). Only `mph` (miles per hour) and `kmph` (kilometers per hour) are supported. The default is `mph`.
- `edgeResponse`: one or more elements. Can be a single edge or a list of edges. It includes the following attributes:
  - `locationId`: a string containing the ID of the location.
  - `edgeId`: a string containing the id of the nearest edge of the input location.
  - `speedLimit`: the speed limit.
- `error`: a string containing an error message when the request is incorrect.

14.4.3 Traffic Speed Support in WSServlet

This topic provides examples of requests and responses related to traffic speed, and schema definitions for the request and response. A request and its corresponding response can be for a single location or multiple locations.

The API for traffic speed is similar to that for speed limit, the main difference being that a time (`requestTime` attribute) is required in the input.

- Traffic Speed Request and Response Examples
- Traffic Speed Request and Response Schema Definitions

14.4.3.1 Traffic Speed Request and Response Examples

Example 14-23 Traffic Speed Request (Single Location)

This example shows a traffic speed request specifying a single location using a location ID (`locationId="1291"`), a longitude-latitude pair, and a time for which you want the average traffic speed (`requestTime="08 Feb 2017 15:00"`). Because the specified time uses the default format of "`dd MMM yyyy HH:mm`", it is not necessary to specify the format in the request.

```
<trafficSpeedRequest requestId="0005">
  <location id="1291" longitude="-93.2857" latitude="45.1705" requestTime="08 
Feb 2017 15:00"/>
</trafficSpeedRequest>
```

The response from this request might look like the following:

```
<trafficSpeedResponse requestId="0005" unit="mph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="24.9"
        requestTime="08 Feb 2017 15:00" trafficSpeed="16.0"/>
</trafficSpeedResponse>
```

That is, on February 5, 2017 at 15:00 (3 pm), the average speed for that edge was 16.0 miles per hour.

Example 14-24 Traffic Speed Request (Multiple Locatons)

This example is a batch request for traffic speeds at three locations, each with its own location ID, each specified by a longitude-latitude pair, and each specifying a request time.

```
<trafficSpeedRequest requestId="0006" unit="kmph">
    <location id="1291" longitude="-93.2857" latitude="45.1705" 
requestTime="08 Feb 2017 15:00"/>
    <location id="211" longitude="-93.24049" latitude="46.69592" 
requestTime="09 Feb 2017 10:00"/>
    <location id="42" longitude="-103.31349" latitude="20.6308" 
requestTime="10 Feb 2017 09:00"/>
</trafficSpeedRequest>
```

The response from this request might look like the following:

```
<trafficSpeedResponse requestId="0006" unit="kmph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="40.0"
        requestTime="08 Feb 2017 15:00" trafficSpeed="26.0"/>
    <edgeResponse locationId="211" edgeId="125949436" speedLimit="95.0"
        requestTime="09 Feb 2017 10:00" trafficSpeed="79.0"/>
    <edgeResponse locationId="42" edgeId="-1073515692" speedLimit="20.0"
        requestTime="10 Feb 2017 09:00" trafficSpeed="9.0"/>
</trafficSpeedResponse>
```

The response includes an `<edgeResponse>` element for each requested location. That is, for each location, it returns the average traffic speed at the specified date and time on the road or street at the point (longitude-latitude) associated with that location.

14.4.3.2 Traffic Speed Request and Response Schema Definitions

The traffic speed **request** XML schema definition (XSD) is as follows.

```
<?xml version="1.0"  ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" >
    <xs:element name="trafficSpeedRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" name="location" type="locationType" />
            </xs:sequence>
            <xs:attribute name="requestId" type="xs:string" use="required"/>
            <xs:attribute name="requestType" type="xs:string" fixed="trafficSpeed"/>
            <xs:attribute name="unit" default="mph">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="mph"/>
                        <xs:enumeration value="kmph"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

In this definition, `<speedLimitRequest>` includes:

- `requestId`: a string containing the ID of the request (mandatory attribute).
- `requestType`: a string that has a fixed value `"trafficSpeed"` (optional attribute). This attribute does not need to be specified in the request, and is intended for possible later use with JSON parsing.
- `unit`: a string containing the speed unit, optional attribute. Only “`mph`”(miles per hour) and “`kmph`”(kilometers per hour) are supported.
- `location` elements: an be a single location or a list of locations, as explained in Specifying One or More Locations.

In addition, for each location, a traffic speed request must specify a time (requestTime). If you do not specify a format for the time, the default `"dd MMM yyyy HH:mm"` is used.

The traffic speed **response** XML schema definition (XSD) is as follows.

```
<?xml version="1.0"  ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
    <xs:element name="trafficSpeedResponse">
        <xs:complexType>
            <xs:sequence>
                <xs:element maxOccurs="unbounded" name="edgeResponse">
                    <xs:complexType>
                        <xs:attribute name="locationId" type="xs:string"/>
                        <xs:attribute name="edgeId" type="xs:long"/>
                        <xs:attribute name="speedLimit" type="xs:double"/>
                        <xs:attribute name="requestTime" type="xs:string"/>
                        <xs:attribute name="trafficSpeed" type="xs:double"/>
                        <xs:attribute name="error" type="xs:string"/>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="requestId" use="required"/>
            <xs:attribute name="unit" default="mph">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="mph"/>
                        <xs:enumeration value="kmph"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

In this definition, `<trafficSpeedResponse` includes:

- `requestId`: a string containing the ID of the request (mandatory attribute).
- `unit`: a string containing the speed unit (optional attribute). Only `mph` (miles per hour) and `kmph` (kilometers per hour) are supported. The default is `mph`.
- `edgeResponse`: one or more elements. Can be a single edge or a list of edges. It includes the following attributes:
  - `locationId`: a string containing the ID of the location.
  - `edgeId`: a string containing the id of the nearest edge of the input location.
  - `speedLimit`: the speed limit.
  - `requestTime`: a string containing the request time.
  - `trafficSpeed`: the traffic speed.
- `error`: a string containing an error message when the request is incorrect.

14.4.4 WSServlet Exception Handling

When the input XML request is incorrect or missing necessary values, WSServlet will throw one or more exceptions in the XML response.

The exception response schema definition is as follows:

```
<?xml version="1.0"  ?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
    <xs:element name="RouteServerException"  type="xs:string"/>
</xs:schema>
```

Throwing an exception breaks the processing flow, which decreases efficiency when handling batch requests.

WSServlet Exception List

The WSServlet servlet can throw the following exceptions.

```
WSE-0001: Cannot parse your xml request
WSE-0002: Cannot traverse xml request doc
WSE-0003: WSServlet can only process speedLimitRequest and trafficSpeedRequest
WSE-0004: Database is not connected
WSE-0100: Speed Limit Request Proccessing Exception
WSE-0101: Speed Limit requestId is null
WSE-0102: Speed Limit requestId is empty
WSE-0300: Traffic Speed Request Proccessing Exception
WSE-0301: Traffic Speed requestId is null
WSE-0302: Traffic Speed requestId is empty
```

WSServlet Error Case Examples

The following are some examples of error cases.

Example 14-25 Request Parsing Error

```
<?xml version="1.0" encoding="UTF-8"?>
<RouteServerException>[WSE-0001: Cannot parse your xml request]</RouteServerException>
```

Example 14-26 Missing Location ID

```
<speedLimitRequest requestId="1" unit="mph">
    <location id="1291" longitude="-93.2857" latitude="45.1705"/>
    <location longitude="-93.24049" latitude="46.69592"/>
    <location id="376" longitude="-71.46006" latitude="42.71004"/>
</speedLimitRequest>
```

This batch speed limit request specifies three different location. The second location element has no ID, which is required; however, this error does not affect the other locations in the request.

Example 14-27 Other Location Input Errors

```
<speedLimitResponse requestId="1" unit="mph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="24.85"/>
    <edgeResponse error="No location id."/>
    <edgeResponse locationId="376" edgeId="22325991" speedLimit="12.43"/>
</speedLimitResponse>
```

Other errors includes invalid location input, result not existing in the database table, and no request time input in traffic speed request.

Example 14-28 Missing Edge

```
<speedLimitResponse requestId="1" unit="mph">
    <edgeResponse locationId="1291" edgeId="-20190321" speedLimit="24.85"/>
    <edgeResponse locationId="211" edgeId="125949436" speedLimit="59.03"/>
    <edgeResponse locationId="376" error="Invalid location input."/>
</speedLimitResponse>
```

In this batch speed limit response, the third `edgeResponse` has the error `“Invalid location input.”` This occurred because the database query did not fine the edge in the table, that is, the location input is not covered by the data set.

Example 14-29 Multiple Errors in Batch Response

```
<trafficSpeedResponse requestId="1" unit="mph">
    <edgeResponse locationId="11" edgeId="-20190321" speedLimit="24.85"
        requestTime="08 Feb 2017 15:00" trafficSpeed="16.0"/>
    <edgeResponse locationId="92" error="Invalid location input."/>
    <edgeResponse locationId="42" edgeId="-1073515692" speedLimit="12.43" error="No
request time."/>
    <edgeResponse locationId="561" edgeId="22325991" speedLimit="12.43" error="No
traffic speed data."/>
</trafficSpeedResponse>
```

This batch traffic speed response has several errors:

- The second `edgeResponse` for location 92 has the error `“Invalid location input”`.
- The third `edgeResponse` for location 42 has the error `"No request time"` because it does not have `requestTime` in the request.
- The fourth `edgeResponse` for location 561 has the error `“No traffic speed data”`, because either the `requestTime` is invalid or the traffic speed data did not exist in the table.

14.5 Data Structures Used by the Routing Engine

Older versions of the routing engine (before Release 12.1) must have the following tables in their schema.

- EDGE
- NODE
- PARTITION
- SIGN_POST

The EDGE and NODE tables store edge and node information about the street network used by the routing engine. To understand how edges and nodes are used to represent street segments, intersections, and other entities in a street network, you must be familiar with the Oracle Spatial Network Data Model, which is described in *Oracle Spatial Topology and Network Data Model Developer's Guide*.

The following sections describe the tables used by the routing engine, in alphabetical order by table name.

- EDGE Table
- NODE Table
- PARTITION Table
- SIGN_POST Table

14.5.1 EDGE Table

The EDGE table contains one row for each directed edge in a street network. Each street segment (a part of a road between two nodes) is an undirected edge that corresponds to one or more directed edges in the EDGE table. The EDGE table contains the columns shown in Table 14-1.

Table 14-1 EDGE Table

Column Name	Data Type	Description
EDGE_ID	NUMBER	Edge ID number. Can be a positive or negative value, as explained in Relationship between Routing Engine and Geocoder. (Primary key.)
START_NODE_ID	NUMBER	Node ID number of the start node of this edge.
END_NODE_ID	NUMBER	Node ID number of the end node of this edge.
PARTITION_ID	NUMBER	Partition ID number of the network partition that contains this edge.
FUNC_CLASS	NUMBER	Functional road class: a number from 1 through 5, with 1 indicating a large, high-speed, high-volume road, and each successive class generally smaller in size, speed, and volume. Class 2 roads have consistent speeds and are used to get traffic to and from class 1 roads. Class 3 roads have high volume and are used to connect class 2 roads. Class 4 roads move volumes of traffic between neighborhoods (for example, a busy main road in a city). Class 5 roads are all other roads (for example, a small, low-volume street in a neighborhood).

Table 14-1 (Cont.) EDGE Table

Column Name	Data Type	Description
LENGTH	NUMBER	Length of this edge, in meters.
SPEED_LIMIT	NUMBER	Assigned speed limit for this edge, in meters per second.
GEOMETRY	SDO_GEOMETRY	Line string geometry representing this edge, with the coordinates ordered from the start node to the end node.
NAME	VARCHAR2(128)	Name of this edge.
DIVIDER	VARCHAR2(1)	A value of `N` indicates that the edge is not divided; other values indicate whether, where, and how turns are allowed on the divided edge. (The routing engine currently considers only whether the edge is divided or not.)

14.5.2 NODE Table

The NODE table contains one row for each node that is the start node or end node of one or more edges in the street network. A node often corresponds to an intersection (the intersection of two edges); however, a node can be independent of any intersection (for example, a "no exit" or "no outlet" street). The NODE table contains the columns shown in Table 14-2.

Table 14-2 NODE Table

Column Name	Data Type	Description
NODE_ID	NUMBER	Node ID number.(Primary key.)
GEOMETRY	SDO_GEOMETRY	Point geometry representing this node.
PARTITION_ID	NUMBER	Partition ID number of the network partition that contains this node.

14.5.3 PARTITION Table

The PARTITION table is generated by the routing engine based on the contents of the EDGE and NODE tables. The PARTITION table contains the columns shown in Table 14-3.

Table 14-3 PARTITION Table

Column Name	Data Type	Description
PARTITION_ID	NUMBER	Partition ID number.(Primary key.)
SUBNETWORK	BLOB	Part of the network included in this partition.
NUM_NODES	NUMBER	Number of nodes in this partition.
NUM_NON_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that are edges that are completely contained within the partition.
NUM_OUTGOING_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that start in this partition and terminate in another partition. (An edge cannot be in more that two partitions; for example, an edge cannot start in one partition, go through a second partition, and end in a third partition.)

Table 14-3 (Cont.) PARTITION Table

Column Name	Data Type	Description
NUM_INCOMING_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that start in another partition and terminate in this partition. (An edge cannot be in more that two partitions; for example, an edge cannot start in one partition, go through a second partition, and end in a third partition.)

14.5.4 SIGN_POST Table

The SIGN_POST table stores sign information that is used to generate driving directions. For example, a sign might indicate that Exit 33A on US Route 3 South goes toward Winchester. A SIGN_POST row might correspond to a physical sign at an exit ramp on a highway, but it does not need to correspond to a physical sign. The SIGN_POST table contains the columns shown in Table 14-4.

Table 14-4 SIGN_POST Table

Column Name	Data Type	Description
FROM_EDGE_ID	NUMBER	Edge ID number of the edge to which this sign applies (for example, the street segment containing the exit ramp). (Primary key.)
TO_EDGE_ID	NUMBER	Edge ID number of the edge to which this sign points (for example, the street segment to which the exit ramp leads).
RAMP	VARCHAR2(64)	Ramp text (for example, `US-3 SOUTH`).
EXIT	VARCHAR2(8)	Exit number (for example, `33A`).
TOWARD	VARCHAR2(64)	Text indicating where the exit is heading (for example, `WINCHESTER`).
LANGUAGE_CODE	CHAR (3 CHAR)	A three-letter language code indicating the language used on the sign. Examples `ENG`, `FRE`, and `SPA` for English, French, and Spanish.

14.6 User Data Structures Used by the Routing Engine

The routing engine uses user data as well as routing engine data. Some user data, such as turn restriction user data, must be present in the routing engine schema. Other user data, such as trucking user data, is optional.

> **Note:**
>
> Effective with Release 12.1, the routing engine running against Release 12.1 or later data expects turn restriction user data to be present. However, the routing engine can also be run against earlier data versions; but if this is done, a much more limited version of the turn restriction data from the PARTITION table is used.

This section explains tables used for the following types of user data.

- Turn Restriction User Data
- Trucking User Data
- Time Zone User Data
- Traffic User Data

14.6.1 Turn Restriction User Data

Turn restrictions are described in the following tables:

- ROUTER_CONDITION Table
- ROUTER_NAV_STRAND Table
- ROUTER_TURN_RESTRICTION_DATA Table

An edge (or a link) is an undirected edge that corresponds to one or more directed edges in the EDGE table (explained in EDGE Table). Turn restrictions are applied to a navigation strand (**nav_strand**) that is a group of two or more edges. A simple turn restriction would be applied to a two-edge nav_strand: the edge where the turn would have started and the edge where the turn would have ended. A nav_strand can have more than two edges to describe very complex restricted maneuvers.

- ROUTER_CONDITION Table
- ROUTER_NAV_STRAND Table
- ROUTER_TURN_RESTRICTION_DATA Table

14.6.1.1 ROUTER_CONDITION Table

The ROUTER_CONDITION table contains the raw data used to build the turn restriction user data for simple conditions. This table is not used during the routing process. Instead it is used to build the ROUTER_TURN_RESTRICTION_DATA user data table. It is part of routing engine data set so the turn restriction user data can be rebuilt if the routing engine data is repartitioned. The ROUTER_CONDITION table contains the columns shown in Table 14-5.

Table 14-5 ROUTER_CONDITION Table

Column Name	Data Type	Description
NAV_STRAND_ID	NUMBER	A unique ID number for a nav_strand.
APPLIES_TO	NUMBER	A number representing a list of vehicles to which the turn restriction applies.

14.6.1.2 ROUTER_NAV_STRAND Table

The ROUTER_NAV_STRAND table contains the raw data used to build the turn restriction user data for complex maneuvers. This table is not used during the routing process. Instead, it is used to build the ROUTER_TURN_RESTRICTION_DATA user data table. It is part of routing engine data set, so the turn restriction user data can be rebuilt if the routing engine data is repartitioned. The ROUTER_NAV_STRAND table contains the columns shown in Table 14-6.

Table 14-6 ROUTER_NAV_STRAND Table

Column Name	Data Type	Description
NAV_STRAND_ID	NUMBER	A unique ID number for a nav_strand that contains this edge.
SEQ_NUM	NUMBER	The edge ID's position within the nav_strand.
LINK_ID	NUMBER	Link (edge) ID of an edge that is part of this nav_strand.
NODE_ID	NUMBER	Node id of the node that connects the first and second link id in the nav_strand. This is zero for all other links in the nav_strand.
APPLIES_TO	NUMBER	A number representing a list of vehicles to which the turn restriction applies.

14.6.1.3 ROUTER_TURN_RESTRICTION_DATA Table

The ROUTER_TURN_RESTRICTION_DATA table contains the user data that describes turn restrictions. This table is used to enforce turn restrictions during the routing process. This table is partitioned to match the partitioning of the EDGE table. When a particular routing engine data partition is brought into the cache, the turn restriction User Data partition of the same number is also brought into the cache.

The ROUTER_TURN_RESTRICTION_DATA table contains the columns shown in Table 14-7.

Table 14-7 ROUTER_TURN_RESTRICTION_DATA Table

Column Name	Data Type	Description
PARTITION_ID	NUMBER	The routing engine data partition ID with which this turn restriction user data is associated.
NUM_EDGES	NUMBER	Number of edges with turn restrictions on them.
TURN_RESTRICTION_DATA	BLOB	BLOB containing the nav_strand information describing the turn restriction and the edges to which the turn restriction applies.

14.6.2 Trucking User Data

Trucking information is described in the following tables:

- ROUTER_TRANSPORT Table
- ROUTER_TRUCKING_DATA Table
- ROUTER_TRANSPORT Table
- ROUTER_TRUCKING_DATA Table

14.6.2.1 ROUTER_TRANSPORT Table

The ROUTER_TRANSPORT table contains the raw data used to build the trucking user data. This table is not used during the routing process. Instead, it is used to build the ROUTER_TRUCKING_DATA Table (a user data table). It is part of routing engine data set so that the trucking user data can be rebuilt if the routing engine data is repartitioned.

When to ROUTER_TRANSPORT table is first imported into the routing engine schema, you must execute the SDO_ROUTER_PARTITION.CREATE_TRUCKING_DATA procedure (see CREATE_TRUCKING_DATA Procedure) to produce the ROUTER_TRUCKING_DATA partitioned user data table.

The ROUTER_TRANSPORT table contains the columns shown in Table 14-8.

Table 14-8 ROUTER_TRANSPORT Table

Column Name	Data Type	Description
EDGE_ID	NUMBER	Edge ID number of the edge to which the restriction applies.
MAINTYPE	NUMBER(2)	Type of truck restriction: height, length, per axle weight, weight, width or legal.
SUBTYPE	NUMBER(2)	Subtype used to extend or provide exceptions to the main type of restriction. For example, a delivery subtype might allow delivery trucks access where other trucks are forbidden.
VALUE	NUMBER(6,2)	A value associated with the main type: for example a value of 20 associated with a weight main type to indicate that any truck in excess of 20 metric tons will not be allowed access to the edge.

14.6.2.2 ROUTER_TRUCKING_DATA Table

The ROUTER_TRUCKING_DATA contains the user data that describes truck restrictions. This table is used to enforce truck restrictions during the routing process. This table is partitioned to match the partitioning of the EDGE table. When a particular routing engine data partition is brought into the cache, the truck restriction User Data partition of the same number is also brought into the cache if the vehicle being routed is a truck.

The ROUTER_TRUCKING_DATA table contains the columns shown in Table 14-9.

Table 14-9 ROUTER_TRUCKING_DATA Table

Column Name	Data Type	Description
PARTITION_ID	NUMBER	ID of the routing engine data partition with which this trucking data is associated.
NUM_EDGES	NUMBER	Number of edges in this partition with trucking restrictions.
TRUCKING_DATA	BLOB	Trucking restrictions for this partition in BLOB format.

14.6.3 Time Zone User Data

The routing engine can track time in its route traversals, but it requires information about time zones. This data is stored in the following tables:

- ROUTER_TIMEZONES Table
- ROUTER_TIMEZONE_DATA Table
- ROUTER_TIMEZONES Table
- ROUTER_TIMEZONE_DATA Table

14.6.3.1 ROUTER_TIMEZONES Table

The ROUTER_TIMEZONES table maps a time zone name to a unique numeric identifier. This table is used to build time zone user data table. It is not used in the route computation process.

It is part of routing engine data set, so the time zone user data can be rebuilt if the routing engine data is repartitioned. The CREATE_TIMEZONE_DATA Procedure should be run to create the time zone user data table ROUTER_TIMEZONE_DATA, every time router data is repartitioned.

The ROUTER_TIMEZONES table contains the columns shown in the following table.

Table 14-10 ROUTER_TIMEZONES Table

Column Name	Data Type	Description
TIMEZONE_ID	NUMBER	Unique identifier for a time zone..
TIMEZONE_NAME	VARCHAR2(30)	Name of the time zone.

14.6.3.2 ROUTER_TIMEZONE_DATA Table

The ROUTER_TIMEZONE_DATA table contains the user data that associates each edge with its corresponding time zone. The table is partitioned so that when a routing engine data partition is brought into the cache, the corresponding time zone user data is brought in simultaneously.

The ROUTER_TIMEZONE_DATA table contains the columns shown in the following table.

Table 14-11 ROUTER_TIMEZONE_DATA Table

Column Name	Data Type	Description
PARTITION_ID	NUMBER	ID of the routing data partition with which this time zone data is associated.
NUM_EDGES	NUMBER	Number of edges in this partition.
TIMEZONE_DATA	BLOB	Time zone data for the edges in this partition.

14.6.4 Traffic User Data

Effective with Release 12.2, the routing engine can include historic traffic pattern data in its computations, making them sensitive to changes in travel time over the course of day. To incorporate this optional feature , the routing engine requires the time zone user data and the traffic patterns data to be available. Traffic pattern user data is stored in the following table.

- TP_USER_DATA Table
- TP_USER_DATA Table

14.6.4.1 TP_USER_DATA Table

The TP_USER_DATA table consists of user data that associates each edge with traffic pattern data. Traffic pattern for an edge consists of speeds along the edge, measured at regular intervals of time. Currently data is available at two granularities, namely, at 15-minute intervals and 1-hour intervals. The granularity is indicated by the SAMPLING_ID value: `1` indicates 15-minute intervals, and `2` indicates 1-hour intervals.

The TP_USER_DATA table contains the columns shown in the following table.

Table 14-12 TP_USER_DATA Table

Column Name	Data Type	Description
PARTITION_ID	NUMBER	ID of the routing data partition with which this traffic data is associated.
SAMPLING_ID	NUMBER	Sampling ID that indicates the granularity for the traffic pattern data: `1` indicates that data was collected at 15-minute intervals, and `2` indicates 1-hour intervals
BLOB	BLOG	Traffic pattern data for the edges in this partition.

15

OpenLS Support

This chapter describes the Oracle Spatial support for web services based on the Open Location Services Initiative (OpenLS) of the Open GeoSpatial Consortium (OGC), versions 1.0 and 1.1.

> **Note:**
>
> Before you use OpenLS, be sure that you understand the concepts described in Introduction to Spatial Web Services, and that you have performed any necessary configuration work as described in that chapter.

For a description of OpenLS, see `http://www.opengeospatial.org/standards/ols`, which includes links for downloads and schemas.

- Supported OpenLS Services
  Spatial supports the following OGC OpenLS services.
- OpenLS Application Programming Interfaces
  Two application programming interfaces (APIs) are provided using Spatial OpenLS services: a web services API and a PL/SQL API..
- OpenLS Service Support and Examples
  This section describes the support provided for geocoding, mapping, routing, and directory service (YP). It also contains examples of OpenLS web services API requests and responses.

15.1 Supported OpenLS Services

Spatial supports the following OGC OpenLS services.

- Location Utility Service (geocoding)
- Presentation Service (mapping)
- Route Service (driving directions)
- Directory Service (YP, or "Yellow Pages")

Spatial does not currently support the OGC OpenLS Gateway Service (mobile positioning).

For all supported services except Directory Service (YP, or Yellow Pages), you must first perform certain operations, which might included acquiring and loading third-party data, as well as configuring and deploying underlying technology on which the Spatial OpenLS service is based. Table 15-1 lists the Spatial OpenLS services, and the chapter or manual that documents the requirements and underlying technologies.

Table 15-1 Spatial OpenLS Services Dependencies

Spatial OpenLS Service	Depends On	Documented In
Geocoding	Geocoding metadata and data	Geocoding Address Data
Mapping	Oracle MapViewer	*Oracle Fusion Middleware User's Guide for Oracle MapViewer*
Driving directions	Routing engine	Routing Engine
Business directory (YP, or Yellow Pages)	Data from an external provider	Business Directory (Yellow Pages) Support

15.2 OpenLS Application Programming Interfaces

Two application programming interfaces (APIs) are provided using Spatial OpenLS services: a web services API and a PL/SQL API..

The web services API uses the same SOAP envelope as Web feature services (described in Web Feature Service (WFS) Support). You enable authentication and authorization using WSS and proxy authentication and user management.

The PL/SQL API is a convenient alternative to web services. Authentication and authorization are enabled through the database connection that you use to call a PL/SQL subprogram to submit an OpenLS request and return the result. The PL/SQL API is implemented in the SDO_OLS package, which is documented in SDO_OLS Package (OpenLS) .

15.3 OpenLS Service Support and Examples

This section describes the support provided for geocoding, mapping, routing, and directory service (YP). It also contains examples of OpenLS web services API requests and responses.

- OpenLS Geocoding
- OpenLS Mapping
- OpenLS Routing
- OpenLS Directory Service (YP)

15.3.1 OpenLS Geocoding

An OpenLS geocoding `<Request>` element includes the `methodName` attribute with a value of either `GeocodeRequest` or `ReverseGeocodeRequest`, and corresponding a top-level element named `<GeocodeRequest>` or `<ReverseGeocodeRequest>`.

If the `methodName` attribute value is `GeocodeRequest`, the `<GeocodeRequest>` element contains an `<Address>` element that can specify a free-form address, a street address, or an intersection address, with zero or more `<Place>` elements and an optional `<PostalCode>` element. The `<Address>` element has the required attribute `countryCode`, and several optional attributes.

If the `methodName` attribute value is `GeocodeRequest`, the `<ReverseGeocodeRequest>` element contains a `<Position>` element for identifying the location to be reverse geocoded, and an optional `<ReverseGeocodePreference>` element for specifying the information to be returned (default = a street address).

Example 15-1 is a request to geocode two addresses in San Francisco, California.

Example 15-1 OpenLS Geocoding Request

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.0">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    maximumResponses="10"
    methodName="GeocodeRequest"
    requestID="123"
    version="1.0">
    <GeocodeRequest>
      <Address countryCode="US">
        <StreetAddress>
          <Building number="400"/>
          <Street>Post Street</Street>
        </StreetAddress>
        <Place type="CountrySubdivision">CA</Place>
        <Place type="Municipality">San Francisco</Place>
        <PostalCode>94102</PostalCode>
      </Address>
      <Address countryCode="US">
        <StreetAddress>
          <Building number="233"/>
          <Street>Winston Drive</Street>
        </StreetAddress>
        <Place type="CountrySubdivision">CA</Place>
        <Place type="Municipality">San Francisco</Place>
        <PostalCode>94132</PostalCode>
      </Address>
    </GeocodeRequest>
  </Request>
</XLS>
```

Example 15-2 OpenLS Geocoding Response

Example 15-2 is the response to the request in Example 15-1. The longitude and latitude coordinates are returned for the two addresses (`-122.4083257 37.788208` for the first, `-122.4753965 37.7269066` for the second).

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  version="1.0">
  <xls:ResponseHeader/>
  <xls:Response requestID="123" version="1.0">
    <xls:GeocodeResponse xmlns:xls="http://www.opengis.net/xls">
      <xls:GeocodeResponseList
        xmlns:xls=http://www.opengis.net/xls
        numberOfGeocodedAddresses="1">
        <xls:GeocodedAddress>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
          </gml:Point>
          <xls:Address countryCode="US">
            <xls:StreetAddress>
              <xls:Building number="400"/>
              <xls:Street>POST ST</xls:Street>
            </xls:StreetAddress>
            <xls:Place type="CountrySubdivision">CA</xls:Place>
            <xls:Place type="Municipality">SAN FRANCISCO</xls:Place>
            <xls:PostalCode>94102</xls:PostalCode>
          </xls:Address>
        </xls:GeocodedAddress>
      </xls:GeocodeResponseList>
      <xls:GeocodeResponseList
        xmlns:xls=http://www.opengis.net/xls
        numberOfGeocodedAddresses="1">
        <xls:GeocodedAddress>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4753965 37.7269066</gml:pos>
          </gml:Point>
          <xls:Address countryCode="US">
            <xls:StreetAddress>
              <xls:Building number="233"/>
              <xls:Street>WINSTON DR</xls:Street>
            </xls:StreetAddress>
            <xls:Place type="CountrySubdivision">CA</xls:Place>
            <xls:Place type="Municipality">SAN FRANCISCO</xls:Place>
            <xls:PostalCode>94132</xls:PostalCode>
          </xls:Address>
        </xls:GeocodedAddress>
      </xls:GeocodeResponseList>
    </xls:GeocodeResponse>
  </xls:Response>
</xls:XLS>
```

15.3.2 OpenLS Mapping

An OpenLS mapping `<Request>` element includes the `methodName` attribute with a value of `PortrayMapRequest`, and a top-level element named `<PortrayMapRequest>`.

The `<PortrayMapRequest>` element contains an `<Output>` element that specifies the output of the map to be generated, including the center point of the map.

The `<PortrayMapRequest>` element can contain a `<Basemap>` element specifying a MapViewer base map and one or more themes, and zero or more `<Overlay>` elements, each specifying information to be overlaid on the base map.

Example 15-3 is a request to portray a map image. The image is to be centered at a specified longitude/latitude point, to use a base map and two MapViewer themes, and identify three points on the map.

Example 15-3 OpenLS Mapping Request

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.1">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    maximumResponses="1"
    methodName="PortrayMapRequest"
    requestID="456"
    version="1.1">
    <PortrayMapRequest>
      <Output
```

```
        BGcolor="#a6cae0"
        content="URL"
        format="GIF_URL"
        height="600"
        transparent="false"
        width="800">
        <CenterContext SRS="8307">
          <CenterPoint srsName="8307">
            <gml:pos>-122.2615 37.5266</gml:pos>
          </CenterPoint>
          <Radius unit="M">50000</Radius>
        </CenterContext>
      </Output>
      <Basemap filter="Include">
        <Layer name="mvdemo.demo_map.THEME_DEMO_COUNTIES"/>
        <Layer name="mvdemo.demo_map.THEME_DEMO_HIGHWAYS"/>
      </Basemap>
      <Overlay zorder="1">
        <POI
          ID="123"
          description="description"
          phoneNumber="1234"
          POIName="Books at Post Str (point)">
          <gml:Point srsName="4326">
            <gml:pos>-122.4083257 37.788208</gml:pos>
          </gml:Point>
        </POI>
      </Overlay>
      <Overlay zorder="2">
        <POI
          ID="456"
          description="description"
          phoneNumber="1234"
          POIName="Books at Winston Dr (address)">
          <Address countryCode="US">
            <StreetAddress>
              <Building number="233"/>
              <Street>Winston Drive</Street>
            </StreetAddress>
            <Place type="CountrySubdivision">CA</Place>
            <Place type="CountrySecondarySubdivision"/>
            <Place type="Municipality">San Francisco</Place>
            <Place type="MunicipalitySubdivision"/>
            <PostalCode>94132</PostalCode>
          </Address>
        </POI>
      </Overlay>
      <Overlay zorder="3">
        <Position levelOfConf="1">
          <gml:Point gid="a boat (point)" srsName="4326">
            <gml:pos>-122.8053965 37.388208</gml:pos>
          </gml:Point>
        </Position>
      </Overlay>
    </PortrayMapRequest>
  </Request>
</XLS>
```

Example 15-4   OpenLS Mapping Response

Example 15-4 is the response to the request in Example 15-3.; however, in an actual response, the line `<xls:URL>Actual URL replaced with constant string for test</xls:URL>` would contain the actual URL of the map image.

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.1">
  <xls:ResponseHeader/>
  <xls:Response numberOfResponses="1" requestID="456" version="1.1">
    <xls:PortrayMapResponse>
      <xls:Map>
        <xls:Content format="GIF_URL" height="600" width="800">
          <xls:URL>Actual URL replaced with constant string for test</xls:URL>
        </xls:Content>
        <xls:BBoxContext srsName="4326">
          <gml:pos>-122.86037685607968 37.07744235794024</gml:pos>
          <gml:pos>-121.66262314392031 37.97575764205976</gml:pos>
        </xls:BBoxContext>
      </xls:Map>
    </xls:PortrayMapResponse>
  </xls:Response>
</xls:XLS>
```

15.3.3 OpenLS Routing

An OpenLS routing `<Request>` element includes the `methodName` attribute with a value of `DetermineRouteRequest`, and a top-level element named `<DetermineRouteRequest>`.

The `<DetermineRouteRequest>` element contains a `<RoutePlan>` element that specifies the route preference and points to be included (and optionally avoided) in the route, with at least the start and end points.

The `<DetermineRouteRequest>` element can also contain zero or more of the following elements: `<RouteGeometryRequest>` to return the line string geometry representing the route, `<RouteMapRequest>` to request a map image of the route, and `<RouteInstructionsRequest>` to request driving directions for the route.

Example 15-5 is a request for the route geometry and map image for the fastest route between an address in Cambridge, Massachusetts and an address in Nashua, New Hampshire.

Example 15-5   OpenLS Routing Request

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.1">
  <RequestHeader clientName="someName" clientPassword="password"/>
    <Request
      maximumResponses="10"
      methodName="DetermineRouteRequest"
      requestID="12345"
      version="1.0">
      <DetermineRouteRequest>
        <RoutePlan>
```

```
          <RoutePreference>Fastest</RoutePreference>
          <WayPointList>
            <StartPoint>
              <POI description="Borders" ID="1" phoneNumber="12345" POIName="Borders">
                <Address countryCode="US">
                  <StreetAddress>
                    <Building number="100"/>
                    <Street>Cambridgeside Pl</Street>
                  </StreetAddress>
                  <Place type="CountrySubdivision">MA</Place>
                  <Place type="Municipality">Cambridge</Place>
                  <PostalCode>02141</PostalCode>
                </Address>
              </POI>
            </StartPoint>
            <EndPoint>
              <Address countryCode="US">
                <StreetAddress>
                  <Building number="1"/>
                  <Street>Oracle Dr</Street>
                </StreetAddress>
                <Place type="CountrySubdivision">New Hampshire</Place>
                <Place type="Municipality">Nashua</Place>
                <PostalCode>03062</PostalCode>
              </Address>
            </EndPoint>
          </WayPointList>
          <AvoidList/>
        </RoutePlan>
      <RouteGeometryRequest maxPoints="100" provideStartingPortion="true" scale="1">
        <BoundingBox>
          <gml:pos/>
          <gml:pos/>
        </BoundingBox>
      </RouteGeometryRequest>
      <RouteMapRequest>
        <Output BGcolor="" format="" height="600" transparent="false" width="800"/>
      </RouteMapRequest>
    </DetermineRouteRequest>
  </Request>
</XLS>
```

Example 15-6 OpenLS Routing Response

Example 15-6 is part of the response to the request in Example 15-5. Example 15-6 shows the total estimated driving time, the total distance, the lower-left and upper-right longitude/latitude coordinates of the minimum bounding rectangle that encloses the route, and the longitude/latitude coordinates of the first few points along the line geometry representing the route.

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.1">
  <xls:ResponseHeader/>
  <xls:Response numberOfResponses="1" requestID="12345" version="1.0">
    <xls:DetermineRouteResponse>
      <xls:RouteSummary>
        <xls:TotalTime>P0DT0H42M26S</xls:TotalTime>
        <xls:TotalDistance uom="M" value="61528.7"/>
        <xls:BoundingBox srsName="4326">
```

```
          <gml:pos dimension="2" srsName="4326">-71.45937289088023 42.36694</gml:pos>
          <gml:pos dimension="2" srsName="4326">-71.06754 42.70824</gml:pos>
        </xls:BoundingBox>
      </xls:RouteSummary>
      <xls:RouteGeometry>
        <gml:LineString srsName="4326">
          <gml:pos
            xmlns:gml=http://www.opengis.net/gml
            dimension="2"
            srsName="4326">-71.07444,42.36792</gml:pos>
          <gml:pos
            xmlns:gml=http://www.opengis.net/gml
            dimension="2"
            srsName="4326">-71.07162,42.37082</gml:pos>
          <gml:pos
            xmlns:gml=http://www.opengis.net/gml
            dimension="2"
            srsName="4326">-71.06954,42.37333</gml:pos>
. . .
```

15.3.4 OpenLS Directory Service (YP)

An OpenLS directory service `<Request>` element includes the `methodName` attribute with a value of `DirectoryRequest`, and a top-level element named `<DirectoryRequest>`.

The `<DirectoryRequest>` element contains a `<POILocation>` element that specifies the location of a point of interest, that is, the center point from which to compute distances of returned businesses.

The `<DirectoryRequest>` element also contains a `<POIProperties>` element that specifies one or more `<POIProperty>` elements, each of which contains a `name` attribute identifying a property and a `value` attribute identifying the value for the property. The `name` attribute can specify any of the following strings: `ID`, `POIName`, `PhoneNumber`, `Keyword`, `NAICS_type`, `NAICS_subType`, `NAICS_category`, `SIC_type`, `SIC_subType`, `SIC_category`, `SIC_code`, or `other`.

Example 15-7 is a request for information about business that have either or both of two specified SIC (Standard Industrial Classification) codes. For this example, the two SIC codes (`1234567890` and `1234567891`) are fictitious, and they are being used with a limited test data set in which these codes have been applied to categories (*Book stores* and *Cafes & Cafeterias*) that do not have these SIC codes in the real world.

Example 15-7 OpenLS Directory Service (YP) Request

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls …"
  version="1.0">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    requestID="123"
    maximumResponses="100"
    version="1.1"
    methodName="DirectoryRequest">
    <DirectoryRequest>
      <POILocation>
        <Address countryCode="US">
        </Address>
      </POILocation>
```

```
          <POIProperties>
            <POIProperty name="SIC_code" value="1234567890"/>
            <POIProperty name="SIC_code" value="1234567891"/>
          </POIProperties>
        </DirectoryRequest>
      </Request>
    </XLS>
```

Example 15-8 OpenLS Directory Service (YP) Response

Example 15-8 is the response to the request in Example 15-7. The response contains information about two businesses for which either or both of the specific SIC codes apply.

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  version="1.0">
  <xls:ResponseHeader/>
  <xls:Response requestID="123" version="1.1">
    <DirectoryResponse xmlns="http://www.opengis.net/xls">
      <xls:POIContext xmlns:xls="http://www.opengis.net/xls">
        <xls:POI
          ID="1"
          POIName="Borders Books &amp; More"
          phoneNumber="415-731-0665"
          description="Books &amp; more">
          <POIAttributeList xmlns="http://www.opengis.net/xls">
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Book stores"
              code="1234567890"
              subType=""
              type=""/>
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Cafes &amp; Cafeterias"
              code="1234567891"
              subType="" type=""/>
          </POIAttributeList>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4753965 37.7269066</gml:pos>
          </gml:Point>
          <xls:Address countryCode="US">
            <xls:StreetAddress>
              <xls:Building number="233"/>
              <xls:Street>Winston Drive</xls:Street>
            </xls:StreetAddress>
            <xls:Place type="CountrySubdivision">CA</xls:Place>
            <xls:Place type="CountrySecondarySubdivision"/>
            <xls:Place type="Municipality">San Francisco</xls:Place>
            <xls:Place type="MunicipalitySubdivision"/>
            <xls:PostalCode>94132</xls:PostalCode>
          </xls:Address>
        </xls:POI>
      </xls:POIContext>
      <xls:POIContext xmlns:xls="http://www.opengis.net/xls">
        <xls:POI
          ID="2"
          POIName="Borders Books &amp; More"
          phoneNumber="415-399-1633"
          description="Books &amp; more">
          <POIAttributeList xmlns="http://www.opengis.net/xls">
```

```
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Book stores"
              code="1234567890"
              subType=""
              type=""/>
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Cafes &amp; Cafeterias"
              code="1234567891"
              subType=""
              type=""/>
          </POIAttributeList>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
          </gml:Point>
          <xls:Address countryCode="US">
            <xls:StreetIntersection>
              <xls:Street>Post St</xls:Street>
              <xls:IntersectingStreet>Powell St</xls:IntersectingStreet>
            </xls:StreetIntersection>
            <xls:Place type="CountrySubdivision">CA</xls:Place>
            <xls:Place type="CountrySecondarySubdivision"/>
            <xls:Place type="Municipality">San Francisco</xls:Place>
            <xls:Place type="MunicipalitySubdivision"/>
            <xls:PostalCode>94102</xls:PostalCode>
          </xls:Address>
        </xls:POI>
      </xls:POIContext>
    </DirectoryResponse>
  </xls:Response>
</xls:XLS>
```

16

Web Feature Service (WFS) Support

Oracle Spatial includes Web Feature Service (WFS) support.

> **Note:**
>
> - You can deploy Oracle Spatial Web Services from Oracle Cloud Marketplace. This packaged application allows you to install Oracle Spatial web services (such as Web Feature Service (WFS), Web Coverage Services (WCS), and Catalog Services for the Web (CSW)) that are deployed in an Apache Tomcat web server instance on Oracle Cloud Infrastructure (OCI).
> - See Deploying and Configuring Spatial Web Services for the installation instructions of Web Feature Service server.
> - If you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, then you must drop the associated indexes before the upgrade and re-create the indexes after the upgrade as described in Index Maintenance Before and After an Upgrade (WFS and CSW).

- WFS Engine
  This topic describes the Web Feature Service engine, including its relationship to clients and to the database server.
- Configuring the WFS Engine
  This topic focuses on the WFS-specific configuration and deployment actions.
- Managing Feature Types
  WFS supports feature types with both spatial and nonspatial attributes.
- Capabilities Documents (WFS)
  A capabilities document is generated by the WFS server in response to a GetCapabilities request. It shows published feature types (such as roads or rivers) and the operations supported (such as insert and delete).
- WFS Operations: Requests and Responses with XML Examples
  This topic presents some feature requests to the WFS engine, and the response to each request, for each of the following operations.
- WFS Administration Console
  The WFS administration console uses your WebLogic Server credentials.
- Diagnosing WFS Issues
  The WFS log files provide diagnostic information.
- Using WFS with Oracle Workspace Manager
  You can use Oracle Workspace Manager to version-enable a WFS table with relational features.
- Dropping WFS Support (Release 21c or Later Only)
  (This topic applies only to release 21c or later; it does not apply to release 19c or earlier.)

- Updating a WFS Instance from an Oracle Database for a Release Before 21c to Release 21c or Later
  (This topic applies only to release 21c or later; it does not apply to release 19c or earlier.)

16.1 WFS Engine

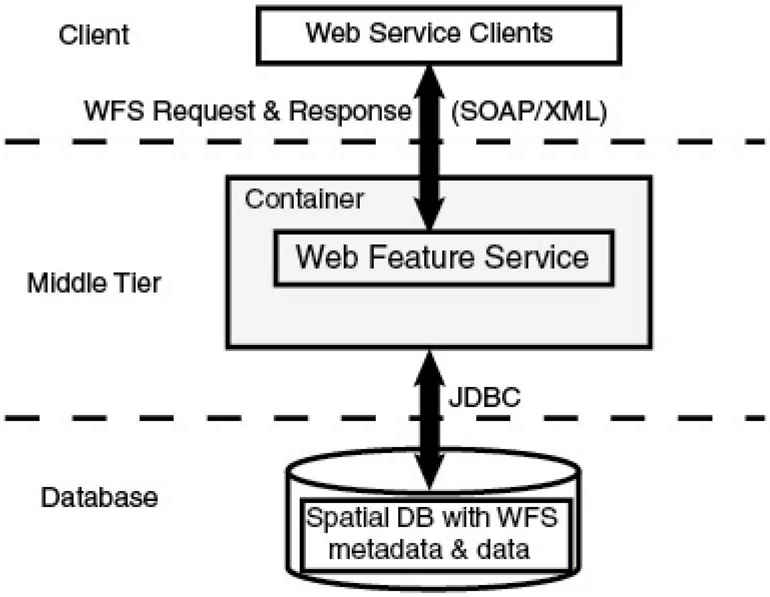
This topic describes the Web Feature Service engine, including its relationship to clients and to the database server.

WFS is implemented as a Java web application and can be deployed in Oracle WebLogic Server 12.1.3 or later. The required Java version is JDK 1.8 or later.

WFS has a metadata layer, which stores in the database the metadata needed to reply to the WFS requests. The metadata includes spatial columns, which can be queried and processed using Oracle Spatial interfaces. The metadata also stores the association of nonspatial and spatial attributes of features, as well as the services that the Web Feature Service provides to its clients.

Figure 16-1 shows the WFS architecture.

Figure 16-1 Web Feature Service Architecture



As shown in Figure 16-1:

- The WFS server is part of the middle tier.
- WFS clients can communicate with a WFS server through requests and responses in SOAP, KVP, or XML format.
- The WFS server performs spatial data and metadata access through JDBC calls to the database.
- The database includes Oracle Spatial with WFS metadata and spatial data, and with PL/SQL packages for administrative operations (see SDO_WFS_PROCESS Package (WFS Processing) and SDO_WFS_LOCK Package (WFS)).

Each database can have one WFS schema, which corresponds to one data source in WebLogic Server.

16.2 Configuring the WFS Engine

This topic focuses on the WFS-specific configuration and deployment actions.

Before following steps in this topic, be sure you understand the information in Deploying and Configuring Spatial Web Services and have performed any necessary operations.

- Editing the WFSConfig.xml File
- Data Source Setup for the WFS Engine

16.2.1 Editing the WFSConfig.xml File

In the **Service Configuration** tab of the WFS administration console, “uncomment” and modify as needed. Consider the following:

- The logging levels can be OFF, SEVERE, WARNING, INFO (the default), CONFIG, FINE, FINER, FINEST, or ALL. The default value is INFO.

  `size_limit` specifies an approximate maximum amount to write (in MB) to any one file. If the value is zero, then there is no limit. The default value is 10

  `file_count` specifies how many output files to cycle through. The default value is 10.
- Proxy configuration allows you to control URLs generated by the Spatial Web Services server. A useful scenario is when an HTTP Proxy Server receives requests from users and passes them to WebLogic Server, to control and protect access to a server on a private network
- Optionally, uncomment the `wfs_query_timeout` element to specify the query timeout value, which is used when a server-side locking API is called. The value can be a non-negative integer, and its unit is seconds. The default value is 10 seconds.
- Optionally, uncomment the `wfs_lock_expiry` element to configure the default WFS lock expiry value, which is the expiration time in minutes for WFS locks, if lock expiry value is not explicitly specified in `GetFeatureWithLock` or `LockFeature` requests. The default value is 4 minutes.
- Optionally, uncomment `gml_consider_coordinate_axis_sequence_ordering` and set it to the value 1 if the spatial reference system (SRS) should be checked for whether ordinates need to be reversed for x,y coordinates when generating the GML.
- The `wfs_xsd_loc_url`, `wfs_ex_xsd_loc_url`, and `gml3_xsd_loc_url` elements are deprecated and not used anymore.

16.2.2 Data Source Setup for the WFS Engine

> **Note:**
>
> In release 19c and earlier, can only have one WFS instance configured; but in release 21c and later, each database schema can be configured as a WFS instance. For information about updating a WFS instance from a release before 21c to release 21c (or later), see Updating a WFS Instance from an Oracle Database for a Release Before 21c to Release 21c or Later.

To set up a data source for the WFS Engine:

1. Perform the steps explained in Adding a WebLogic Data Source.
2. Configure the database schema following the step depending on your database version.
   For Release 19c and Earlier:

   Each database can have only one schema configured for WFS, which corresponds to one data source in WebLogic Server. However, you can have multiple data sources configured for WFS in WebLogic. Each data source can be accessed through a different URL, where the last part of the URL corresponds to the data source name configured in WebLogic Server. The following is an example link with a WLS data source name `wfsdata1`:

   ```
   http://localhost:80/oraclespatial/wfs/wfsdata1?service=WFS&
   version=1.0.0&request=GetCapabilities
   ```

   For Release 21c and Later:

   Run the following command using the same user previously configured as a WLS data source:

   ```
   Execute mdsys.sdo_wfs_process.init;
   ```

   Effective with Oracle Database release 21c, each database can have multiple schemas configured for WFS. Each data source can be accessed through a different URL, where the last part of the URL corresponds to the data source name configured in WebLogic Server. The following is an example link with a WLS data source name `wfsdata1`:

   ```
   http://localhost:80/oraclespatial/wfs/wfsdata1?
   service=WFS&version=1.0.0&request=GetCapabilities
   ```

After the WFS Engine is deployed and data source is created, you can test the deployment with WFS Engine test queries, such as one of these GetCapabilities queries:

- For WFS 1.0.0:

  ```
  http://<machine-name:port>/oraclespatial/wfs/<data source name>?
  request=GetCapabilities&service=WFS&version=1.0.0
  ```

- For WFS 1.1.0:

  ```
  http://<machine-name:port>/oraclespatial/wfs/<data source name>?
  request=GetCapabilities&service=WFS&version=1.1.0
  ```

16.3 Managing Feature Types

WFS supports feature types with both spatial and nonspatial attributes.

Feature types expose the content of database tables as feature instances. Feature types are well suited for those who use Oracle Spatial to manage their geospatial data and use Oracle Database to manage other business data. The Spatial WFS implementation provides ways to access the data, especially in service-oriented architecture (SOA) systems implemented using web services.

The WFS administration console enables you to perform operations that include:

- Publishing feature types
- Dropping (unpublishing) feature types
- Viewing and configuring logging
- Editing capabilities templates

There are two ways to publish and unpublish feature types:

- Using the WFS Administration Console: Publishing and Unpublishing Feature Types
- Using the SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema Procedure, and Dropping Feature Types

Using the WFS Administration Console: Publishing and Unpublishing Feature Types

Follow these steps to publish a feature type using the WFS administration console.

1. Log in to the WFS administration console with your WebLogic Server credentials
2. Click **WFS**, then **Publish Feature**.
3. From Available Tables, right-click a table that has not yet been published.
4. Click **Publish**.

You can repeat the preceding steps to publish another feature type.

To drop an already published procedure, use the preceding steps, except that in the last one click **Unpublish** instead of Publish.

Using the SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema Procedure

You can use the SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema procedure to publish multiple feature types, as is the following command line example.

```
EXECUTE SDO_WFS_PROCESS.PUBLISH_FEATURETYPES_IN_SCHEMA('USER', 'http://
www.myserver.com/user_data', 'udns', 'http://localhost:7003/oraclespatial/
wfs', p_tablename_pattern=>'GEOD_STATES');
```

Dropping Feature Types

You can use the following procedures to drop one or more feature types.

- To drop a single feature type: SDO_WFS_PROCESS.DropFeatureType
- To drop multiple feature types: SDO_WFS_PROCESS.DropFeatureTypes

16.4 Capabilities Documents (WFS)

A capabilities document is generated by the WFS server in response to a GetCapabilities request. It shows published feature types (such as roads or rivers) and the operations supported (such as insert and delete).

The WFS server uses a capabilities template, and adds information about the feature type and operations to this template to create the capabilities document.

A client uses the HTTP GET/KVP protocol to access this capabilities document:

```
http://<hostname:port>/oraclespatial/wfs/<data source name>/?
request=GetCapabilities&service=WFS
```

In the preceding format:

- *hostname* is the host name of the system where the application server is running.
- *port* is the port number where the application server is running.
- `oraclespatial` is the default context root where the Spatial web services application is mounted.
- `data source name` the data source configured on the application server to access spatial data. Is possible to have multiple data sources configured in a WLS instance, and WFS can expose data of each data source through a dedicated URL

16.5 WFS Operations: Requests and Responses with XML Examples

This topic presents some feature requests to the WFS engine, and the response to each request, for each of the following operations.

- GetCapabilities
- DescribeFeatureType
- GetFeature
- GetFeatureWithLock
- LockFeature
- Transaction, with a subelement specifying the transaction type:
  - Insert
  - Update
  - Delete

Several examples in this section refer to features in the COLA_MARKETS_CS table used in Example of Coordinate System Transformation, where the MKT_ID column contains the unique numeric ID of each feature, the NAME column contains each feature's name (`cola_a`, `cola_b`, `cola_c`, or `cola_d`), and the SHAPE column contains the geometry associated with each feature.

Example 16-1 GetCapabilities Request (WFS)

Example 16-1 is a request to get the capabilities of the WFS server named WFS at a specified namespace URL. This request will return a capabilities document, as explained in Capabilities Documents

```
<?xml version="1.0" ?>
<GetCapabilities
   service="WFS"
   version="1.0.0"
   xmlns="http://www.opengis.net/wfs" />
```

Example 16-2 GetCapabilities Response (WFS)

Example 16-2 is an excerpt of the response from the request in Example 16-1.

```
<WFS_Capabilities xmlns="http://www.opengis.net/wfs" version="1.0.0" xmlns:ogc="http://
www.opengis.net/ogc" xmlns:myns="http://www.example.com/myns">
  <Service>
    <Name> Oracle WFS </Name>
    <Title> Oracle Web Feature Service </Title>
    <Abstract> Web Feature Service maintained by Oracle </Abstract>
    <OnlineResource>http://localhost:8888/SpatialWS-SpatialWS-context-root/wfsservlet</
OnlineResource>
  </Service>
  <Capability>
    <Request>
      <GetCapabilities>
        <DCPType>
          <HTTP>
            <Get onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
wfsservlet"/>
          </HTTP>
        </DCPType>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </GetCapabilities>
      <DescribeFeatureType>
        <SchemaDescriptionLanguage>
          <XMLSCHEMA/>
        </SchemaDescriptionLanguage>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </DescribeFeatureType>
      <GetFeature>
        <ResultFormat>
          <GML2/>
        </ResultFormat>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </GetFeature>
      <GetFeatureWithLock>
        <ResultFormat>
          <GML2/>
        </ResultFormat>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </GetFeatureWithLock>
      <Transaction>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </Transaction>
      <LockFeature>
        <DCPType>
          <HTTP>
            <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort"/>
          </HTTP>
        </DCPType>
      </LockFeature>
    </Request>
  </Capability>
  <FeatureTypeList>
    <Operations>
      <Insert/>
      <Update/>
      <Delete/>
      <Query/>
      <Lock/>
    </Operations>
  <FeatureType xmlns:myns="http://www.example.com/myns">
  <Name> myns:COLA</Name>
  <Title> LIST OF COLA MARKETS </Title>
  <SRS> SDO:8307</SRS>
</FeatureType><FeatureType xmlns:myns="http://www.example.com/myns">
  <Name> myns:COLAVIEW1 </Name>
  <Title> LIST OF COLA MARKET VIEW </Title>
  <SRS> SDO:8307</SRS>
</FeatureType><FeatureType xmlns:wfs="http://www.opengis.net/wfs">
  <Name xmlns:myns="http://www.example.com/myns1">myns:SampleFeature</Name>
  <Title>SAMPLE FEATURE</Title>
  <SRS>EPSG:32615</SRS>
</FeatureType></FeatureTypeList>
  <ogc:Filter_Capabilities xmlns:ogc="http://www.opengis.net/ogc">
    <ogc:Spatial_Capabilities>
      <ogc:Spatial_Operators>
        <ogc:BBOX/>
        <ogc:Equals/>
        <ogc:Disjoint/>
        <ogc:Intersect/>
        <ogc:Touches/>
        <ogc:Crosses/>
        <ogc:Within/>
        <ogc:Contains/>
        <ogc:Overlaps/>
        <ogc:Beyond/>
        <ogc:DWithin/>
      </ogc:Spatial_Operators>
    </ogc:Spatial_Capabilities>
    <ogc:Scalar_Capabilities>
      <ogc:Logical_Operators/>
      <ogc:Comparison_Operators>
        <ogc:Simple_Comparisons/>
        <ogc:Like/>
        <ogc:Between/>
        <ogc:NullCheck/>
      </ogc:Comparison_Operators>
      <ogc:Arithmetic_Operators>
        <ogc:Simple_Arithmetic/>
      </ogc:Arithmetic_Operators>
    </ogc:Scalar_Capabilities>
  </ogc:Filter_Capabilities>
</WFS_Capabilities>
```

Example 16-3   DescribeFeatureType Request (WFS)

Example 16-3 is a request to describe the feature type named `COLA`.

```
<?xml version="1.0" ?>
<wfs:DescribeFeatureType
   service="WFS"
   version="1.0.0"
   xmlns:wfs="http://www.opengis.net/wfs"
   xmlns:myns="http://www.example.com/myns"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
   xsi:schemaLocation="http://www.opengis.net/wfs ../wfs/1.0.0/WFS-basic.xsd">
   <wfs:TypeName>myns:COLA</wfs:TypeName>
</wfs:DescribeFeatureType>
```

Example 16-4   DescribeFeatureType Response (WFS)

Example 16-4 is the response from the request in Example 16-3. The response is an XML schema definition (XSD).

```
<xsd:schema targetNamespace="http://www.example.com/myns" xmlns:wfs="http://
www.opengis.net/wfs" xmlns:myns="http://www.example.com/myns" xmlns:gml="http://
www.opengis.net/gml" elementFormDefault="qualified" version="1.0.0" xmlns:xsd="http://
www.w3.org/2001/XMLSchema">
   <xsd:import namespace="http://www.opengis.net/gml" schemaLocation="http://
localhost:8888/examples/servlets/xsds/feature.xsd"/>
   <xsd:element name="COLA" type="myns:COLAType" substitutionGroup="gml:_Feature"/>
   <xsd:complexType name="COLAType">
      <xsd:complexContent>
         <xsd:extension base="gml:AbstractFeatureType">
            <xsd:sequence>
               <xsd:element name="MKT_ID" type="xsd:double"/>
               <xsd:element name="NAME" nillable="true">
                  <xsd:simpleType>
                     <xsd:restriction base="xsd:string">
                        <xsd:maxLength value="32"/>
                     </xsd:restriction>
                  </xsd:simpleType>
               </xsd:element>
               <xsd:element name="SHAPE" type="gml:PolygonMemberType" nillable="true"/>
            </xsd:sequence>
            <xsd:attribute name="fid" type="xsd:double"/>
         </xsd:extension>
      </xsd:complexContent>
   </xsd:complexType>
</xsd:schema>
```

Example 16-5 GetFeature Request (WFS)

Example 16-5 is a request to get the MKT_ID, NAME, and SHAPE properties of the feature or features of type COLA where the MKT_ID value is greater than 2 and the NAME value is equal to `cola_c`, or where the MKT_ID value is greater than 3 and the NAME value is equal to `cola_d`.

Note that for GetFeature and GetFeatureWithLock, the `<Query>` and `<PropertyName>` elements, which list the property names to be selected, can be any top-level element of the queried feature type, in which case its entire content (which may be nested) is returned in the query response. XPaths of arbitrary depth are not supported in `<PropertyName>` elements directly under the `<Query>` element; however, they are supported in `<PropertyName>` elements in a `<Filter>` element under the `<Query>` element, as shown in Example 16-5 and Example 16-7

```
<?xml version="1.0" ?>
<wfs:GetFeature
   service="WFS"
   version="1.0.0"
   xmlns:wfs="http://www.opengis.net/wfs"
   xmlns:ogc="http://www.opengis.net/ogc"
   xmlns:myns="http://www.example.com/myns"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://www.opengis.net/wfs ../wfs/1.0.0/WFS-basic.xsd">
   <wfs:Query typeName="myns:COLA">
      <ogc:PropertyName>myns:MKT_ID</ogc:PropertyName>
      <ogc:PropertyName>myns:NAME</ogc:PropertyName>
      <ogc:PropertyName>myns:SHAPE</ogc:PropertyName>
      <ogc:Filter>
          <ogc:And>
            <ogc:And>
                <ogc:PropertyIsGreaterThan>
                        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
                        <ogc:Literal> 2 </ogc:Literal>
                </ogc:PropertyIsGreaterThan>
                <ogc:PropertyIsEqualTo>
                        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
                <ogc:Literal>cola_c</ogc:Literal>
                </ogc:PropertyIsEqualTo>
            </ogc:And>
            <ogc:Or>
                <ogc:PropertyIsEqualTo>
                        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
                        <ogc:Literal>3</ogc:Literal>
                </ogc:PropertyIsEqualTo>
                <ogc:PropertyIsEqualTo>
                        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
                        <ogc:Literal>cola_d</ogc:Literal>
                </ogc:PropertyIsEqualTo>
            </ogc:Or>
          </ogc:And>
      </ogc:Filter>
   </wfs:Query>
</wfs:GetFeature>
```

Example 16-6 GetFeature Response (WFS)

Example 16-6 is the response from the request in Example 16-5.

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:FeatureCollection xsi:schemaLocation="http://www.example.com/myns http://
localhost:8888/wfsservlet?featureTypeId=1 http://www.opengis.net/wfs ../wfs/1.0.0/WFS-
basic.xsd" xmlns:wfs="http://www.opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance">
   <gml:boundedBy xmlns:gml="http://www.opengis.net/gml">
      <gml:Box srsName="SDO:8307">
         <gml:coordinates>3.0,3.0 6.0,5.0</gml:coordinates>
      </gml:Box>
   </gml:boundedBy>
   <gml:featureMember xmlns:gml="http://www.opengis.net/gml">
      <myns:COLA fid="3" xmlns:myns="http://www.example.com/myns">
         <myns:MKT_ID>3</myns:MKT_ID>
         <myns:NAME>cola_c</myns:NAME>
         <myns:SHAPE>
            <gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml">
               <gml:outerBoundaryIs>
                  <gml:LinearRing>
                     <gml:coordinates decimal="." cs="," ts=" ">3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </gml:coordinates>
                  </gml:LinearRing>
               </gml:outerBoundaryIs>
            </gml:Polygon>
         </myns:SHAPE>
      </myns:COLA>
   </gml:featureMember>
</wfs:FeatureCollection>
```

Example 16-7 GetFeatureWithLock Request (WFS)

Example 16-7 is a request to get the MKT_ID, NAME, and SHAPE properties of the feature of type COLA where the MKT_ID value is greater than 2 and the NAME value is equal to `cola_c`, or where the MKT_ID value is equal to 3, and to lock that feature.

```
<?xml version="1.0" ?>
<wfs:GetFeatureWithLock
   service="WFS"
   version="1.0.0"
   expiry="5"
   xmlns:wfs="http://www.opengis.net/wfs"
   xmlns:ogc="http://www.opengis.net/ogc"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:myns="http://www.example.com/myns"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
   <wfs:Query typeName="myns:COLA">
      <ogc:PropertyName>myns:MKT_ID</ogc:PropertyName>
      <ogc:PropertyName>myns:NAME</ogc:PropertyName>
      <ogc:PropertyName>myns:SHAPE</ogc:PropertyName>
      <ogc:Filter>
         <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
            <ogc:Literal> 3 </ogc:Literal>
         </ogc:PropertyIsEqualTo>
      </ogc:Filter>
   </wfs:Query>
</wfs:GetFeatureWithLock>
```

Example 16-8 GetFeatureWithLock Response (WFS)

Example 16-8 is the response from the request in Example 16-7.

```
<wfs:FeatureCollection xmlns:wfs="http://www.opengis.net/wfs" lockId="1"
xsi:schemaLocation="http://www.example.com/myns http://localhost:8888/SpatialWS-
SpatialWS-context-root/wfsservlet?featureTypeId=1 " xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance">
   <gml:boundedBy xmlns:gml="http://www.opengis.net/gml">
      <gml:Box srsName="SDO:8307">
         <gml:coordinates>3.0,3.0 6.0,5.0</gml:coordinates>
      </gml:Box>
   </gml:boundedBy>
   <gml:featureMember xmlns:gml="http://www.opengis.net/gml">
      <myns:COLA xmlns:myns="http://www.example.com/myns" fid="3">
         <myns:MKT_ID>3</myns:MKT_ID>
         <myns:NAME>cola_c</myns:NAME>
         <myns:SHAPE>
            <gml:Polygon srsName="SDO:8307">
               <gml:outerBoundaryIs>
                  <gml:LinearRing>
                     <gml:coordinates decimal="." cs="," ts=" ">3.0,3.0 6.0,3.0 6.0,5.0
4.0,5.0 3.0,3.0 </gml:coordinates>
                  </gml:LinearRing>
               </gml:outerBoundaryIs>
            </gml:Polygon>
         </myns:SHAPE>
      </myns:COLA>
   </gml:featureMember>
</wfs:FeatureCollection>
```

Example 16-9 LockFeature Request (WFS)

Example 16-9 is a request to lock the feature where the MKT_ID value is equal to 2.

```
<?xml version="1.0" ?>
<wfs:LockFeature
   service="WFS"
   version="1.0.0"
   expiry="5"
   xmlns:wfs="http://www.opengis.net/wfs"
   xmlns:ogc="http://www.opengis.net/ogc"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:myns="http://www.example.com/myns"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
   <wfs:Lock typeName="myns:COLA">
      <ogc:Filter>
           <ogc:PropertyIsEqualTo>
              <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
              <ogc:Literal> 2 </ogc:Literal>
           </ogc:PropertyIsEqualTo>
      </ogc:Filter>
   </wfs:Lock>
</wfs:LockFeature>
```

Example 16-10 LockFeature Response (WFS)

Example 16-10 is the response from the request in Example 16-9.

```
<wfs:WFS_LockFeatureResponse xmlns:wfs="http://www.opengis.net/wfs">
   <wfs:LockId>2</wfs:LockId>
</wfs:WFS_LockFeatureResponse>
```

Example 16-11 Insert Request (WFS)

Example 16-11 is a request to insert a feature, with MKT_ID = 5 and NAME = `cola_e`, into the table associated with the WFS service named `WFS`.

```
<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://www.e
xample.com/myns" xmlns:myns="http://www.example.com/myns" xmlns:gml="http://ww
w.opengis.net/gml" xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
<wfs:Insert handle="INSERT01" >
<myns:COLA fid="5" xmlns:myns="http://www.example.com/myns">
         <myns:MKT_ID>5</myns:MKT_ID>
         <myns:NAME>cola_e</myns:NAME>
         <myns:SHAPE>
            <gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml">
               <gml:outerBoundaryIs>
                  <gml:LinearRing>
                     <gml:coordinates decimal="." cs="," ts=" ">1.0,3.0 6.0,3.0 6.0,5.0
4.0,5.0 1.0,3.0 </gml:coordinates>
                  </gml:LinearRing>
               </gml:outerBoundaryIs>
            </gml:Polygon>
         </myns:SHAPE>
      </myns:COLA>
</wfs:Insert>
</wfs:Transaction>
```

Example 16-12 Insert Response (WFS)

Example 16-12 is the response from the request in Example 16-11.

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
   <wfs:InsertResult handle="INSERT01">
      <ogc:FeatureId fid="5" xmlns:ogc="http://www.opengis.net/ogc"/>
   </wfs:InsertResult>
   <wfs:TransactionResult handle="TX01">
      <wfs:Status>
         <wfs:SUCCESS/>
      </wfs:Status>
   </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>
```

Example 16-13 Update Request (WFS)

Example 16-13 is a request to update the feature, where MKT_ID is greater than 2 and less than 4 and where NAME is not null, in the table associated with the WFS service named `WFS`. This request specifies that the NAME value of the specified feature is to be set to `cola_cl`.

```
<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://
www.example.com/myns"
xmlns:myns="http://www.example.com/myns" xmlns:gml="http://www.opengis.net/gml"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
<wfs:Update handle="UPDATE1" typeName="myns:COLA" >
<wfs:Property>
        <wfs:Name>myns:COLA/myns:NAME</wfs:Name>
        <wfs:Value>cola_c1</wfs:Value>
</wfs:Property>
<ogc:Filter>
          <ogc:And>
```

```
                <ogc:And>
                    <ogc:PropertyIsGreaterThan>
                            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
                            <ogc:Literal> 2 </ogc:Literal>
                    </ogc:PropertyIsGreaterThan>
                    <ogc:PropertyIsLessThan>
                            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
                            <ogc:Literal> 4 </ogc:Literal>
                    </ogc:PropertyIsLessThan>
                </ogc:And>
                <ogc:Not>
                    <ogc:PropertyIsNull>
                            <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
                    </ogc:PropertyIsNull>
                </ogc:Not>
              </ogc:And>
</ogc:Filter>
</wfs:Update>
</wfs:Transaction>
```

Example 16-14   Update Response (WFS)

Example 16-14 is the response from the request in Example 16-13.

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
   <wfs:TransactionResult handle="TX01">
      <wfs:Status>
         <wfs:SUCCESS/>
      </wfs:Status>
   </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>
```

Example 16-15   Delete Request (WFS)

Example 16-15 is a request to delete the feature, where MKT_ID is greater than 3 and NAME is equal to `cola_e` and is not null, in the table associated with the WFS service named `WFS`.

```
<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://
www.example.com/myns"
xmlns:myns="http://www.example.com/myns" xmlns:gml="http://www.opengis.net/gml"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
<wfs:Delete handle="DELETE1" typeName="myns:COLA" >
<ogc:Filter>
          <ogc:And>
            <ogc:And>
                <ogc:PropertyIsGreaterThan>
                        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
                        <ogc:Literal> 3 </ogc:Literal>
                </ogc:PropertyIsGreaterThan>
                <ogc:PropertyIsEqualTo>
                        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
                        <ogc:Literal> cola_e </ogc:Literal>
                </ogc:PropertyIsEqualTo>
            </ogc:And>
            <ogc:Not>
                <ogc:PropertyIsNull>
                        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
                </ogc:PropertyIsNull>
            </ogc:Not>
          </ogc:And>
```

```
</ogc:Filter>
</wfs:Delete>
</wfs:Transaction>
```

Example 16-16   Delete Response (WFS)

Example 16-16 is the response from the request in Example 16-15.

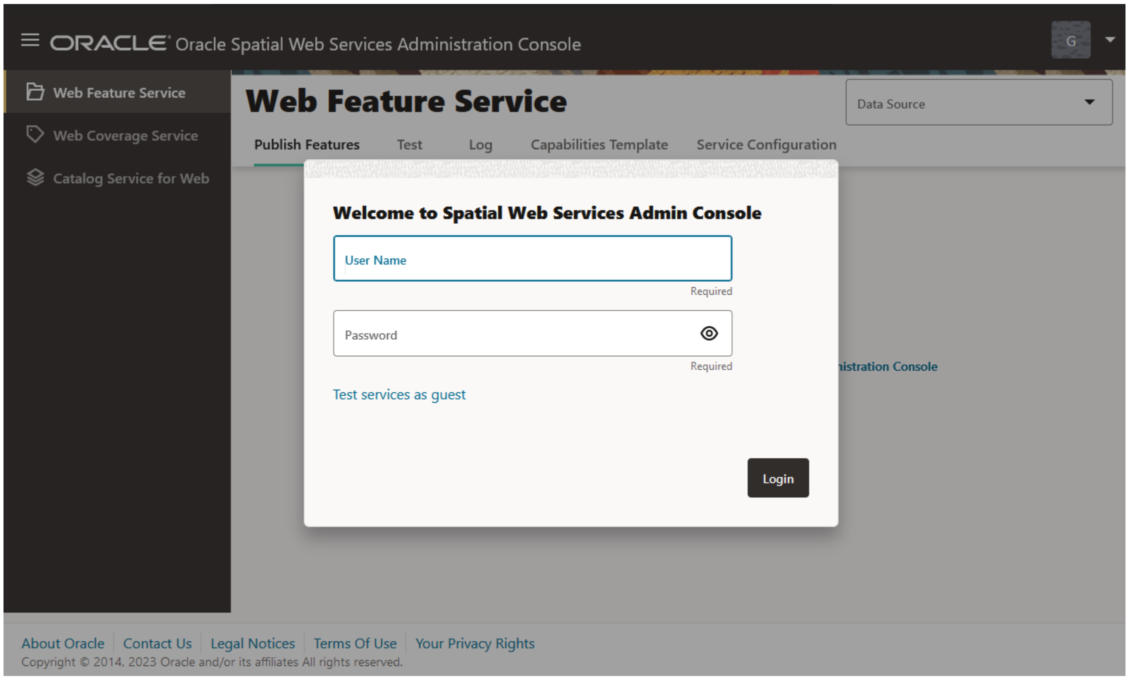
```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
   <wfs:TransactionResult handle="TX01">
      <wfs:Status>
         <wfs:SUCCESS/>
      </wfs:Status>
   </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>
```

16.6 WFS Administration Console

The WFS administration console uses your WebLogic Server credentials.

The following figure shows the administration console page for WFS:

Figure 16-2   WFS Administration Console



Before you use any Oracle Spatial Service page, select a **Data Source** from the list of all available data source names. (The currently selected data source is shown in the upper-right corner, and you can change it there at any time.)

The **Web Feature Service** menu item lets you manage the WFS feature types. It comprises the following tabs:

- **Publish Features:** This allows you to publish/unpublish feature types.

- **Service Configuration:** This allows you to update the `WFSConfig.xml` file.
- **Capabilities Template:** This allows you to update the `GetCapabilities` template.
- **Test:** This allows you to:
  - Get or query features based on spatial and non-spatial constraints
  - Create a new feature instance (an insert operation)
  - Delete a feature instance
  - Update a feature instance
- **Log:** This allows you to check the WFS log files. You can click **Refresh** to see new log messages generated since the screen was loaded. You can also download a specific log file in zip file format.

16.7 Diagnosing WFS Issues

The WFS log files provide diagnostic information.

These log files are located inside the `log` directory of the configuration folder. In the WFS Administration Console, you can use the Log tab for WFS to see and download the WFS log files.

This topic explains some types of log messages and how to deal with them.

"DataSource jdbc/wfs_admin_ds not found" — GetCapabilities response error message

The response may be similar to the following (reformatted for readability):

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport
  xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance"
  xsi:schemaLocation="http://www.opengis.net/ows/2.0 http://schemas.opengis.net/ows/2.0/
owsExceptionReport.xsd" version="2.0.1">
  <ows:Exception exceptionCode="NoApplicableCode" locator="DataSource jdbc/wfs_admin_ds
not found"/>
</ows:ExceptionReport>
```

This means that a WFS data source is not configured or that WebLogic Server cannot connect to the database. See Data Source Setup for the WFS Engine for information about configuring WFS data sources.

Exceptions that indicate the WFS metadata is not populated properly

If you suspect that the WFS metadata may not be populated properly, then connected as a user with sufficient privileges, check that:

- The feature type is published and appears in the MDSYS.WFS_FeatureType$ table. (This table is used by the WFS server.)
- If custom SRS name prefixes are used, the MDSYS.WFS_Srs$ table is populated properly.

Newly published feature type(s) not appearing in any of the responses

If any published feature types are not appearing in any responses, ensure that you have used the SDO_WFS_PROCESS.InsertFtMDUpdated when you published a new feature type.

You can also use the SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema procedure to publish all the feature types in a WFS schema.

16.8 Using WFS with Oracle Workspace Manager

You can use Oracle Workspace Manager to version-enable a WFS table with relational features.

To do so, first register the WFS table using the SDO_WFS_LOCK.RegisterFeatureTable procedure; then execute the DBMS_WM.EnableVersioning procedure. (For information about Workspace Manager, including reference documentation for the DBMS_WM PL/SQL package, see *Oracle Database Workspace Manager Developer's Guide*.)

You can create workspaces and perform transactional WFS changes to these workspaces by using the WFS-T (Web Feature Services transaction) interfaces. However, to use interfaces other than WFS-T, you must use a SQL*Plus session for which database transactions are enabled on the WFS tables. These database transactions include the following:

- Update and delete operations on WFS tables
- Workspace maintenance operations, such as refreshing a workspace or merging workspaces

To enable database transactions on the WFS tables, call the SDO_WFS_LOCK.EnableDBTxns procedure (documented in SDO_WFS_LOCK Package (WFS)). After you execute this procedure, database transactions are permitted on the WFS tables and WFS-T semantics are maintained for WFS transactions, until the end of the session.

16.9 Dropping WFS Support (Release 21c or Later Only)

(This topic applies only to release 21c or later; it does not apply to release 19c or earlier.)

To delete all WFS metadata from a schema, execute the following command:

```
execute mdsys.sdo_wfs_process.dropMetadata;
```

This removes the WFS instance associated with that database schema.

16.10 Updating a WFS Instance from an Oracle Database for a Release Before 21c to Release 21c or Later

(This topic applies only to release 21c or later; it does not apply to release 19c or earlier.)

Effective with release 21c, WFS metadata has moved from the MDSYS schema to a user schema. If you have a WFS instance configured with an Oracle Database version before 21c, you must execute the following command after you update your database to version 21c or later:

```
execute mdsys.sdo_wfs_process.migrateMetadataFromMDSYS;
```

This migrates all existing WFS metadata to the new WFS instance in the user schema.

17

Web Coverage Service (WCS) Support

This chapter describes the Oracle Spatial implementation of the Open GIS Consortium (OGC) standard for Web Coverage Service Interface Standard (WCS), which, supports retrieval of “coverages” (according to the OGC, “electronic encoding of geospatial data, that is, digital geospatial information representing space and time-varying phenomena”).

> **Note:**
>
> - You can deploy Oracle Spatial Web Services from Oracle Cloud Marketplace. This packaged application allows you to install Oracle Spatial web services (such as Web Feature Service (WFS), Web Coverage Services (WCS), and Catalog Services for the Web (CSW)) that are deployed in an Apache Tomcat web server instance on Oracle Cloud Infrastructure (OCI).
> - See Deploying and Configuring Spatial Web Services for the installation instructions of Web Coverage Service server.

The Oracle Spatial implementation will be referred to as Web Coverage Service, or WCS.

Web Coverage Service (WCS) enables electronic retrieval of geospatial data as "coverages.” WCS provides data and descriptions, a syntax for querying the data, and the ability to return data on which you can perform various operations (visualize, interpret, extrapolate, and so on). WCS supports the storage of both GridCoverage (GeoRaster object without coordinate reference system) and RectifiedGridCoverage (GeoRaster object with coordinate reference system and georeferenced with an affine transformation) raster types

Oracle Spatial implements the following OGC standards.

- 09-110r4 WCS Core 2.0 Interface Standard - Core.
- 09-146r2 OGC GML Application Schema – Coverages.
- 09-147r3 OGC Web Coverage Service 2.0 Interface Standard – KVP Protocol Binding Extension – Corrigendum.
- 09-148r1 OGC Web Coverage Service 2.0 Interface Standard – XML/POST Protocol Binding Extension.
- 09-149r1 OGC Web Coverage Service 2.0 Interface Standard – XML/SOAP Protocol Binding Extension.
- 11-053r1 OGC Web Coverage Service Interface Standard – CRS Extension
- 12-039 OGC Web Coverage Service Interface Standard – Scaling Extension.
- 12-040 OGC Web Coverage Service Interface Standard – Range Subsetting Extension.
- 12-049 OGC Web Coverage Service Interface Standard – Interpolation Extension.
- 12-052 OGC WCS 2.0.1 Corrigendum Release Notes.
- 12-100r1 OGC GML Application Schema – Coverages – GeoTIFF Coverage Encoding Profile.

Oracle WCS also extends the OGC standards to support all GDAL-supported image or raster features as output format in a GetCoverage request.

> **Note:**
>
> Before you use WCS, be sure that you understand the concepts described in Introduction to Spatial Web Services, and that you have performed any necessary configuration work as described in that chapter.

- Web Coverage Service Architecture
  In Oracle Spatial, WCS is implemented as a Java web application and can be deployed to run in WebLogic 12.1.3 or later.
- Database Schemas for WCS
  For Web Coverage Service purposes, this document refers to Oracle Database schemas that can be user schemas and/or WCS schemas.
- Database Objects Used for WCS
  Several tables and other database objects are used to implement WCS operations.
- PL/SQL Subprograms for Using WCS
  SDO_WCS procedures and functions enable you to perform operations that include the following actions.
- Setting Up WCS Using WebLogic Server
  For setting up WCS, Oracle WebLogic Server (WLS) 12.1.3 or later is required.
- WCS Administration Console
  You can launch the Oracle Spatial Web Services Administration Console web application in your browser using the URL- `http://<system-name>:<port>/oraclespatial/`.
- Oracle Implementation Extension for WCS
  The Oracle WCS extension defines optional elements inside a wcs:Extension element in a WCS request, to let you control the following aspects of request processing.
- WCS Operations: Requests and Responses with XML Examples
  WCS provides three major operations, and each operation has a request and response format.
- WCS Extensions Implemented
  This topic describes the WCS Extensions implemented and gives examples of some elements defined by each extension.
- Diagnosing WCS Issues
  WCS log files provide diagnostic information.

17.1 Web Coverage Service Architecture

In Oracle Spatial, WCS is implemented as a Java web application and can be deployed to run in WebLogic 12.1.3 or later.

The required Java version is JDK 1.8 or later.

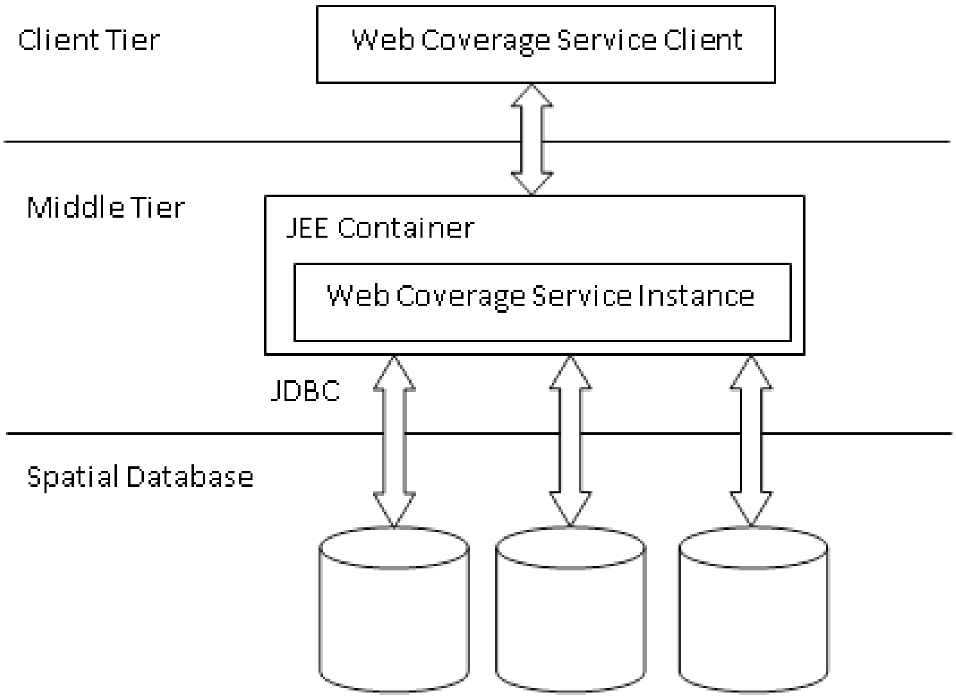
This implementation of WCS is packaged in the Spatial Web Services `sdows.ear` file in the `$ORACLE_HOME/md/jlib` directory. For information about deploying this file, see Deploying and Configuring Spatial Web Services.

WCS implements three protocol binding extensions, KVP (HTTP GET), XML/POST (HTTP/POST), and XML/SOAP. It also uses GDAL to generate image formats supported by GDAL. A GDAL instance must be configured on the same system as the application container where Spatial Web Services is deployed. See Deploying and Configuring Spatial Web Services for GDAL installation instructions.

The SDO_WCS package inside Oracle Database contains procedures to initialize a WCS schema, publish GeoRaster objects as WCS coverages, and process WCS requests.

The following figure shows the WCS architecture.

Figure 17-1   Web Coverage Service Architecture



17.2 Database Schemas for WCS

For Web Coverage Service purposes, this document refers to Oracle Database schemas that can be user schemas and/or WCS schemas.

- A **user schema** is any schema used to store GeoRaster objects.

  In some examples used in this document, the schema of a database user named SCOTT is a user schema.

- A **WCS schema** is any database schema with an SDO_WCS_COVERAGE table, which must be created using the WCS Administration Console or the SDO_WCS.Init procedure. The coverage information is stored in a WCS schema.

  In some examples in this document, the schema of a specially created database user named WCS_USER is the WCS schema.

A given Oracle Database schema can be a user schema, a WCS schema, or both a user schema and a WCS schema.

Each WCS instance requires a WCS schema configured as a JDBC data source in the application container. Generally, only one WCS schema is configured for a specific database, but many WCS instances can be configured for use with the same database.

17.3 Database Objects Used for WCS

Several tables and other database objects are used to implement WCS operations.

In a WCS schema:

- Table SDO_WCS_COVERAGE contains metadata for all published coverages. The metadata includes coverage ID, raster ID, and raster data table. Each row corresponds to a coverage.
- Sequence SDO_WCS_COVERAGE_ID_SEQ is used to generate a unique coverage ID value.

In a user schema:

- Table WCS_TEMP_TABLE is used as a temporary storage for GeoRaster objects when reprojection or transformation is involved when processing a GetCoverage Operation (WCS) request. GeoRaster objects are kept in this table until the response is sent, after which the objects are deleted from the table.
- Table WCS_TEMP_RDT is the raster data table for GeoRaster objects in the WCS_TEMP_TABLE table.

17.4 PL/SQL Subprograms for Using WCS

SDO_WCS procedures and functions enable you to perform operations that include the following actions.

- Initializing a WCS schema.
- Creating temporary tables to store GeoRaster when a reprojection or transformation is needed. (CRS Extension or Scaling Extension.).
- Granting and revoking privileges to WCS schema.
- Publishing coverages
- Dropping (unpublishing) coverages

SDO_WCS.Initcreates the SDO_WCS_COVERAGE table, causing that database schema to become a WCS schema.

SDO_WCS.PublishCoverage has two formats. One format publishes a GeoRaster object as a coverage, stores metadata in SDO_WCS_COVERAGE table, and assigns a unique coverage ID to it. The other format publishes all unpublished GeoRaster objects in a specified column.

SDO_WCS.CreateTempTable should be executed once for each user schema. This procedure creates a GeoRaster table and an RDT table for temporarily storing a GeoRaster object when reprojection or transformation is involved in processing a GetCoverage Operation (WCS) request.

17.5 Setting Up WCS Using WebLogic Server

For setting up WCS, Oracle WebLogic Server (WLS) 12.1.3 or later is required.

This topic uses an example that assumes the following:

- A user schema SCOTT has a table named IMAGE, defined as:

```
CREATE TABLE IMAGE (
   id NUMBER PRIMARY KEY,
   name VARCHAR2(32),
   raster MDSYS.SDO_GEORASTER);
```

- The WCS schema is named WCS_USER.

Setting up the WCS server involves deploying the `sdows.ear` file into WebLogic Server (explained in Deploying and Configuring Spatial Web Services), as well as the following actions.

- Configuring the Database Schemas
- Setting Up WCS Data Sources
- Configuring GDAL for the WCS Server

17.5.1 Configuring the Database Schemas

> **Note:**
>
> If you plan to use the same Oracle Database schema both to store GeoRaster objects and to access them through WCS, skip this section and go to Setting Up WCS Data Sources.

To configure the Oracle Database schemas, follow these steps:

1. Create metadata tables. To do so, use SQL*Plus to connect to Oracle Database as the user that you want to be the WCS user (in this example, a user named WCS_USER), and enter the following:

   ```
   CALL SDO_WCS.init();
   ```

2. Connect as the database user (in this example, SCOTT, which owns a GeoRaster table named IMAGE) that stores GeoRaster objects.

   ```
   connect scott/<password-for-scott>
   CALL SDO_WCS.createTempTable();
   CALL SDO_WCS.grantPrivilegesToWCS('IMAGE','WCS_USER');
   ```

3. Connect as the WCS user (in this example, WCS_USER), and publish the GeoRaster images from a user table containing the desired GeoRaster objects (for example, from the RASTER column in the SCOTT.IMAGES table).

   ```
   connect wcs_user/<password-for-wcs_user>
   CALL SDO_WCS.publishCoverage('SCOTT','IMAGE','RASTER');
   ```

17.5.2 Setting Up WCS Data Sources

Each database can have multiple WCS schemas, each of which corresponds to one data source in WebLogic. You can also have multiple data sources configured for WCS in WebLogic server. Each data source can be accessed through a different URL, where the last part of the URL corresponds to the data source name configured in WebLogic Server.

The following is an example link with a WLS data source named `wcsdata1`:

```
http://localhost:80/oraclespatial/wcs/wcsdata1?service=WCS&
version=2.0.1&request=GetCapabilities
```

You can configure a WCS data source by following the steps explained in Adding a WebLogic Data Source.

17.5.3 Configuring GDAL for the WCS Server

The Oracle WCS implementation can generate any GDAL supported format. You must configure a GDAL instance on the same system as WebLogic Server. The GDAL VRT driver and the GDAL Oracle GeoRaster driver are needed to communicate with the WCS server. (To get GDAL, you can download it from http://www.gdal.org, you can get its Linux and Windows versions from your Oracle Database installation as described in Oracle Spatial GeoRaster Developer's Guide, or you can download it from My Oracle Support using the Patch ID listed in MOS note 2997919.1.)

1. To know if you have the necessary GDAL drivers, execute the following GDAL command:

   ```
   <GDAL_HOME>/bin/gdalinfo --formats
   ```

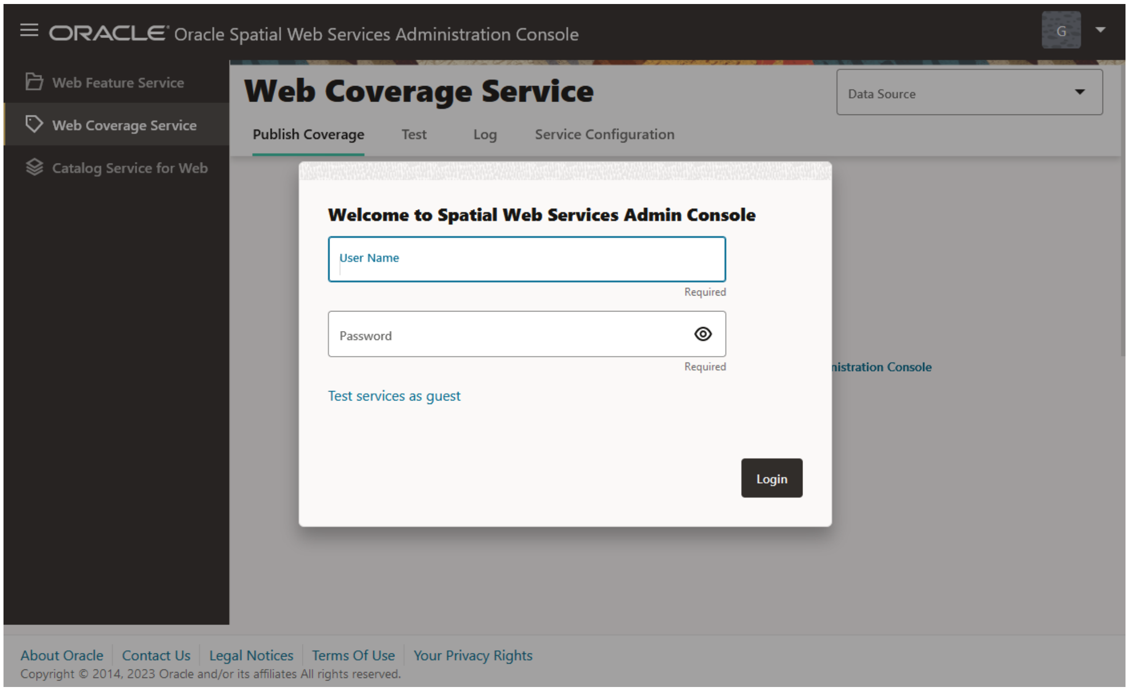
2. Ensure GDAL is available to the running Oracle WebLogic Server by starting the server from a terminal where GDAL is setup or by invoking the `gdal_setup` script from the WebLogic Server `setDomainEnv` script located in your WebLogic domain `bin` folder.
3. Copy `gdal.jar` (located in the `gdal/lib` directory) to the WebLogic Server domain's `lib` directory and restart the server.
4. Configure the GDAL database connection parameters using the Service Configuration tab of the WCS Administration Console.
5. Optionally, specify creation options (`CreationOption`) to GDAL in a GetCoverage Operation (WCS) request.

17.6 WCS Administration Console

You can launch the Oracle Spatial Web Services Administration Console web application in your browser using the URL- `http://<system-name>:<port>/oraclespatial/`.

The following figure shows the administration console page for WCS:

Figure 17-2 WCS Administration Console



Welcome to Spatial Web Services Admin Console

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As seen in the preceding figure, you must provide your **User Name** and **Password** credentials to login to the console. If you do not have the user credentials, then you can use the **Test service as guest** link which opens the test page. You do not need authentication to use the test page. The test page allows you to create OGC requests by showing all available service operation requests. All other pages require you to be authenticated.

Before you can use any administration console page, select a WCS data source from the list of all available data source names. (The currently selected data source is shown in the upper-right corner, and you can change it there at any time.)

The user interface for the WCS administration console allows you to publish coverages, manage configurations, test, and diagnose problems. It comprises the following tabs:

- Publish Coverage
- Test
- Log
- Service Configuration

Publish Coverage Tab

You can publish new coverages using the **Publish Coverage** tab. Note that to use the publish coverage page you need to be an authenticated user with administrator role.

This page shows an HTML table with all GeoRaster objects. You can choose to publish or unpublish individual GeoRaster objects by right-clicking the desired row.

A GeoRaster cannot be published more than once in a WCS instance.

Test Tab

You can send post requests using the **Test** tab. This tab is initially empty, in which case you need to send a `GetCapabilities` request to populate following elements:

- **Operation**: An HTML select element with all operations discovered on last `GetCapabilities` response.
- **Coverage**: An HTML select element which is populated with content of last `GetCapabilities` response. It contains all Coverage IDs from `GetCapabilities` response received.

Create Request: Populates the request test area with a request to the specified operations, coverage IDs, and operation URLs.

Request: A text area whose content will be sent in a post request to the Operation URL. This element can be populated by clicking **Create Request**, and you can edit that request as needed.

Operation URL: The URL where the request is to be sent. This element can be populated by clicking **Create Request**, and you can edit that request as needed.

Send Request: Sends an HTTP post request to the Operation URL using the content of the request. The response of the HTTP post request will be shown in the Response.

Response: A text area populated with the response of a **Send Request** operation.

Log Tab

You can visualize and download WCS log files using the **Log** tab. Log files are generated inside the directory referenced by the `SDOWS_HOME` environment variable. Using this tab requires administrator credentials.

All Oracle WCS log files have file names in the form `wcs_`*`<data_source_name>`*`_`*`n`*`.log`, where *n* is a consecutive number, and for the newest log files *n* is 0 (zero).

This tab shows the content of the `wcs_<data_source_name>_0.log` file, which has the most recent log messages generated by the WCS server. However, you can select other log files to see their contents. You can also refresh the display to include new log messages generated since the page was loaded or last refreshed.

Download lets you download the selected log file in zip format.

Service Configuration Tab

As an administrator, you can configure WCS logging, GDAL parameters, and `GetCapabilities` responses (`ServiceIdentification` and `ServiceProvider`) by modifying the `WCSConfig.xml` file using the **Service Configuration** tab.

You can configure logging attributes such as:

- **Log level:** The logging levels can be `SEVERE`, `WARNING`, `INFO` (default), `CONFIG`, `FINE`, `FINER`, `FINEST`, or `ALL`.
- **Log file size:** Log rotation is supported based on the file size. By limiting the number of files, you can limit how much disk space the log files will take. Log files are generated inside the directory referenced by the `SDOWS_HOME` environment variable, and they have names in the form `wcs_`*`<data_source_name>`*`_`*`n`*`.log`, where `wcs_`*`<data_source_name>`*`_0.log` has the most recent log messages; and when it has

reached its file size limit, the oldest file is removed and all log files are renamed so that `wcs_<data_source_name>_0.log` can be used for the next set of log messages.

- **Log size limit:** This is the file size limit in megabytes (default 10).
- **Log file count:** This denotes the maximum number of log files.

The GDAL database connection is configured using the `gdalParameters` element as follows:

- `<gdalParameters user="<user>" password="!<password>" connectionString="<db_host:port:sid>" temporaryDirectory="<directory>" />`
- The specified user must have privileges to read all GeoRaster objects that are published as coverages. It is recommended that this user be the same as the WCS user.
- The password must be encrypted by the server. You must add an exclamation point (!) character at the beginning of password attribute, to make the server encrypt the password.
- The temporary directory should point to a writable directory to be used by GDAL to generate output files. Example: `/tmp`

To validate that GDAL was properly configured, go to the About tab in the Oracle Spatial Web Services administration console (`http://<host>:<port>/oraclespatial`), which shows the GDAL version if it was properly configured.

`ServiceIdentification` and `ServiceProvider` can be configured by uncommenting the appropriate element and specifying the desired information, complying with the XML schemas at http://schemas.opengis.net/ows/2.0/owsGetCapabilities.xsd.

When you click **Save Changes**, the server applies the changes, and no restart is needed.

17.7 Oracle Implementation Extension for WCS

The Oracle WCS extension defines optional elements inside a wcs:Extension element in a WCS request, to let you control the following aspects of request processing.

- GDAL `CreationOption` in a GetCoverage request
- `CompressResponseFile` in a GetCoverage request

All formats included in your GDAL installation are supported the GetCoverage request. You can see the full list of formats and their names in the Capabilities XML document.

GDAL CreationOption in a GetCoverage Request

This element sends a `-co` parameter to GDAL on GetCoverage requests. Every GDAL driver defines its own creation option parameters.

Examples:

- XML Request:

```
<wcs:GetCoverage xmlns:wcs="http://www.opengis.net/wcs/2.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/2.0 http://
schemas.opengis.net/wcs/2.0/wcsAll.xsd"
  xmlns:ora="http://www.oracle.com/spatial/wcs"
  service="WCS" version="2.0.1">
  <wcs:Extension>
      <ora:CreationOption>WORLDFILE=YES</ora:CreationOption>
  </wcs:Extension>
  <wcs:CoverageId>C0005</wcs:CoverageId>
  <wcs:format>image/jpeg</wcs:format>
</wcs:GetCoverage>
```

- KVP Request:

```
http://.../oraclespatial/wcs?
service=WCS&version=2.0.1&request=GetCoverage&format=image/
jpeg&coverageId=C0005&CO=WORLDFILE=YES
```

CompressResponseFile in a GetCoverage Request

This element compresses the generated image into a zip file.

Examples:

- XML Request:

```
<wcs:GetCoverage xmlns:wcs="http://www.opengis.net/wcs/2.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/2.0 http://
schemas.opengis.net/wcs/2.0/wcsAll.xsd"
  xmlns:ora="http://www.oracle.com/spatial/wcs"
  service="WCS" version="2.0.1">
  <wcs:Extension>
      <ora:CompressResponseFile>true</ora:CompressResponseFile>
  </wcs:Extension>
  <wcs:CoverageId>C0005</wcs:CoverageId>
  <wcs:format>image/jpeg</wcs:format>
</wcs:GetCoverage>
```

- KVP Request:

```
http://.../oraclespatial/wcs?
service=WCS&version=2.0.1&request=GetCoverage&format=image/
jpeg&coverageId=C0005&COMPRESS=YES
```

17.8 WCS Operations: Requests and Responses with XML Examples

WCS provides three major operations, and each operation has a request and response format.

When a client performs any sequence of WCS requests, it should first issue a GetCapabilities request to the server to obtain an up-to-date listing of available data. Then, it may issue a DescribeCoverage request to find out more details about particular coverages offered. To retrieve a coverage or part of a coverage, the client issues a GetCoverage request.

- GetCapabilities Operation (WCS)
- DescribeCoverage Operation (WCS)
- GetCoverage Operation (WCS)

17.8.1 GetCapabilities Operation (WCS)

A GetCapabilities operation allows a WCS client to retrieve service and coverage metadata offered by a WCS server.

All WCS servers must implement KVP protocol for GetCapabilities requests. A user begins interaction with a WCS Server by sending a GetCapabilities request using KVP protocol (HTTP GET request) to the URL. For example:

```
http://host:port/oraclespatial/wcs/<data source name>?service=WCS&request=GetCapabilities
```

A GetCapabilities operation returns an XML document describing the service and brief descriptions of the coverages that clients can request. Clients would generally run the GetCapabilities operation and cache its result for use throughout a session, or reuse it for multiple sessions.

GetCapabilities response includes the following:

- WCS response version. If the request does not specify the desired response version, the server returns latest version supported.
- The profile list of the `ServiceIdentification` identifies an OGC Interface Standard conformance class.
- Operation elements in `OperationsMetadata` contain the URL for each WCS operation of each protocol. Each WCS operation of each WCS protocol might have a different URL.
- `formatSupported` elements in `ServiceMetadata` list all available output formats by a GetCoverage request. This list includes GDAL-supported formats when configured. For example:

  ```
  <wcs:ServiceMetadata>
    <wcs:formatSupported>image/tiff</wcs:formatSupported>
    <wcs:formatSupported>image/jp2</wcs:formatSupported>
    <wcs:formatSupported>application/x-ogc-nitf</wcs:formatSupported>
    <wcs:formatSupported>application/x-ogc-aaigrid</wcs:formatSupported>
    <wcs:formatSupported>image/png</wcs:formatSupported>
    <wcs:formatSupported>image/jpeg</wcs:formatSupported>
  </wcs:ServiceMetadata>
  ```

- Extension elements allow WCS extension standards to define their individual extra service metadata. This element includes 16.8.2 12-039 OGC Web Coverage Service Interface Standard – Scaling Extension elements like: nearest-neighbor, bilinear, biquadratic, ... It also includes 16.8.1 11-053r1 OGC Web Coverage Service Interface Standard – CRS Extension includes crsSupported elements.
- The list of coverages offered by this server includes a coverage ID, which is a unique identifier used in DescribeCoverage and GetCoverage operation requests and the coverage subtype.

17.8.2 DescribeCoverage Operation (WCS)

A DescribeCoverage operation lets clients request detailed metadata for one or more coverages offered by a WCS server, and it provides an estimate of the amount of data to be expected in the domain and range set. A DescribeCoverage request provides a list of coverage identifiers and prompts the server to return, for each identifier, a description of the corresponding coverage. The following is an XML/POST DescribeCoverage request example:

```
<wcs:DescribeCoverage xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xmlns:wcs="http://www.opengis.net/wcs/2.0"
        xsi:schemaLocation="http://schemas.opengis.net/wcs/2.0 ../wcsAll.xsd"
service="WCS"
        version="2.0.1">
  <wcs:CoverageId>C0001</wcs:CoverageId>
  <wcs:CoverageId>C0002</wcs:CoverageId>
  ...
</wcs:DescribeCoverage>
```

The DescribeCoverage response contains a list of coverage metadata, one for each coverage identifier passed in the request. Coverage metadata is an XML document of type `gml:Grid` for

`GridCoverages`, and of type `gml:rectifiedGrid` for `RectifiedGridCoverages`. The xsd schemas for those documents can be found in http://schemas.opengis.net/wcs/2.0/.

The `gml:Grid` element implicitly defines a grid, which is a network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way. The region of interest within the grid is given in terms of its `gml:limits`, being the grid coordinates of diagonally opposed corners of a rectangular region. `gml:axisLabels` is provided with a list of labels of the axes of the grid (`gml:axisName` has been deprecated). `gml:dimension` specifies the dimension of the grid.

The `gml:limits` element contains a single `gml:GridEnvelope`. The `gml:low` and `gml:high` property elements of the envelope are lists of integers, which are coordinate tuples. The coordinates are measured as offsets from the origin of the grid, along each axis, of the diagonally opposing corners of a "rectangular" region of interest.

A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system. It is defined by specifying the position (in some geometric space) of the grid "origin" and of the vectors that specify the post locations.

Note that the grid limits (post indexes) and axis name properties are inherited from `gml:GridType`, and that `gml:RectifiedGrid` adds a `gml:origin` property (contains or references a `gml:Point`) and a set of `gml:offsetVector` properties.

17.8.3 GetCoverage Operation (WCS)

A GetCoverage operation is normally run after GetCapabilities and DescribeCoverage operation responses have shown what requests are allowed and what data is available. The GetCoverage operation returns a coverage (that is, values or properties of a set of geographic locations) encoded in a well-known coverage format.

A GetCoverage request prompts a WCS service to process a particular coverage selected from the service’s offering and return a derived coverage.

The WCS Core standard defines the *domain subsetting* operation, which delivers all data from a coverage inside a specified request envelope (“bounding box”), relative to the coverage’s envelope – more precisely, the intersection of the request envelope with the coverage envelope.

Domain subsetting is subdivided into *trimming* and *slicing*. A trim operation identifies a dimension and a lower and upper bound (which both must lie inside the coverage’s domain) and delivers a coverage whose domain, in the dimension specified, is reduced to these new, narrower limits. The resulting coverage’s dimension is identical to that of the input coverage. The following is an example of a `DimensionTrim` element:

```
<wcs:DimensionTrim>
  <wcs:Dimension>N</wcs:Dimension>
  <wcs:TrimLow>8.16270027015798</wcs:TrimLow>
  <wcs:TrimHigh>8.34362402047258</wcs:TrimHigh>
</wcs:DimensionTrim>
```

A domain slice operation receives a dimension and a position (which must lie inside the coverage’s domain) and delivers a coverage that is a slice of the offered coverage obtained at the cutting position specified. The dimension of the resulting coverage is reduced by one as compared to the original coverage.

Both trimming and slicing can be combined in a request and on as many dimensions as desired. However, in any request, at most one operation can be applied per dimension. The following is an example of a `DimensionSlice` element:

```
<wcs:DimensionSlice>
  <wcs:Dimension>N</wcs:Dimension>
  <wcs:SlicePoint>8.16270027015798</wcs:SlicePoint>
</wcs:DimensionSlice>
```

The encoding format in which the coverage will be returned is specified by the combination of format and mediaType elelemts. The formats supported are those listed in the server's Capabilities document, and the default is either `application/gml+xml` or `image/jpeg` if GDAL is configured. For example:

```
<wcs:format>image/jpeg</wcs:format>
<wcs:mediaType>multipart/related</wcs:mediaType>
```

17.9 WCS Extensions Implemented

This topic describes the WCS Extensions implemented and gives examples of some elements defined by each extension.

It concludes with a GetCoverage request example that includes all the extensions.

11-053r1 OGC Web Coverage Service Interface Standard – CRS Extension

This WCS CRS Extension defines how to request and obtain a coverage in CRSs different from the Native CRS, and also how to provide a subsetting bounding box with coordinates in a CRS different from the Native CRS. A WCS server supporting this WCS CRS Extension announces the CRSs supported by listing their CRS Identifiers in its Capabilities document. For example:

```
<wcscrs:subsettingCrs>http://www.opengis.net/def/crs/EPSG/0/4326</wcscrs:subsettingCrs>
<wcscrs:outputCrs>http://www.opengis.net/def/crs/EPSG/0/4326</wcscrs:outputCrs>
```

112-039 OGC Web Coverage Service Interface Standard – Scaling Extension

This extension allows scaling of a coverage along one or more of its axes during its server-side processing in a GetCoverage request. For example:

```
<scal:ScaleByFactor>
 <scal:axis>E</scal:axis>
  <scal:scaleFactor>0.5</scal:scaleFactor>
</scal:ScaleByFactor>
```

112-040 OGC Web Coverage Service Interface Standard – Range Subsetting Extension

This extension allows extraction of specific fields, according to the range type specification, from the range set of a coverage during server-side processing of a coverage in a GetCoverage request. For example:

```
<rsub:RangeSubset>
    <rsub:RangeItem>
        <rsub:RangeComponent>band1</rsub:RangeComponent>
    </rsub:RangeItem>
    <rsub:RangeItem>
        <rsub:RangeInterval>
            <rsub:startComponent>band3</rsub:startComponent>
            <rsub:endComponent>band5</rsub:endComponent>
        </rsub:RangeInterval>
    </rsub:RangeItem>
</rsub:RangeSubset>
```

112-049 OGC Web Coverage Service Interface Standard – Interpolation Extension

This extension gives control over interpolation of a coverage during its server-side processing.

This allows the WCS client to control and specify the interpolation mechanism to be applied to a coverage during server processing. For example:

```
<int:Interpolation>
  <int:globalInterpolation>
    http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
  </int:globalInterpolation>
</int:Interpolation>
```

112-100r1 OGC GML Application Schema – Coverages – GeoTIFF Coverage Encoding Profile

This encoding profile specifies the usage of the GeoTIFF data format for the encoding of GML coverages. For example:

```
<wcs:format>image/tiff</wcs:format>
```

Example Showing All Extensions

The following is an example of a GetCoverage request example with all extensions included:

```
<wcs:GetCoverage xmlns:wcs="http://www.opengis.net/wcs/2.0"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wcs/2.0 http://schemas.opengis.net/wcs/2.0/
wcsAll.xsd"
  xmlns:scal="http://www.opengis.net/wcs/scaling/1.0"
  xmlns:wcscrs="http://www.opengis.net/wcs/service-extension/crs/1.0"
  xmlns:rsub="http://www.opengis.net/wcs/rangesubsetting/1.0"
  xmlns:int="http://www.opengis.net/wcs/interpolation/1.0"
  service="WCS" version="2.0.1">
  <wcs:Extension>
    <wcscrs:subsettingCrs>http://www.opengis.net/def/crs/EPSG/0/4326</
wcscrs:subsettingCrs>
    <wcscrs:outputCrs>http://www.opengis.net/def/crs/EPSG/0/4326</wcscrs:outputCrs>
    <rsub:RangeSubset>
      <rsub:RangeItem>
        <rsub:RangeComponent>L3</rsub:RangeComponent>
      </rsub:RangeItem>
    </rsub:RangeSubset>
    <int:Interpolation>
      <int:globalInterpolation>
        http://www.opengis.net/def/interpolation/OGC/1/nearest-neighbor
      </int:globalInterpolation>
    </int:Interpolation>
    <scal:ScaleByFactor>
      <scal:scaleFactor>0.5</scal:scaleFactor>
    </scal:ScaleByFactor>
  </wcs:Extension>
  <wcs:CoverageId>C0005</wcs:CoverageId>
  <wcs:DimensionSlice>
    <wcs:Dimension>N</wcs:Dimension>
    <wcs:SlicePoint>8.16270027015798</wcs:SlicePoint>
  </wcs:DimensionSlice>
  <wcs:DimensionTrim>
    <wcs:Dimension>E</wcs:Dimension>
    <wcs:TrimLow>112.990337346209</wcs:TrimLow>
    <wcs:TrimHigh>113.028655200765</wcs:TrimHigh>
  </wcs:DimensionTrim>
  <wcs:format>image/tiff</wcs:format>
  <wcs:mediaType>multipart/related</wcs:mediaType>
</wcs:GetCoverage>
```

17.10 Diagnosing WCS Issues

WCS log files provide diagnostic information.

In the WCS Administration Console , the **Service Configuration** tab lets you configure logging, and the **Log** tab lets you visualize and download WCS log files.

This topic explains some error messages and how to deal with them.

“DataSource jdbc/wcs_admin_ds not found” GetCapabilities response error message

An OWS error response may be like the following (reformatted here for readability):

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport
  xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance"
  xsi:schemaLocation="http://www.opengis.net/ows/2.0 http://schemas.opengis.net/ows/2.0/
owsExceptionReport.xsd" version="2.0.1">
  <ows:Exception exceptionCode="NoApplicableCode" locator="DataSource jdbc/wcs_admin_ds
not found"/>
</ows:ExceptionReport>
```

This means that a WCS data source is not configured or that WebLogic Server cannot connect to the database. Setting Up WCS Data Sources for information about configuring WCS data sources.

“INFO: GDAL was not found” message in WCS log file shown every time WebLogic Server starts

If no GDAL supported formats are needed, you can ignore this message. This message indicates that gdal.jar not found in the WebLogic Server libraries or that the LD_LIBRARY_PATH not properly configured.

- If `java.lang.NoClassDefFoundError: org/gdal/gdal/gdal` appears in the WCS log, then the `gdal.jar` file was not found.
- If `java.lang.UnsatisfiedLinkError: org.gdal.gdal.gdalJNI.GetDriverCount()I` appears in the WCS log, then the `libgdal.so` file was not found in LD_LIBRARY_PATH.

For more information, see Configuring GDAL for the WCS Server

GDALParameter error response

An error message like the following is generated when GDAL is not properly configured:

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.opengis.net/ows/2.0
http://schemas.opengis.net/ows/2.0/owsExceptionReport.xsd" version="2.0.1">
  <ows:Exception exceptionCode="NoApplicableCode" locator="GDALParameters">
    <ows:ExceptionText>...</ows:ExceptionText>
  </ows:Exception>
</ows:ExceptionReport>
```

The error indicates that the GDAL database connection parameters are not correct. See the **Service Configuration** tab in the WCS Administration Console

Database connection error

The following message in the WCS log means that the database is not running:

```
SEVERE: Error discovering coverages
java.sql.SQLRecoverableException: No more data to read from socket
```

“Error reading log file” message on WCS administration console Log tab

If an authenticated user does not interact with the WCS server administration console for a given period of time, the user session in the browser might have timed out. In this case, refresh the browser display, and re-authenticate to get a new session.

Document received does not conform with protocol syntax

An error message like the following indicates that the request contains XML elements or character elements that are not defined in any OGC specification:

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.opengis.net/ows/2.0
http://schemas.opengis.net/ows/2.0/owsExceptionReport.xsd" version="2.0.1">
  <ows:Exception exceptionCode="InvalidEncodingSyntax" locator="asdc">
    <ows:ExceptionText>Document received does not conform with protocol syntax.</
ows:ExceptionText>
  </ows:Exception>
</ows:ExceptionReport>
```

18

Catalog Services for the Web (CSW) Support

Oracle Spatial provides an implementation of version 2.0.2 of the Open GIS Consortium specification for catalog services for the web.

> **Note:**
>
> - You can deploy Oracle Spatial Web Services from Oracle Cloud Marketplace. This packaged application allows you to install Oracle Spatial web services (such as Web Feature Service (WFS), Web Coverage Services (WCS), and Catalog Services for the Web (CSW)) that are deployed in an Apache Tomcat web server instance on Oracle Cloud Infrastructure (OCI).
> - See Deploying and Configuring Spatial Web Services for the installation instructions of Catalog Service for the web server.

According to this specification: "Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Metadata in catalogues represent resource characteristics that can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to registered information resources within an information community."

The Oracle Spatial implementation will be referred to as Catalog Services for the Web, or CSW.

> **Note:**
>
> Effective with Release 18.1, the Oracle Spatial implementation of CSW supports CSW data that uses either of the following record types (metadata profiles):
>
> - DCMI (Dublin Core Metadata Initiative)
> - ISO (ISO standard 19139)
>
> You specify the record type for your CSW data in the `csw_xsd_id` parameter value (`1` for DCMI, `2` for ISO) in the call to the SDO_CSW.INITIALIZE_CSW procedure.
>
> For more information about using each record type, see CSW Major Operations (DCMI Profile) and CSW Major Operations (ISO Profile).

Before you use CSW, be sure that you understand the concepts described in Introduction to Spatial Web Services, and that you have performed any necessary configuration work as described in that chapter.

- CSW Engine and Architecture
  This topic describes CSW, including its relationship to clients and to the database server.

- Database Schema and Objects for CSW
  A CSW schema is any user schema that is used to store CSW records. In some examples used in this document, the schema of a database user named SCOTT or MDMETT is a CSW schema.
- Configuring and Deploying the CSW Engine
  This topic focuses on configuring and deploying Catalog Services for the Web, specifically CSW 2.0.2.
- Capabilities Documents (CSW)
  A client can get information about the server’s capabilities.
- CSW Major Operations (DCMI Profile)
  This topic covers loading and querying CSW data, and provides examples of requests and responses for various operations. It applies to using CSW data using the DCMI record type.
- CSW Major Operations (ISO Profile)
  This topic covers loading and querying CSW data, and provides examples of requests and responses for various operations. It applies to using CSW data using the ISO record type.
- CSW Administration Console
  The Oracle Spatial Web Services administration console includes a CSW administration page.
- Diagnosing CSW Issues
  The CSW log files provide diagnostic information.

18.1 CSW Engine and Architecture

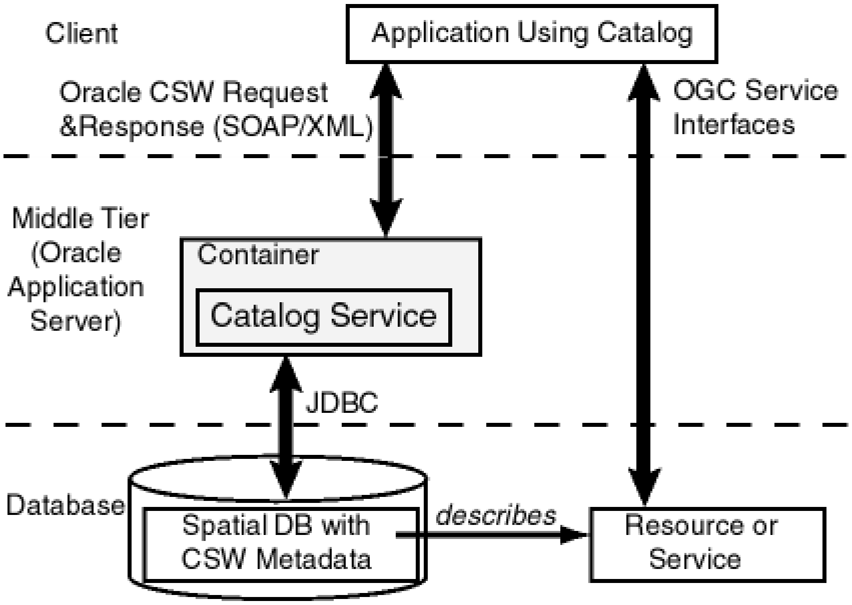
This topic describes CSW, including its relationship to clients and to the database server.

CSW is implemented as a Java web application and can be deployed in WebLogic 12.1.3 or later. The required Java version is JDK 1.8 or later.

CSW has a metadata layer, which stores in the database the metadata needed to reply to catalog requests. The metadata includes spatial columns, which can be queried and processed using Oracle Spatial interfaces. The metadata also stores the association of nonspatial and spatial attributes of records, as well as the services that the catalog service provides to its clients.

Figure 18-1 shows the CSW architecture.

Figure 18-1 CSW Architecture



As shown in Figure 18-1:

- CSW is part of a container in the middle tier.
- CSW can communicate with a web service client using CSW requests and responses in SOAP/XML/KVP format.
- CSW performs spatial data and metadata access through JDBC calls to the database.
- The database includes Oracle Spatial with CSW metadata and data.

18.2 Database Schema and Objects for CSW

A CSW schema is any user schema that is used to store CSW records. In some examples used in this document, the schema of a database user named SCOTT or MDMETT is a CSW schema.

A CSW database instance stores CSW catalog records in a CSW schema. The CSW web service instance requires one or more CSW schemas configured as a JDBC data source in the application container, with each CSW schema corresponding to one data source in Oracle WebLogic Server. Normally, only one CSW schema is configured for a specific database, but many CSW web services can be configured for use with the same database using different CSW schemas.

Oracle Spatial provides the view USER_SDO_CSW_SERVICE_INFO, which contains CSW metadata for the supported CSW `recordType`. The USER_SDO_CSW_SERVICE_INFO view contains the following columns:

```
CSW_VERSION     VARCHAR2(20),
CSW_XSD_ID      NUMBER,
CSW_TABLE_NAME  VARCHAR2(80)
```

You can examine the CSW_XSD_ID column value in this view to find out the CSW `recordType` used by your CSW schema: `1` for DCMI or `2` for ISO. (For more information about using each record type, see CSW Major Operations (DCMI Profile) and CSW Major Operations (ISO Profile).)

The SDO_CSW PL/SQL package enables you to perform CSW instance creation and other operations. It includes CSW initialization, and allows you to create and maintain Spatial and XQFT indexes. For reference information about the subprograms, see SDO_CSW Package (Catalog Services for the Web).

18.3 Configuring and Deploying the CSW Engine

This topic focuses on configuring and deploying Catalog Services for the Web, specifically CSW 2.0.2.

Be sure that you have previously performed any necessary operations described in Deploying and Configuring Spatial Web Services.

The CSW APIs enable you to perform operations that include:

- Specifying information about record type domains and record view transformations
- Populating the USER_SDO_CSW_SERVICE_INFO table for DCMI (Dublin Core Metadata Initiative) or ISO records
- Unpublishing record types by dropping them from the USER_SDO_CSW_SERVICE_INFO table
- Granting to users and revoking from users privileges on CSW record types and on the XML query full text context index

Configuring the CSW engine involves the following:

- Initializing CSW
- Setting Up CSW Data Sources
- Editing the CSWConfig.xml File
- Loading Data for CSW
- Testing the CSW Deployment
- Creating and Maintaining Spatial and XQFT Indexes

Initializing CSW

Before initializing CSW, the following privileges should be granted to the CSW schema. Here, the schema of a database user named MDMETT is a CSW schema.

```
GRANT CONNECT, RESOURCE, UNLIMITED TABLESPACE, CTXAPP TO MDMETT;
GRANT EXECUTE ON CTXSYS.CTX_DDL TO MDMETT;
GRANT SELECT ON MDSYS.SDO_XSD_TABLE TO MDMETT;
GRANT SELECT,ALTER ON MDSYS.md_identifier_sq$ TO MDMETT;
```

To use Catalog Services for the Web in Oracle Spatial, you must call the SDO_CSW.INITIALIZE_CSW procedure to initialize the CSW 2.0.2 service. This procedure creates the user table if it does not already exist, and prepares the indexes. For example:

```
DECLARE
BEGIN
sdo_csw.initialize_csw(
  'MDMETT',
  '2.0.2', -- must be 2.0.2
  1, -- for DCMI
  'MY_CSW_CATALOG_TABLE',
  4326,
  1
  );
  END;
  /
```

If the CSW database instance is not instantiated, you can call the SDO_CSW.INITIALIZE_CSW procedure, which initializes a CSW schema and creates the CSW catalog table and appropriate indexes if they do not exist. For example, the preceding example will enable the MDMETT schema as the CSW schema, create the MY_CSW_CATALOG_TABLE table as the CSW catalog table, and create (spatial and XML Query Full Text) indexes on it.

The SDO_CSW.INITIALIZE_CSW procedure can also be used to just register the CSW schema and catalog table if the CSW catalog table and necessary indexes already exist. For details and examples, see the SDO_CSW.INITIALIZE_CSW reference topic.

Setting Up CSW Data Sources

After the CSW schema is created, set up a data source for the CSW engine in Oracle WebLogic Server following the instructions as explained in Adding a WebLogic Data Source.

> **Note:**
>
> Each database can have multiple CSW schemas, each of which corresponds to one data source in WebLogic Server. You can also have multiple data sources configured for CSW in WebLogic Server. Each data source can be accessed through a different URL, where the last part of the URL correspond to the data source name configured in WebLogic Server. The following is an example link with a CSW data source named `cswdata1`:
>
> ```
> http://localhost:80/oraclespatial/csw/cswdata1?service=CSW&
> version=2.0.2&request=GetCapabilities
> ```

Editing the CSWConfig.xml File

You may need to modify some or all of the following settings using the CSW Administration Console:

- `log_level`, which accepts the following values (reflecting increasing amounts of information to be stored in the log file): `OFF`, `SEVERE`, `WARNING`, `INFO` (the default), `CONFIG`, `FINE`, `FINER`, `FINEST`, and `ALL`.
- `size_limit`, an integer that specifies an approximate maximum amount of megabytes to write to any log file before creating a new file for log rotation. If `size_limit` is 0 (zero), there is no limit. The default value is 10.
- `file_count`, which specifies how many output files to cycle through. Older log files will be deleted to limit the disk space taken by log files. The default value is 10.
- `ServiceIdentification` and `ServiceProvider`, which provide appropriate content to deliver in CSW GetCapabilities responses. If these two values are required to be different than the default values provided by the Oracle Spatial CSW service, then they must be

uncommented and edited as required in order to have the correct information returned in CSW GetCapabilities responses. If this section remains commented, default content will be delivered on the client side.

Loading Data for CSW

A client-side Java loader, provided by Oracle Spatial, is in the following .jar file (assuming the default Spatial installation directory of `$ORACLE_HOME/md`):

```
$ORACLE_HOME/md/jlib/sdocswloader.jar
```

After the CSW schema is initialized, you can use the `sdocswloader.jar` Java package to load CSW 2.0.2 data. This package takes a large file containing CSW XML records and loads them into the user CSW table. For information about how to use this package, see Loading CSW 2.0.2 Data (DCMI) for the DCMI profile and Loading CSW 2.0.2 Data (ISO) for the ISO profile.

Testing the CSW Deployment

After the CSW engine is deployed and the data source is created, you can test the deployment with a set of CSW engine test queries. The following example is a GetCapabilities query for CSW 2.0.2:

```
http://machine-name:port/oraclespatial/csw/<data source name>?
request=GetCapabilities&service=CSW&version=2.0.2
```

Creating and Maintaining Spatial and XQFT Indexes

In some cases you may need to manually create or maintain spatial and XML Query Full Text (XQFT) indexes. These indexes are created automatically (if they do not already exist) by the first format of the SDO_CSW.INITIALIZE_CSW procedure, in which you do not need to create them. However, in some scenarios you may need to drop and re-create the index, and/or to synchronize the index, such as the following:

- Scenario 1: The spatial index creation did not complete successfully when you used the SDO_CSW.INITIALIZE_CSW procedure.
- Scenario 2: The spatial index creation did not complete successfully when you called the SDO_CSW.CREATE_SPATIAL_IDX procedure.
- Scenario 3: The spatial index becomes invalid for any reason, such as mentioned in Exchanging Partitions Including Indexes
- Scenario 4: There have been significant insert, update, or delete operations on the CSW user data table.

If you need to re-create or rebuild the spatial index due to scenario 1, 2, or 3, then you must drop the spatial index first (by using SQL statement `DROP INDEX <index_name> [FORCE]`), and then re-create the spatial index using the SDO_CSW.CREATE_SPATIAL_IDX procedure.

For scenario 4, it is faster to call SDO_CSW.SYNC_INDEX for the XQFT index, in which case the existing XQFT index is automatically updated. However, if you need to re-create the XQFT index, then you can call the SDO_CSW.CREATE_XQFT_IDX procedure to drop the existing XQFT index and then create a new one.

18.4 Capabilities Documents (CSW)

A client can get information about the server’s capabilities.

A capabilities document is generated by the CSW server in response to a GetCapabilities request. The capabilities document contains information extracted from CSW metadata stored in an Oracle database, including a record type and the type of operations supported.

The client can use HTTP GET, POST, and SOAP protocols to access this capabilities document. The following example uses the HTTP protocol:

```
http:///<machine-name:port>/oraclespatial/csw?
request=GetCapabilities&service=CSW&acceptversion=2.0.0&outputFormat=text/xml
```

In the preceding formats:

- *machine-name* is the name of the system where the application server is running.
- *port* is the port number where the application server is running.
- *oraclespatial* is the web application context root where the Oracle Spatial web services application is mounted.

18.5 CSW Major Operations (DCMI Profile)

This topic covers loading and querying CSW data, and provides examples of requests and responses for various operations. It applies to using CSW data using the DCMI record type.

If your CSW data uses the DCMI (Dublin Core Metadata Initiative) profile, the `recordType` attribute for each record will contain the value `1`.

When you call the SDO_CSW.INITIALIZE_CSW procedure, you specify the record type for your CSW data in the `csw_xsd_id` parameter value (`1` for DCMI, `2` for ISO).

The view USER_SDO_CSW_SERVICE_INFO contains CSW metadata for the supported CSW `recordType`, as explained in Database Schema and Objects for CSW.

- Loading CSW 2.0.2 Data (DCMI)
  After the CSW table is created when you initialize the CSW schema, you can start loading your CSW 2.0.2 data (DCMI records) into this table.
- Querying CSW 2.0.2 Data (DCMI)
  For querying CSW data, the GetCapabilities, DescribeRercord, and GetRecords CSW requests are supported, using the queryable elements described in this topic.
- CSW Operations: Requests and Responses with XML Examples (DCMI)
  This topic presents some requests to the CSW engine, and usually the responses to requests, for the following operations.

18.5.1 Loading CSW 2.0.2 Data (DCMI)

After the CSW table is created when you initialize the CSW schema, you can start loading your CSW 2.0.2 data (DCMI records) into this table.

Oracle Spatial provides a client-side loader for this purpose: `$ORACLE_HOME/md/jlib/sdocswloader.jar` (assuming the default Spatial installation directory of `$ORACLE_HOME/md`):

The `sdocswloader.jar` package can take large files containing CSW XML records and load them into the CSW table. For example, assume that you have three XML files, csw_records1.txt, csw_records2.txt, and csw_records3.txt, which contain many DCMI records. Follow these steps to load them into the CSW table.

1. Create an XML configuration file named `sdo_csw_demo.xml` (or any other name as you wish), as in in the following example.

```
<?xml version='1.0' encoding='windows-1252'?>
<Connection>
  <Driver>Thin</Driver>
  <Hostname>localhost</Hostname>
  <Port>52504</Port>
  <ServiceName>SERVICENAME </ServiceName>
  <ServerMode>DEDICATED</ServerMode>
  <Schema>MDMETT</Schema>
  <Password>MDMETT</Password>
  <!-- Requires access to V$MYSTAT and V$SESS_TIME_MODEL -->
  <logServerStats>true</logServerStats>
  <clientSideEncoding>true</clientSideEncoding>
  <!-- SAX : for Splitting Large XML Files into smaller Files -->
  <!-- FOLDER : for walking a client side directory tree loading Files -->
  <mode>SAX</mode>
  <Pool>false</Pool>
  <Namespaces
                xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"/>
  <!-- List of Files to be processed -->
  <FileList>
    <!-- replace the following with full file path names for the records -->
    <File>csw_records1.txt</File>
    <File>csw_records2.txt</File>
    <File>csw_records3.txt</File>
  </FileList>
  <Tables>
    <Table name=”CSW CATALOG TABLE_NAME” path="/root/csw:Record">
        <Column name="XML_COLUMN" path="/root/csw:Record” type="xml"/>
        <Column name="METADATA_ID" path="/root/csw:Record/dc:identifier"
type="string"/>
    </Table>
  </Tables>
    <!-- Each Writer process will commit its workload after this number of inserts --
>
  <CommitCharge>100</CommitCharge>
  <!-- Number of Concurrent Writer Threads -->
  <ThreadCount>10</ThreadCount>
  <!—replace the following with full file path name for the logger -->
  <LogFileName>csw_records.log</LogFileName>
  <ErrorTable>CSW_ERROR_TABLE_NAME</ErrorTable>
  <schemaInstancePrefix>xsi</schemaInstancePrefix>
  <schemaLocation/>
  <noNamespaceSchemaLocation/>
</Connection>
```

This configuration file allows the loader to process the DCMI records with DCMI namespaces.

The `username` parameter in this file refers to the CSW schema name.

The `Table` name is the CSW table that you would like to populate; the first `Column` name is the column where you have the records to be stored as Oracle XMLType objects in the

CSW table, and the second `Column` name is the column where you want the record ID values to be stored in the CSW table.

> **Note:**
>
> If the table and the log directory do not exist, do the following before running XMLLoader (in the next major step):
>
> a. Create a CSW_ERROR_TABLE_NAME in the CSW schema, to contain a log of errors. For example: `CREATE TABLE CSW_ERROR_TABLE of XMLTYPE;`
>
> b. Create a directory named `log` where the `csw_records.log` file will be created.

2. Create a `runXMLLoader.sh` (for Linux) or `runXMLLoader.bat` (for Windows) file, as shown in the following examples:

   - Linux: `runXMLLoader.sh`

     ```
     PATH=$ORACLE_HOME/jdk/bin:$PATH
     java -Xmx2048M -classpath "$ORACLE_HOME/md/jlib/
     sdocswloader.jar:$ORACLE_HOME/lib/xmlparserv2.jar:$ORACLE_HOME/jdbc/lib/
     ojdbc8.jar:$ORACLE_HOME/rdbms/jlib/xdb8.jar" -
     Doracle.spatial.xmlloader.ConnectionParameters= /mydir/sdo_csw_demo.xml
     oracle.spatial.xmlloader.saxLoader.XMLLoader
     ```

   - Windows:`runXMLLoader.bat`

     ```
     set ORACLE_HOME=e:\app\oracle\product\12.2.0\dbhome_1
     set PATH=%ORACLE_HOME%\jdk\bin;%PATH%
     java -cp %CD%\XMLLoader.jar;%ORACLE_HOME%\lib\xmlparserv2.jar;%ORACLE_HOME%
     \jdbc\lib\ojdbc8.jar;%ORACLE_HOME%\jdbc\lib\ojdbc8dms.jar;%ORACLE_HOME%
     \rdbms\jlib\xdb8.jar -Doracle.spatial.xmlloader.ConnectionParameters=%1
     oracle.spatial.xmlloader.saxLoader.XMLLoader
     ```

   These files use the `sdo_csw_demo.xml` file, and they assume JDK 1.8. You may need to modify the files if you have another Java environment, and you may need to make other changes to the configuration file and related script files for your system environment.

In this example scenario, the CSW table is populated with the records in the three CSW 2.0.2 data files when `runXMLLoader.sh` or `runXMLLoader.bat` is run.

18.5.2 Querying CSW 2.0.2 Data (DCMI)

For querying CSW data, the GetCapabilities, DescribeRercord, and GetRecords CSW requests are supported, using the queryable elements described in this topic.

The following table lists the queryable elements for querying CSW data that is in DCMI format. For each query element, the DCMI name of the element it listed along with a brief description.

Table 18-1 Queryable Elements for DCMI

DCMI Name	Description
csw:AnyText	A target for full-text search of character data types in a catalogue
dc:contributor	An entity responsible for making contributions to the content of the resource.
dc:coverage	The spatial or temporal topic of the resource, the spatial applicability of the resource, or the jurisdiction under which the resource is relevant.

Table 18-1 (Cont.) Queryable Elements for DCMI

DCMI Name	Description
dc:creator	An entity primarily responsible for making the content of the resource.
dc:date	A date of a creation or update event of the metadata resource.
dc:description	An account of the resource.
dc:format	The physical or digital manifestation of the resource.
dc:identifier	An unambiguous reference to the resource within a given context.
dc:language	A language of the intellectual content of the resource.
dc:publisher	An entity responsible for making the resource available. This would equate to the Distributor in ISO and FGDC metadata.
dc:relation	A reference to a related resource.
dc:rights	Information about rights held in and over the resource
dc:source	A reference to a resource from which the present resource is derived.
dc:subject	A topic of the content of the resource. This is a place where a Topic Category or other taxonomy could be applied.
dc:title	A name given to the resource. Also known as “Name”.
dc:type	The nature or genre of the content of the resource.
dct:abstract	An account of the content of the resource. This is also known as the “Abstract” in other aspects of OGC, FGDC, and ISO metadata.
dct:modified	Date on which the resource was last changed
dct:spatial	The spatial extent or scope of the content of the resource.
ows:BoundingBox	Bounding Box

The queryable elements that can be used in a csw:Constraint element with a cws:ElementName or csw:ElementSetName element can be grouped into the following modes:

- **Brief** (Brief mode as specified in the OGC CSW 2.0.2 specification)
- **Summary** (Summary mode as specified in the OGC CSW 2.0.2 specification)
- **Full** (Always returns the full original DCMI record)

The csw:ElementySetName element specifies a mode (`brief`, `summary`, or `full`); the csw:ElementName element does not specify a mode, but just the name of a queryable element.

The **Brief** mode queryable elements are the following:

```
dc:identifier
dc:title
dc:type
ows:BoundingBox
```

The **Summary** mode queryable elements are the following:

```
dc:format
dc:identifier
dc:relation
dc:subject
dc:title
dc:type
dct:abstract
```

```
dct:modified
ows:BoundingBox
```

The **Full** mode queryable elements are any supported in the OGC specification and in the Brief and Summary modes. What distinguishes Full mode is that the query always returns the full original DCMI record, whereas the other modes return only the elements specified in the csw:Constraint element.

The **Full** mode queryable elements are the following:

```
csw:AnyText
dc:contributor
dc:coverage
dc:creator
dc:date
dc:description
dc:format
dc:identifier
dc:language
dc:publisher
dc:relation
dc:rights
dc:source
dc:subject
dc:title
dc:type
dct:abstract
dct:modified
dct:spatial
ows:BoundingBox
```

Usage notes about ISO Queryables and some special cases:

- gmd:date queryable is the same as gmd:modified queryable. Use either one in CSW request. gmd:date.
- gmd:format and gmd:formatVersion: ElementName mode considers the path with distributionFormat node. Summary, Comprehensive, and Full ElementSetName mode considers also the distributorFormat node. Brief mode does not have these queryables.
- gmd:hasSecurityConstraints queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): unclassified, restricted, confidential, secret, topSecret.
- gmd:keywordType queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): discipline, place, stratum, temporal, theme.
- gmd:referenceSystem: This is a union set queryable with referenceSystem, code, codeSpace, and version queryables. Use one of referenceSystem (also alias for code queryable), code, codeSpace, or version queryable in the csw:ElementName element of the CSW request, then all of these will appear in the response if they exist in the result set of ISO records (thus, the “related to” explanations). The csw:Constraint element can have any of these queryables.
- gmd:spatialResolution: This is also a union set queryable with spatialResolution, denominator, distance, and distanceUOM queryables. Use one of spatialResolution (also alias for denominator queryable), denominator, distance, or distanceUOM in the csw:ElementName element of the CSW request, then all of these will appear in the response if they exist in the results of ISO records (thus, the “related to” explanations). The csw:Constraint element can have any of these queryables.

- gmd:topicCategory queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): farming, biota, boundaries, climatologyMeteorologyAtmosphere, economy, elevation, environment, geoscientificInformation, health, imageryBaseMapsEarthCover, intelligenceMilitary, inlandWaters, location, oceans, planningCadastre, society, structure, transportation, and utilitiesCommunication.
- ogc:Not logic is only supported for csw:Constraint/ogc:Filter/ogc:Not/ogc:PropertyIsLike.
- PropertyIsNull is not supported for revisionDate, publicationDate, creationDate, contributor, creator, or publisher queryables.
- srv:operatesOnData: This is also union set queryable with operatesOn, operatesOnIdentifier, operatesOnName queryables. This is a bit different than the above union sets described: operatesOn is processed different and independent than operatesOnIdentifier and operatesOnName queryables. When operatesOnIndetifier is in csw:ElementSet element of CSW request, then the operatesOnName will appear in the response if it exists in the results of ISO records. Similar argument for operatesOnIdentifier queryable but not operatesOn queryable. Thus, Table 1 shows “related to” explanation. The csw:Constraint can have any of these queryables.
- srv:serviceOperation: This is also a union set queryable with serviceOperation, operation, DCP, and linkage queryables. Use one of serviceOperation (also alias for operation queryable), operation, DCP, linkage in the csw:ElementName element of the CSW request, then all of these will appear in the response if they exist in the result set of ISO records (thus, the “related to” explanations). The csw:Constraint element can have any of these queryables.

18.5.3 CSW Operations: Requests and Responses with XML Examples (DCMI)

This topic presents some requests to the CSW engine, and usually the responses to requests, for the following operations.

- GetCapabilities Operation (CSW, DCMI)
- DescribeRecord Operation (CSW, DCMI)
- GetRecords Operation (CSW, DCMI)
- GetRecordById Operation (CSW, DCMI)

18.5.3.1 GetCapabilities Operation (CSW, DCMI)

The GetCapabilities operation allows CSW clients to retrieve Catalog service metadata from the CSW engine (server). The response to a GetCapabilities request is an XML document containing Catalog service metadata document about the server. This operation specifies the XML document that a CSW instance will return to describe its capabilities.

The CSW server accepts the *service*, *Sections*, *AcceptVersions*, and *AcceptFormats* request parameters, and may implement the *updateSequence*parameter. All CSW servers must implement the HTTP GET (that is, GET KVP) protocol for GetCapabilities operation. This service also supports POST XML and SOAP protocols.

The service metadata document (the CSW GetCapabilities response) contains the following sections:

- Service Identification: Metadata about a specified CSW implementation.
- Service Provider: Metadata about the organization offering the CSW service.

- Operations Metadata: Metadata about the CSW operations offered by a specific CSW implementation, including the URLs for operation requests. This section also lists which record types are allowed for each operation supported.
- Filter_Capabilities: Metadata about the filter capabilities of the server if the server implements the Filter predicate encoding as defined in [OGC 04-095].

Depending on the values in the *Sections* parameter of the GetCapabilities operation request, any combination of these sections can be requested to reduce response size. If the Sections parameter is not specified, then all sections will be returned

Example 18-1 GetCapabilities Request

The following is a request to get the capabilities of the CSW server named CSW at a specified namespace URL. This request will return a capabilities document, as explained in Capabilities Documents (CSW).

```
<csw:GetCapabilities service="CSW" xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
xmlns:ows="http://www.opengis.net/ows/2.0">
  <ows:AcceptVersions>
    <ows:Version>2.0.2</ows:Version>
    <ows:Version>0.7.2</ows:Version>
  </ows:AcceptVersions>
  <ows:AcceptFormats>
    <ows:OutputFormat>text/xml</ows:OutputFormat>
  </ows:AcceptFormats>
</csw:GetCapabilities>
```

18.5.3.2 DescribeRecord Operation (CSW, DCMI)

The DescribeRecord operation allows a client to discover elements of the information model supported by the catalog service. The operation allows some or all of the information model to be described. The Oracle Spatial catalog service supports HTTP GET, POST XML and SOAP protocols.

For XML encoded DescribeRecord requests, the namespace declarations are specified using standard XML conventions (`xmlns` attributes) and described in the document "Namespaces in XML" [https://www.w3.org/TR/1999/REC-xml-names-19990114/].

For KVP encoding, namespace declarations are specified using the `NAMESPACE` parameter, which is a comma-separated list of namespace declarations of the form xmlns([*prefix*=]*namespace-url)*.

The `TypeName` parameter specifies a list of type names that are to be described by the catalog service. A type name is the name of a queryable entity from the information model of the catalog. The Oracle Spatial catalog service allows only `csw:Record` for the `TypeName` parameter.

The `outputFormat` parameter specifies the MIME type of the response document. The default output format attribute is the MIME type *application/xml*. All supported output formats should be declared in the Capabilities document. The Oracle Spatial catalog service supports by default `application/xml`.

The `schemaLanguage` parameter is used to specify the schema language that should be used to describe the specified types. The default value is `XMLSCHEMA`, which indicates that the XML-Schema schema description language should be used. The Oracle Spatial catalog service supports `XMLSCHEMA` for this parameter if it is present in the request.

An example HTTP GET request is:

```
http://<host:port>/oraclespatial/csw/<data source name>?
service=CSW&request=DescribeRecord&version=2.0.2&outputFormat=application/
xml&schemaLanguage=XMLSCHEMA&typeName=csw:Record&namespace=xmlns(csw=http://
www.opengis.org/cat/csw)
```

The DescribeRecord operation response is an XML document with a `DescribeRecordResponse` element that includes zero or more `SchemaComponent` subelements, each of which contains the description of one or more type names in the requested schema language. The Oracle Spatial catalog service DescribeRecord response for the DCMI profile has only one `SchemaComponent` because the `TypeName` value is `csw:Record`.

Example 18-2 DescribeRecord Request

The following is a request to describe the record with the type name `Record` for a specified namespace..

```
<csw:DescribeRecord xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                    xsd:schemaLanguage="http://www.w3.org/XML/Schema"
                    service="CSW"
                    version="2.0.2">
  <csw:TypeName>csw:Record</csw:TypeName>
</csw:DescribeRecord>
```

Example 18-3 DescribeRecord Response

The following is the response from the preceding request. The response is an XML schema definition (XSD). See the `<xsd:documentation>` elements in the response for explanatory comments.

```
<csw:DescribeRecordResponse xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:dct="http://purl.org/dc/terms/"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xmlns:xlink="http://www.w3.org/1999/xlink" xsi:schemaLocation="http://
www.opengis.net/cat/csw/2.0.2 http://schemas.opengis.net/csw/2.0.2/CSW-discovery.xsd">
  <csw:SchemaComponent schemaLanguage="http://www.w3.org/XML/Schema"
targetNamespace="http://www.opengis.net/cat/csw/2.0.2">    <xsd:schema id="csw-record"
       targetNamespace="http://www.opengis.net/cat/csw/2.0.2"
       xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
       xmlns:xsd="http://www.w3.org/2001/XMLSchema"
       xmlns:dc="http://purl.org/dc/elements/1.1/"
       xmlns:dct="http://purl.org/dc/terms/" xmlns:ows="http://www.opengis.net/ows"
       elementFormDefault="qualified" version="2.0.2.2">
       <xsd:annotation>
          <xsd:appinfo>
             <dc:identifier xmlns:dc="http://purl.org/dc/elements/1.1/">http://
schemas.opengis.net/csw/2.0.2/record.xsd</dc:identifier>
          </xsd:appinfo>
          <xsd:documentation xml:lang="en">
             This schema defines the basic record types that must be supported
             by all CSW implementations. These correspond to full, summary, and
             brief views based on DCMI metadata terms.

             CSW is an OGC Standard.
             Copyright (c) 2004,2010 Open Geospatial Consortium.
             To obtain additional rights of use, visit http://www.opengeospatial.org/
legal/ .
          </xsd:documentation>
       </xsd:annotation>
       <xsd:include schemaLocation="csw.xsd"/>
       <xsd:import namespace="http://purl.org/dc/terms/" schemaLocation="http://
schemas.opengis.net/csw/2.0.2/rec-dcterms.xsd"/>
       <xsd:import namespace="http://purl.org/dc/elements/1.1/" schemaLocation="http://
schemas.opengis.net/csw/2.0.2/rec-dcmes.xsd"/>
       <xsd:import namespace="http://www.opengis.net/ows" schemaLocation="http://
schemas.opengis.net/ows/1.0.0/owsAll.xsd"/>

       <xsd:element name="AbstractRecord" id="AbstractRecord"
                    type="csw:AbstractRecordType" abstract="true" />
       <xsd:complexType name="AbstractRecordType" id="AbstractRecordType"
                        abstract="true"/>

       <xsd:element name="DCMIRecord" type="csw:DCMIRecordType"
                    substitutionGroup="csw:AbstractRecord"/>
       <xsd:complexType name="DCMIRecordType">
          <xsd:annotation>
             <xsd:documentation xml:lang="en">
                This type encapsulates all of the standard DCMI metadata terms,
                including the Dublin Core refinements; these terms may be mapped
                to the profile-specific information model.
             </xsd:documentation>
          </xsd:annotation>
          <xsd:complexContent>
             <xsd:extension base="csw:AbstractRecordType">
                <xsd:sequence>
                   <xsd:group ref="dct:DCMI-terms"/>
                </xsd:sequence>
             </xsd:extension>
          </xsd:complexContent>
       </xsd:complexType>

       <xsd:element name="BriefRecord" type="csw:BriefRecordType"
                    substitutionGroup="csw:AbstractRecord"/>
       <xsd:complexType name="BriefRecordType" final="#all">
          <xsd:annotation>
             <xsd:documentation xml:lang="en">
                This type defines a brief representation of the common record
                format.  It extends AbstractRecordType to include only the
                 dc:identifier and dc:type properties.
             </xsd:documentation>
          </xsd:annotation>
          <xsd:complexContent>
             <xsd:extension base="csw:AbstractRecordType">
                <xsd:sequence>
                   <xsd:element ref="dc:identifier"
                                minOccurs="1" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:title"
                                minOccurs="1" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:type"
                                minOccurs="0"/>
                   <xsd:element ref="ows:BoundingBox"
                                minOccurs="0" maxOccurs="unbounded"/>
                </xsd:sequence>
             </xsd:extension>
          </xsd:complexContent>
       </xsd:complexType>

       <xsd:element name="SummaryRecord" type="csw:SummaryRecordType"
                    substitutionGroup="csw:AbstractRecord"/>
       <xsd:complexType name="SummaryRecordType" final="#all">
          <xsd:annotation>
```

```
             <xsd:documentation xml:lang="en">
                This type defines a summary representation of the common record
                format.  It extends AbstractRecordType to include the core
                properties.
             </xsd:documentation>
          </xsd:annotation>
          <xsd:complexContent>
             <xsd:extension base="csw:AbstractRecordType">
                <xsd:sequence>
                   <xsd:element ref="dc:identifier"
                                minOccurs="1" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:title"
                                minOccurs="1" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:type"
                                minOccurs="0"/>
                   <xsd:element ref="dc:subject"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:format"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="dc:relation"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="dct:modified"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="dct:abstract"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="dct:spatial"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="ows:BoundingBox"
                                minOccurs="0" maxOccurs="unbounded"/>
                </xsd:sequence>
             </xsd:extension>
          </xsd:complexContent>
       </xsd:complexType>
       <xsd:element name="Record" type="csw:RecordType"
                    substitutionGroup="csw:AbstractRecord"/>
       <xsd:complexType name="RecordType" final="#all">
          <xsd:annotation>
             <xsd:documentation xml:lang="en">
                This type extends DCMIRecordType to add ows:BoundingBox;
                it may be used to specify a spatial envelope for the
                catalogued resource.
             </xsd:documentation>
          </xsd:annotation>
          <xsd:complexContent>
             <xsd:extension base="csw:DCMIRecordType">
                <xsd:sequence>
                   <xsd:element name="AnyText" type="csw:EmptyType"
                                minOccurs="0" maxOccurs="unbounded"/>
                   <xsd:element ref="ows:BoundingBox"
                                minOccurs="0" maxOccurs="unbounded"/>
                </xsd:sequence>
             </xsd:extension>
          </xsd:complexContent>
       </xsd:complexType>
       <xsd:complexType name="EmptyType" />
    </xsd:schema>
</csw:SchemaComponent>
</csw:DescribeRecordResponse>
```

18.5.3.3 GetRecords Operation (CSW, DCMI)

The primary tools for resource discovery in CSW are the two operations: **search** and **present**. In the HTTP protocol binding these are combined in the form of the GetRecords operation, which performs a search and present.

The “search” portion of the GetRecords operation is encoded using the `Query` element, which includes the parameters parameters `typeName` and `Constraint`.

- The `typeName` parameter is used to specify which entities (record Types) of the catalog service will be queried.
- The Constraint parameter is used to specify which query constraints will be applied to identify the request set.

The “present” portion of the GetRecords operation is encoded using the `outputSchema` parameter and the `ElementName`/`ElementSetName` parameter(s).

- The `outputSchema` parameter indicates which XSD schema (that is, `http://www.opengis.net/cat/csw/2.0.2`) will be used to generate the response to the GetRecords operation.
- The `ElementName` or `ElementSetName` parameter is used to specify which properties of the `outputSchema` to include in each record in the GetRecords response.

(The following description does not repeat some parameters also used with DescribeRecord, such as `namespace` and `outputFormat`.)

The `resultType` parameter may have the value `hits`, `results`, or `validate`. The value determines whether the catalog service returns just a summary of the result set (`hits`), includes one or more records from the result set (`results`), or validates the request message (`validate`).

The `startPosition` parameter is used to indicate at which record position the catalog should start generating output. The default value is 1, meaning that it starts at the first record in the result set.

The `maxRecords` parameter is used to define the maximum number of records that should be returned from the result set of a query. If it is not specified, then 10 records will be returned. If its value is set to zero, then the behavior is identical to setting `resultType` to `hits`.

The `typeNames` parameter is a list of one or more names of queryable entities in the catalog's information model that may be constrained in the predicate of the query. (`csw:Record` indicates the DCMI profile.)

The `ElementName` parameter is used to specify one or more metadata record elements, from the output schema specified using the `outputSchema` parameter, so that the query will present in the response to the a GetRecords operation.

The `ElementSetName` parameter can be brief, summary or full, to indicate which named set the service will present to the client.

The `ElementName` and `ElementSetName` parameters are mutually exclusive. Either an `ElementSetName` parameter or one or more `ElementSetName` parameters should be specified in a query.

The `ConstraintLanguage` parameter must be `Filter` for the Oracle Spatial CSW service. `CQL` is not supported.

The `constraint` parameter specifies which filtering capabilities are used to get certain records. The following filtering capabilities are supported by the Oracle Spatial CSW service:

- Logical operators: And, Or, Not
- Comparison operators: PropertyIsEqualTo, PropertyIsNotEqualTo, PropertyIsLessThan, PropertyIsGreaterThan, PropertyIsLessThanOrEqualTo, PropertyIsGreaterThanOrEqualTo, PropertyIsLike, PropertyIsNull, csw:AnyText
- Spatial operators: BBOX
- Simple arithmetic: add, sub, div, mul, function

The `GetRecordsResponse` element is a container for the response to the GetRecords request.

The `SearchStatus` element indicates the status of the response. The search status consists of a timestamp attribute indicating when the result set was created.

The `SearchResults` element contains the `SearchResults` element, which is the set of records returned by the GetRecords operation. The following attributes can be used with the `SearchResults` element: `ElementSet(brief/summary/full)`, `numberOfRecordaMatched`, `numberOfRecordsReturned`, `nextRecord`.

Oracle Spatial Catalog Service supports HTTP GET, POST XML and SOAP protocols for the GetRecords operation.

Example 18-4 GetRecords Request with PropertyIsEqualTo and PropertyIsLike

The following is a request to GetRecords with `PropertyIsEqualTo` and `PropertyIsLike` specified. It finds the result set of records where the type is equal to the URL `http://purl.org/dc/dcmitype/Image` or where the format is a String value containing anything between and including “application/” and “xml” tokens. (The following characters are flexible: `escapeChar`, `singleChar`, and `wildcard`.)

```
<csw:GetRecords xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="csw:Record">
      <csw:ElementSetName>summary</csw:ElementSetName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:Or>
               <ogc:PropertyIsLike escapeChar="\" singleChar="?" wildCard="*">
                  <ogc:PropertyName>dc:format</ogc:PropertyName>
                  <ogc:Literal>application/*xml</ogc:Literal>
               </ogc:PropertyIsLike>
               <ogc:PropertyIsEqualTo>
                  <ogc:PropertyName>dc:type</ogc:PropertyName>
                  <ogc:Literal>http://purl.org/dc/dcmitype/Image</ogc:Literal>
               </ogc:PropertyIsEqualTo>
            </ogc:Or>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

For GetRecords Requests, `ElementSetName` can be `summary`, `full`, or `brief`.

The CSW 2.0.2 specification allows either `ElementSetName` (only 1) or `ElementName` (can be more than 1) in the GetRecords Request.

The Spatial catalog service supports only synchronous processing of GetRecords requests.

Example 18-5 GetRecords Response with PropertyIsEqualTo and PropertyIsLike

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ns9="http://www.opengis.net/ows" xmlns:ns8="http://purl.org/dc/terms/"
xmlns:ns7="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:ogc="http://www.opengis.net/ogc"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" version="2.0.2"
xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../cswAll.xsd">
  <csw:SearchStatus timestamp="2016-06-09T02:16:36Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="summary" recordSchema="http://www.opengis.net/cat/csw/
2.0.2" numberOfRecordsMatched="4" numberOfRecordsReturned="4" nextRecord="0">
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:19887a8a-f6b0-4a63-ae56-7fba0e17801f</ns7:identifier>
      <ns7:title>Lorem ipsum</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
      <ns7:subject>Tourism--Greece</ns7:subject>
      <ns7:format>image/svg+xml</ns7:format>
      <ns8:abstract>Quisque lacus diam, placerat mollis, pharetra in, commodo sed,
augue. Duis iaculis arcu vel arcu.</ns8:abstract>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:66ae76b7-54ba-489b-a582-0f0633d96493</ns7:identifier>
      <ns7:title>Maecenas enim</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Text</ns7:type>
      <ns7:subject>Marine sediments</ns7:subject>
      <ns7:format>application/xhtml+xml</ns7:format>
      <ns8:abstract>Pellentesque tempus magna non sapien fringilla blandit.</
ns8:abstract>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:829babb0-b2f1-49e1-8cd5-7b489fe71a1e</ns7:identifier>
      <ns7:title>Vestibulum massa purus</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
      <ns7:format>image/jp2</ns7:format>
      <ns7:relation>urn:uuid:9a669547-b69b-469f-a11f-2d875366bbdc</ns7:relation>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:a06af396-3105-442d-8b40-22b57a90d2f2</ns7:identifier>
      <ns7:title>Lorem ipsum dolor sit amet</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
      <ns7:format>image/jpeg</ns7:format>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-6 GetRecords Request with PropertyIsLike

The following is a request to GetRecords with `PropertyIsLike` where the client wants to fetch records whose property title is like “Lorem ipsum*”. (The following characters are flexible: `escapeChar`, `singleChar`, and `wildcard`.)

```
<csw:GetRecords xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                maxRecords="20"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="csw:Record">
      <csw:ElementSetName>summary</csw:ElementSetName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:PropertyIsLike escapeChar="\" singleChar="?" wildCard="*">
               <ogc:PropertyName>dc:title</ogc:PropertyName>
               <ogc:Literal>Lorem ipsum*</ogc:Literal>
            </ogc:PropertyIsLike>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-7 GetRecords Response with PropertyIsLike

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ns9="http://www.opengis.net/ows" xmlns:ns8="http://purl.org/dc/terms/"
xmlns:ns7="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:ogc="http://www.opengis.net/ogc"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" version="2.0.2"
xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../cswAll.xsd">
  <csw:SearchStatus timestamp="2016-06-10T01:38:22Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="summary" recordSchema="http://www.opengis.net/cat/csw/
2.0.2" numberOfRecordsMatched="2" numberOfRecordsReturned="2" nextRecord="0">
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:19887a8a-f6b0-4a63-ae56-7fba0e17801f</ns7:identifier>
      <ns7:title>Lorem ipsum</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
      <ns7:subject>Tourism--Greece</ns7:subject>
      <ns7:format>image/svg+xml</ns7:format>
      <ns8:abstract>Quisque lacus diam, placerat mollis, pharetra in, commodo sed,
augue. Duis iaculis arcu vel arcu.</ns8:abstract>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
    <csw:SummaryRecord>
      <ns7:identifier>urn:uuid:a06af396-3105-442d-8b40-22b57a90d2f2</ns7:identifier>
      <ns7:title>Lorem ipsum dolor sit amet</ns7:title>
      <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
      <ns7:format>image/jpeg</ns7:format>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:SummaryRecord>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-8 GetRecords Request with PropertyIsGreaterThan

The following is a request to GetRecords with PropertyIsGreaterThan where the client would like to fetch records where their dates are later than the date value 2004-01-01.

```
<csw:GetRecords xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="csw:Record">
      <csw:ElementName>dc:identifier</csw:ElementName>
      <csw:ElementName>dc:type</csw:ElementName>
      <csw:ElementName>dc:date</csw:ElementName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:PropertyIsGreaterThan>
               <ogc:PropertyName>dc:date</ogc:PropertyName>
               <ogc:Literal>2004-01-01Z</ogc:Literal>
            </ogc:PropertyIsGreaterThan>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-9 GetRecords Response with PropertyIsGreaterThan

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ns9="http://www.opengis.net/ows" xmlns:ns8="http://purl.org/dc/terms/"
xmlns:ns7="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:ogc="http://www.opengis.net/ogc"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" version="2.0.2"
xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../cswAll.xsd">
  <csw:SearchStatus timestamp="2015-06-29T05:50:16Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="" recordSchema="http://www.opengis.net/cat/csw/2.0.2"
numberOfRecordsMatched="3" numberOfRecordsReturned="3" nextRecord="0">
    <csw:Record>
      <ns7:identifier>urn:uuid:784e2afd-a9fd-44a6-9a92-a3848371c8ec</ns7:identifier>
      <ns7:type>http://purl.org/dc/dcmitype/Text</ns7:type>
      <ns7:date>2006-05-12Z</ns7:date>
    </csw:Record>
    <csw:Record>
      <ns7:identifier>urn:uuid:94bc9c83-97f6-4b40-9eb8-a8e8787a5c63</ns7:identifier>
      <ns7:type>http://purl.org/dc/dcmitype/Dataset</ns7:type>
      <ns7:date>2006-03-26Z</ns7:date>
    </csw:Record>
    <csw:Record>
```

```
      <ns7:identifier>urn:uuid:9a669547-b69b-469f-a11f-2d875366bbdc</ns7:identifier>
      <ns7:type>http://purl.org/dc/dcmitype/Dataset</ns7:type>
      <ns7:date>2005-10-24Z</ns7:date>
    </csw:Record>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-10 GetRecords Request with BoundingBox (BBOX)

The following is a request to GetRecords with `BoundingBox` (BBOX) where the client wants to fetch records whose geometry does not fall into the Bounding Box of (40,-9;50, -5) and where the type is equal to the case-insensitive String URL value `HTTP://purl.org/dc/dcmitype/dataset`. This means that type could be `http://purl.org/dc/dcmitype/dataset` or anything starting with that. This request benefits from both spatial and XQFT indexes.

```
<csw:GetRecords xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="csw:Record">
      <csw:ElementName>dc:identifier</csw:ElementName>
      <csw:ElementName>dc:type</csw:ElementName>
      <csw:ElementName>ows:BoundingBox</csw:ElementName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:And>
               <ogc:Not>
                  <ogc:BBOX>
                     <ogc:PropertyName>ows:BoundingBox</ogc:PropertyName>
                     <gml:Envelope srsName="urn:x-ogc:def:crs:EPSG:6.11:4326">
                        <gml:lowerCorner>40.0 -9.0</gml:lowerCorner>
                        <gml:upperCorner>50.0 -5.0</gml:upperCorner>
                     </gml:Envelope>
                  </ogc:BBOX>
               </ogc:Not>
               <ogc:PropertyIsEqualTo matchCase="false">
                  <ogc:PropertyName>dc:type</ogc:PropertyName>
                  <ogc:Literal>HTTP://purl.org/dc/dcmitype/dataset</ogc:Literal>
               </ogc:PropertyIsEqualTo>
            </ogc:And>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-11 GetRecords Response with BoundingBox (BBOX)

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ns9="http://www.opengis.net/ows" xmlns:ns8="http://purl.org/dc/terms/"
xmlns:ns7="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:ogc="http://www.opengis.net/ogc"
```

```
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" version="2.0.2"
xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../cswAll.xsd">
  <csw:SearchStatus timestamp="2015-06-29T05:50:16Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="" recordSchema="http://www.opengis.net/cat/csw/2.0.2"
numberOfRecordsMatched="2" numberOfRecordsReturned="2" nextRecord="0">
    <csw:Record>
      <ns7:identifier>urn:uuid:88247b56-4cbc-4df9-9860-db3f8042e357</ns7:identifier>
      <ns7:type>http://purl.org/dc/dcmitype/Dataset</ns7:type>
      <ns9:BoundingBox></ns9:BoundingBox>
    </csw:Record>
    <csw:Record>
      <ns7:identifier>urn:uuid:94bc9c83-97f6-4b40-9eb8-a8e8787a5c63</ns7:identifier>
      <ns7:type>http://purl.org/dc/dcmitype/Dataset</ns7:type>
      <ns9:BoundingBox crs="urn:x-ogc:def:crs:EPSG:6.11:4326" dimensions="2">
        <ns9:LowerCorner>47.595 -4.097</ns9:LowerCorner>
        <ns9:UpperCorner>51.217 0.889</ns9:UpperCorner>
      </ns9:BoundingBox>
    </csw:Record>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

18.5.3.4 GetRecordById Operation (CSW, DCMI)

The GetRecordById operation is a subset of the GetRecords operation, and is included as a convenient short form for retrieving and linking to records in the CSW service. The GetRecordById request retrieves catalog records using their identifier.

The GetRecordById operation is an implementation of the "present" operation as described in GetRecords Operation (CSW, DCMI). The parameters are `ElementSetName`, `outputFormat`, `outputSchema`, and `Id`.

The GetRecordById response is the list of requested records with matched `Id` values.

Oracle Spatial CSW supports HTTP GET, POST XML, and SOAP protocols for this request.

Example 18-12 GetRecordById Request

The following is a request to get the records with the record ID values `urn:uuid:a06af396-3105-442d-8b40-22b57a90d2f2`, `urn:uuid:19887a8a-f6b0-4a63-ae56-7fba0e17801f`, and `urn:uuid:ab42a8c4-95e8-4630-bf79-33e59241605a`.

```
<csw:GetRecordById xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                   xmlns:dc="http://purl.org/dc/elements/1.1/"
                   xmlns:dct="http://purl.org/dc/terms/"
                   xmlns:gml="http://www.opengis.net/gml"
                   xmlns:ogc="http://www.opengis.net/ogc"
                   xmlns:ows="http://www.opengis.net/ows"
                   xmlns:xi="http://www.w3.org/2001/XInclude"
                   xmlns:xlink="http://www.w3.org/1999/xlink"
                   xmlns:xs="http://www.w3.org/2001/XMLSchema"
                   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                   outputFormat="application/xml"
                   service="CSW"
                   version="2.0.2">
  <csw:Id>urn:uuid:a06af396-3105-442d-8b40-22b57a90d2f2</csw:Id>
  <csw:Id>urn:uuid:19887a8a-f6b0-4a63-ae56-7fba0e17801f</csw:Id>
  <csw:Id>urn:uuid:ab42a8c4-95e8-4630-bf79-33e59241605a</csw:Id>
  <csw:ElementSetName>brief</csw:ElementSetName>
</csw:GetRecordById>
```

Example 18-13 GetRecordById Response

The following is the response from the preceding request.

```
<csw:GetRecordByIdResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ns9="http://www.opengis.net/ows" xmlns:ns8="http://purl.org/dc/terms/"
xmlns:ns7="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:ogc="http://www.opengis.net/ogc"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" xsi:schemaLocation="http://
www.opengis.net/cat/csw/2.0.2 ../../cswAll.xsd">
  <BriefRecord>
    <ns7:identifier>urn:uuid:19887a8a-f6b0-4a63-ae56-7fba0e17801f</ns7:identifier>
    <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
    <ns7:title>Lorem ipsum</ns7:title>
    <ns9:BoundingBox></ns9:BoundingBox>
  </BriefRecord>
  <BriefRecord>
    <ns7:identifier>urn:uuid:a06af396-3105-442d-8b40-22b57a90d2f2</ns7:identifier>
    <ns7:type>http://purl.org/dc/dcmitype/Image</ns7:type>
    <ns7:title>Lorem ipsum dolor sit amet</ns7:title>
    <ns9:BoundingBox></ns9:BoundingBox>
  </BriefRecord>
  <BriefRecord>
    <ns7:identifier>urn:uuid:ab42a8c4-95e8-4630-bf79-33e59241605a</ns7:identifier>
    <ns7:type>http://purl.org/dc/dcmitype/Service</ns7:type>
    <ns9:BoundingBox></ns9:BoundingBox>
  </BriefRecord>
</csw:GetRecordByIdResponse>
```

18.6 CSW Major Operations (ISO Profile)

This topic covers loading and querying CSW data, and provides examples of requests and responses for various operations. It applies to using CSW data using the ISO record type.

If your CSW data uses the ISO profile, the `recordType` attribute for each record will contain the value `2`.

When you call the SDO_CSW.INITIALIZE_CSW procedure, you specify the record type for your CSW data in the `csw_xsd_id` parameter value (`1` for DCMI, `2` for ISO).

The view USER_SDO_CSW_SERVICE_INFO contains CSW metadata for the supported CSW `recordType`, as explained in Database Schema and Objects for CSW.

- Loading CSW 2.0.2 Data (ISO)
  After the CSW ISO Profile table is created when you initialize the CSW ISO Profile schema, you can start loading your CSW 2.0.2 data (ISO 19139 records) into this table.
- Querying CSW 2.0.2 Data (ISO)
  For querying CSW ISO Profile data, the GetCapabilities, DescribeRercord, and GetRecords CSW requests are supported, using the queryable elements described in this topic.
- CSW Operations: Requests and Responses with XML Examples (ISO)
  This topic presents some requests to the CSW engine, and usually the responses to requests, for the following operations.

18.6.1 Loading CSW 2.0.2 Data (ISO)

After the CSW ISO Profile table is created when you initialize the CSW ISO Profile schema, you can start loading your CSW 2.0.2 data (ISO 19139 records) into this table.

Oracle Spatial provides a client-side loader for this purpose: `$ORACLE_HOME/md/jlib/sdocswloader.jar` (assuming the default Spatial installation directory of `$ORACLE_HOME/md`):

The `sdocswloader.jar` package can take large files containing CSW ISO Profile XML records and load them into the CSW ISO Profile table. For example, assume that you have three XML files, `csw_records1.txt`, `csw_records2.txt`, and `csw_records3.txt`, which contain many ISO records. Follow these steps to load them into the CSW ISO Profile table.

1. Create an XML configuration file named `sdo_csw_demo.xml` (or any other name as you wish), as in the following example.

```
<?xml version='1.0' encoding='windows-1252'?>
<Connection>
   <Driver>Thin</Driver>
   <Hostname>localhost</Hostname>
   <Port>52504</Port>
   <ServiceName>SERVICENAME </ServiceName>
   <ServerMode>DEDICATED</ServerMode>
   <Schema>MDMETT</Schema>
   <Password>MDMETT</Password>
   <!-- Requires access to V$MYSTAT and V$SESS_TIME_MODEL -->
   <logServerStats>true</logServerStats>
   <clientSideEncoding>true</clientSideEncoding>
   <!-- SAX : for Splitting Large XML Files into smaller Files -->
   <!-- FOLDER : for walking a client side directory tree loading Files -->
   <mode>SAX</mode>
   <Pool>false</Pool>
   <Namespaces
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
        xmlns:dc="http://purl.org/dc/elements/1.1/"
        xmlns:dct="http://purl.org/dc/terms/"
        xmlns:gml="http://www.opengis.net/gml"
        xmlns:ogc="http://www.opengis.net/ogc"
        xmlns:ows="http://www.opengis.net/ows"
        xmlns:xi="http://www.w3.org/2001/XInclude"
        xmlns:xlink="http://www.w3.org/1999/xlink"
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:xsd="http://www.w3.org/2001/XMLSchema"
        xmlns:gmi="http://www.isotc211.org/2005/gmi"
        xmlns:gco="http://www.isotc211.org/2005/gco"
        xmlns:gmx="http://www.isotc211.org/2005/gmx"
        xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
        xmlns:gmd="http://www.isotc211.org/2005/gmd"
        xmlns:srv="http://www.isotc211.org/2005/srv"
   />
   <!-- List of Files to be processed -->
   <FileList>
   <!-- replace the following with full file path names for the records -->
      <File>csw_records1.txt</File>
      <File>csw_records2.txt</File>
      <File>csw_records3.txt</File>
   </FileList>
   <Tables>
      <Table name="SDO_CSW_DEMO_TABLE" path="/root/gmd:MD_Metadata">
```

```
         <Column name="XML_COLUMN" path="/root/gmd:MD_Metadata" type="xml"/>
         <Column name="METADATA_ID" path="/root/gmd:MD_Metadata/gmd:fileIdentifier/
gco:CharacterString" type="string"/>
      </Table>
   </Tables>
   <!-- Each Writer process will commit its workload after this number of inserts -->
   <CommitCharge>100</CommitCharge>
   <!-- Number of Concurrent Writer Threads -->
   <ThreadCount>10</ThreadCount>
   <!—replace the following with full file path name for the logger -->
   <LogFileName>csw_records.log</LogFileName>
   <ErrorTable>CSW_ERROR_TABLE_NAME</ErrorTable>
   <schemaInstancePrefix>xsi</schemaInstancePrefix>
   <schemaLocation/>
   <noNamespaceSchemaLocation/>
</Connection>
```

This configuration file allows the loader to process the ISO19139 records with ISO19139 namespaces.

The `username` parameter in this file refers to the CSW ISO Profile schema name.

The `Table` name is the CSW ISO Profile table that you would like to populate; the first `Column` name is the column where you have the records to be stored as Oracle XMLType objects in the CSW ISO Profile table, and the second `Column` name is the column where you want the record ID values to be stored in the CSW ISO Profile table.

> **Note:**
>
> If the table and the log directory do not exist, do the following before running XMLLoader (in the next major step):
>
> a. Create a CSW_ERROR_TABLE_NAME table in the CSW ISO Profile schema, to contain a log of errors. For example: `CREATE TABLE CSW_ERROR_TABLE of XMLTYPE;`
>
> b. Create a directory named `log` where the `csw_records.log` file will be created.

2. Create a `runXMLLoader.sh` (for Linux) or `runXMLLoader.bat` (for Windows) file, as shown in the following examples:

   - Linux: `runXMLLoader.sh`

     ```
     PATH=$ORACLE_HOME/jdk/bin:$PATH
     java -Xmx2048M -classpath "$ORACLE_HOME/md/jlib/
     sdocswloader.jar:$ORACLE_HOME/lib/xmlparserv2.jar:$ORACLE_HOME/jdbc/lib/
     ojdbc8.jar:$ORACLE_HOME/rdbms/jlib/xdb8.jar" -
     Doracle.spatial.xmlloader.ConnectionParameters= /mydir/sdo_csw_demo.xml
     oracle.spatial.xmlloader.saxLoader.XMLLoader
     ```

   - Windows:`runXMLLoader.bat`

     ```
     set ORACLE_HOME=e:\app\oracle\product\12.2.0\dbhome_1
     set PATH=%ORACLE_HOME%\jdk\bin;%PATH%
     java -cp %CD%\XMLLoader.jar;%ORACLE_HOME%\lib\xmlparserv2.jar;%ORACLE_HOME%
     \jdbc\lib\ojdbc8.jar;%ORACLE_HOME%\jdbc\lib\ojdbc8dms.jar;%ORACLE_HOME%
     \rdbms\jlib\xdb8.jar -Doracle.spatial.xmlloader.ConnectionParameters=%1
     oracle.spatial.xmlloader.saxLoader.XMLLoader
     ```

These files use the `sdo_csw_demo.xml` file, and they assume JDK 1.8. You may need to modify the files if you have another Java environment, and you may need to make other changes to the configuration file and related script files for your system environment.

In this example scenario, the CSW table is populated with the records in the three CSW 2.0.2 ISO Profile data files when `runXMLLoader.sh` or `runXMLLoader.bat` is run.

18.6.2 Querying CSW 2.0.2 Data (ISO)

For querying CSW ISO Profile data, the GetCapabilities, DescribeRercord, and GetRecords CSW requests are supported, using the queryable elements described in this topic.

The following sample queries are POST requests, the first using csw:ElementName elements and the second using the csw:ElementSetName element. In each case the ogc:PropertyName element is used to specify a property to query within an ogc:Filter element within a csw:Constraint element.

Sample Request 1: Specifying ElementName elements in the query

```
<csw:GetRecords xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:srv="http://www.isotc211.org/2005/srv"
                xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementName>gmd:identifier</csw:ElementName>
      <csw:ElementName>gmd:type</csw:ElementName>
      <csw:ElementName>gmd:date</csw:ElementName>
      <csw:ElementName>gmd:abstract</csw:ElementName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:PropertyIsLike escapeChar="\" singleChar="?" wildCard="*">
               <ogc:PropertyName>gmd:abstract</ogc:PropertyName>
               <ogc:Literal>*Oracle CSW*</ogc:Literal>
            </ogc:PropertyIsLike>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Sample Request 2: Specifying an ElementSetName element in the query

```
<csw:GetRecords xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:srv="http://www.isotc211.org/2005/srv"
               xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                outputFormat="application/xml"
                outputSchema="http://www.isotc211.org/2005/gmd"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementSetName>brief</csw:ElementSetName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:PropertyIsEqualTo>
               <ogc:PropertyName>gmd:title</ogc:PropertyName>
               <ogc:Literal>Oracle CSW 2.0.2 Service Record</ogc:Literal>
            </ogc:PropertyIsEqualTo>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

The preceding sample requests showed simple queries using queryable elements. Note that the csw:Constraint element can have a more complex structure, such as with with ogc:And connectors. See OGC CSW 2.0.2 Specification OGC 07-045 for more details.

The queryable elements that can be used in a csw:Constraint element with a cws:ElementName or csw:ElementSetName element can be grouped into the following modes:

- **Brief** (Brief mode as specified in the OGC CSW 2.0.2 specification)
- **Summary** (Summary mode as specified in the OGC CSW 2.0.2 specification)
- **Comprehensive** (An Oracle-specific mode that includes Summary, plus other elements. Comprehensive mode applies to the ISO profile only, not to the DCMI profile.))
- **Full** (Always returns the full original ISO record)

The csw:ElementySetName element specifies a mode (`brief`, `summary`, `comprehensive`, or `full`); the csw:ElementName element does not specify a mode, but just the name of a queryable element. In Sample Request 2, the ElementSetName element specifies the brief mode (`<csw:ElementSetName>`**`brief`**`</csw:ElementSetName>`).

The **Brief** mode queryable elements are the following:

```
gmd:title
gmd:graphicOverview
gmd:identifier
gmd:type
ows:BoundingBox
srv:serviceType
srv:serviceTypeVersion
```

The **Summary** mode queryable elements are the following:

```
gmd:abstract
gmd:characterSet
gmd:creator
gmd:contributor
srv:couplingType
ows:BoundingBox
gmd:format
```

```
gmd:formatVersion
gmd:graphicOverview
gmd:hierarchyLevelName
gmd:fileIdentifier (or identifier)
gmd:language
gmd:lineage
gmd:metadataCharacterSet
gmd:metadataStandardName
gmd:metadataStandardVersion
gmd:modified
gmd:onlineResource
gmd:parentIdentifier
gmd:publisher
gmd:resourceIdentifier
gmd:resourceLanguage
gmd:referenceSystem)
gmd:revisionDate
gmd:rights
gmd:spatialResolution
gmd:spatialRepresentationType
gmd:title
gmd:topicCategory (Certain values allowed)
gmd:type (same as hierarchyLevel)
srv:serviceOperation
srv:serviceType
srv:serviceTypeVersion
```

The Oracle-specific **Comprehensive** mode queryable elements include all of the Summary mode elements, plus the following elements:

```
gmd:alternateTitle
gmd:code (related to gmd:referenceSystem)
gmd:codeSpace (related to gmd:referenceSystem)
gmd:creationDate (related to gmd:revisionDate)
gmd:crs (related to gmd:referenceSystem)
gmd:date (or gmd:modified)
gmd:denominator (related to gmd:spatialResolution)
gmd:distance (related to gmd:spatialResolution)
gmd:distanceUOM (related to gmd:spatialResolution)
gmd:hasSecurityConstraints
gmd:keyword
gmd:keywordType
gmd:organisationName
gmd:publicationDate (related to gmd:revisionDate)
gmd:relation
gmd:version (related to gmd:referenceSystem)
srv:DCP (related to srv:serviceOperation)
srv:linkage (related to srv:serviceOperation)
srv:operatesOn (related to Union set srv:OperatesOnData but processed independently than
related others)
srv:operatesOnIdentifier (related to srv:OperatesOnData)
srv:operatesOnName (related to srv:OperatesOnData)
srv:operation (related to srv:serviceOperation)
```

The **Full** mode queryable elements are any supported in the OGC specification and in the Brief, Summary, and Comprehensive modes (indicated in the csw:ElementSetName element of CSW ISO Profile request). What distinguishes Full mode is that the query always returns the full original ISO record, whereas the other modes return only the elements specified in the csw:ElementSeName element or specifically in the csw:ElementName elements of the CSW ISO Profile request.

Usage notes about ISO Queryables and some special cases:

- gmd:date queryable is the same as gmd:modified queryable. Use either one in CSW ISO Profile request. gmd:date.
- gmd:format and gmd:formatVersion: ElementName mode considers the path with distributionFormat node. Summary, Comprehensive, and Full ElementSetName mode considers also the distributorFormat node. Brief mode does not have these queryables.
- gmd:hasSecurityConstraints queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): unclassified, restricted, confidential, secret, topSecret.
- gmd:keywordType queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): discipline, place, stratum, temporal, theme.
- gmd:referenceSystem: This is a union set queryable with referenceSystem, crs, code, codeSpace, and version queryables. Use one of referenceSystem (also aliases for cars and code queryables), crs, code, codeSpace, or version queryable in the csw:ElementName element of the CSW ISO Profile request, then all of these will appear in the response if they exist in the result set of ISO records (thus, the “related to” explanations). The csw:Constraint element in the CSW ISO Profile request can have any of these queryables.
- gmd:spatialResolution: This is also a union set queryable with spatialResolution, denominator, distance, and distanceUOM queryables. Use one of spatialResolution (also alias for denominator queryable), denominator, distance, or distanceUOM in the csw:ElementName element of the CSW request, then all of these will appear in the response if they exist in the results of ISO records (thus, the “related to” explanations). The csw:Constraint element can have any of these queryables.
- gmd:topicCategory queryable can only have the following values (it is also strongly recommended to use these values because data is not supposed to have values other than these): farming, biota, boundaries, climatologyMeteorologyAtmosphere, economy, elevation, environment, geoscientificInformation, health, imageryBaseMapsEarthCover, intelligenceMilitary, inlandWaters, location, oceans, planningCadastre, society, structure, transportation, and utilitiesCommunication.
- ogc:Not logic is only supported for csw:Constraint/ogc:Filter/ogc:Not/ogc:PropertyIsLike.
- PropertyIsNull is not supported for revisionDate, publicationDate, creationDate, contributor, creator, or publisher queryables.
- srv:operatesOnData: This is also union set queryable with operatesOn, operatesOnIdentifier, operatesOnName queryables. This is a bit different than the above union sets described: operatesOn is processed different and independent than operatesOnIdentifier and operatesOnName queryables. When operatesOnIndetifier is in csw:ElementSet element of CSW request, then the operatesOnName will appear in the response if it exists in the results of ISO records. Similar argument for operatesOnIdentifier queryable but not operatesOn queryable. Thus, Table 1 shows “related to” explanation. The csw:Constraint can have any of these queryables.
- srv:serviceOperation: This is also a union set queryable with serviceOperation, operation, DCP, and linkage queryables. Use one of serviceOperation (also alias for operation queryable), operation, DCP, linkage in the csw:ElementName element of the CSW request, then all of these will appear in the response if they exist in the result set of ISO records (thus, the “related to” explanations). The csw:Constraint element can have any of these queryables.

The following table identifies the text search path (starting with `gmd:MD_Metadata/`) for a csw:Constraint element of a CSW ISO Profiole request. In other words, when a queryable in first column in this table is placed into a csw:Constraint element, the second column shows what the CSW service is looking for in the ISO records data for filtering purposes.

Table 18-2 Queryable Elements and Text Search Paths (ISO)

Queryable Element	Text Search Path: Starts with gmd:MD_Metadata/
gmd:abstract	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:abstract/gco:CharacterString
gmd:alternateTitle	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/gmd:CI_Citation/gmd:alternateTitle/gco:CharacterString
gmd:characterSet	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:characterSet/gmd:MD_CharacterSetCode[@codeListValue
gmd:code (related to gmd:referenceSystem)	gmd:MD_Metadata/gmd:referenceSystemInfo/gmd:MD_ReferenceSystem/gmd:referenceSystemIdentifier/gmd:RS_Identifier/gmd:code/gco:CharacterString
gmd:codeSpace (related to gmd:referenceSystem)	gmd:referenceSystemInfo/gmd:MD_ReferenceSystem/gmd:referenceSystemIdentifier/gmd:RS_Identifier/gmd:codeSpace/gco:CharacterString
gmd:contributor	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:pointOfContact/gmd:CI_ResponsibleParty[gmd:organisationName (where.[gmd:role/gmd:CI_RoleCode/@codeListValue=”author”])
gmd:creationDate (related to gmd:revisionDate)	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/gmd:CI_Citation/gmd:date/gmd:CI_Date[gmd:date/xs:date(gco:Date) (where [gmd:dateType/gmd:CI_DateTypeCode/@codeListValue=“creation”])
gmd:creator	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:pointOfContact/gmd:CI_ResponsibleParty[gmd:organisationName (where [gmd:role/gmd:CI_RoleCode/@codeListValue=”originator”])
gmd:date (or gmd:modified)	gmd:dateStamp/xs:date(gco:Date)
gmd:denominator (related to gmd:spatialResolution)	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:spatialResolution/gmd:MD_Resolution/gmd:equivalentScale/gmd:MD_RepresentativeFraction/gmd:denominator
gmd:distance (related to gmd:spatialResolution)	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:spatialResolution/gmd:MD_Resolution/gmd:distance/gco:Distance
gmd:distanceUOM (related to gmd:spatialResolution)	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:spatialResolution/gmd:MD_Resolution/gmd:distance/gco:Distance[@uom
gmd:fileIdentifier (or identifier)	gmd:fileIdentifier/gco:CharacterString
gmd:format	gmd:distributionInfo/gmd:MD_Distribution/gmd:distributionFormat/gmd:MD_Format/gmd:version/gco:CharacterString
gmd:formatVersion	gmd:distributionInfo/gmd:MD_Distribution/gmd:distributionFormat/gmd:MD_Format/gmd:version/gco:CharacterString
gmd:graphicOverview	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:graphicOverview/gmd:MD_BrowseGraphic/gmd:fileName/gco:CharacterString
gmd:hasSecurityConstraints	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:resourceConstraints/gmd:MD_SecurityConstraints/gmd:classification/gmd:MD_ClassificationCode[@codeListValue
gmd:hierarchyLevelName	gmd:hierarchyLevelName/gco:CharacterString
gmd:keyword	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:descriptiveKeywords/gmd:MD_Keywords/gmd:keyword/gco:CharacterString

Table 18-2 (Cont.) Queryable Elements and Text Search Paths (ISO)

Queryable Element	Text Search Path: Starts with gmd:MD_Metadata/
gmd:keywordType	gmd:identificationInfo/gmd:MD_DataIdentification/ gmd:descriptiveKeywords/gmd:MD_Keywords/gmd:type/ gmd:MD_KeywordTypeCode[@codeListValu
gmd:language	gmd:language/gco:CharacterString
gmd:lineage	gmd:dataQualityInfo/gmd:DQ_DataQuality/gmd:lineage/gmd:LI_Lineage/ gmd:statement/gco:CharacterString
gmd:metadataCharacterSet	gmd:characterSet/gmd:MD_CharacterSetCode[@codeListValue
gmd:metadataStandardName	gmd:metadataStandardName/gco:CharacterString
gmd:metadataStandardVersion	gmd:metadataStandardVersion/gco:CharacterString
gmd:modified	gmd:dateStamp/xs:date(gco:Date)
gmd:onlineResource	gmd:distributionInfo/gmd:MD_Distribution/gmd:transferOptions/ gmd:MD_DigitalTransferOptions/gmd:onLine/gmd:CI_OnlineResource/ gmd:linkage/gmd:URL
gmd:organisationName	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:pointOfContact/ gmd:CI_ResponsibleParty/gmd:organisationName/gco:CharacterString
gmd:parentIdentifier	gmd:parentIdentifier/gco:CharacterString
gmd:publicationDate (related to gmd:revisionDate)	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/ gmd:CI_Citation/gmd:date/gmd:CI_Date[gmd:date/xs:date(gco:Date) (where [gmd:dateType/gmd:CI_DateTypeCode/ @codeListValue=“publication"])
gmd:publisher	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:pointOfContact/ gmd:CI_ResponsibleParty[gmd:organisationName (where [gmd:role/ gmd:CI_RoleCode/@codeListValue=“publisher”])
gmd:referenceSystem	gmd:referenceSystemInfo/gmd:MD_ReferenceSystem/ gmd:referenceSystemIdentifier/gmd:RS_Identifier/gmd:code/ gco:CharacterString
gmd:relation	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:aggregationInfo/ gmd:MD_AggregateInformation/gmd:associationType/ gmd:DS_AssociationTypeCode[@codeListValue
gmd:resourceIdentifier	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/ gmd:CI_Citation/gmd:identifier/gmd:MD_Identifier/gmd:code/ gco:CharacterString
gmd:resourceLanguage	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:language/ gco:CharacterString
gmd:revisionDate	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/ gmd:CI_Citation/gmd:date/gmd:CI_Date[gmd:date/xs:date(gco:Date) (where [gmd:dateType/gmd:CI_DateTypeCode/ @codeListValue=“revision”])
gmd:rights	gmd:identificationInfo/gmd:MD_DataIdentification/ gmd:resourceConstraints/gmd:MD_LegalConstraints/ gmd:accessConstraints/gmd:MD_RestrictionCode[@codeListValue
gmd:spatialRepresentationType	gmd:identificationInfo/gmd:MD_DataIdentification/ gmd:spatialRepresentationType/ gmd:MD_SpatialRepresentationTypeCode[@codeListValue
gmd:spatialResolution	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:spatialResolution/ gmd:MD_Resolution/gmd:equivalentScale/ gmd:MD_RepresentativeFraction/gmd:denominator

Table 18-2 (Cont.) Queryable Elements and Text Search Paths (ISO)

Queryable Element	Text Search Path: Starts with gmd:MD_Metadata/
gmd:title	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:citation/gmd:CI_Citation/gmd:title/gco:CharacterStrin
gmd:topicCategory	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:topicCategory/gmd:MD_TopicCategoryCode
gmd:type (same as hierarchyLevel)	gmd:hierarchyLevel/gmd:MD_ScopeCode[@codeListValue
gmd:version (related to gmd:referenceSystem)	gmd:MD_Metadata/gmd:referenceSystemInfo/gmd:MD_ReferenceSystem/gmd:referenceSystemIdentifier/gmd:RS_Identifier/gmd:version/gco:CharacterString
ows:BoundingBox	gmd:identificationInfo/gmd:MD_DataIdentification/gmd:extent/gmd:EX_Extent/gmd:geographicElement
srv:couplingType	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:couplingType/srv:SV_CouplingType[@codeListValue
srv:DCP (related to srv:serviceOperation)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:containsOperations/srv:SV_OperationMetadata/srv:DCP/srv:DCPList[@codeListValue
srv:linkage (related to srv:serviceOperation)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:containsOperations/srv:SV_OperationMetadata/srv:connectPoint/gmd:CI_OnlineResource/gmd:linkage/gmd:URL
srv:operatesOn (related to Union set srv:OperatesOnData but processed independently than related others)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:operatesOn[@uuidref
srv:operatesOnIdentifier (related to srv:OperatesOnData)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:coupledResource/srv:SV_CoupledResource/srv:identifier/gco:CharacterString
srv:operatesOnName (related to srv:OperatesOnData)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:coupledResource/srv:SV_CoupledResource/srv:operationName/gco:CharacterString
srv:operation (related to srv:serviceOperation)	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:containsOperations/srv:SV_OperationMetadata/srv:operationName/gco:CharacterString
srv:serviceOperation	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:containsOperations/srv:SV_OperationMetadata/srv:operationName/gco:CharacterString
srv:serviceType	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:serviceType/gco:LocalName
srv:serviceTypeVersion	gmd:identificationInfo/srv:SV_ServiceIdentification/srv:serviceTypeVersion/gco:CharacterString

18.6.3 CSW Operations: Requests and Responses with XML Examples (ISO)

This topic presents some requests to the CSW engine, and usually the responses to requests, for the following operations.

- GetCapabilities Operation (CSW, ISO)

- DescribeRecord Operation (CSW, ISO)
- GetRecords Operation (CSW, ISO)

18.6.3.1 GetCapabilities Operation (CSW, ISO)

The GetCapabilities operation allows CSW clients to retrieve Catalog service metadata from the CSW engine (server). The response to a GetCapabilities request is an XML document containing Catalog service metadata document about the server. This operation specifies the XML document that a CSW instance will return to describe its capabilities.

The CSW server accepts the *service*, *Sections*, *AcceptVersions*, and *AcceptFormats* request parameters, and may implement the *updateSequence*parameter. All CSW servers must implement the HTTP GET (that is, GET KVP) protocol for GetCapabilities operation. This service also supports POST XML and SOAP protocols.

The service metadata document (the CSW GetCapabilities response) contains the following sections:

- Service Identification: Metadata about a specified CSW implementation.
- Service Provider: Metadata about the organization offering the CSW service.
- Operations Metadata: Metadata about the CSW operations offered by a specific CSW implementation, including the URLs for operation requests. This section also lists which record types are allowed for each operation supported.
- Filter_Capabilities: Metadata about the filter capabilities of the server if the server implements the Filter predicate encoding as defined in [OGC 04-095].

Depending on the values in the *Sections* parameter of the GetCapabilities operation request, any combination of these sections can be requested to reduce response size. If the Sections parameter is not specified, then all sections will be returned

Example 18-14 GetCapabilities Request

The following is a request to get the capabilities of the CSW server named CSW at a specified namespace URL. This request will return a capabilities document, as explained in Capabilities Documents (CSW).

```
<csw:GetCapabilities service="CSW" xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
xmlns:ows="http://www.opengis.net/ows/2.0">
  <ows:AcceptVersions>
    <ows:Version>2.0.2</ows:Version>
    <ows:Version>0.7.2</ows:Version>
  </ows:AcceptVersions>
  <ows:AcceptFormats>
    <ows:OutputFormat>text/xml</ows:OutputFormat>
  </ows:AcceptFormats>
</csw:GetCapabilities>
```

18.6.3.2 DescribeRecord Operation (CSW, ISO)

The DescribeRecord operation allows a client to discover elements of the information model supported by the catalog service. The operation allows some or all of the information model to be described. The Oracle Spatial catalog service supports HTTP GET, POST XML and SOAP protocols.

The only difference between the DCMI and ISO profile DescribeRecord operation is in the TypeName parameter value, where for ISO the value is `<csw:TypeName>`**`gmd:MD_Metadata`**`</`

`csw:TypeName>`. whereas for DCMI it is `<csw:TypeName>`**`csw:Record`**`</csw:TypeName>`. For example:

```
http://<host:port>/oraclespatial/csw/<data source name>?
service=CSW&request=DescribeRecord&version=2.0.2&outputFormat=application/
xml&schemaLanguage=XMLSCHEMA&typeName=gmd:MD_Metadata&namespace=xmlns(csw=http
://www.opengis.org/cat/csw)
```

For XML encoded DescribeRecord requests, the namespace declarations are specified using standard XML conventions (`xmlns` attributes) and described in the document "Namespaces in XML" [https://www.w3.org/TR/1999/REC-xml-names-19990114/].

For KVP encoding, namespace declarations are specified using the `NAMESPACE` parameter, which is a comma-separated list of namespace declarations of the form xmlns([*prefix*=]*namespace-url)*.

The `TypeName` parameter specifies a list of type names that are to be described by the catalog service. A type name is the name of a queryable entity from the information model of the catalog. The Oracle Spatial catalog service allows only `gmd:Metadata` for the `TypeName` parameter.

The `outputFormat` parameter specifies the MIME type of the response document. The default output format attribute is the MIME type *application/xml*. All supported output formats should be declared in the Capabilities document. The Oracle Spatial catalog service supports by default `application/xml`.

The `schemaLanguage` parameter is used to specify the schema language that should be used to describe the specified types. The default value is `XMLSCHEMA`, which indicates that the XML-Schema schema description language should be used. The Oracle Spatial catalog service supports `XMLSCHEMA` for this parameter if it is present in the request.

An example HTTP GET request is:

```
http://<host:port>/oraclespatial/csw/<data source name>?
service=CSW&request=DescribeRecord&version=2.0.2&outputFormat=application/
xml&schemaLanguage=XMLSCHEMA&typeName=csw:Record&namespace=xmlns(csw=http://
www.opengis.org/cat/csw)
```

The DescribeRecord operation response is an XML document with a `DescribeRecordResponse` element that includes zero or more `SchemaComponent` subelements, each of which contains the description of one or more type names in the requested schema language.

Example 18-15   DescribeRecord Request

The following is a request to describe the record with the type name `MD_Metadata` for a specified namespace..

```
<csw:DescribeRecord
                    xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                    xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                    xmlns:gmd="http://www.isotc211.org/2005/gmd"
                    xmlns:srv="http://www.isotc211.org/2005/srv"
                    xmlns:dc="http://purl.org/dc/elements/1.1/"
                    xmlns:dct="http://purl.org/dc/terms/"
                    xmlns:ows="http://www.opengis.net/ows"
                    xmlns:xi="http://www.w3.org/2001/XInclude"
                    xmlns:xlink="http://www.w3.org/1999/xlink"
                    xmlns:xs="http://www.w3.org/2001/XMLSchema"
                    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                    service="CSW"
                    version="2.0.2">
  <csw:TypeName>gmd:MD_Metadata</csw:TypeName>
</csw:DescribeRecord>
```

Example 18-16 DescribeRecord Response

The following is the response from the preceding request. The response is an XML schema definition (XSD). See the `<xsd:documentation>` elements in the response for explanatory comments.

```
<?xml version='1.0' encoding='UTF-8'?>
<csw:DescribeRecordResponse xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:dct="http://purl.org/dc/terms/"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xmlns:xlink="http://www.w3.org/1999/xlink" xsi:schemaLocation="http://
www.opengis.net/cat/csw/2.0.2 http://schemas.opengis.net/csw/2.0.2/CSW-discovery.xsd">
  <csw:SchemaComponent schemaLanguage="http://www.w3.org/XML/Schema"
targetNamespace="http://www.isotc211.org/2005/gmd">
        <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:xlink="http://
www.w3.org/1999/xlink" xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:gmd="http://
www.isotc211.org/2005/gmd" targetNamespace="http://www.isotc211.org/2005/gmd"
elementFormDefault="qualified" version="2012-07-13">
            <!-- ================================= Annotation
================================ -->
            <xs:annotation>
                <xs:documentation>Geographic MetaData (GMD) extensible markup language
is a component of the XML Schema Implementation of Geographic Information Metadata
documented in ISO/TS 19139:2007. GMD includes all the definitions of http://
www.isotc211.org/2005/gmd namespace. The root document of this namespace is the file
gmd.xsd. This metadataEntity.xsd schema implements the UML conceptual schema defined in
A.2.1 of ISO 19115:2003. It contains the implementation of the class MD_Metadata.</
xs:documentation>
            </xs:annotation>
            <!-- ================================== Imports
================================== -->
            <xs:import namespace="http://www.isotc211.org/2005/gco"
schemaLocation="http://schemas.opengis.net/iso/19139/20070417/gco/gco.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/gmd.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/spatialrepresentation.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/metadataextension.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/content.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/metadataapplication.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/applicationschema.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/portrayalcatalogue.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/dataquality.xsd"/>
            <xs:include schemaLocation="http://schemas.opengis.net/iso/
19139/20070417/gmd/freetext.xsd"/>
            <!--
########################################################################### -->
            <!--
########################################################################### -->
```

```
            <!-- ================================== Classes
================================== -->
            <xs:complexType name="MD_Metadata_Type">
                <xs:annotation>
                    <xs:documentation>Information about the metadata</xs:documentation>
                </xs:annotation>
                <xs:complexContent>
                    <xs:extension base="gco:AbstractObject_Type">
                        <xs:sequence>
                            <xs:element name="fileIdentifier"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="language"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="characterSet"
type="gmd:MD_CharacterSetCode_PropertyType" minOccurs="0"/>
                            <xs:element name="parentIdentifier"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="hierarchyLevel"
type="gmd:MD_ScopeCode_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="hierarchyLevelName"
type="gco:CharacterString_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="contact"
type="gmd:CI_ResponsibleParty_PropertyType" maxOccurs="unbounded"/>
                            <xs:element name="dateStamp" type="gco:Date_PropertyType"/>
                            <xs:element name="metadataStandardName"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="metadataStandardVersion"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="dataSetURI"
type="gco:CharacterString_PropertyType" minOccurs="0"/>
                            <xs:element name="locale" type="gmd:PT_Locale_PropertyType"
minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="spatialRepresentationInfo"
type="gmd:MD_SpatialRepresentation_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="referenceSystemInfo"
type="gmd:MD_ReferenceSystem_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="metadataExtensionInfo"
type="gmd:MD_MetadataExtensionInformation_PropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                            <xs:element name="identificationInfo"
type="gmd:MD_Identification_PropertyType" maxOccurs="unbounded"/>
                            <xs:element name="contentInfo"
type="gmd:MD_ContentInformation_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="distributionInfo"
type="gmd:MD_Distribution_PropertyType" minOccurs="0"/>
                            <xs:element name="dataQualityInfo"
type="gmd:DQ_DataQuality_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="portrayalCatalogueInfo"
type="gmd:MD_PortrayalCatalogueReference_PropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                            <xs:element name="metadataConstraints"
type="gmd:MD_Constraints_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="applicationSchemaInfo"
type="gmd:MD_ApplicationSchemaInformation_PropertyType" minOccurs="0"
maxOccurs="unbounded"/>
                            <xs:element name="metadataMaintenance"
type="gmd:MD_MaintenanceInformation_PropertyType" minOccurs="0"/>
                            <xs:element name="series"
type="gmd:DS_Aggregate_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="describes"
type="gmd:DS_DataSet_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="propertyType"
```

```
type="gco:ObjectReference_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="featureType"
type="gco:ObjectReference_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="featureAttribute"
type="gco:ObjectReference_PropertyType" minOccurs="0" maxOccurs="unbounded"/>
                        </xs:sequence>
                    </xs:extension>
                </xs:complexContent>
            </xs:complexType>

<!-- ........................................................................ -->
            <xs:element name="MD_Metadata" type="gmd:MD_Metadata_Type"/>

<!-- ........................................................................ -->
            <xs:complexType name="MD_Metadata_PropertyType">
                <xs:sequence minOccurs="0">
                    <xs:element ref="gmd:MD_Metadata"/>
                </xs:sequence>
                <xs:attributeGroup ref="gco:ObjectReference"/>
                <xs:attribute ref="gco:nilReason"/>
            </xs:complexType>
            <!--
=========================================================================== -->
        </xs:schema>
  </csw:SchemaComponent>
</csw:DescribeRecordResponse>
```

18.6.3.3 GetRecords Operation (CSW, ISO)

The primary tools for resource discovery in CSW are the two operations: **search** and **present**. In the HTTP protocol binding these are combined in the form of the GetRecords operation, which performs a search and present.

The “search” portion of the GetRecords operation is encoded using the `Query` element, which includes the parameters parameters `typeName` and `Constraint`.

- The `typeName` parameter is used to specify which entities (record Types) of the catalog service will be queried.
- The Constraint parameter is used to specify which query constraints will be applied to identify the request set.

The “present” portion of the GetRecords operation is encoded using the `outputSchema` parameter and the `ElementName`/`ElementSetName` parameter(s).

- The `outputSchema` parameter indicates which XSD schema (that is, `http://www.opengis.net/cat/csw/2.0.2`) will be used to generate the response to the GetRecords operation.
- The `ElementName` or `ElementSetName` parameter is used to specify which properties of the `outputSchema` to include in each record in the GetRecords response.

(The following description does not repeat some parameters also used with DescribeRecord, such as `namespace` and `outputFormat`.)

The `resultType` parameter may have the value `hits`, `results`, or `validate`. The value determines whether the catalog service returns just a summary of the result set (`hits`), includes one or more records from the result set (`results`), or validates the request message (`validate`).

The `startPosition` parameter is used to indicate at which record position the catalog should start generating output. The default value is 1, meaning that it starts at the first record in the result set.

The `maxRecords` parameter is used to define the maximum number of records that should be returned from the result set of a query. If it is not specified, then 10 records will be returned. If its value is set to zero, then the behavior is identical to setting `resultType` to `hits`.

The `typeNames` parameter is a list of one or more names of queryable entities in the catalog's information model that may be constrained in the predicate of the query. (`god:MD_Metadata` indicates the ISO profile.)

The `ElementName` parameter is used to specify one or more metadata record elements, from the output schema specified using the `outputSchema` parameter, so that the query will be present in the response to a GetRecords operation.

The `ElementSetName` parameter can be brief, summary, comprehensive, or full, to indicate which named set the service will present to the client.

The `ElementName` and `ElementSetName` parameters are mutually exclusive. Either an `ElementSetName` parameter or one or more `ElementSetName` parameters should be specified in a query.

The `ConstraintLanguage` parameter must be `Filter` for the Oracle Spatial CSW service. (`CQL` is not supported for the ISO profile.)

The `constraint` parameter specifies which filtering capabilities are used to get certain records. The following filtering capabilities are supported by the Oracle Spatial CSW service:

- Logical operators: And, Or, Not
- Comparison operators: PropertyIsEqualTo, PropertyIsNotEqualTo, PropertyIsLessThan, PropertyIsGreaterThan, PropertyIsLessThanOrEqualTo, PropertyIsGreaterThanOrEqualTo, PropertyIsLike, PropertyIsNull, csw:AnyText
- Spatial operators: BBOX
- Simple arithmetic: add, sub, div, mul, function

The `GetRecordsResponse` element is a container for the response to the GetRecords request.

The `SearchStatus` element indicates the status of the response. The search status consists of a timestamp attribute indicating when the result set was created.

The `SearchResults` element contains the `SearchResults` element, which is the set of records returned by the GetRecords operation. The following attributes can be used with the `SearchResults` element: `ElementSet(brief/summary/full)`, `numberOfRecordaMatched`, `numberOfRecordsReturned`, `nextRecord`.

Oracle Spatial Catalog Service supports HTTP GET, POST XML and SOAP protocols for the GetRecords operation.

Example 18-17   GetRecords Request with PropertyIsEqualTo and PropertyIsLike

The following is a request to GetRecords with `PropertyIsEqualTo` and `PropertyIsLike` specified. It finds the result set of records where the type is equal to the string data set or where the format is a String value containing the “WAR” token. (The following characters are flexible: `escapeChar`, `singleChar`, and `wildcard`.)

```
<csw:GetRecords
                xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:srv="http://www.isotc211.org/2005/srv"
                xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementSetName>summary</csw:ElementSetName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:Or>
               <ogc:PropertyIsLike escapeChar="\" singleChar="?" wildCard="*">
                  <ogc:PropertyName>apiso:format</ogc:PropertyName>
                  <ogc:Literal>WAR</ogc:Literal>
               </ogc:PropertyIsLike>
               <ogc:PropertyIsEqualTo>
                  <ogc:PropertyName>apiso:type</ogc:PropertyName>
                  <ogc:Literal>dataset</ogc:Literal>
               </ogc:PropertyIsEqualTo>
            </ogc:Or>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

For GetRecords Requests, `ElementSetName` can be `summary`, `full`, or `brief`, or `comprehensive`.

The CSW 2.0.2 specification allows either `ElementSetName` (only 1) or `ElementName` (can be more than 1) in the GetRecords Request.

The Spatial catalog service supports only synchronous processing of GetRecords requests.

Example 18-18 GetRecords Response with PropertyIsEqualTo and PropertyIsLike

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:srv="http://www.isotc211.org/2005/
srv" xmlns:dct="http://purl.org/dc/terms/" xmlns:ns7="http://www.opengis.net/ows/2.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:gco="http://www.isotc211.org/
2005/gco" version="2.0.2" xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../
cswAll.xsd">
  <csw:SearchStatus timestamp="2017-09-28T02:26:48Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="summary" recordSchema="http://www.isotc211.org/2005/
gmd" numberOfRecordsMatched="2" numberOfRecordsReturned="2" nextRecord="0">
    <csw:SummaryRecordISO>
      <gmd:abstract>This feature class is Test Data for Oracle CSW 2.0.2 Service.</
gmd:abstract>
      <gmd:creator>Jane Doe</gmd:creator>
      <gmd:EX_GeographicBoundingBox dimensions="2">
        <gmd:WestBoundLongitude>-109.047013285</gmd:WestBoundLongitude>
        <gmd:SouthBoundLatitude>34.2585812994</gmd:SouthBoundLatitude>
        <gmd:EastBoundLongitude>-106.876969333</gmd:EastBoundLongitude>
        <gmd:NorthBoundLatitude>37.0002329277</gmd:NorthBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
      <gmd:format>WAR</gmd:format>
      <gmd:format>ZIP</gmd:format>
      <gmd:formatVersion>12.2.0.2</gmd:formatVersion>
      <gmd:formatVersion>Unknown Format Version</gmd:formatVersion>
      <gmd:graphicOverview>
        <gmd:MD_BrowseGraphic>
          <gmd:fileName>webservice_catalog_services.png</gmd:fileName>
          <gmd:fileDescription>large_thumbnail</gmd:fileDescription>
          <gmd:fileType>png</gmd:fileType>
        </gmd:MD_BrowseGraphic>
      </gmd:graphicOverview>
      <gmd:hierarchyLevelName>UTI</gmd:hierarchyLevelName>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8cccc</gmd:fileIdentifier>
      <gmd:language>eng</gmd:language>
      <gmd:lineage>
        <gmd:LI_Lineage>
          <gmd:statement>DATA FROM TNRIS</gmd:statement>
          <gmd:processStep>
            <gmd:LI_ProcessStep>
              <gmd:description>The data was downloaded from TNRIS</gmd:description>
              <gmd:rationale>No rationale</gmd:rationale>
              <gmd:dateTime>
                <gco:DateTime>1998-01-01T00:00:00.000Z</gco:DateTime>
              </gmd:dateTime>
              <gmd:processor>
                <gmd:CI_ResponsibleParty>
                  <gmd:individualName>No individualName</gmd:individualName>
                  <gmd:organisationName>Oracle Spatial Labs</gmd:organisationName>
                  <gmd:positionName>Technical Member</gmd:positionName>
                  <gmd:contactInfo>
                    <gmd:CI_Contact>
                      <gmd:phone>
                        <gmd:CI_Telephone>
                          <csw:voice>603-897-8888</csw:voice>
                          <csw:facsimile>603-897-4444</csw:facsimile>
                        </gmd:CI_Telephone>
                     </gmd:phone>
                      <gmd:address>
                        <gmd:CI_Address>
                          <gmd:deliveryPoint>ABC03 3330</gmd:deliveryPoint>
                          <gmd:deliveryPoint>3 Oracle Drive</gmd:deliveryPoint>
                          <gmd:city>Nashua</gmd:city>
                          <gmd:administrativeArea>NH</gmd:administrativeArea>
                          <gmd:postalCode>03062-0003</gmd:postalCode>
                          <gmd:country>USA</gmd:country>
                          <gmd:electronicMailAddress>baris.kazar@oracle.com</
gmd:electronicMailAddress>
                        </gmd:CI_Address>
                      </gmd:address>
                      <gmd:onlineResource>
                        <gmd:CI_OnlineResource>
                          <gmd:linkage>http://www.myoracle.com/</gmd:linkage>
                          <gmd:protocol>HTTP</gmd:protocol>
                          <gmd:applicationProfile>The web browser</
gmd:applicationProfile>
                          <gmd:name>The Data Dictionary</gmd:name>
                          <gmd:description>This http link contains the data dictionary
```

```
for the resource.</gmd:description>
                          <gmd:function>
                            <gmd:CI_OnLineFunctionCode codeList="http://www.isotc211.org/
2005/resources/Codelist/gmxCodelists.xml#CI_OnLineFunctionCode"
codeListValue="information" codeSpace="002">information</gmd:CI_OnLineFunctionCode>
                          </gmd:function>
                        </gmd:CI_OnlineResource>
                      </gmd:onlineResource>
                      <gmd:hoursOfService>8AM - 7PM Eastern Time</gmd:hoursOfService>
                      <gmd:contactInstructions>No contactInstructions</
gmd:contactInstructions>
                    </gmd:CI_Contact>
                  </gmd:contactInfo>
                  <gmd:role>
                    <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/
Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="processor" codeSpace="No value"></
gmd:CI_RoleCode>
                  </gmd:role>
                </gmd:CI_ResponsibleParty>
              </gmd:processor>
            </gmd:LI_ProcessStep>
          </gmd:processStep>
        </gmd:LI_Lineage>
      </gmd:lineage>
      <gmd:metadataCharacterSet>utf8</gmd:metadataCharacterSet>
      <gmd:metadataStandardName>ISO19115</gmd:metadataStandardName>
      <gmd:metadataStandardVersion>2003/Cor.1:2008</gmd:metadataStandardVersion>
      <gmd:modified>2015-10-22</gmd:modified>
      <gmd:onlineResource>http://www.oracle.com/oraclespatial/mycsw1/</
gmd:onlineResource>
      <gmd:parentIdentifier>CSW-WEB-SERVICES</gmd:parentIdentifier>
      <gmd:publisher>Ali Ali</gmd:publisher>
      <gmd:resourceIdentifier>Downloadable Data</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>GHRSST &gt; Group for High Resolution Sea Surface
Temperature</gmd:resourceIdentifier>
      <gmd:resourceLanguage>eng; USA</gmd:resourceLanguage>
      <gmd:referenceSystem>
        <gmd:code> urn:ogc:def:crs:EPSG:4957</gmd:code>
        <gmd:codeSpace>http://someurl</gmd:codeSpace>
        <gmd:version>6.18.3</gmd:version>
      </gmd:referenceSystem>
      <gmd:revisionDate>2017-03-21</gmd:revisionDate>
      <gmd:rights>otherRestrictions</gmd:rights>
      <gmd:spatialResolution>
        <gmd:denominator>25000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution>
        <gmd:denominator>50000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>3.0</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>2.0</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialRepresentationType>vector</gmd:spatialRepresentationType>
      <gmd:title>European Petroleum Survey Group (EPSG) Geodetic Parameter Registry</
gmd:title>
      <gmd:title>Oracle CSW 2.0.2 Service Record</gmd:title>
      <gmd:topicCategory>planningCadastre</gmd:topicCategory>
      <gmd:type>dataset</gmd:type>
    </csw:SummaryRecordISO>
    <csw:SummaryRecordISO>
      <gmd:abstract>This feature class is Test Data for Oracle CSW 2.0.2 Service.</
gmd:abstract>
      <gmd:characterSet>utf16</gmd:characterSet>
      <gmd:contributor>John Doe</gmd:contributor>
      <gmd:EX_GeographicBoundingBox dimensions="2">
        <gmd:WestBoundLongitude>-119.047013285</gmd:WestBoundLongitude>
        <gmd:SouthBoundLatitude>24.2585812994</gmd:SouthBoundLatitude>
        <gmd:EastBoundLongitude>-116.876969333</gmd:EastBoundLongitude>
        <gmd:NorthBoundLatitude>27.0002329277</gmd:NorthBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
      <gmd:format>ZIP</gmd:format>
      <gmd:formatVersion>Unknown Format Version</gmd:formatVersion>
      <gmd:graphicOverview>
        <gmd:MD_BrowseGraphic>
          <gmd:fileName>webservice_catalog_services2.jpeg</gmd:fileName>
          <gmd:fileDescription>medium_thumbnail</gmd:fileDescription>
          <gmd:fileType>jpeg</gmd:fileType>
        </gmd:MD_BrowseGraphic>
      </gmd:graphicOverview>
      <gmd:hierarchyLevelName>UTI</gmd:hierarchyLevelName>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8dddd</gmd:fileIdentifier>
      <gmd:language>eng</gmd:language>
      <gmd:lineage>
        <gmd:LI_Lineage>
          <gmd:statement>No statement</gmd:statement>
          <gmd:processStep>
            <gmd:LI_ProcessStep>
              <gmd:description>The data was downloaded from TNRIS</gmd:description>
              <gmd:rationale>No rationale</gmd:rationale>
              <gmd:dateTime>
                <gco:DateTime>1999-01-01T00:00:00.000Z</gco:DateTime>
              </gmd:dateTime>
              <gmd:processor>
                <gmd:CI_ResponsibleParty>
                  <gmd:individualName>No individualName</gmd:individualName>
                  <gmd:organisationName>Oracle Spatial Labs</gmd:organisationName>
                  <gmd:positionName>Manager</gmd:positionName>
                  <gmd:contactInfo>
                    <gmd:CI_Contact>
                      <gmd:phone>
                        <gmd:CI_Telephone>
                          <csw:voice>603-897-7777</csw:voice>
                          <csw:facsimile>603-897-5555</csw:facsimile>
                        </gmd:CI_Telephone>
                      </gmd:phone>
                      <gmd:address>
                        <gmd:CI_Address>
                          <gmd:deliveryPoint>ABC03 3330</gmd:deliveryPoint>
                          <gmd:deliveryPoint>3 Oracle Drive</gmd:deliveryPoint>
                          <gmd:city>Nashua</gmd:city>
                          <gmd:administrativeArea>NH</gmd:administrativeArea>
                          <gmd:postalCode>03062-0003</gmd:postalCode>
                          <gmd:country>USA</gmd:country>
                          <gmd:electronicMailAddress>qingyun.xie@oracle.com</
gmd:electronicMailAddress>
                        </gmd:CI_Address>
                      </gmd:address>
                      <gmd:hoursOfService>8AM - 7PM Eastern Time</gmd:hoursOfService>
                      <gmd:contactInstructions>No contactInstructions</
gmd:contactInstructions>
                    </gmd:CI_Contact>
                  </gmd:contactInfo>
                  <gmd:role>
                    <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/
Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="processor" codeSpace="No
value">processor</gmd:CI_RoleCode>
                  </gmd:role>
                </gmd:CI_ResponsibleParty>
              </gmd:processor>
            </gmd:LI_ProcessStep>
          </gmd:processStep>
        </gmd:LI_Lineage>
      </gmd:lineage>
      <gmd:metadataCharacterSet>utf8</gmd:metadataCharacterSet>
      <gmd:metadataStandardName>ISO19139</gmd:metadataStandardName>
      <gmd:metadataStandardVersion>2003/Cor.1:2006</gmd:metadataStandardVersion>
      <gmd:modified>2015-10-21</gmd:modified>
      <gmd:onlineResource>http://www.oracle.com/oraclespatial/mycsw2/</
gmd:onlineResource>
      <gmd:parentIdentifier>CSW-WEB-SERVICES</gmd:parentIdentifier>
      <gmd:resourceIdentifier>Downloadable Data</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:de.pangaea:project:IODP</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302:site:M0001</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302:site:M0001:hole:A</
gmd:resourceIdentifier>
      <gmd:resourceLanguage>eng; USA</gmd:resourceLanguage>
      <gmd:referenceSystem>
        <gmd:code> urn:ogc:def:crs:EPSG:4957</gmd:code>
        <gmd:codeSpace>No codeSpace value for ReferenceSystem</gmd:codeSpace>
        <gmd:version>6.18.3</gmd:version>
      </gmd:referenceSystem>
      <gmd:revisionDate>2015-11-23T14:44:00</gmd:revisionDate>
      <gmd:rights>license</gmd:rights>
      <gmd:spatialResolution>
        <gmd:denominator>60000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf2/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>2.8</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialRepresentationType>vector</gmd:spatialRepresentationType>
      <gmd:title>European Petroleum Survey Group (EPSG) Geodetic Parameter Registry</
gmd:title>
      <gmd:title>Oracle CSW 2.0.2 Service Record</gmd:title>
      <gmd:topicCategory>planningCadastre</gmd:topicCategory>
      <gmd:type>dataset</gmd:type>
    </csw:SummaryRecordISO>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-19 GetRecords Request with PropertyIsLike

The following is a request to GetRecords with `PropertyIsLike` where the client wants to fetch records whose property title is like “Oracle CSW*Service”. (The following characters are flexible: `escapeChar`, `singleChar`, and `wildcard`.)

```
<csw:GetRecords
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
```

```
                 xmlns:srv="http://www.isotc211.org/2005/srv"
                 xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                 xmlns:dc="http://purl.org/dc/elements/1.1/"
                 xmlns:dct="http://purl.org/dc/terms/"
                 xmlns:gml="http://www.opengis.net/gml"
                 xmlns:ogc="http://www.opengis.net/ogc"
                 xmlns:ows="http://www.opengis.net/ows"
                 xmlns:xi="http://www.w3.org/2001/XInclude"
                 xmlns:xlink="http://www.w3.org/1999/xlink"
                 xmlns:xs="http://www.w3.org/2001/XMLSchema"
                 xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                 resultType="results"
                 service="CSW"
                 version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementSetName>summary</csw:ElementSetName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:PropertyIsLike escapeChar="\" singleChar="?" wildCard="*">
               <ogc:PropertyName>apiso:title</ogc:PropertyName>
               <ogc:Literal>Oracle CSW*Service*</ogc:Literal>
            </ogc:PropertyIsLike>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-20   GetRecords Response with PropertyIsLike

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:srv="http://www.isotc211.org/2005/
srv" xmlns:dct="http://purl.org/dc/terms/" xmlns:ns7="http://www.opengis.net/ows/2.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:gco="http://www.isotc211.org/
2005/gco" version="2.0.2" xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../
cswAll.xsd">
  <csw:SearchStatus timestamp="2017-09-14T01:32:01Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="summary" recordSchema="http://www.isotc211.org/2005/
gmd" numberOfRecordsMatched="2" numberOfRecordsReturned="2" nextRecord="0">
    <csw:SummaryRecordISO>
      <gmd:abstract>This feature class is Test Data for Oracle CSW 2.0.2 Service.</
gmd:abstract>
      <gmd:creator>Jane Doe</gmd:creator>
      <gmd:EX_GeographicBoundingBox dimensions="2">
        <gmd:WestBoundLongitude>-109.047013285</gmd:WestBoundLongitude>
        <gmd:SouthBoundLatitude>34.2585812994</gmd:SouthBoundLatitude>
        <gmd:EastBoundLongitude>-106.876969333</gmd:EastBoundLongitude>
        <gmd:NorthBoundLatitude>37.0002329277</gmd:NorthBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
      <gmd:format>WAR</gmd:format>
      <gmd:format>ZIP</gmd:format>
      <gmd:formatVersion>12.2.0.2</gmd:formatVersion>
      <gmd:formatVersion>Unknown Format Version</gmd:formatVersion>
      <gmd:graphicOverview>
        <gmd:MD_BrowseGraphic>
          <gmd:fileName>webservice_catalog_services.png</gmd:fileName>
          <gmd:fileDescription>large_thumbnail</gmd:fileDescription>
          <gmd:fileType>png</gmd:fileType>
        </gmd:MD_BrowseGraphic>
      </gmd:graphicOverview>
      <gmd:hierarchyLevelName>UTI</gmd:hierarchyLevelName>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8cccc</gmd:fileIdentifier>
      <gmd:language>eng</gmd:language>
      <gmd:lineage>
        <gmd:LI_Lineage>
          <gmd:statement>DATA FROM TNRIS</gmd:statement>
          <gmd:processStep>
            <gmd:LI_ProcessStep>
              <gmd:description>The data was downloaded from TNRIS</gmd:description>
              <gmd:rationale>No rationale</gmd:rationale>
              <gmd:dateTime>
                <gco:DateTime>1998-01-01T00:00:00.000-08:00</gco:DateTime>
              </gmd:dateTime>
              <gmd:processor>
                <gmd:CI_ResponsibleParty>
                  <gmd:individualName>No individualName</gmd:individualName>
                  <gmd:organisationName>Oracle Spatial Labs</gmd:organisationName>
                  <gmd:positionName>Technical Member</gmd:positionName>
                  <gmd:contactInfo>
                    <gmd:CI_Contact>
                      <gmd:phone>
                        <gmd:CI_Telephone>
                          <csw:voice>603-897-8888</csw:voice>
                          <csw:facsimile>603-897-4444</csw:facsimile>
                        </gmd:CI_Telephone>
                      </gmd:phone>
                      <gmd:address>
                        <gmd:CI_Address>
                          <gmd:deliveryPoint>ABC03 3330</gmd:deliveryPoint>
                          <gmd:deliveryPoint>3 Oracle Drive</gmd:deliveryPoint>
                          <gmd:city>Nashua</gmd:city>
                          <gmd:administrativeArea>NH</gmd:administrativeArea>
                          <gmd:postalCode>03062-0003</gmd:postalCode>
                          <gmd:country>USA</gmd:country>
                          <gmd:electronicMailAddress>baris.kazar@oracle.com</
gmd:electronicMailAddress>
                        </gmd:CI_Address>
                      </gmd:address>
                      <gmd:onlineResource>
                        <gmd:CI_OnlineResource>
                          <gmd:linkage>http://www.myoracle.com/</gmd:linkage>
                          <gmd:protocol>HTTP</gmd:protocol>
                          <gmd:applicationProfile>The web browser</
gmd:applicationProfile>
                          <gmd:name>The Data Dictionary</gmd:name>
                          <gmd:description>This http link contains the data dictionary
for the resource.</gmd:description>
                          <gmd:function>
                            <gmd:CI_OnLineFunctionCode codeList="http://www.isotc211.org/
2005/resources/Codelist/gmxCodelists.xml#CI_OnLineFunctionCode"
codeListValue="information" codeSpace="002">information</gmd:CI_OnLineFunctionCode>
                          </gmd:function>
                        </gmd:CI_OnlineResource>
                      </gmd:onlineResource>
                      <gmd:hoursOfService>8AM - 7PM Eastern Time</gmd:hoursOfService>
                      <gmd:contactInstructions>No contactInstructions</
gmd:contactInstructions>
                    </gmd:CI_Contact>
                  </gmd:contactInfo>
                  <gmd:role>
```

```
                    <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/
Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="processor" codeSpace="No value"></
gmd:CI_RoleCode>
                  </gmd:role>
                </gmd:CI_ResponsibleParty>
              </gmd:processor>
            </gmd:LI_ProcessStep>
          </gmd:processStep>
        </gmd:LI_Lineage>
      </gmd:lineage>
      <gmd:metadataCharacterSet>utf8</gmd:metadataCharacterSet>
      <gmd:metadataStandardName>ISO19115</gmd:metadataStandardName>
      <gmd:metadataStandardVersion>2003/Cor.1:2008</gmd:metadataStandardVersion>
      <gmd:modified>2015-10-22</gmd:modified>
      <gmd:onlineResource>http://www.oracle.com/oraclespatial/mycsw1/</
gmd:onlineResource>
      <gmd:parentIdentifier>CSW-WEB-SERVICES</gmd:parentIdentifier>
      <gmd:publisher>Ali Ali</gmd:publisher>
      <gmd:resourceIdentifier>Downloadable Data</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>GHRSST &gt; Group for High Resolution Sea Surface
Temperature</gmd:resourceIdentifier>
      <gmd:resourceLanguage>eng; USA</gmd:resourceLanguage>
      <gmd:referenceSystem>
        <gmd:code> urn:ogc:def:crs:EPSG:4957</gmd:code>
        <gmd:codeSpace>http://someurl</gmd:codeSpace>
        <gmd:version>6.18.3</gmd:version>
      </gmd:referenceSystem>
      <gmd:revisionDate>2017-03-21</gmd:revisionDate>
      <gmd:rights>otherRestrictions</gmd:rights>
      <gmd:spatialResolution>
        <gmd:denominator>25000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution>
        <gmd:denominator>50000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>3.0</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>2.0</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialRepresentationType>vector</gmd:spatialRepresentationType>
      <gmd:title>European Petroleum Survey Group (EPSG) Geodetic Parameter Registry</
gmd:title>
      <gmd:title>Oracle CSW 2.0.2 Service Record</gmd:title>
      <gmd:topicCategory>planningCadastre</gmd:topicCategory>
      <gmd:type>dataset</gmd:type>
    </csw:SummaryRecordISO>
    <csw:SummaryRecordISO>
      <gmd:abstract>This feature class is Test Data for Oracle CSW 2.0.2 Service.</
gmd:abstract>
      <gmd:characterSet>utf16</gmd:characterSet>
      <gmd:contributor>John Doe</gmd:contributor>
      <gmd:EX_GeographicBoundingBox dimensions="2">
        <gmd:WestBoundLongitude>-119.047013285</gmd:WestBoundLongitude>
        <gmd:SouthBoundLatitude>24.2585812994</gmd:SouthBoundLatitude>
        <gmd:EastBoundLongitude>-116.876969333</gmd:EastBoundLongitude>
        <gmd:NorthBoundLatitude>27.0002329277</gmd:NorthBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
      <gmd:format>ZIP</gmd:format>
      <gmd:formatVersion>Unknown Format Version</gmd:formatVersion>
      <gmd:graphicOverview>
        <gmd:MD_BrowseGraphic>
          <gmd:fileName>webservice_catalog_services2.jpeg</gmd:fileName>
          <gmd:fileDescription>medium_thumbnail</gmd:fileDescription>
          <gmd:fileType>jpeg</gmd:fileType>
        </gmd:MD_BrowseGraphic>
      </gmd:graphicOverview>
      <gmd:hierarchyLevelName>UTI</gmd:hierarchyLevelName>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8dddd</gmd:fileIdentifier>
      <gmd:language>eng</gmd:language>
      <gmd:lineage>
        <gmd:LI_Lineage>
          <gmd:statement>No statement</gmd:statement>
          <gmd:processStep>
            <gmd:LI_ProcessStep>
              <gmd:description>The data was downloaded from TNRIS</gmd:description>
              <gmd:rationale>No rationale</gmd:rationale>
              <gmd:dateTime>
                <gco:DateTime>1999-01-01T00:00:00.000-08:00</gco:DateTime>
              </gmd:dateTime>
              <gmd:processor>
                <gmd:CI_ResponsibleParty>
                  <gmd:individualName>No individualName</gmd:individualName>
                  <gmd:organisationName>Oracle Spatial Labs</gmd:organisationName>
                  <gmd:positionName>Manager</gmd:positionName>
                  <gmd:contactInfo>
                    <gmd:CI_Contact>
                      <gmd:phone>
                        <gmd:CI_Telephone>
                          <csw:voice>603-897-7777</csw:voice>
                          <csw:facsimile>603-897-5555</csw:facsimile>
                        </gmd:CI_Telephone>
                      </gmd:phone>
                      <gmd:address>
                        <gmd:CI_Address>
                          <gmd:deliveryPoint>ABC03 3330</gmd:deliveryPoint>
                          <gmd:deliveryPoint>3 Oracle Drive</gmd:deliveryPoint>
                          <gmd:city>Nashua</gmd:city>
                          <gmd:administrativeArea>NH</gmd:administrativeArea>
                          <gmd:postalCode>03062-0003</gmd:postalCode>
                          <gmd:country>USA</gmd:country>
                          <gmd:electronicMailAddress>qingyun.xie@oracle.com</
gmd:electronicMailAddress>
                        </gmd:CI_Address>
                      </gmd:address>
                      <gmd:hoursOfService>8AM - 7PM Eastern Time</gmd:hoursOfService>
                      <gmd:contactInstructions>No contactInstructions</
gmd:contactInstructions>
                    </gmd:CI_Contact>
                  </gmd:contactInfo>
                  <gmd:role>
                    <gmd:CI_RoleCode codeList="http://www.isotc211.org/2005/resources/
Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="processor" codeSpace="No
value">processor</gmd:CI_RoleCode>
                  </gmd:role>
                </gmd:CI_ResponsibleParty>
              </gmd:processor>
            </gmd:LI_ProcessStep>
          </gmd:processStep>
        </gmd:LI_Lineage>
      </gmd:lineage>
      <gmd:metadataCharacterSet>utf8</gmd:metadataCharacterSet>
      <gmd:metadataStandardName>ISO19139</gmd:metadataStandardName>
      <gmd:metadataStandardVersion>2003/Cor.1:2006</gmd:metadataStandardVersion>
      <gmd:modified>2015-10-21</gmd:modified>
      <gmd:onlineResource>http://www.oracle.com/oraclespatial/mycsw2/</
gmd:onlineResource>
      <gmd:parentIdentifier>CSW-WEB-SERVICES</gmd:parentIdentifier>
      <gmd:resourceIdentifier>Downloadable Data</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:de.pangaea:project:IODP</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302:site:M0001</gmd:resourceIdentifier>
      <gmd:resourceIdentifier>urn:org.iodp:exp:302:site:M0001:hole:A</
gmd:resourceIdentifier>
      <gmd:resourceLanguage>eng; USA</gmd:resourceLanguage>
      <gmd:referenceSystem>
        <gmd:code> urn:ogc:def:crs:EPSG:4957</gmd:code>
        <gmd:codeSpace>No codeSpace value for ReferenceSystem</gmd:codeSpace>
        <gmd:version>6.18.3</gmd:version>
      </gmd:referenceSystem>
      <gmd:revisionDate>2015-11-23T14:44:00</gmd:revisionDate>
      <gmd:rights>license</gmd:rights>
      <gmd:spatialResolution>
        <gmd:denominator>60000</gmd:denominator>
      </gmd:spatialResolution>
      <gmd:spatialResolution uom="http://standards.iso.org/ittf2/
PubliclyAvailableStandards/ISO_19139_Schemas/resources/uom/gmxUom.xml#m">
        <gmd:distance>2.8</gmd:distance>
      </gmd:spatialResolution>
      <gmd:spatialRepresentationType>vector</gmd:spatialRepresentationType>
      <gmd:title>European Petroleum Survey Group (EPSG) Geodetic Parameter Registry</
gmd:title>
      <gmd:title>Oracle CSW 2.0.2 Service Record</gmd:title>
      <gmd:topicCategory>planningCadastre</gmd:topicCategory>
      <gmd:type>dataset</gmd:type>
    </csw:SummaryRecordISO>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-21 GetRecords Request with PropertyIsGreaterThan

The following is a request to GetRecords with PropertyIsGreaterThan where the client would like to fetch records where their dates are later than the date value 2004-01-01.

```
<csw:GetRecords
                xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:srv="http://www.isotc211.org/2005/srv"
                xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementName>apiso:identifier</csw:ElementName>
```

```
        <csw:ElementName>apiso:type</csw:ElementName>
        <csw:ElementName>apiso:modified</csw:ElementName>
        <csw:Constraint version="1.1.0">
           <ogc:Filter>
              <ogc:PropertyIsGreaterThan>
                 <ogc:PropertyName>apiso:modified</ogc:PropertyName>
                 <ogc:Literal>2004-01-01Z</ogc:Literal>
              </ogc:PropertyIsGreaterThan>
           </ogc:Filter>
        </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-22   GetRecords Response with PropertyIsGreaterThan

The following is the response from the preceding request.

```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:srv="http://www.isotc211.org/2005/
srv" xmlns:dct="http://purl.org/dc/terms/" xmlns:ns7="http://www.opengis.net/ows/2.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:gco="http://www.isotc211.org/
2005/gco" version="2.0.2" xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../
cswAll.xsd">
  <csw:SearchStatus timestamp="2017-06-06T06:34:22Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="" recordSchema="http://www.isotc211.org/2005/gmd"
numberOfRecordsMatched="2" numberOfRecordsReturned="2" nextRecord="0">
    <csw:RecordISO>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8cccc</gmd:fileIdentifier>
      <gmd:modified>2015-10-22</gmd:modified>
      <gmd:type>dataset</gmd:type>
    </csw:RecordISO>
    <csw:RecordISO>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8dddd</gmd:fileIdentifier>
      <gmd:modified>2015-10-21</gmd:modified>
      <gmd:type>dataset</gmd:type>
    </csw:RecordISO>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

Example 18-23   GetRecords Request with BoundingBox (BBOX)

The following is a request to GetRecords with `BoundingBox` (BBOX) where the client wants to fetch records whose geometry falls into the Bounding Box of (60,12;70, 20) This request benefits from both spatial and XQFT indexes.

```
csw:GetRecords
                xmlns:csw="http://www.opengis.net/cat/csw/2.0.2"
                xmlns:apiso="http://www.opengis.net/cat/csw/apiso/1.0"
                xmlns:gmd="http://www.isotc211.org/2005/gmd"
                xmlns:srv="http://www.isotc211.org/2005/srv"
                xmlns:dc="http://purl.org/dc/elements/1.1/"
                xmlns:dct="http://purl.org/dc/terms/"
                xmlns:gml="http://www.opengis.net/gml"
                xmlns:ogc="http://www.opengis.net/ogc"
                xmlns:ows="http://www.opengis.net/ows"
                xmlns:xi="http://www.w3.org/2001/XInclude"
                xmlns:xlink="http://www.w3.org/1999/xlink"
                xmlns:xs="http://www.w3.org/2001/XMLSchema"
                xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                maxRecords="0"
                resultType="results"
                service="CSW"
                version="2.0.2">
   <csw:Query typeNames="gmd:MD_Metadata">
      <csw:ElementName>apiso:identifier</csw:ElementName>
      <csw:ElementName>ows:BoundingBox</csw:ElementName>
      <csw:Constraint version="1.1.0">
         <ogc:Filter>
            <ogc:Not>
               <ogc:BBOX>
                  <ogc:PropertyName>ows:BoundingBox</ogc:PropertyName>
                  <gml:Envelope srsName="urn:x-ogc:def:crs:EPSG:6.11:4326">
                     <gml:lowerCorner>60.0 12.0</gml:lowerCorner>
                     <gml:upperCorner>70.0 20.0</gml:upperCorner>
                  </gml:Envelope>
               </ogc:BBOX>
            </ogc:Not>
         </ogc:Filter>
      </csw:Constraint>
   </csw:Query>
</csw:GetRecords>
```

Example 18-24 GetRecords Response with BoundingBox (BBOX)

The following is the response from the preceding request.

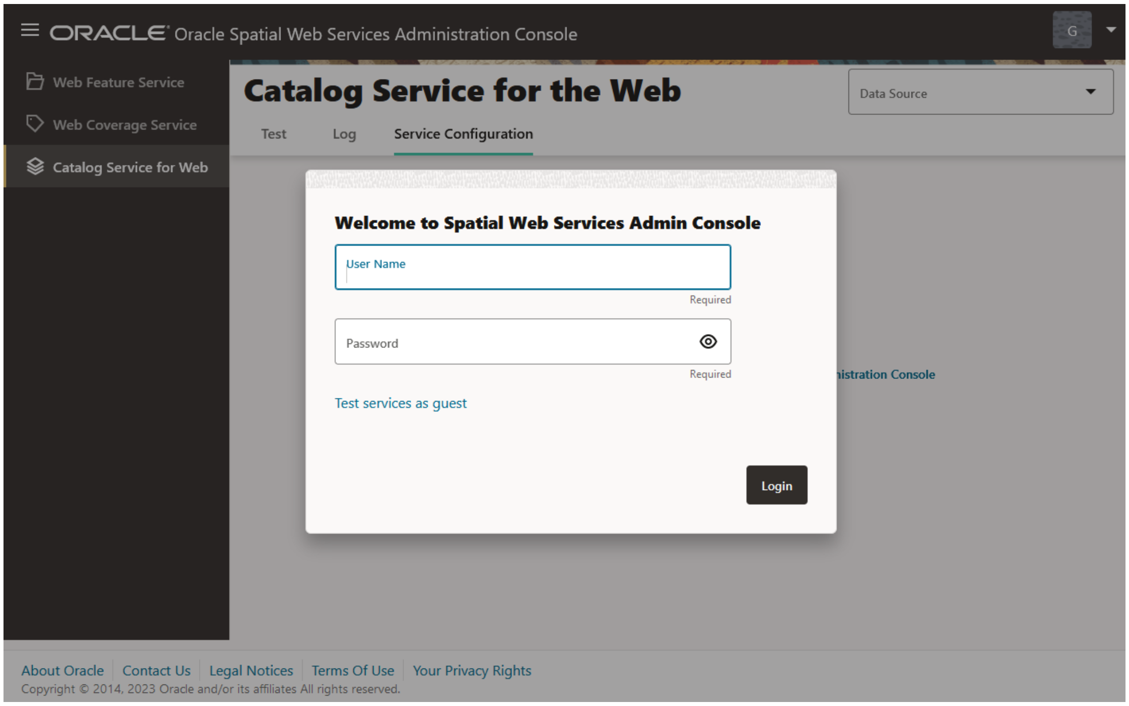
```
<csw:GetRecordsResponse xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:gml="http://www.opengis.net/gml/3.2"
xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:srv="http://www.isotc211.org/2005/
srv" xmlns:dct="http://purl.org/dc/terms/" xmlns:ns7="http://www.opengis.net/ows/2.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:ows="http://www.opengis.net/ows"
xmlns:csw="http://www.opengis.net/cat/csw/2.0.2" xmlns:xlink="http://www.w3.org/1999/
xlink" xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:gco="http://www.isotc211.org/
2005/gco" version="2.0.2" xsi:schemaLocation="http://www.opengis.net/cat/csw/2.0.2 ../../
cswAll.xsd">
  <csw:SearchStatus timestamp="2017-08-16T09:46:09Z"></csw:SearchStatus>
  <csw:SearchResults elementSet="" recordSchema="http://www.isotc211.org/2005/gmd"
numberOfRecordsMatched="1" numberOfRecordsReturned="1" nextRecord="0">
    <csw:RecordISO>
      <gmd:EX_GeographicBoundingBox dimensions="2">
        <gmd:WestBoundLongitude>-109.047013285</gmd:WestBoundLongitude>
        <gmd:SouthBoundLatitude>34.2585812994</gmd:SouthBoundLatitude>
        <gmd:EastBoundLongitude>-106.876969333</gmd:EastBoundLongitude>
        <gmd:NorthBoundLatitude>37.0002329277</gmd:NorthBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
      <gmd:fileIdentifier>210553_L400_S0005K_00000000_00002b2b-26c0-4aa1-a444-
c7e1eee8cccc</gmd:fileIdentifier>
    </csw:RecordISO>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

18.7 CSW Administration Console

The Oracle Spatial Web Services administration console includes a CSW administration page.

The following figure shows the administration console page for CSW:

Figure 18-2   CSW Administration Console



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Before you can use any administration console page, select a CSW data source from the list of all available data source names. (The currently selected data source is shown in the upper-right corner, and you can change it there at any time.)

You can access the CSW administration console by going to the following URL:

```
http://<system-name>:<port>/oraclespatial/
```

The user interface for the CSW administration console allows you to edit configurations, test, and diagnose problems. It comprises the following tabs:

- **Test**
  The **Test** tab enables you to quickly generate and invoke `getCapabilities`, `describeRecord`, `getRecords`, and `getRecordByID` operations to test and query the CSW service and catalog data. You can edit the query statements based on spatial and nonspatial constraints.
- **Log**
  The **Log** tab shows any errors generated during CSW operations processing, which can help you diagnose any possible problems.
- **Service Configuration**
  The **Service Configuration** tab lets you edit and update the `CSWConfig.xml` file.

18.8 Diagnosing CSW Issues

The CSW log files provide diagnostic information.

In the CSW Administration Console, you can use the Log tab see and download the CSW log files.

This topic explains some types of log messages and how to deal with them.

“DataSource jdbc/csw_admin_ds not found” — GetCapabilities response error message

The response may be similar to the following (reformatted for readability):

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport
  xmlns:ows="http://www.opengis.net/ows/2.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance"
  xsi:schemaLocation="http://www.opengis.net/ows/2.0 http://schemas.opengis.net/ows/2.0/
owsExceptionReport.xsd" version="2.0.1">
  <ows:Exception exceptionCode="NoApplicableCode" locator="DataSource jdbc/csw_admin_ds
not found"/>
</ows:ExceptionReport>
```

This means that a CSW data source is not configured or that WebLogic Server cannot connect to the database. See **Setting Up CSW Data Sources** in Configuring and Deploying the CSW Engine for information about configuring CSW data sources.

MDSYS.SDO_XSD_TABLE does not exist or the specified XSD ID is incorrect

This means that the XML schema could not be found. Ensure that Oracle Spatial is installed properly, and check the XSD_ID column of the SDO_XSD_TABLE table and the USER_SDO_CSW_SERVICE_INFO view.

CSW catalog table issues

Ensure that the Catalog Services for the Web catalog table, the SRID parameter, the metadata ID, and the XML schema definition (XSD) type are correctly specified.

The XQFT index cannot be dropped or created for the CSW catalog table

The XQuery Full Text (XQFT) index could not be dropped or created for the Catalog Services for the Web catalog table. Ensure that the CSW catalog table is ready for dropping or building an XQFT index.

A Catalog Services for the Web (CSW) *server-side* error occurred

Ensure that the CSW metadata is correct and the CSW catalog table is properly defined.

A Catalog Services for the Web (CSW) *client-side* error occurred

Ensure that the CSW record types are properly published, and that the `sdows.ear` file and WebLogic Server (WLS) are properly configured.

Database connection error

The following message in the CSW log means that the database is not running:

```
SEVERE: Error discovering coverages
java.sql.SQLRecoverableException: No more data to read from socket
```

“Error reading log file” message on CSW administration console Log tab

If an authenticated user does not interact with the CSW server administration console for a given period of time, the user session in the browser might have timed out. In this case, refresh the browser display, and re-authenticate to get a new session.

Document received does not conform with protocol syntax

An error message like the following indicates that the request contains XML elements or character elements that are not defined in any OGC specification:

```
<?xml version='1.0' encoding='UTF-8'?>
<ows:ExceptionReport xmlns:ows="http://www.opengis.net/ows/2.0" version="2.0.2"
language="">
  <ows:Exception exceptionCode="InvalidEncodingSyntax" locator="request">
    <ows:ExceptionText>Document received does not conform with protocol syntax.</
ows:ExceptionText>
  </ows:Exception>
</ows:ExceptionReport>
```

Part III

Reference Information

This document has the following parts:

- Conceptual and Usage Information provides conceptual and usage information about Oracle Spatial.
- Spatial Web Services provides conceptual and usage information about Oracle Spatial web services.
- Part III provides reference information about Oracle Spatial operators, functions, and procedures.
- Supplementary Information provides supplementary information (appendixes and a glossary).

To understand the examples in the reference chapters, you must understand the conceptual and data type information in Spatial Data Types and Metadata, especially SDO_GEOMETRY Object Type.

- SQL Statements for Indexing Spatial Data
  This chapter describes the SQL statements used when working with the spatial object data type.
- Spatial Operators
  This chapter describes the operators that you can use when working with the spatial object data type.
- Spatial Aggregate Functions
  This chapter contains reference and usage information for the spatial aggregate functions.
- SDO_CS Package (Coordinate System Transformation)
  The MDSYS.SDO_CS package contains subprograms for working with coordinate systems.
- SDO_CSW Package (Catalog Services for the Web)
  The MDSYS.SDO_CSW package contains subprograms for various processing operations related to support for Catalog Services for the Web (CSW).
- SDO_GCDR Package (Geocoding)
  The MDSYS.SDO_GCDR package contains subprograms for performing geocoding.
- SDO_GEOM Package (Geometry)
  The MDSIS.SDO_GEOM package contains subprograms for working with geometry objects.
- SDO_LRS Package (Linear Referencing System)
  The MDSYS.SDO_LRS package contains subprograms that create, modify, query, and convert linear referencing elements.
- SDO_MIGRATE Package (Upgrading)
  The MDSYS.SDO_MIGRATE package contains a single subprogram, SDO_MIGRATE.TO_CURRENT.
- SDO_OLS Package (OpenLS)
  The MDSYS.SDO_OLS package contains subprograms for Spatial OpenLS support.

- SDO_PC_PKG Package (Point Clouds)
  The MDSYS.SDO_PC_PKG package contains subprograms to support working with point clouds.
- SDO_SAM Package (Spatial Analysis and Mining)
  The MDSYS.SDO_SAM package contains subprograms for spatial analysis and data mining.
- SDO_TIN_PKG Package (TINs)
  The MDSYS.SDO_TIN_PKG package contains subprograms to support working with triangulated irregular networks (TINs).
- SDO_TRKR Package (Location Tracking)
  The MDSYS.SDO_TRKR package contains subprograms for using the location tracking server.
- SDO_TUNE Package (Tuning)
  The MDSYS.SDO_TUNE package contains subprograms for spatial tuning.
- SDO_WCS Package (Web Coverage Service)
  The MDSYS.SDO_WCS package contains subprograms associated with Oracle Spatial support for Web Coverage Service (WCS).
- SDO_UTIL Package (Utility)
  The MDSYS.SDO_UTIL package contains spatial utility subprograms.
- SDO_WFS_LOCK Package (WFS)
  The MDSYS.SDO_WFS_LOCK package contains subprograms for WFS support for registering and unregistering feature tables.
- SDO_WFS_PROCESS Package (WFS Processing)
  The MDSYS.SDO_WFS_PROCESS package contains subprograms for various processing operations related to support for Web Feature Services.

19

SQL Statements for Indexing Spatial Data

This chapter describes the SQL statements used when working with the spatial object data type.

For complete reference information about any statement, see *Oracle Database SQL Language Reference*.

Bold italic text is often used in the **Keywords and Parameters** sections in this chapter to identify a grouping of keywords, followed by specific keywords in the group. For example, ***INDEX_PARAMS*** identifies the start of a group of index-related keywords.

- ALTER INDEX
- ALTER INDEX REBUILD
- ALTER INDEX RENAME TO
- CREATE INDEX
- DROP INDEX

19.1 ALTER INDEX

Purpose

Alters specific parameters for a spatial index.

Syntax

```
ALTER INDEX [schema.]index PARAMETERS ('index_params  [physical_storage_params]' )
    [{ NOPARALLEL | PARALLEL [ integer ] }] ;
```

Keywords and Parameters

Value	Description
INDEX_PARAMS	Changes the characteristics of the spatial index.
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see Three-Dimensional Spatial Objects. Data type is NUMBER. Default = 2.
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. The default value is best for most applications; however, a value of 0 is recommended if no updates will be performed to the geometry column. Data type is NUMBER. Default = 10.

Value	Description
PHYSICAL_STORAGE_PARAMS	Determines the storage parameters used for altering the spatial index data table. A spatial index data table is a standard Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.
tablespace	Specifies the tablespace in which the index data table is created. This parameter is the same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
{ NOPARALLEL | PARALLEL [integer] }	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for the CREATE INDEX statement for guidelines and restrictions that apply to the use of the PARALLEL keyword. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

Prerequisites

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

Usage Notes

Use this statement to change the parameters of an existing index.

See the Usage Notes for the CREATE INDEX statement for usage information about many of the other available parameters.

Examples

The following example modifies the tablespace for partition IP2 of the spatial index named BGI.

```
ALTER INDEX bgi MODIFY PARTITION ip2
   PARAMETERS ('tablespace=TBS_3');
```

Related Topics

- ALTER INDEX REBUILD
- ALTER INDEX RENAME TO
- CREATE INDEX
- ALTER TABLE (clauses for partition maintenance) in *Oracle Database SQL Language Reference*

19.2 ALTER INDEX REBUILD

Syntax

```
ALTER INDEX [schema.]index REBUILD
     [PARAMETERS ('rebuild_params [physical_storage_params]' ) ]
     [{ NOPARALLEL | PARALLEL [ integer ] }] ;
```

or

```
ALTER INDEX [schema.]index REBUILD ONLINE
     [PARAMETERS ('rebuild_params [physical_storage_params]' ) ]
     [{ NOPARALLEL | PARALLEL [ integer ] }] ;
```

or

```
ALTER INDEX [schema.]index REBUILD PARTITION partition
     [PARAMETERS ('rebuild_params [physical_storage_params]' ) ];
```

Purpose

Rebuilds a spatial index or a specified partition of a partitioned index.

Keywords and Parameters

Value	Description
REBUILD_PARAMS	Specifies in a command string the index parameters to use in rebuilding the spatial index.
index_status=cleanup	For an online rebuild operation (ALTER INDEX REBUILD ONLINE), performs cleanup operations on tables associated with the older version of the index.
layer_gtype	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column in SDO_GTYPE (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.
sdo_dml_batch_size	Specifies the number of index updates to be processed in each batch of updates after a commit operation. The default value is 4000; for example, if you insert 5000 rows into the spatial table and then perform a commit operation, the updates to the spatial index table are performed in two batches of insert operations (4000 and 1000). See the Usage Notes for the CREATE INDEX statement for more information. Data type is NUMBER.
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see Three-Dimensional Spatial Objects. Data type is NUMBER. Default = 2.
sdo_max_memory	Specifies the amount of maximum memory that can be allocated to perform a spatial index build or rebuild operation. Can be from 64000 (about 64 KB) to 200000000 (about 200 MB). If the specified number of bytes cannot be allocated, 64000 (about 64 KB) is allocated. Specifying a value greater than the default can significantly improve index creation performance; however, do not specify more than 20 percent of available memory. Data type is NUMBER. Default = 10000000 (about 10 MB).

Value	Description
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. Data type is NUMBER. Default = 10.
PHYSICAL_STORAGE_PARAMS	Determines the storage parameters used for rebuilding the spatial index data table. A spatial index data table is a regular Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.
tablespace	Specifies the tablespace in which the index data table is created. Same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
{ NOPARALLEL | PARALLEL [integer] }	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for the rebuilding of the index and for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for the CREATE INDEX statement for guidelines and restrictions that apply to the use of the PARALLEL keyword. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

Prerequisites

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

Usage Notes

An ALTER INDEX REBUILD 'rebuild_params' statement rebuilds the index using supplied parameters. Spatial index creation involves creating and inserting index data, for each row in the underlying table column being spatially indexed, into a table with a prescribed format. All rows in the underlying table are processed before the insertion of index data is committed, and this requires adequate rollback segment space.

The ONLINE keyword rebuilds the index without blocking the index; that is, queries can use the spatial index while it is being rebuilt. However, after all queries issued during the rebuild operation have completed, you must clean up the old index information (in the MDRT tables) by entering a SQL statement in the following form:

```
ALTER INDEX [schema.]index REBUILD ONLINE PARAMETERS ('index_status=cleanup');
```

The following limitations apply to the use of the ONLINE keyword:

- Only query operations are permitted while the index is being rebuilt. Insert, update, and delete operations that would affect the index are blocked while the index is being rebuilt; and an online rebuild is blocked while any insert, update, or delete operations that would affect the index are being performed.
- You cannot use the ONLINE keyword for a rebuild operation if the index was created using the `'sdo_non_leaf_tbl=TRUE'` parameter.
- You cannot use the ONLINE keyword for a partitioned spatial index.

Effective with Release 12.1, the ALTER INDEX REBUILD statement reuses any previous parameters from the index creation. If new or changed parameters are passed, new parameters are merged with the previous ones, and changed parameters override the previous ones.

For more information about using the `layer_gtype` keyword to constrain data in a layer to a geometry type, see Constraining Data to a Geometry Type.

With a partitioned spatial index, you must use a separate ALTER INDEX REBUILD statement for each partition to be rebuilt.

If you want to use a *local* partitioned spatial index, follow the procedure in Creating a Local Partitioned Spatial Index.

See also the Usage Notes for the CREATE INDEX statement for usage information about many of the available parameters and about the use of the PARALLEL keyword.

Examples

The following example rebuilds OLDINDEX and specifies the tablespace in which to create the index data table.

```
ALTER INDEX oldindex REBUILD PARAMETERS('tablespace=TBS_3');
```

Related Topics

- CREATE INDEX
- DROP INDEX
- ALTER TABLE and ALTER INDEX (clauses for partition maintenance) in *Oracle Database SQL Language Reference*

19.3 ALTER INDEX RENAME TO

Syntax

```
ALTER INDEX [schema.]index RENAME TO <new_index_name>;

ALTER INDEX [schema.]index PARTITION partition RENAME TO <new_partition_name>;
```

Purpose

Changes the name of a spatial index or a partition of a spatial index.

Keywords and Parameters

Value	Description
new_index_name	Specifies the new name of the index.

Value	Description
new_partition_name	Specifies the new name of the partition.

Prerequisites

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

Usage Notes

None.

Examples

The following example renames OLDINDEX to NEWINDEX.

```
ALTER INDEX oldindex RENAME TO newindex;
```

Related Topics

- CREATE INDEX
- DROP INDEX

19.4 CREATE INDEX

Syntax

```
CREATE INDEX [schema.]index ON [schema.]table (column)
     INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2
     [PARAMETERS ('index_params  [physical_storage_params]' )]
     [{ NOPARALLEL | PARALLEL [ integer ] }];
```

Purpose

Creates a spatial index on a column of type SDO_GEOMETRY.

Keywords and Parameters

Value	Description
INDEX_PARAMS	Determines the characteristics of the spatial index.
layer_gtype	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column in SDO_GTYPE (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.
sdo_dml_batch_size	Specifies the number of index updates to be processed in each batch of updates after a commit operation. The default value is 4000; for example, if you insert 5000 rows into the spatial table and then perform a commit operation, the updates to the spatial index table are performed in two batches of insert operations (4000 and 1000). See the Usage Notes for more information. Data type is NUMBER.

Value	Description
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see Three-Dimensional Spatial Objects. Data type is NUMBER. Default = 2.
sdo_max_memory	Specifies the amount of maximum memory that can be allocated to perform a spatial index build or rebuild operation. Can be from 64000 (about 64 KB) to 200000000 (about 200 MB). If the specified number of bytes cannot be allocated, 64000 (about 64 KB) is allocated. Specifying a value greater than the default can significantly improve index creation performance; however, do not specify more than 20 percent of available memory. Data type is NUMBER. Default = 10000000 (about 10 MB).
sdo_non_leaf_tbl	`'sdo_non_leaf_tbl=TRUE'` creates a separate index table (with a name in the form MDNT_...$) for nonleaf nodes of the index, in addition to creating an index table (with a name in the form MDRT_...$) for leaf nodes. `'sdo_non_leaf_tbl=FALSE'` creates a single table (with a name in the form MDRT_...$) for both leaf nodes and nonleaf nodes of the index. See the Usage Notes for more information. Data type is VARCHAR2. Default = FALSE
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. Data type is NUMBER. Default = 10.
sequence_initial	Specifies the "initial" sequence cache value used internally by Spatial during index creation. If the spatial data set size is expected to increase significantly, run-time performance of DML operations may be improved by increasing the `sequence_initial` value (for example, `'sequence_initial=500'`). Default = 100. (For "normal" DML environments, the default value is suggested.)
sequence_next	Specifies the "next" sequence cache value used internally by Spatial after index creation, that is, when the index is updated as a result of normal user DML operations. If large amounts of spatial data are expected to be added frequently, run-time performance of DML operations may be improved by increasing the `sequence_next` value (for example, `'sequence_next=500'`).Default = 100. (For "normal" DML environments, the default value is suggested.)
PHYSICAL_STORAGE_PARAMS	Determines the storage parameters used for creating the spatial index data table. A spatial index data table is a regular Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.
tablespace	Specifies the tablespace in which the index data table is created. Same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.

Value	Description
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
work_tablespace	Specifies the tablespace for temporary tables used in creating the index. (Applies only to creating spatial R-tree indexes, and not to other types of indexes.) Specifying a work tablespace reduces fragmentation in the index tablespace, but it requires storage space of two times the size of the final index; however, after the index is created you can drop or reuse the work tablespace.
securefile	`'securefile=TRUE'` enables SecureFiles Intelligent Compression to be used; `'securefile=FALSE'` causes SecureFiles Intelligent Compression not to be used. See the `compression` parameter explanation for more information. Data type is VARCHAR2. Default = `'securefile=FALSE'`
compression	`'compression=<OFF|LOW|MEDIUM|HIGH>'` controls the level of spatial index node compression. To specify any value other than `OFF`, you must also specify `'securefile=TRUE'`, and you must have a license for the Oracle Advanced Compression Option and implement SecureFiles Intelligent Compression. See the Usage Notes for more information. Data type is VARCHAR2. Default = `'compression=OFF'`
{ NOPARALLEL | PARALLEL [integer] }	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for the creation of the index and for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for more information about parallel index creation. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

Prerequisites

- All current SQL CREATE INDEX prerequisites apply.
- You must have EXECUTE privilege on the index type and its implementation type.
- The USER_SDO_GEOM_METADATA view must contain an entry with the dimensions and coordinate boundary information for the table column to be spatially indexed.

Usage Notes

For information about spatial indexes, see Indexing of Spatial Data.

For an explaiation of “_V2” in INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2, see Using System-Managed Spatial Indexes.

Before you create a spatial index, be sure that the rollback segment size and the SORT_AREA_SIZE parameter value are adequate, as described in Creating a Spatial Index.

If an R-tree index is used on linear referencing system (LRS) data and if the LRS data has four dimensions (three plus the M dimension), the `sdo_indx_dims` parameter must be used and must specify 3 (the number of dimensions minus one), to avoid the default `sdo_indx_dims` value of 2, which would index only the X and Y dimensions. For example, if the dimensions are X, Y, Z, and M, specify `sdo_indx_dims=3` to index the X, Y, and Z dimensions, but not the measure (M) dimension. (The LRS data model, including the measure dimension, is explained in LRS Data Model.)

A partitioned spatial index can be created on a partitioned table. See Using Partitioned Spatial Indexes for more information about partitioned spatial indexes, including benefits and restrictions.

If you want to use a *local* partitioned spatial index, follow the procedure in Creating a Local Partitioned Spatial Index.

A spatial index cannot be created on an index-organized table.

You can specify the PARALLEL keyword to cause the index creation to be parallelized. For example:

```
CREATE INDEX cola_spatial_idx ON cola_markets(shape)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2 PARALLEL;
```

For information about using the PARALLEL keyword, see the description of the `parallel_clause` in the section on the CREATE INDEX statement in *Oracle Database SQL Language Reference*. In addition, the following notes apply to the use of the PARALLEL keyword for creating or rebuilding (using the ALTER INDEX REBUILD statement) spatial indexes:

- The performance cost and benefits from parallel execution for creating or rebuilding an index depend on system resources and load. If the CPUs or disk controllers are already heavily loaded, you should not specify the PARALLEL keyword.
- Specifying PARALLEL for creating or rebuilding an index on tables with simple geometries, such as point data, usually results in less performance improvement than on tables with complex geometries.

Other options available for regular indexes (such as ASC and DESC) are not applicable for spatial indexes.

Spatial index creation involves creating and inserting index data, for each row in the underlying table column being spatially indexed, into a table with a prescribed format. All rows in the underlying table are processed before the insertion of index data is committed, and this requires adequate rollback segment space.

If a tablespace name is provided in the parameters clause, the user (underlying table owner) must have appropriate privileges for that tablespace.

For more information about using the `layer_gtype` keyword to constrain data in a layer to a geometry type, see Constraining Data to a Geometry Type.

The `sdo_dml_batch_size` parameter can improve application performance, because Spatial can preallocate system resources to perform multiple index updates more efficiently than successive single index updates; however, to gain the performance benefit, you must not perform commit operations after each insert operation or at intervals less than or equal to the `sdo_dml_batch_size` value. You should not specify a value greater than 10000 (ten thousand), because the cost of the additional memory and other resources required will probably outweigh any marginal performance increase resulting from such a value.

Specifying `'sdo_non_leaf_tbl=TRUE'` can help query performance with large data sets if the entire R-tree table may not fit in the KEEP buffer pool. In this case, you must also cause Oracle to buffer the MDNT_...$ table in the KEEP buffer pool, for example, by using ALTER TABLE and specifying STORAGE (BUFFER_POOL KEEP). For partitioned indexes, the same `sdo_non_leaf_tbl` value must be used for all partitions. Any physical storage parameters, except for `tablespace`, are applied only to the MDRT_...$ table. The MDNT_...$ table uses only the `tablespace` parameter, if specified, and default values for all other physical storage parameters.

The `compression` parameter with a value of `LOW`, `MEDIUM`, or `HIGH` causes the SecureFiles Intelligent Compression feature to be used. The higher the compression, the higher the latency incurred.

- 'compression=HIGH' incurs more work, but compresses the data better.
- 'compression=LOW' uses a lightweight compression algorithm that removes most of the CPU cost that is typical with file compression. Compressed SecureFiles, thus providing a very efficient choice for SecureFiles LOB storage. SecureFiles LOBs compressed at `LOW` generally consume less storage and CPU time than BasicFiles LOBs, and help applications run faster because of a reduction in disk I/O.

> **Note:**
>
> When using `compression` with any value other than `OFF`, set the `DB_BLOCK_CHECKING` database parameter to `FALSE` or `OFF`. Using any other `DB_BLOCK_CHECKING` database parameter value in conjunction with a `compression` value other than `OFF` could adversely affect spatial index DML (insert, update, or delete) operations.

If you are creating a function-based spatial index, the number of parameters must not exceed 32. For information about using function-based spatial indexes, see SDO_GEOMETRY Objects in Function-Based Indexes.

To determine if a CREATE INDEX statement for a spatial index has failed, check to see if the DOMIDX_OPSTATUS column in the USER_INDEXES view is set to FAILED. This is different from the case of regular indexes, where you check to see if the STATUS column in the USER_INDEXES view is set to FAILED.

If the CREATE INDEX statement fails because of an invalid geometry, the ROWID of the failed geometry is returned in an error message along with the reason for the failure.

If the CREATE INDEX statement fails for any reason, then the DROP INDEX statement must be used to clean up the partially built index and associated metadata. If DROP INDEX does not work, add the FORCE parameter and try again.

Examples

The following example creates a spatial R-tree index named COLA_SPATIAL_IDX.

```
CREATE INDEX cola_spatial_idx ON cola_markets(shape)
   INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
```

Related Topics

- ALTER INDEX
- DROP INDEX

19.5 DROP INDEX

Syntax

```
DROP INDEX [schema.]index [FORCE];
```

Purpose

Deletes a spatial index.

Keywords and Parameters

Value	Description
FORCE	Causes the spatial index to be deleted from the system tables even if the index is marked in-progress or some other error condition occurs.

Prerequisites

You must have EXECUTE privileges on the index type and its implementation type.

Usage Notes

Use DROP INDEX indexname FORCE to clean up after a failure in the CREATE INDEX statement.

Examples

The following example deletes a spatial index named OLDINDEX and forces the deletion to be performed even if the index is marked in-process or an error occurs.

```
DROP INDEX oldindex FORCE;
```

Related Topics

- CREATE INDEX

20

Spatial Operators

This chapter describes the operators that you can use when working with the spatial object data type.

For an overview of spatial operators, including how they differ from spatial procedures and functions, see Spatial Operators_ Procedures_ and Functions. Table 20-1 lists the main operators.

Table 20-1 Main Spatial Operators

Operator	Description
SDO_FILTER	Specifies which geometries may interact with a given geometry.
SDO_GEOM_MBR	Returns the minimum bounding rectangle of a geometry object.
SDO_JOIN	Performs a spatial join based on one or more topological relationships.
SDO_NN	Determines the nearest neighbor geometries to a geometry.
SDO_NN_DISTANCE	Returns the distance of an object returned by the SDO_NN operator.
SDO_POINTINPOLYGON	Takes a set of rows whose first column is a point's x-coordinate value and the second column is a point's y-coordinate value, and returns those rows that are within a specified polygon geometry.
SDO_RELATE	Determines whether or not two geometries interact in a specified way. (See also Table 20-2 for convenient alternative operators for performing specific mask value operations.)
SDO_WITHIN_DISTANCE	Determines if two geometries are within a specified distance from one another.

Table 20-2 lists operators, provided for convenience, that perform an SDO_RELATE operation of a specific mask type.

Table 20-2 Convenience Operators for SDO_RELATE Operations

Operator	Description
SDO_ANYINTERACT	Checks if any geometries in a table have the ANYINTERACT topological relationship with a specified geometry.
SDO_CONTAINS	Checks if any geometries in a table have the CONTAINS topological relationship with a specified geometry.
SDO_COVEREDBY	Checks if any geometries in a table have the COVEREDBY topological relationship with a specified geometry.
SDO_COVERS	Checks if any geometries in a table have the COVERS topological relationship with a specified geometry.
SDO_EQUAL	Checks if any geometries in a table have the EQUAL topological relationship with a specified geometry.
SDO_INSIDE	Checks if any geometries in a table have the INSIDE topological relationship with a specified geometry.

Table 20-2 (Cont.) Convenience Operators for SDO_RELATE Operations

Operator	Description
SDO_ON	Checks if any geometries in a table have the ON topological relationship with a specified geometry.
SDO_OVERLAPBDYDISJOINT	Checks if any geometries in a table have the OVERLAPBDYDISJOINT topological relationship with a specified geometry.
SDO_OVERLAPBDYINTERSECT	Checks if any geometries in a table have the OVERLAPBDYINTERSECT topological relationship with a specified geometry.
SDO_OVERLAPS	Checks if any geometries in a table overlap (that is, have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship with) a specified geometry.
SDO_TOUCH	Checks if any geometries in a table have the TOUCH topological relationship with a specified geometry.

Note:

For any numbers in string (VARCHAR2) parameters to Spatial operators and subprograms, the period (.) must be used for any decimal points regardless of the locale. Example: `'distance=3.7'`

The rest of this chapter provides reference information on the operators, listed in alphabetical order.

For information about using operators with topologies, see *Oracle Spatial Topology and Network Data Model Developer's Guide*.

- SDO_ANYINTERACT
- SDO_CONTAINS
- SDO_COVEREDBY
- SDO_COVERS
- SDO_EQUAL
- SDO_FILTER
- SDO_GEOM_MBR
- SDO_INSIDE
- SDO_JOIN
- SDO_NN
- SDO_NN_DISTANCE
- SDO_ON
- SDO_OVERLAPBDYDISJOINT
- SDO_OVERLAPBDYINTERSECT
- SDO_OVERLAPS
- SDO_POINTINPOLYGON

- SDO_RELATE
- SDO_TOUCH
- SDO_WITHIN_DISTANCE

20.1 SDO_ANYINTERACT

Format

```
SDO_ANYINTERACT(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the ANYINTERACT topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=ANYINTERACT'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_ANYINTERACT(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the ANYINTERACT topological relationship, and FALSE otherwise.

Usage Notes

> **Note:**
>
> The SDO_ANYINTERACT operator is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

See the Usage Notes for the SDO_RELATE operator in this chapter.
For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the ANYINTERACT relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_ANYINTERACT(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(4,6, 8,8))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
         4 cola_d
```

20.2 SDO_CONTAINS

Format

```
SDO_CONTAINS(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the CONTAINS topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=CONTAINS'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_CONTAINS(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the CONTAINS topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the CONTAINS relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 2,2, 4,6). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_a` contains the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_CONTAINS(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(2,2, 4,6))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         1 cola_a
```

20.3 SDO_COVEREDBY

Format

```
SDO_COVEREDBY(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the COVEREDBY topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=COVEREDBY'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_COVEREDBY(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the COVEREDBY topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the COVEREDBY relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_a` is covered by the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_COVEREDBY(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(1,1, 5,8))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         1 cola_a
```

20.4 SDO_COVERS

Format

```
SDO_COVERS(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the COVERS topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=COVERS'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_COVERS(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the COVERS topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the COVERS relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 4,6). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_a` covers the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_COVERS(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(1,1, 4,6))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         1 cola_a
```

20.5 SDO_EQUAL

Format

```
SDO_EQUAL(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the EQUAL topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=EQUAL'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_EQUAL(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the EQUAL topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the EQUAL relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,7). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, `cola_a` (and only `cola_a`) has the same boundary and interior as the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_EQUAL(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(1,1, 5,7))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         1 cola_a
```

20.6 SDO_FILTER

Format

```
SDO_FILTER(geometry1, geometry2, param);
```

Description

Identifies either the set of spatial objects that are likely to interact spatially with a given object (such as an area of interest), or pairs of spatial objects that are likely to interact spatially. Objects interact spatially if they are not disjoint.

This operator performs only a primary filter operation. The secondary filtering operation, performed by the SDO_RELATE operator, can be used to determine with certainty if objects interact spatially.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.
param	Optionally specifies either or both of the `min_resolution` and `max_resolution` keywords. Data type is VARCHAR2. The `min_resolution` keyword includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, `min_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.) The `max_resolution` keyword includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, `max_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.)

Returns

The expression SDO_FILTER(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that are non-disjoint, and FALSE otherwise.

Usage Notes

> **Note:**
>
> The SDO_FILTER operator is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The SDO_FILTER operator must always be used in a WHERE clause and the condition that includes the operator should be an expression of the form SDO_FILTER(arg1, arg2) = 'TRUE'. (The expression must not equate to any value other than 'TRUE'.)

`geometry2` can come from a table or be a transient SDO_GEOMETRY object, such as a bind variable or SDO_GEOMETRY constructor.

- If the `geometry2` column is not spatially indexed, the operator indexes the query window in memory and performance is very good.
- If two or more geometries from `geometry2` are passed to the operator, the ORDERED optimizer hint must be specified, and the table in `geometry2` must be specified first in the FROM clause.

If `geometry1` and `geometry2` are based on different coordinate systems, `geometry2` is temporarily transformed to the coordinate system of `geometry1` for the operation to be performed, as described in Different Coordinate Systems for Geometries with Operators and Functions.

> **Note:**
>
> If the DBMS_RLS.ADD_POLICY procedure has been used to add a fine-grained access control policy to a table or view, and if the specified policy function uses a spatial operator, the operator must be SDO_FILTER. No other spatial operators are supported in that context.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example selects the geometries that are likely to interact with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_FILTER(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(4,6, 8,8))
    ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
         4 cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only `cola_a` and `cola_b` are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The circle `cola_d` is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_FILTER(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'min_resolution=4.1'
    ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column objects are likely to interact spatially with the GEOMETRY column object in the QUERY_POLYS table that has a GID value of 1.

```
SELECT A.gid
  FROM Polygons A, query_polys B
  WHERE B.gid = 1
  AND SDO_FILTER(A.Geometry, B.Geometry) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with the geometry stored in the `aGeom` variable.

```
Select A.Gid
  FROM Polygons A
  WHERE SDO_FILTER(A.Geometry, :aGeom) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with the specified rectangle having the lower-left coordinates (x1,y1) and the upper-right coordinates (x2, y2).

```
Select A.Gid
  FROM Polygons A
  WHERE SDO_FILTER(A.Geometry, sdo_geometry(2003,NULL,NULL,
                                   sdo_elem_info_array(1,1003,3),
                                   sdo_ordinate_array(x1,y1,x2,y2))
                   ) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with any GEOMETRY column object in the QUERY_POLYS table. In this example, the ORDERED optimizer hint is used and the QUERY_POLYS (`geometry2`) table is specified first in the FROM clause, because multiple geometries from `geometry2` are involved (see the Usage Notes).

```
SELECT /*+ ORDERED */
  A.gid
  FROM query_polys B, polygons A
  WHERE SDO_FILTER(A.Geometry, B.Geometry) = 'TRUE';
```

Related Topics

- SDO_RELATE

20.7 SDO_GEOM_MBR

```
SDO_GEOM_MBR(geometry);
```

Description

SDO_GEOM_MBR is a SQL operator that determines the minimum bounding rectangle of a geometry object.

Though it is functionally identical to the SDO_GEOM.SDO_MBR function, it provides better performance.

Keywords and Parameters

Value	Description
geometry	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.

Returns

SDO_GEOM_MBR returns a single rectangle that minimally encloses the geometry.

Usage Notes

See the Usage Notes for the SDO_GEOM.SDO_MBR subprogram.

Examples

The following example returns the minimum bounding rectangle of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. Since `cola_d` is a circle, the minimum bounding rectangle in this case is a square.)

```
-- Return the minimum bounding rectangle of cola_d (a circle).
SELECT SDO_GEOM_MBR(c.shape)
  FROM cola_markets c WHERE c.name = 'cola_d';

SDO_GEOM_MBR(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(6, 7, 10, 11))
```

20.8 SDO_INSIDE

Format

```
SDO_INSIDE(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the INSIDE topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=INSIDE'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_INSIDE(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the INSIDE topological relationship, and FALSE otherwise.

Usage Notes

> **Note:**
>
> The SDO_INSIDE operator is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the INSIDE relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 5,6, 12,12). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_d` (the circle) is inside the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_INSIDE(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(5,6, 12,12))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         4 cola_d
```

20.9 SDO_JOIN

Format

```
SDO_JOIN(table_name1, column_name1, table_name2, column_name2,
params,preserve_join_order, table1_partition, table2_partition) RETURN SDO_ROWIDSET;
```

Description

Performs a spatial join based on one or more topological relationships.

Keywords and Parameters

Value	Description
table_name1	Name of the first table to be used in the spatial join operation. The table must have a column of type SDO_GEOMETRY. Data type is VARCHAR2.
column_name1	Name of the spatial column of type SDO_GEOMETRY in `table_name1`. A spatial R-tree index must be defined on this column. Data type is VARCHAR2.
table_name2	Name of the second table to be used in the spatial join operation. (It can be the same as or different from `table_name1`. If `table_name2` is the same as `table_name1`, see "Optimizing Self-Joins" in this section.) The table must have a column of type SDO_GEOMETRY. Data type is VARCHAR2.
column_name2	Name of the spatial column of type SDO_GEOMETRY in `table_name2`. A spatial R-tree index must be defined on this column. Data type is VARCHAR2.
params	Optional parameter string of keywords and values; available only if `mask=ANYINTERACT`. Determines the behavior of the operator. See Table 20-3 in the Usage Notes for information about the available keywords. Data type is VARCHAR2. Default is NULL.
preserve_join_order	Optional parameter to specify if the join order is guaranteed to be preserved during processing of the operator. If the value is `0` (the default), the order of the tables might be changed; if the value is `1`, the order of the tables is not changed. Data type is NUMBER. Default is 0.
table1_partition	Name of the table partition in `table_name1`. Must be specified if the table has a partitioned spatial index; must be null if the table does not have a partitioned spatial index. (For information about using partitioned spatial indexes, see Using Partitioned Spatial Indexes.) Data type is VARCHAR2. Default is null.
table2_partition	Name of the table partition in `table_name2`. Must be specified if the table has a partitioned spatial index; must be null if the table does not have a partitioned spatial index. (For information about using partitioned spatial indexes, see Using Partitioned Spatial Indexes.) Data type is VARCHAR2. Default is null.

Returns

SDO_JOIN returns an object of SDO_ROWIDSET, which consists of a table of objects of SDO_ROWIDPAIR. Oracle Spatial defines the type SDO_ROWIDSET as:

```
CREATE TYPE sdo_rowidset as TABLE OF sdo_rowidpair;
```

Oracle Spatial defines the object type SDO_ROWIDPAIR as:

```
CREATE TYPE sdo_rowidpair AS OBJECT
   (rowid1  VARCHAR2(24),
    rowid2  VARCHAR2(24));
```

In the SDO_ROWIDPAIR definition, `rowid1` refers to a rowid from `table_name1`, and `rowid2` refers to a rowid from `table_name2`.

Usage Notes

SDO_JOIN is technically not an operator, but a table function. (For an explanation of table functions, see *Oracle Database PL/SQL Language Reference*.) However, it is presented in the chapter with spatial operators because its usage is similar to that of the operators, and because it is not part of a package with other functions and procedures.

This table function is recommended when you need to perform full table joins.

The geometries in `column_name1` and `column_name2` must have the same SRID (coordinate system) value and the same number of dimensions.

For best performance, use the `/*+ ORDERED */` optimizer hint, and specify the SDO_JOIN table function first in the FROM clause.

If a table is version-enabled (using the Workspace Manager feature), you must specify the *`<table_name>`*`_LT` table created by Workspace Manager. For example, if the COLA_MARKETS table is version-enabled and you want to perform a spatial join operation on that table, specify COLA_MARKETS_LT (not COLA_MARKETS) with the SDO_JOIN table function. (However, for all other spatial functions, procedures, and operators, do not use the *`<table_name>`*`_LT` name.)

Table 20-3 shows the keywords for the `params` parameter.

Table 20-3 params Keywords for the SDO_JOIN Operator

Keyword	Description
mask	The topological relationship of interest.Valid values are 'mask=<*value*>' where <*value*> is one or more of the mask values valid for the SDO_RELATE operator (`TOUCH`, `OVERLAPBDYDISJOINT`, `OVERLAPBDYINTERSECT`, `EQUAL`, `INSIDE`, `COVEREDBY`, `CONTAINS`, `COVERS`, `ANYINTERACT`, `ON`), or `FILTER`, which checks if the MBRs (the filter-level approximations) intersect. Multiple masks are combined with the logical Boolean operator OR (for example, `'mask=inside+touch'`); however, `FILTER` cannot be combined with any other mask. If this parameter is null or contains an empty string, `mask=FILTER` is assumed.

Table 20-3 (Cont.) params Keywords for the SDO_JOIN Operator

Keyword	Description
distance	Specifies a numeric distance value that is added to the tolerance value (explained in Tolerance) before the relationship checks are performed. For example, if the tolerance is 10 meters and you specify `'distance=100 unit=meter'`, two objects are considered to have spatial interaction if they are within 110 meters of each other.If you specify `distance` but not `unit`, the unit of measurement associated with the data is assumed.
unit	Specifies a unit of measurement to be associated with the distance value (for example, `'distance=100 unit=meter'`). See Unit of Measurement Support for more information about unit of measurement specification. If you specify `unit`, you must also specify `distance`.Data type is VARCHAR2. Default = unit of measurement associated with the data. For geodetic data, the default is meters.

Before you call SDO_JOIN, you must commit any previous DML statements in your session. Otherwise, the following error will be returned: `ORA-13236: internal error in R-tree processing: [SDO_Join in active txns not supported]`

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Optimizing Self-Joins

If you are performing a self-join (that is, if `table_name1` and `table_name2` specify the same table), you can improve the performance by optimizing the self-join.

If SDO_JOIN is called without a mask (for example, `ANYINTERACT`) or distance specification, it compares only the index structure of the two geometry columns being joined. This can quickly identify geometry pairs that are "likely" to interact. If SDO_JOIN is called with a mask or distance specification, after the index is used to identify geometry pairs that are likely to interact, geometry coordinates are also compared to see if the geometry pairs actually do interact. Coordinate comparison is the most expensive part of the SDO_JOIN operation.

In a self-join, where the same geometry column is compared to itself, each geometry pair is returned twice in the result set. For example:

- For the geometry pair with ID values (1,2), the pair (2,1) is also returned. The undesired effect in SDO_JOIN is that the coordinates of the same geometry pair are compared twice, instead of once.
- ID pairs that are equal are returned twice. For example, a table with 50,000 rows will return ID pair (1,1) twice, ID pair (2,2) twice, and so on. This is also an undesired effect.

When calling SDO_JOIN in a self-join scenario, you can eliminate the undesired effects by eliminating duplicate comparison of geometry pairs and all coordinate comparisons where the ID values of the pairs match. This optimization uses SDO_JOIN for the primary filter only, and calls the SDO_GEOM.RELATE function to compare geometry coordinates. The following statement accomplishes this optimization by adding "`AND b.rowid < c.rowid`" as a predicate to the `WHERE` clause.

```
SQL> set autotrace trace explain
SQL> SELECT /*+ ordered use_nl (a,b) use_nl (a,c) */ b.id, c.id
          FROM TABLE(sdo_join('GEOD_STATES','GEOM','GEOD_STATES','GEOM')) a,
                      GEOD_STATES b,
                      GEOD_STATES c
          WHERE a.rowid1 = b.rowid
               AND a.rowid2 = c.rowid
               AND b.rowid < c.rowid
               AND SDO_GEOM.RELATE (b.geom, 'ANYINTERACT', c.geom, .05) = 'TRUE'

Execution Plan
----------------------------------------------------------
Plan hash value: 1412731386
---------------------------------------------------------------------------------------------------
| Id  | Operation                           | Name          | Rows  | Bytes | Cost (%CPU)| Time     |
---------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |               |     1 |  1124 | 12787   (1)| 00:02:34 |
|   1 |  NESTED LOOPS                       |               |     1 |  1124 | 12787   (1)| 00:02:34 |
|   2 |   NESTED LOOPS                      |               |  4574 |  2514K|  8206   (1)| 00:01:39 |
|   3 |    COLLECTION ITERATOR PICKLER FETCH| SDO_JOIN      |       |       ||         |
|*  4 |    TABLE ACCESS BY USER ROWID       | GEOD_STATES |     1 |   561 |1   (0)| 00:00:01 |
|*  5 |   TABLE ACCESS BY USER ROWID        | GEOD_STATES |     1 |   561 |1   (0)| 00:00:01 |
Predicate Information (identified by operation id):
---------------------------------------------------
   4 - access(CHARTOROWID(VALUE(KOKBF$)))
   5 - access(CHARTOROWID(VALUE(KOKBF$)))
       filter("B".ROWID<"C".ROWID AND
               "SDO_GEOM"."RELATE"("B"."GEOM",'ANYINTERACT',"C"."GEOM",.05)='TRUE')

SQL> set autotrace off
```

In the preceding example, It is very important that `AND b.rowid < c.rowid` be before the call to SDO_GEOM.RELATE in the `WHERE` clause. This will omit the undesired scenarios for the invocation of the SDO_GEOM.RELATE function. Also, note that the example uses the `ORDERED` and `USE_NL` hints, and that the execution plan does not contain `TABLE ACCESS FULL` or `HASH JOIN`.

Cross-Schema Invocation of SDO_JOIN

You can invoke the SDO_JOIN table function on an indexed table that is not in your schema, if you have been granted SELECT access to both the spatial table and to the index table for the spatial index that was created on the spatial table. To find the name of the index table for a spatial index, query the SDO_INDEX_TABLE column in the USER_SDO_INDEX_METADATA view. For example, the following statement returns the name of the index table for the COLA_MARKETS_IDX spatial index:

```
SELECT sdo_index_table FROM user_sdo_index_metadata
  WHERE sdo_index_name = 'COLA_SPATIAL_IDX';
```

Assume that user A owns spatial table T1 (with index table MDRT_F9AA$), and that user B owns spatial table T2 and wants to join geometries from both T1 and T2. Assume also that the geometry column in both tables is named GEOMETRY.

User A or a suitably privileged user must connect as user A and execute the following statements:

```
GRANT select on T1 to B;
GRANT select on MDRT_F9AA$ to B;
```

User B can now connect and execute an SDO_JOIN query, such as the following:

```
SELECT COUNT(*) FROM
  (SELECT * FROM
    TABLE(SDO_JOIN('A.T1', 'GEOMETRY',
                   'B.T2', 'GEOMETRY',
                   'mask=anyinteract')) );
```

Examples

The following example joins the COLA_MARKETS table with itself to find, for each geometry, all other geometries that have any spatial interaction with it. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, `rowid1` and `rowid2` correspond to the names of the attributes in the SDO_ROWIDPAIR type definition. Note that in the output, `cola_d` (the circle) interacts only with itself, and not with any of the other geometries.

```
SELECT /*+ ordered */ a.name, b.name
  FROM TABLE(SDO_JOIN('COLA_MARKETS', 'SHAPE',
                      'COLA_MARKETS', 'SHAPE',
                      'mask=ANYINTERACT')) c,
       cola_markets a,
       cola_markets b
  WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid
  ORDER BY a.name;

NAME                             NAME
-------------------------------- --------------------------------
cola_a                           cola_c
cola_a                           cola_b
cola_a                           cola_a
cola_b                           cola_c
cola_b                           cola_b
cola_b                           cola_a
cola_c                           cola_c
cola_c                           cola_b
cola_c                           cola_a
cola_d                           cola_d

10 rows selected.
```

Related Topics

- SDO_RELATE

20.10 SDO_NN

Format

```
SDO_NN(geometry1, geometry2, param [, number]);
```

Description

Identifies the nearest neighbors for a geometry.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is required. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. The nearest neighbor or neighbors to `geometry2` will be returned from `geometry1`. (`geometry2` is specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Value	Description
param	Determines the behavior of the operator. The available keywords are listed in Table 20-4. If you do not specify this parameter, the operator returns all rows in increasing distance order from `geometry2`. Data type is VARCHAR2.
number	If the SDO_NN_DISTANCE ancillary operator is included in the call to SDO_NN, specifies the same number used in the call to SDO_NN_DISTANCE. Data type is NUMBER.

Table 20-4 lists the keywords for the `param` parameter.

Table 20-4   Keywords for the SDO_NN Param Parameter

Keyword	Description
distance	Specifies the number of distance units after which to stop searching for nearest neighbors. If you do not also specify the `unit` keyword, the default is the unit of measurement associated with the data. Data type is NUMBER. For example: 'distance=10 unit=mile'
ellipsoidal	Specifies if ellipsoidal distance is always used with geodetic data (`true`), or if spherical distance is used in some cases (`false`, the default). See Distance: Spherical versus Ellipsoidal with Geodetic Data. For example: 'ellipsoidal=true'
sdo_batch_size	Specifies the number of rows to be evaluated at a time when the SDO_NN expression may need to be evaluated multiple times in order to return the desired number of results that satisfy the WHERE clause. Available only when an R-tree index is used. If you specify `sdo_batch_size=0` (or if you omit the `param` parameter completely), Spatial calculates a batch size suited to the result set size. See the Usage Notes and Examples for more information. Data type is NUMBER. For example: 'sdo_batch_size=10'
sdo_num_res	Specifies the number of results (nearest neighbors) to be returned. If neither `sdo_batch_size` nor `sdo_num_res` is specified, this is equivalent to specifying sdo_batch_size=0. See the Usage Notes and Examples for more information. Data type is NUMBER. For example: 'sdo_num_res=5'
unit	If the `distance` keyword or the SDO_NN_DISTANCE ancillary operator is included in the call to SDO_NN, specifies the unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table. See Unit of Measurement Support for more information about unit of measurement specification. Data type is VARCHAR2. Default = unit of measurement associated with the data. For geodetic data, the default is meters. For example: 'unit=KM'

Returns

This operator returns the `sdo_num_res` number of objects from `geometry1` that are nearest to `geometry2` in the query. In determining how near two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

Usage Notes

> **Note:**
>
> The SDO_NN operator is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The operator is disabled if the table does not have a spatial index or if the number of dimensions for the query window does not match the number of dimensions specified when the index was created.

The operator must always be used in a WHERE clause, and the condition that includes the operator should be an expression of the form SDO_NN(arg1, arg2, '<some_parameter>') = 'TRUE'. (The expression must not equate to any value other than 'TRUE'.)

The operator can be used in the following ways:

- If all geometries in the layer are candidates, use the `sdo_num_res` keyword to specify the number of geometries returned.

  The `sdo_num_res` keyword is especially useful when you are concerned only with proximity (for example, the three closest banks, regardless of bank name).
- If any geometries in the table might be nearer than the geometries specified in the WHERE clause, use the `sdo_batch_size` keyword and use the WHERE clause (including the ROWNUM pseudocolumn) to limit the number of geometries returned.

  The `sdo_batch_size` keyword is especially useful when you need to consider one or more columns from the ***same*** table as the nearest neighbor search column in the WHERE clause (for example, the three closest banks whose name contains *MegaBank*).
- You can also specify both the `sdo_num_res` and `sdo_batch_size` keywords, as explained later in these Usage Notes.

As an example of the `sdo_batch_size` keyword, assume that a RESTAURANTS table contains different types of restaurants, and you want to find the two nearest Italian restaurants to your hotel but only if they are within two miles. The query might look like the following:

```
SELECT r.name FROM restaurants r WHERE
   SDO_NN(r.geometry, :my_hotel,
      'sdo_batch_size=10 distance=2 unit=mile') = 'TRUE'
   AND r.cuisine = 'Italian' AND ROWNUM <=2;
```

In this example, the `ROWNUM <=2` clause is necessary to limit the number of results returned to no more than 2 where CUISINE is `Italian`. However, if the `sdo_batch_size` keyword is not specified in this example, and if `sdo_num_res=2` is specified instead of `ROWNUM <=2`, only the two nearest restaurants within two miles are considered, regardless of their CUISINE value; and if the CUISINE value of these two rows is not `Italian`, the query may return no rows.

The `sdo_batch_size` value can affect the performance of nearest neighbor queries. A good general guideline is to specify the number of candidate rows likely to satisfy the WHERE clause. Using the preceding example of a query for Italian restaurants, if approximately 20 percent of the restaurants nearest to the hotel are Italian and if you want 2 restaurants, an `sdo_batch_size` value of 10 will probably result in the best performance. On the other hand, if only approximately 5 percent of the restaurants nearest to the hotel are Italian and if you want 2 restaurants, an `sdo_batch_size` value of 40 would be better.

You can specify `sdo_batch_size=0`, which causes Spatial to calculate a batch size that is suitable for the result set size. However, the calculated batch size may not be optimal, and the calculation incurs some processing overhead; if you can determine a good `sdo_batch_size` value for a query, the performance will probably be better than if you specify `sdo_batch_size=0`.

Specify the `number` parameter only if you are using the SDO_NN_DISTANCE ancillary operator in the call to SDO_NN. See the information about the SDO_NN_DISTANCE operator in this chapter.

If two or more objects from `geometry1` are an equal distance from `geometry2`, any of the objects can be returned on any call to the function. For example, if `item_a`, `item_b`, and `item_c` are nearest to and equally distant from `geometry2`, and if `sdo_num_res=2`, two of those three objects are returned, but they can be any two of the three.

If the SDO_NN operator uses a partitioned spatial index (see Using Partitioned Spatial Indexes), the requested number of geometries is returned for *each* partition that contains candidate rows based on the query criteria. For example, if you request the 5 nearest restaurants to a point and the spatial index has 4 partitions, the operator returns up to 20 (5*4) geometries. In this case, you must use the ROWNUM pseudocolumn (here, `WHERE ROWNUM <=5`) to return the 5 nearest restaurants.

If `geometry1` and `geometry2` are based on different coordinate systems, `geometry2` is temporarily transformed to the coordinate system of `geometry1` for the operation to be performed, as described in Different Coordinate Systems for Geometries with Operators and Functions.

SDO_NN is not supported for spatial joins.

In some situations the SDO_NN operator will not use the spatial index unless an optimizer hint forces the index to be used. This can occur when a query involves a join; and if the optimizer hint is not used in such situations, an internal error occurs. To prevent such errors, you should always specify an optimizer hint to use the spatial index with the SDO_NN operator, regardless of how simple or complex the query is. For example, the following excerpt from a query specifies to use the COLA_SPATIAL_IDX index that is defined on the COLA_MARKETS table:

```
SELECT /*+ INDEX(c cola_spatial_idx) */
  c.mkt_id, c.name, ... FROM cola_markets c, ...;
```

However, if the column predicate in the WHERE clause specifies any nonspatial column in the table for `geometry1` that has an associated index, be sure that this index is not used by specifying the NO_INDEX hint for that index. For example, if there was an index named COLA_NAME_IDX defined on the NAME column, you would need to specify the hints in the preceding example as follows:

```
SELECT /*+ INDEX(c cola_spatial_idx) NO_INDEX(c cola_name_idx) */
  c.mkt_id, c.name, ... FROM cola_markets c, ...;
```

(Note, however, that there is no index named COLA_NAME_IDX in the example in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

If you join two or more tables with the SDO_NN operator and the `sdo_num_res` keyword, specify the LEADING hint for the outer table, USE_NL hint to have a nested loops join, and the INDEX hint for the inner table (the table with the spatial index). For example:

```
SELECT  /*+ LEADING(b) USE_NL(b a) INDEX(a cola_spatial_idx) */ a.gid
   FROM cola_qry  b,  cola_markets  a
      WHERE SDO_NN(a.shape, b.shape, 'sdo_num_res=1')='TRUE';
```

However, if you join two or more tables with the SDO_NN operator, the `sdo_batch_size` keyword, and the ROWNUM clause, the best way to implement the logic is to use a PL/SQL block. For example:

```
BEGIN
  FOR item IN ( SELECT b.shape FROM cola_qry b)
  LOOP
    SELECT  /*+ INDEX(a cola_spatial_idx) */ a.gid INTO local_gid
    FROM cola_markets  a
    WHERE SDO_NN(a.shape, item.shape, 'sdo_batch_size=10')='TRUE'
      and a.name like 'cola%' and ROWNUM <2;
  END LOOP;
END;
```

For detailed information about using optimizer hints, see *Oracle Database SQL Tuning Guide*.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds the two objects from the SHAPE column in the COLA_MARKETS table that are nearest to a specified point (10,7). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT /*+ INDEX(c cola_spatial_idx) */
 c.mkt_id, c.name  FROM cola_markets c  WHERE SDO_NN(c.shape,
   sdo_geometry(2001, NULL, sdo_point_type(10,7,NULL), NULL,
   NULL),  'sdo_num_res=2') = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         4 cola_d
```

The following example uses the `sdo_batch_size` keyword to find the two objects (ROWNUM <=2), with a NAME value less than 'cola_d', from the SHAPE column in the COLA_MARKETS table that are nearest to a specified point (10,7). The value of 3 for `sdo_batch_size` represents a best guess at the number of nearest geometries that need to be evaluated before the WHERE clause condition is satisfied. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT /*+ INDEX(c cola_spatial_idx) */ c.mkt_id, c.name
   FROM cola_markets c
   WHERE SDO_NN(c.shape,  sdo_geometry(2001, NULL,
      sdo_point_type(10,7,NULL), NULL,  NULL),
      'sdo_batch_size=3') = 'TRUE'
   AND c.name < 'cola_d' AND ROWNUM <= 2;

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         3 cola_c
```

See also the more complex SDO_NN examples in SDO_NN Examples.

Related Topics

- SDO_NN_DISTANCE

20.11 SDO_NN_DISTANCE

Format

```
SDO_NN_DISTANCE(number);
```

Description

Returns the distance of an object returned by the SDO_NN operator. Valid only within a call to the SDO_NN operator.

Keywords and Parameters

Value	Description
number	Specifies a number that must be the same as the last parameter passed to the SDO_NN operator. Data type is NUMBER.

Returns

This operator returns the distance of an object returned by the SDO_NN operator. In determining how near two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

Usage Notes

SDO_NN_DISTANCE is an ancillary operator to the SDO_NN operator. It returns the distance between the specified geometry and a nearest neighbor object. This distance is passed as ancillary data to the SDO_NN operator. (For an explanation of how operators can use ancillary data, see the section on ancillary data in *Oracle Database Data Cartridge Developer's Guide*.)

You can choose any arbitrary number for the `number` parameter. The only requirement is that it must match the last parameter in the call to the SDO_NN operator.

Use a bind variable to store and operate on the distance value.

Examples

The following example finds the two objects from the SHAPE column in the COLA_MARKETS table that are nearest to a specified point (10,7), and it finds the distance between each object and the point. (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT   /*+ INDEX(c cola_spatial_idx) */
   c.mkt_id, c.name, SDO_NN_DISTANCE(1) dist
   FROM cola_markets c
   WHERE SDO_NN(c.shape,  sdo_geometry(2001, NULL,
      sdo_point_type(10,7,NULL), NULL,  NULL),
      'sdo_num_res=2', 1) = 'TRUE' ORDER BY dist;

    MKT_ID NAME                                   DIST
---------- -------------------------------- ----------
         4 cola_d                            .828427125
         2 cola_b                            2.23606798
```

Note the following about this example:

- 1 is used as the `number` parameter for SDO_NN_DISTANCE, and 1 is also specified as the last parameter to SDO_NN (after `'sdo_num_res=2'`).
- The column alias `dist` holds the distance between the object and the point. (For geodetic data, the distance unit is meters; for non-geodetic data, the distance unit is the unit associated with the data.)

The following example uses the `sdo_batch_size` keyword in selecting the two closest Italian restaurants to your hotel from a YELLOW_PAGES table that contains different types of businesses:

```
SELECT * FROM
 (SELECT /*+ FIRST_ROWS */ y.name FROM YELLOW_PAGES  y
  WHERE SDO_NN(y.geometry, :my_hotel, 'sdo_batch_size=100', 1) = 'TRUE'
   AND y.business = 'Italian Restaurant'
  ORDER BY SDO_NN_DISTANCE(1))
WHERE ROWNUM <=10;
```

In the preceding query, the FIRST_ROWS hint enables the optimizer to improve performance by pushing the ORDER BY operation into the spatial index. `:my_hotel` can be either a bind variable or a literal value.

The FIRST_ROWS hint is also available to a local partitioned spatial index. In the preceding example, if the YELLOW_PAGES table is partitioned by name, the query will be executed as follows:

1. For each partition, the ORDER BY operation is processed using the spatial index until 10 rows are found.
2. After all partitions are completed, all rows found in the preceding step are sorted, and the top 10 rows are returned.

Related Topics

- SDO_NN

20.12 SDO_ON

Format

```
SDO_ON(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the ON topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=ON'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_ON(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the ON topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the ON relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) This example returns no rows because there are no line string geometries in the SHAPE column.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_ON(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(4,6, 8,8))
            ) = 'TRUE';

no rows selected
```

20.13 SDO_OVERLAPBDYDISJOINT

Format

```
SDO_OVERLAPBDYDISJOINT(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the OVERLAPBDYDISJOINT topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=OVERLAPBDYDISJOINT'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_OVERLAPBDYDISJOINT(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the OVERLAPBDYDISJOINT topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the OVERLAPBDYDISJOINT relationship with a line string geometry (here, a horizontal line from 0,6 to 2,6). (The example uses the definitions and data described and illustrated inSimple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_a` has the OVERLAPBDYDISJOINT relationship with the line string geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_OVERLAPBDYDISJOINT(c.shape,
            SDO_GEOMETRY(2002, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,2,1),
              SDO_ORDINATE_ARRAY(0,6, 2,6))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         1 cola_a
```

20.14 SDO_OVERLAPBDYINTERSECT

Format

```
SDO_OVERLAPBDYINTERSECT(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the OVERLAPBDYINTERSECT topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=OVERLAPBDYINTERSECT'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.

Value	Description
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_OVERLAPBDYINTERSECT(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the OVERLAPBDYINTERSECT topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the OVERLAPBDYINTERSECT relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, `cola_a`, `cola_b`, and `cola_d` have the OVERLAPBDYINTERSECT relationship with the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_OVERLAPBDYINTERSECT(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(4,6, 8,8))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
         4 cola_d
```

20.15 SDO_OVERLAPS

Format

```
SDO_OVERLAPS(geometry1, geometry2);
```

Description

Checks if any geometries in a table overlap (that is, have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship with) a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=OVERLAPBDYDISJOINT+OVERLAPBDYINTERSECT'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

For information about 3D support with Spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_OVERLAPS(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship, and FALSE otherwise.

Usage Notes

For the operator to evaluate to TRUE, the geometries must two polygons, two lines, or two multipoints. For example, if one geometry is a line and other is a polygon, they cannot overlap.

See also the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

Examples

The following example finds geometries that overlap a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, three of the geometries in the SHAPE column overlap the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_OVERLAPS(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(4,6, 8,8))
            ) = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
         4 cola_d
```

20.16 SDO_POINTINPOLYGON

Format

```
SDO_POINTINPOLYGON(cur, geom_obj, tol, params) RETURN ANYDATASET;
```

Description

Takes a set of rows, and returns those rows that are within a specified polygon geometry.

Keywords and Parameters

Value	Description
cur	One of the following: • A REF cursor: the first two columns in the SELECT of the SQL for ref_cursor must be an X and Y point coordinates pair from a user table. The two columns must be of type NUMBER. (Any other columns can be number, character, and date types). Data type is SYS_REFCURSOR. • A REF cursor: the first column in the SELECT of the SQL for the ref cursor must be a spatial geometry object from a user table. The column must be of type SDO_GEOMETRY. (Any other columns can be number, character, and date types). Data type is SYS_REFCURSOR.
geom_obj	Spatial geometry object: either a geometry from a table or a transient instance of a geometry, against which all of the selected points from `cur` will be checked. Data type is SDO_GEOMETRY.
tol	Tolerance value (see Tolerance). Must be greater than 0.0. Data type is NUMBER.
params	Optional parameter string of keywords and values. Determines the behavior of the operator. See Table 20-5 in the Usage Notes for information about the available keywords. Data type is VARCHAR2. Default is NULL.

Returns

SDO_POINTINPOLYGON returns an object of ANYDATASET TYPE, which is described in *Oracle Database PL/SQL Packages and Types Reference*. The ANYDATASET output columns are those specified by the `cur` parameter.

Usage Notes

SDO_POINTINPOLYGON is technically not an operator, but a table function. (For an explanation of table functions, see *Oracle Database PL/SQL Language Reference*.) However, it is presented in the chapter with spatial operators because its usage is similar to that of the operators, and because it is not part of a package with other functions and procedures.

The SQL statement used in the `cur` parameter can have any number of predicates in the WHERE clause. This feature can be used to filter the data on other attributes before passing the resulting rows into the SDO_POINTINPOLYGON operator.

The output columns are identical to the input columns, but the only rows returned are those matching the selection criteria.

Table 20-5 shows the keywords for the `params` parameter.

Table 20-5 params Keywords for the SDO_POINTINPOLYGON Operator

Keyword	Description
mask	The topological relationship of interest. Valid values are 'mask=<*value*>' where <*value*> is one or more of the following: `TOUCH`, `OVERLAPBDYDISJOINT`, `OVERLAPBDYINTERSECT`, `EQUAL`, `INSIDE`, `COVEREDBY`, `CONTAINS`, `COVERS`, `ANYINTERACT`, `ON`. Multiple masks are combined with the logical Boolean operator OR, for example, `'mask=inside+touch'`. See Spatial Relationships and Filtering for an explanation of the nine-intersection relationship pattern. If `cur` is a pair of X and Y point coordinates, `TOUCH` and `ON` are synonymous. If this parameter is null or contains an empty string, `mask=ANYINTERACT` is assumed.
sdo_batch_size	Specifies the maximum number of rows that are processed in a batch. The default value is 4000 and the maximum value is 32768. Data type is NUMBER. For example: 'sdo_batch_size=5000'

To use parallel query servers, you must do either of the following:

- Specify the `/*+ PARALLEL(<table alias>, <n>) */` optimizer hint, where <*table_alias*> is the specified table alias and <*n*> is the degree-of-parallelism.
- Enable parallel query execution by entering the following command from a suitably privileged account:

  ```
  ALTER SESSION FORCE PARALLEL QUERY;
  ```

Examples

The following example creates a new table named COLA_MARKET_POINTS based on the data from the COLA_MARKETS table, which is described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data. The example then selects a point within each geometry where the MKT_ID column value is greater than 1. (It uses the SDO_UTIL.INTERIOR_POINT function to get a point that is guaranteed to be inside each geometry that matches the query criteria.)

```
-- Create a new table with a different name based on the data from the
-- COLA_MARKETS table. This table has four columns: X, Y, MKT_ID, and NAME.

CREATE TABLE cola_market_points AS
SELECT a.point.sdo_point.x X, a.point.sdo_point.y Y, MKT_ID, NAME
 FROM (
SELECT mkt_id, name, sdo_util.interior_point(shape) point FROM cola_markets) a;

-- Limit to MKT_ID > 1. Also, use the PARALLEL hint.
SELECT /*+ PARALLEL(a, 4) */ *
FROM TABLE(sdo_PointInPolygon(
  CURSOR(select * from cola_market_points where mkt_id > 1),
  SDO_GEOMETRY(
    2003,
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1, 1003, 1),
    MDSYS.SDO_ORDINATE_ARRAY(1, 1, 8, 1, 8, 6, 5, 7, 1, 1)),
  0.05)) a;
```

```
         X          Y     MKT_ID NAME
---------- ---------- ---------- --------------------------------
    6.3125      2.875          2 cola_b
    4.6875      3.875          3 cola_c
```

The following example does the same SDO_POINTINPOLYGON query as the previous one, but without the need to create a COLA_MARKET_POINTS table, and where for each row with a MKT_ID column value greater than 1, a point geometry is returned instead the just the X and Y coordinate pair. (The output has been reformatted for readability.)

```
-- Limit to MKT_ID > 1. Also, use the PARALLEL hint.
SELECT /*+ PARALLEL(a, 4) */ name, mkt_id, point
FROM TABLE(sdo_PointInPolygon(
  CURSOR(select sdo_util.interior_point(shape) point, mkt_id, name
         from cola_markets where mkt_id > 1),
SDO_GEOMETRY
  2003,
  NULL,
  NULL,
  MDSYS.SDO_ELEM_INFO_ARRAY(1, 1003, 1),
  MDSYS.SDO_ORDINATE_ARRAY(1, 1, 8, 1, 8, 6, 5, 7, 1, 1)),  0.05)) a;

NAME   MKT_ID  POINT(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO,
SDO_ORDINATES)
------ -------
----------------------------------------------------------------------------
cola_b   2      SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(6.3125, 2.875, NULL), NULL, NULL)
cola_c   3      SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(4.6875, 3.875, NULL), NULL, NULL)
```

The following example uses a bind variable in the WHERE clause, and it specifies a `params` string. It assumes the existence of a table named PIP_DATA.

```
DECLARE
 my_cursor SYS_REFCURSOR;
 my_pip_cursor SYS_REFCURSOR;
 stmt varchar2(2000);
 cnt number;
BEGIN
  stmt := 'SELECT count(*) FROM ' ||
          ' TABLE (Sdo_PointInPolygon(' ||
          'CURSOR(select * from pip_data where x < :x1),' ||
          ' :g1, :tol, ''mask=DISJOINT sdo_batch_size=6000'')) ';
 open my_cursor for stmt
 using 100, -- :x1
       SDO_GEOMETRY( 2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1, 1003, 1),
              SDO_ORDINATE_ARRAY(10, 10, 70,10, 70, 70, 50,70,
                                 40,50, 20,70, 10,70, 10,10)), -- :g1
       0.05; -- :tol
 FETCH my_cursor into cnt;
 dbms_output.put_line(to_char(cnt));
END;
/
```

Related Topics

- SDO_UTIL.INTERIOR_POINT

20.17 SDO_RELATE

Format

```
SDO_RELATE(geometry1, geometry2,  param);
```

Description

Identifies either the spatial objects that have a particular spatial interaction with a given object such as an area of interest, or pairs of spatial objects that have a particular spatial interaction.

This operator performs both primary and secondary filter operations.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.
param	Specifies the `mask` keyword, and optionally either or both of the `min_resolution` and `max_resolution` keywords. The data type for this parameter is VARCHAR2. The `mask` keyword specifies the topological relationship of interest. This is a required parameter. Valid `mask` keyword values are one or more of the following in the nine-intersection pattern: `TOUCH`, `OVERLAPBDYDISJOINT`, `OVERLAPBDYINTERSECT`, `EQUAL`, `INSIDE`, `COVEREDBY`, `CONTAINS`, `COVERS`, `ANYINTERACT`, `ON`. Multiple masks are combined with the logical Boolean operator OR, for example, '`mask=inside+touch'`. See Spatial Relationships and Filtering for an explanation of the nine-intersection relationship pattern. The `min_resolution` keyword includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, `min_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.) The `max_resolution` keyword includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, `max_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.) For backward compatibility, any additional keywords for the `param` parameter that were supported before release 10.1 will still work; however, the use of those keywords is discouraged and is not supported for new uses of the operator.

Returns

The expression SDO_RELATE(geometry1,geometry2, 'mask = <some_mask_val>') = 'TRUE' evaluates to TRUE for object pairs that have the topological relationship specified by <some_mask_val>, and FALSE otherwise.

Usage Notes

The operator is disabled if the number of dimensions for the query window does not match the number of dimensions specified when the index was created.

The operator must always be used in a WHERE clause, and the condition that includes the operator should be an expression of the form SDO_RELATE(arg1, arg2, 'mask = <some_mask_val>') = 'TRUE'. (The expression must not equate to any value other than 'TRUE'.)

`geometry2` can come from a table or be a transient SDO_GEOMETRY object, such as a bind variable or SDO_GEOMETRY constructor.

- If the `geometry2` column is not spatially indexed, the operator indexes the query window in memory and performance is very good.
- If `geometry2` passed to the operator originates from a table or view, the LEADING optimizer hint is not required, but may be helpful to inform the optimizer the driving table or view in the query should be the one that contains `geometry2`. The table or view specified in the LEADING hint should correspond to the table name or view name that contains `geometry2`. If the table or view is aliased in the FROM clause, the alias should be specified in the LEADING hint.

If `geometry1` and `geometry2` are based on different coordinate systems, `geometry2` is temporarily transformed to the coordinate system of `geometry1` for the operation to be performed, as described in Different Coordinate Systems for Geometries with Operators and Functions.

Unlike with the SDO_GEOM.RELATE function, DISJOINT and DETERMINE masks are not allowed in the relationship mask with the SDO_RELATE operator. This is because SDO_RELATE uses the spatial index (if one is available) to find candidates that may interact, and the information to satisfy DISJOINT or DETERMINE is not present in the index.

Multiple masks can be combined using the logical Boolean operator OR, for example, `'mask=touch+coveredby'`. Effective with Release 12.1, if you set the SPATIAL_VECTOR_ACCELERATION system parameter to `TRUE` (highly recommended, as explained in SPATIAL_VECTOR_ACCELERATION System Parameter), you do not need to use UNION ALL with such masks. However, if you are ***not*** setting SPATIAL_VECTOR_ACCELERATION to `TRUE`, better performance may result if the spatial query specifies each mask individually and uses the UNION ALL syntax to combine the results. This is due to internal optimizations that Spatial can apply under certain conditions when masks are specified singly rather than grouped within the same SDO_RELATE operator call. (There are two exceptions, `inside+coveredby` and `contains+covers`, where the combination performs better than the UNION ALL alternative.)

For example, consider the following query using the logical Boolean operator OR to group multiple masks:

```
SELECT a.gid
  FROM polygons a, query_polys B
  WHERE B.gid = 1
  AND SDO_RELATE(A.Geometry, B.Geometry,
                   'mask=touch+coveredby') = 'TRUE';
```

If SPATIAL_VECTOR_ACCELERATION is `TRUE`, then preceding query is simplest and has the best performance. However, if SPATIAL_VECTOR_ACCELEERATION is `FALSE`, the preceding query may result in better performance if it is expressed as follows, using UNION ALL to combine results of multiple SDO_RELATE operator calls, each with a single mask:

```
SELECT a.gid
      FROM polygons a, query_polys B
      WHERE B.gid = 1
      AND SDO_RELATE(A.Geometry, B.Geometry,
                   'mask=touch') = 'TRUE'
UNION ALL
```

```
SELECT a.gid
      FROM polygons a, query_polys B
      WHERE B.gid = 1
      AND SDO_RELATE(A.Geometry, B.Geometry,
                   'mask=coveredby') = 'TRUE';
```

The following considerations apply to relationships between lines and a multipoint geometry (points in a point cluster). Assume the example of a line and a multipoint geometry (for example, SDO_GTYPE = 2005) consisting of three points.

- If none of the points has any interaction with the line, the relationship between the line and the point cluster is DISJOINT.
- If one of the points is on the interior of the line and the other two points are disjoint, the relationship between the line and the point cluster is OVERLAPBDYDISJOINT.
- If one of the points is on the boundary of the line (that is, if it is on the start point or end point of the line) and the other two points are disjoint, the relationship between the line and the point cluster is TOUCH.
- If one of the points is on the boundary of the line (that is, if it is on the start point or end point of the line), another point is on the interior of the line, and the third point is disjoint, the relationship between the line and the point cluster is OVERLAPBDYDISJOINT (not OVERLAPBDYINTERSECT).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following examples are similar to those for the SDO_FILTER operator; however, they identify a specific type of interaction (using the `mask` keyword), and they determine with certainty (not mere likelihood) if the spatial interaction occurs.

The following example selects the geometries that have any interaction with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_RELATE(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'mask=anyinteract') = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
         4 cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only `cola_a` and `cola_b` are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The circle `cola_d` is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_RELATE(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'mask=anyinteract min_resolution=4.1') = 'TRUE';

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
         1 cola_a
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column objects have any spatial interaction with the GEOMETRY column object in the QUERY_POLYS table that has a GID value of 1.

```
SELECT A.gid
  FROM Polygons A, query_polys B
  WHERE B.gid = 1
  AND SDO_RELATE(A.Geometry, B.Geometry,
                 'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where a GEOMETRY column object has any spatial interaction with the geometry stored in the `aGeom` variable.

```
SELECT A.Gid
  FROM Polygons A
  WHERE SDO_RELATE(A.Geometry, :aGeom, 'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where a GEOMETRY column object has any spatial interaction with the specified rectangle having the lower-left coordinates (x1,y1) and the upper-right coordinates (x2, y2).

```
SELECT A.Gid
  FROM Polygons A
  WHERE SDO_RELATE(A.Geometry, sdo_geometry(2003,NULL,NULL,
                                   sdo_elem_info_array(1,1003,3),
                                   sdo_ordinate_array(x1,y1,x2,y2)),
                     'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object has any spatial interaction with any GEOMETRY column object in the QUERY_POLYS table. In this example, the LEADING optimizer hint is used and QUERY_POLYS (`geometry2`) table is specified first in the FROM clause, because multiple geometries from `geometry2` are involved (see the Usage Notes).

```
SELECT /*+ LEADING(B) */
  A.gid
  FROM query_polys B, polygons A
  WHERE SDO_RELATE(A.Geometry, B.Geometry, 'mask=ANYINTERACT') = 'TRUE';
```

Related Topics

- SDO_FILTER
- SDO_JOIN
- SDO_WITHIN_DISTANCE
- SDO_GEOM.RELATE function

20.18 SDO_TOUCH

Format

```
SDO_TOUCH(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the TOUCH topological relationship with a specified geometry. Equivalent to specifying the SDO_RELATE operator with `'mask=TOUCH'`.

See the section on the SDO_RELATE operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO_TOUCH(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the TOUCH topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the SDO_RELATE operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial, see Spatial Relationships and Filtering.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example finds geometries that have the TOUCH relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,7). (The example uses the definitions and data in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.) In this example, only `cola_b` has the TOUCH relationship with the query window geometry.

```
SELECT c.mkt_id, c.name
  FROM cola_markets c
  WHERE SDO_TOUCH(c.shape,
            SDO_GEOMETRY(2003, NULL, NULL,
              SDO_ELEM_INFO_ARRAY(1,1003,3),
              SDO_ORDINATE_ARRAY(1,1, 5,7))
            ) = 'TRUE';
  FROM cola_markets c

    MKT_ID NAME
---------- --------------------------------
         2 cola_b
```

20.19 SDO_WITHIN_DISTANCE

Format

```
SDO_WITHIN_DISTANCE(geometry1, aGeom, params);
```

Description

Identifies the set of spatial objects that are within some specified distance of a given object, such as an area of interest or point of interest.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column has the set of geometry objects that will be operated on to determine if they are within the specified distance of the given object (`aGeom`). A spatial index on this column is recommended. Data type is SDO_GEOMETRY.
aGeom	Specifies the object to be checked for distance against the geometry objects in `geometry1`. Specify either a geometry from a table (using a bind variable) or a transient instance of a geometry (using the SDO_GEOMETRY constructor). Data type is SDO_GEOMETRY.
params	A quoted string containing one or more keywords (with values) that determine the behavior of the operator. The remaining items (`distance`, `ellipsoidal`, `max_resolution`, `min_resolution`, `querytype`, and `unit`) are potential keywords for the `params` parameter. Data type is VARCHAR2.
distance	Specifies the distance value. If a coordinate system is associated with the geometry, the distance unit is assumed to be the unit associated with the coordinate system. This is a required keyword. Data type is NUMBER.
ellipsoidal	Specifies if ellipsoidal distance is always used with geodetic data (`true`), or if spherical distance is used in some cases (`false`, the default). See Distance: Spherical versus Ellipsoidal with Geodetic Data. For example: 'ellipsoidal=true'
max_resolution	Includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, `max_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.)
min_resolution	Includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, `min_resolution=10` includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.)
querytype	Set `'querytype=FILTER'` to perform only a primary filter operation. If `querytype` is not specified, both primary and secondary filter operations are performed (default). Data type is VARCHAR2.
unit	Specifies the unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, `'unit=KM'`). See Unit of Measurement Support for more information about unit of measurement specification. Data type is NUMBER. Default = unit of measurement associated with the data. For geodetic data, the default is meters.

Returns

The expression SDO_WITHIN_DISTANCE(arg1, arg2, arg3) = 'TRUE' evaluates to TRUE for object pairs that are within the specified distance, and FALSE otherwise.

Usage Notes

> **Note:**
>
> The SDO_WITHIN_DISTANCE operator is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The distance between two extended objects (nonpoint objects such as lines and polygons) is defined as the minimum distance between these two objects. The distance between two adjacent polygons is zero.

The operator is disabled if the number of dimensions for the query window does not match the number of dimensions specified when the spatial index (if one is being used) was created.

The operator must always be used in a WHERE clause and the condition that includes the operator should be an expression of the form:

```
SDO_WITHIN_DISTANCE(arg1, arg2, 'distance = <some_dist_val>') = 'TRUE'
```

(The expression must not equate to any value other than 'TRUE'.)

The geometry column must have a spatial index built on it. If the data is geodetic, the spatial index must be an R-tree index.

SDO_WITHIN_DISTANCE is not supported for spatial joins. See Within-Distance Operator for a discussion on how to perform a spatial join within-distance operation.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see Three-Dimensional Spatial Objects.

Examples

The following example selects the geometries that are within a distance of 10 from a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described and illustrated in Simple Example: Inserting_ Indexing_ and Querying Spatial Data. In this case, all geometries shown in that figure are returned.)

```
SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'distance=10') = 'TRUE';

NAME
--------------------------------
cola_b
cola_a
cola_c
cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only `cola_a` and `cola_b` are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The trapezoid `cola_c` is excluded, because its MBR has sides with lengths of 3 and 2; and the circle `cola_d` is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'distance=10 min_resolution=4.1') = 'TRUE';

NAME
--------------------------------
cola_b
cola_a
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is within 10 distance units of the geometry stored in the `aGeom` variable.

```
SELECT A.GID
  FROM POLYGONS A
  WHERE
    SDO_WITHIN_DISTANCE(A.Geometry, :aGeom, 'distance = 10') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is within 10 distance units of the specified rectangle having the lower-left coordinates (x1,y1) and the upper-right coordinates (x2, y2).

```
SELECT A.GID
  FROM POLYGONS A
  WHERE
    SDO_WITHIN_DISTANCE(A.Geometry, sdo_geometry(2003,NULL,NULL,
                             sdo_elem_info_array(1,1003,3),
                             sdo_ordinate_array(x1,y1,x2,y2)),
                     'distance = 10') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GID value in the QUERY_POINTS table is 1 and a POLYGONS.GEOMETRY object is within 10 distance units of the QUERY_POINTS.GEOMETRY object.

```
SELECT A.GID
  FROM POLYGONS A, Query_Points B
  WHERE B.GID = 1 AND
    SDO_WITHIN_DISTANCE(A.Geometry, B.Geometry, 'distance = 10') = 'TRUE';
```

See also the more complex SDO_WITHIN_DISTANCE examples in SDO_WITHIN_DISTANCE Examples.

Related Topics

- SDO_FILTER
- SDO_RELATE

21

Spatial Aggregate Functions

This chapter contains reference and usage information for the spatial aggregate functions.

See the usage information about spatial aggregate functions in Spatial Aggregate Functions.

Most of these aggregate functions accept a parameter of type SDOAGGRTYPE, which is described in SDOAGGRTYPE Object Type.

> **Note:**
>
> Spatial aggregate functions are supported for two-dimensional geometries only, except for SDO_AGGR_MBR, which is supported for both two-dimensional and three-dimensional geometries.

- SDO_AGGR_CENTROID
- SDO_AGGR_CONCAT_LINES
- SDO_AGGR_CONCAVEHULL
- SDO_AGGR_CONVEXHULL
- SDO_AGGR_LRS_CONCAT
- SDO_AGGR_MBR
- SDO_AGGR_SET_UNION
- SDO_AGGR_UNION

21.1 SDO_AGGR_CENTROID

Format

```
SDO_AGGR_CENTROID(
     AggregateGeometry  SDOAGGRTYPE
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the centroid ("center of gravity") of the specified geometry objects.

Parameters

AggregateGeometry
An object of type SDOAGGRTYPE (see SDOAGGRTYPE Object Type) that specifies the geometry column and dimensional array.

Usage Notes

The behavior of the function depends on whether the geometry objects are all polygons, all points, or a mixture of polygons and points:

- If the geometry objects are all polygons, the centroid of all the objects is returned.
- If the geometry objects are all points, the centroid of all the objects is returned.
- If the geometry objects are a mixture of polygons and points (specifically, if they include at least one polygon and at least one point), any points are ignored, and the centroid of all the polygons is returned.

The result is weighted by the area of each polygon in the geometry objects. If the geometry objects are a mixture of polygons and points, the points are not used in the calculation of the centroid. If the geometry objects are all points, the points have equal weight.

See also the information about the SDO_GEOM.SDO_CENTROID function in SDO_GEOM Package (Geometry).

Examples

The following example returns the centroid of the geometry objects in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_AGGR_CENTROID(SDOAGGRTYPE(shape, 0.005))
  FROM cola_markets;

SDO_AGGR_CENTROID(SDOAGGRTYPE(SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POINT
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(5.21295938, 5.00744233, NULL), NULL, NUL
L)
```

21.2 SDO_AGGR_CONCAT_LINES

Format

```
SDO_AGGR_CONCAT_LINES(
     geom  SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry that concatenates the specified line or multiline geometries.

Parameters

geom
Geometry objects.

Usage Notes

Each input geometry must be a two-dimensional line or multiline geometry (that is, the SDO_GTYPE value must be 2002 or 2006). This function is not supported for LRS geometries. To perform an aggregate concatenation of LRS geometric segments, use the SDO_AGGR_LRS_CONCAT spatial aggregate function.

The input geometries must be line strings whose vertices are connected by straight line segments. Circular arcs and compound line strings are not supported.

If any input geometry is a multiline geometry, the elements of the geometry must be disjoint. If they are not disjoint, this function may return incorrect results.

The topological relationship between the geometries in each pair of geometries to be concatenated must be DISJOINT or TOUCH; and if the relationship is TOUCH, the geometries must intersect only at two end points.

You can use the SDO_UTIL.CONCAT_LINES function (described in SDO_LRS Package (Linear Referencing System)) to concatenate two line or multiline geometries.

An exception is raised if any input geometries are not line or multiline geometries, or if not all input geometries are based on the same coordinate system.

Examples

The following example inserts two line geometries in the COLA_MARKETS table, and then returns the aggregate concatenation of these geometries. (The example uses the data definitions from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- First, insert two line geometries.
INSERT INTO cola_markets VALUES(1001, 'line_1', SDO_GEOMETRY(2002, NULL, NULL,
  SDO_ELEM_INFO_ARRAY(1,2,1), SDO_ORDINATE_ARRAY(1,1, 5,1)));
INSERT INTO cola_markets VALUES(1002, 'line_2', SDO_GEOMETRY(2002, NULL, NULL,
  SDO_ELEM_INFO_ARRAY(1,2,1), SDO_ORDINATE_ARRAY(5,1, 8,1)));
-- Perform aggregate concatenation of all line geometries in layer.
SELECT SDO_AGGR_CONCAT_LINES(c.shape) FROM cola_markets c
   WHERE c.mkt_id > 1000;

SDO_AGGR_CONCAT_LINES(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
1, 1, 5, 1, 8, 1))
```

21.3 SDO_AGGR_CONCAVEHULL

Format

```
SDO_AGGR_CONCAVEHULL(
     AggregateGeometry  SDOAGGRTYPE
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the concave hull of the specified geometry objects.

Parameters

AggregateGeometry
An object of type SDOAGGRTYPE (see SDOAGGRTYPE Object Type) that specifies the geometry column and dimensional array.

Usage Notes

See also the information about the SDO_GEOM.SDO_CONCAVEHULL function in SDO_GEOM Package (Geometry).

Examples

The following example returns the concave hull of the geometry objects in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_AGGR_CONCAVEHULL(SDOAGGRTYPE(shape, 0.005))
  FROM cola_markets;

SDO_AGGR_CONCAVEHULL(SDOAGGRTYPE(SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3, 3, 5, 1, 8, 1, 10, 1, 12, 1, 14, 1, 14, 5, 13, 9, 14, 10, 14, 13, 12, 15,
10, 14, 10, 13, 8, 11, 6, 12, 5, 13, 2, 11, 6, 10, 6, 9, 5, 7, 4, 5, 2, 4, 3, 3)
)
```

21.4 SDO_AGGR_CONVEXHULL

Format

```
SDO_AGGR_CONVEXHULL(
     AggregateGeometry  SDOAGGRTYPE
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the convex hull of the specified geometry objects.

Parameters

AggregateGeometry
An object of type SDOAGGRTYPE (see SDOAGGRTYPE Object Type) that specifies the geometry column and dimensional array.

Usage Notes

See also the information about the SDO_GEOM.SDO_CONVEXHULL function in SDO_GEOM Package (Geometry).

Examples

The following example returns the convex hull of the geometry objects in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_AGGR_CONVEXHULL(SDOAGGRTYPE(shape, 0.005))
  FROM cola_markets;

SDO_AGGR_CONVEXHULL(SDOAGGRTYPE(SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POI
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(8, 1, 10, 7, 10, 11, 8, 11, 6, 11, 1, 7, 1, 1, 8, 1))
```

21.5 SDO_AGGR_LRS_CONCAT

Format

```
SDO_AGGR_LRS_CONCAT(
     AggregateGeometry  SDOAGGRTYPE
     ) RETURN SDO_GEOMETRY;
```

Description

Returns an LRS geometry that concatenates specified LRS geometries.

Parameters

AggregateGeometry
An object of type SDOAGGRTYPE (see SDOAGGRTYPE Object Type) that specifies the geometry column and dimensional array.

Usage Notes

This function performs an aggregate concatenation of any number of LRS geometries. If you want to control the order in which the geometries are concatenated, you must use a subquery with the NO_MERGE optimizer hint and the ORDER BY clause. (See the examples.)

The direction of the resulting segment is the same as the direction of the first geometry in the concatenation.

A *3D* format of this function (SDO_AGGR_LRS_CONCAT_3D) is available. For information about *3D* formats of LRS functions, see 3D Formats of LRS Functions.)

For information about the Spatial linear referencing system, see Linear Referencing System.

Examples

The following example adds an LRS geometry to the LRS_ROUTES table, and then performs two queries that concatenate the LRS geometries in the table. The first query does not control the order of concatenation, and the second query controls the order of concatenation. Notice the difference in direction of the two segments: the segment resulting from the second query has decreasing measure values because the first segment in the concatenation (`Route0`) has decreasing measure values. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Add a segment with route_id less than 1 (here, zero).
INSERT INTO lrs_routes VALUES(
  0,
  'Route0',
  SDO_GEOMETRY(
    3302,  -- Line string; 3 dimensions (X,Y,M); 3rd is measure dimension.
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- One line string, straight segments
    SDO_ORDINATE_ARRAY(
      5,14,5,   -- Starting point - 5 is measure from start.
      10,14,0)  -- Ending point - 0 measure (decreasing measure)
  )
);

1 row created.
```

```
-- Concatenate all routes (no ordering specified).
SELECT SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(route_geometry, 0.005))
    FROM lrs_routes;

SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(ROUTE_GEOMETRY,0.005))(SDO_GTYPE, SDO_SRID
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27, 10, 14,
32))

-- Aggregate concatenation using subquery for ordering.
SELECT
SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(route_geometry, 0.005))
FROM (
             SELECT /*+ NO_MERGE */ route_geometry
             FROM lrs_routes
             ORDER BY route_id);

SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(ROUTE_GEOMETRY,0.005))(SDO_GTYPE, SDO_SRID
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 32, 2, 4, 30, 8, 4, 24, 12, 4, 20, 12, 10, 14, 8, 10, 10, 5, 14, 5, 10, 14
, 0))
```

21.6 SDO_AGGR_MBR

Format

```
SDO_AGGR_MBR(
     geom  SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the minimum bounding rectangle (MBR) of the specified geometries, that is, a single rectangle that minimally encloses the geometries.

Parameters

geom
Geometry objects.

Usage Notes

> **Note:**
>
> The SDO_AGGR_MBR function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function does not return an MBR geometry if a proper MBR cannot be constructed. Specifically:

- If the input geometries are all null, the function returns a null geometry.
- If all data in the input geometries is on a single point, the function returns the point.

- If all data in the input geometries consists of points on a straight line, the function returns a two-point line.

The SDO_TUNE.EXTENT_OF function, documented in SDO_TUNE Package (Tuning), also returns the MBR of geometries. The SDO_TUNE.EXTENT_OF function has better performance than the SDO_AGGR_MBR function if a spatial index is defined on the geometry column; however, the SDO_TUNE.EXTENT_OF function is limited to two-dimensional geometries, whereas the SDO_AGGR_MBR function is not. In addition, the SDO_TUNE.EXTENT_OF function computes the extent for all geometries in a table; by contrast, the SDO_AGGR_MBR function can operate on subsets of rows.

Examples

The following example returns the minimum bounding rectangle of the geometry objects in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_AGGR_MBR(shape) FROM cola_markets;

SDO_AGGR_MBR(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(1, 1, 10, 11))
```

21.7 SDO_AGGR_SET_UNION

Format (as Function in SDO_AGGR Package)

```
SDO_AGGR.SDO_AGGR_SET_UNION(
     geometry SDO_GEOMETRY_ARRAY,
     tol      NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_AGGR.SDO_AGGR_SET_UNION(
     cur  SYS_REFCURSOR,
     tol  NUMBER
     ) RETURN SDO_GEOMETRY;
```

Format (as Spatial Aggregate Function [Deprecated])

```
SDO_AGGR_SET_UNION(
     geometry  SDO_GEOMETRY_ARRAY,
     tol       NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the aggregate union of all the geometry objects from an input VARRAY of SDO_GEOMETRY objects or a REF cursor.

Parameters

geometry
An array of geometry objects of object type SDO_GEOMETRY_ARRAY, which is defined as `VARRAY OF SDO_GEOMETRY`.

cur
A REF cursor that returns a set of the geometry objects for which to return the aggregate union of all the geometry objects.

tol
Tolerance value (see Tolerance).

Usage Notes

> **Note:**
>
> Effective with Oracle Database Release 12*c* (12.1), the format as a spatial aggregate function is deprecated, and will be removed in an upcoming major release.
>
> You should instead use one of the formats for the SDO_AGGR.SDO_AGGR_SET_UNION function.

SDO_AGGR_SET_UNION provides faster performance than SDO_AGGR_UNION but less flexibility, and SDO_AGGR_SET_UNION should be considered when performance is especially important and when it satisfies your functional needs.

SDO_AGGR_UNION is a SQL aggregate function, and therefore it is very flexible and can be used with complex SQL GROUP BY clauses. However, SDO_AGGR_SET_UNION can be much faster than SDO_AGGR_UNION. SDO_AGGR_SET_UNION is useful when the geometries to be grouped can easily be gathered into a collection, such as a VARRAY of SDO_GEOMETRY objects).

SDO_AGGR_SET_UNION:

- *Cannot* aggregate a set of *overlapping* polygons. For overlapping polygons, use SDO_AGGR_UNION.
- *Can* effectively aggregate a set of *non-overlapping* polygons, including polygons that touch.
- Can aggregate sets of lines and points, even if they overlap.

Examples

The following example creates a generic routine to build a geometry set to pass to SDO_AGGR_SET_UNION. It takes as input a table name, column name, and optional predicate to apply, and returns an SDO_GEOMETRY_ARRAY ready to use with SDO_AGGR_SET_UNION. The first SELECT statement after the `get_geom_set` function creation calls the SDO_AGGR.SDO_AGGR_UNION PL/SQL function, the second SELECT statement calls the deprecated spatial aggregate function, and the third SELECT statement calls the SDO_AGGR.SDO_AGGR_UNION PL/SQL function using the format that specifies a cursor. All the SELECT statements return the same result. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
CREATE OR REPLACE FUNCTION get_geom_set (table_name  VARCHAR2,
                                         column_name VARCHAR2,
                                         predicate   VARCHAR2 := NULL)
  RETURN SDO_GEOMETRY_ARRAY DETERMINISTIC AS

  type              cursor_type is REF CURSOR;
  query_crs         cursor_type ;
  g                 SDO_GEOMETRY;
  GeometryArr     SDO_GEOMETRY_ARRAY;
  where_clause    VARCHAR2(2000);
BEGIN
  IF predicate IS NULL
  THEN
    where_clause := NULL;
  ELSE
    where_clause := ' WHERE ';
  END IF;

  GeometryArr := SDO_GEOMETRY_ARRAY();
  OPEN query_crs FOR ' SELECT ' || column_name ||
                     ' FROM ' || table_name ||
                       where_clause || predicate;
   LOOP
    FETCH query_crs into g;
     EXIT when query_crs%NOTFOUND ;
     GeometryArr.extend;
     GeometryArr(GeometryArr.count) := g;
   END LOOP;
   RETURN GeometryArr;
END;
/

-- Call SDO_AGGR_SET_UNION function in SDO_AGGR PL/SQL package.
SELECT sdo_aggr.sdo_aggr_set_union (get_geom_set ('COLA_MARKETS', 'SHAPE',
  'name <> ''cola_c'''), .0005 ) FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(GET_GEOM_SET('COLA_MARKETS','SHAPE','NAME<>''COLA_C'
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))

-- CALL SDO_AGGR_SET_UNION spatial aggregate function (deprecated format).
SELECT sdo_aggr_set_union (get_geom_set ('COLA_MARKETS', 'SHAPE',
  'name <> ''cola_c'''), .0005 ) FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(GET_GEOM_SET('COLA_MARKETS','SHAPE','NAME<>''COLA_C'
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))

-- Call SDO_AGGR_SET_UNION function in SDO_AGGR PL/SQL package; specify
-- a cursor as input.
SELECT sdo_aggr.sdo_aggr_set_union
  (CURSOR(SELECT shape FROM COLA_MARKETS WHERE name <> 'cola_c'), .0005 )
  FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(CURSOR(SELECTSHAPEFROMCOLA_MARKETSWHERENAME<>'COLA_C
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))
```

21.8 SDO_AGGR_UNION

Format

```
SDO_AGGR_UNION(
     AggregateGeometry  SDOAGGRTYPE
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the topological union (OR operation) of the specified geometry objects.

Parameters

AggregateGeometry
An object of type SDOAGGRTYPE (see SDOAGGRTYPE Object Type) that specifies the geometry column and dimensional array.

Usage Notes

Do not use SDO_AGGR_UNION to merge line string or multiline string geometries; instead, use the SDO_AGGR_CONCAT_LINES spatial aggregate function.

See also the information about the SDO_GEOM.SDO_UNION function in SDO_GEOM Package (Geometry).

Examples

The following example returns the union of all geometries except `cola_d` (in this case, `cola_a`, `cola_b`, and `cola_c`). (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_AGGR_UNION(
  SDOAGGRTYPE(c.shape, 0.005))
  FROM cola_markets c
  WHERE c.name <> 'cola_d';

SDO_AGGR_UNION(SDOAGGRTYPE(C.SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POINT(
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))
```

22

SDO_CS Package (Coordinate System Transformation)

The MDSYS.SDO_CS package contains subprograms for working with coordinate systems.

You can perform explicit coordinate transformations on a single geometry or an entire layer of geometries (that is, all geometries in a specified column in a table).

To use the subprograms in this chapter, you must understand the conceptual information about coordinate systems in Coordinate System and Coordinate Systems (Spatial Reference Systems).

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_CS.ADD_PREFERENCE_FOR_OP
- SDO_CS.CONVERT_3D_SRID_TO_2D
- SDO_CS.CONVERT_NADCON_TO_XML
- SDO_CS.CONVERT_NTV2_TO_XML
- SDO_CS.CONVERT_XML_TO_NADCON
- SDO_CS.CONVERT_XML_TO_NTV2
- SDO_CS.CREATE_CONCATENATED_OP
- SDO_CS.CREATE_OBVIOUS_EPSG_RULES
- SDO_CS.CREATE_PREF_CONCATENATED_OP
- SDO_CS.DELETE_ALL_EPSG_RULES
- SDO_CS.DELETE_OP
- SDO_CS.DETERMINE_CHAIN
- SDO_CS.DETERMINE_DEFAULT_CHAIN
- SDO_CS.FIND_GEOG_CRS
- SDO_CS.FIND_PROJ_CRS
- SDO_CS.FIND_SRID
- SDO_CS.FROM_GEOHASH
- SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS
- SDO_CS.FROM_USNG
- SDO_CS.GENERATE_SCRIPT_FROM_SRID
- SDO_CS.GET_EPSG_DATA_VERSION
- SDO_CS.GET_GEOHASH_CELL_HEIGHT
- SDO_CS.GET_GEOHASH_CELL_WIDTH
- SDO_CS.INSERT_SRID

- SDO_CS.LOAD_EPSG_MATRIX
- SDO_CS.MAKE_2D
- SDO_CS.MAKE_3D
- SDO_CS.MAP_EPSG_SRID_TO_ORACLE
- SDO_CS.MAP_ORACLE_SRID_TO_EPSG
- SDO_CS.REVOKE_PREFERENCE_FOR_OP
- SDO_CS.TO_GEOHASH
- SDO_CS.TO_OGC_SIMPLEFEATURE_SRS
- SDO_CS.TO_USNG
- SDO_CS.TRANSFORM
- SDO_CS.TRANSFORM_LAYER
- SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS
- SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS
- SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM
- SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS
- SDO_CS.UPDATE_WKTS_FOR_EPSG_OP
- SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM
- SDO_CS.UPDATE_WKTS_FOR_EPSG_PM
- SDO_CS.VALIDATE_EPSG_MATRIX
- SDO_CS.VALIDATE_WKT

22.1 SDO_CS.ADD_PREFERENCE_FOR_OP

Format

```
SDO_CS.ADD_PREFERENCE_FOR_OP(
     op_id        IN NUMBER,
     source_crs   IN NUMBER DEFAULT NULL,
     target_crs   IN NUMBER DEFAULT NULL,
     use_case     IN VARCHAR2 DEFAULT NULL);
```

Description

Adds a preference for an operation between a source coordinate system and a target coordinate system.

Parameters

op_id
ID number of the operation. Must be a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in SDO_COORD_OPS Table).

source_crs
The SRID of the source coordinate reference system. Must be null or a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

target_crs
The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

use_case
Name of the use case to be associated with this preference. Must be null or a value from the USE_CASE column of the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

Usage Notes

If `use_case` is null, the transformation plan associated with the operation is a systemwide preference, and a row is added (or two rows are added if a reverse operation exists) to the SDO_PREFERRED_OPS_SYSTEM table (described in SDO_PREFERRED_OPS_SYSTEM Table). If `use_case` is not null, the transformation plan associated with the operation is a preference associated with the specified use case, and a row is added (or two rows are added if a reverse operation exists) to the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

To create a concatenated operation and make it preferred either systemwide or for a specified use case, you can use the SDO_CS.CREATE_PREF_CONCATENATED_OP convenience procedure.

To revoke a preference for an operation between a source coordinate system and a target coordinate system, use the SDO_CS.REVOKE_PREFERENCE_FOR_OP procedure.

Examples

The following example adds a preference for operation 19977 to be used in transformations from SRID 4301 to SRID 4326 when use case use_case_B is specified for the transformation.

```
EXECUTE SDO_CS.ADD_PREFERENCE_FOR_OP(19977, 4301, 4326, 'use_case_B');
```

22.2 SDO_CS.CONVERT_3D_SRID_TO_2D

Format

```
SDO_CS.CONVERT_3D_SRID_TO_2D(
     srid3d  IN NUMBER) RETURN NUMBER;
```

Description

Converts a three-dimensional SRID value into a two-dimensional SRID value.

Parameters

srid_3d
The SRID of a three-dimensional coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

> **Note:**
>
> The SDO_CS.CONVERT_3D_SRID_TO_2D function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function returns the SRID value of a functionally equivalent two-dimensional coordinate reference system that corresponds to the input coordinate reference system.

- If a compound 3D SRID is input, there is only one corresponding two-dimensional SRID, and it is returned.
- If a Geographic 3D SRID is input, there may be multiple possible corresponding two-dimensional SRIDs, and one of them is returned.
- If a two-dimensional SRID is input, it is returned.

For information about three-dimensional coordinate reference system support, see Three-Dimensional Coordinate Reference System Support.

Examples

The following example returns an equivalent two-dimensional SRID for each coordinate reference system listed in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table). For 2D SRID values in that table, the function returns the existing value.

```
SELECT
    crs.srid "nD SRID",
    crs.coord_ref_sys_kind "nD Type",
    sdo_cs.convert_3d_srid_to_2d(crs.srid) "2D SRID",
    (SELECT
        coord_ref_sys_kind
      FROM
        sdo_coord_ref_sys crs2
      WHERE
        crs2.srid = sdo_cs.convert_3d_srid_to_2d(crs.srid)
    ) "2D Type"
  FROM sdo_coord_ref_sys crs
  ORDER BY crs.coord_ref_sys_kind,crs.srid;

   nD SRID nD Type                     2D SRID 2D Type
---------- ------------------------ ---------- ------------------------
      4097 COMPOUND                       4093 PROJECTED
      4098 COMPOUND                       4094 PROJECTED
      4099 COMPOUND                       4095 PROJECTED
      …    …                              …    …
      7400 COMPOUND                       4807 GEOGRAPHIC2D
      …    …                              …    …
      5800 ENGINEERING                    5800 ENGINEERING
      …    …                              …    …
      4000 GEOCENTRIC
      …    …                              …    …
      4326 GEOGRAPHIC2D                   4326 GEOGRAPHIC2D
      …    …                              …    …
      4327 GEOGRAPHIC3D                   4326 GEOGRAPHIC2D
```

```
         …     …                                    …     …
        27700  PROJECTED                           27700  PROJECTED
         …     …                                    …     …
         3855  VERTICAL                             3855  VERTICAL
         …     …                                    …     …
```

22.3 SDO_CS.CONVERT_NADCON_TO_XML

Format

```
SDO_CS.CONVERT_NADCON_TO_XML(
     laa_clob   IN CLOB,
     loa_clob   IN CLOB,
     xml_grid   OUT XMLTYPE );
```

Description

Converts a NADCON (North American Datum Conversion) grid in ASCII format to an Oracle Spatial XML representation.

Parameters

laa_clob
Latitude values of the NADCON grid in a CLOB object.

loa_clob
Longitude values of the NADCON grid in a CLOB object.

xml_grid
Output XML document containing the Oracle Spatial XML representation of the NADCON grid.

Usage Notes

To convert an Oracle Spatial XML representation to a NADCON grid, use the SDO_CS.CONVERT_XML_TO_NADCON procedure.

Examples

The following example converts a NADCON grid in ASCII format to an Oracle Spatial XML representation, converts the resulting XML representation back to a NADCON ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
  laa       CLOB;
  loa       CLOB;
  xml       XMLTYPE;
  laa_file  BFILE;
  loa_file  BFILE;
BEGIN
  laa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.laa');
  loa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.loa');
  DBMS_LOB.OPEN(laa_file, DBMS_LOB.LOB_READONLY);
  DBMS_LOB.OPEN(loa_file, DBMS_LOB.LOB_READONLY);

  DBMS_LOB.CREATETEMPORARY(laa, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.CREATETEMPORARY(loa, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.OPEN(laa, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.OPEN(loa, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.LOADCLOBFROMFILE(laa, laa_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.LOADCLOBFROMFILE(loa, loa_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.CLOSE(laa);
  DBMS_LOB.CLOSE(loa);
  DBMS_LOB.CLOSE(laa_file);
  DBMS_LOB.CLOSE(loa_file);

  SDO_CS.convert_NADCON_to_XML(laa, loa, xml);
  SDO_CS.convert_XML_to_NADCON(xml, laa, loa);
  DBMS_OUTPUT.PUT_LINE(SUBSTR(laa, 1, 32000));
  DBMS_OUTPUT.PUT_LINE(SUBSTR(loa, 1, 32000));
END;
/
NADCON EXTRACTED REGION                                NADGRD
  33  49   1  -107.00000      .25000    25.00000      .25000      .00000
     .006731      .006444     .006208     .006036     .005935     .005904
     .005932      .006002     .006092     .006174     .006218     .006198
     .006087      .005867     .005522     .005045     .004432     .003688
     .002818      .001836     .000759    -.000385    -.001559    -.002704
. . .
NADCON EXTRACTED REGION                                NADGRD
  33  49   1  -107.00000      .25000    25.00000      .25000      .00000
     .008509      .007147     .005756     .004331     .002879     .001410
    -.000060     -.001507    -.002904    -.004222    -.005431    -.006498
    -.007395     -.008095    -.008579    -.008832    -.008848    -.008632
    -.008200     -.007577    -.006800    -.005911    -.004957    -.003974
. . .
```

22.4 SDO_CS.CONVERT_NTV2_TO_XML

Format

```
SDO_CS.CONVERT_NTV2_TO_XML(
     ntv2_clob  IN CLOB,
     xml_grid   OUT XMLTYPE );
```

Description

Converts an NTv2 (National Transformation Version 2) grid in ASCII format to an Oracle Spatial XML representation.

Parameters

ntv2_clob
NTv2 grid values in a CLOB object.

xml_grid
Output XML document containing the Oracle Spatial XML representation of the NTv2 grid.

Usage Notes

To convert an Oracle Spatial XML representation to an NTv2 grid, use the SDO_CS.CONVERT_XML_TO_NTV2 procedure.

Examples

The following example converts an NTv2 grid in ASCII format to an Oracle Spatial XML representation, converts the resulting XML representation back to an NTv2 ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
  ntv2      CLOB;
  xml       XMLTYPE;
  ntv2_file BFILE;
BEGIN
  ntv2_file := BFILENAME('MY_WORK_DIR', 'samplentv2.gsa');
  DBMS_LOB.OPEN(ntv2_file, DBMS_LOB.LOB_READONLY);

  DBMS_LOB.CREATETEMPORARY(ntv2, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.OPEN(ntv2, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.LOADCLOBFROMFILE(ntv2, ntv2_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.CLOSE(ntv2);
  DBMS_LOB.CLOSE(ntv2_file);

  SDO_CS.convert_NTv2_to_XML(ntv2, xml);
  SDO_CS.convert_XML_to_NTv2(xml, ntv2);
  DBMS_OUTPUT.PUT_LINE(SUBSTR(ntv2, 1, 32000));
END;
/
NUM_OREC 11
NUM_SREC 11
NUM_FILE  2
GS_TYPE SECONDS
VERSION NTv2.0
DATUM_F NAD27
DATUM_T NAD83
MAJOR_F  6378206.400
MINOR_F  6356583.800
MAJOR_T  6378137.000
MINOR_T  6356752.314
SUB_NAMEALbanff
PARENT  NONE
CREATED 95-06-29
UPDATED 95-07-04
S_LAT     183900.000000
N_LAT     184500.000000
E_LONG    415800.000000
W_LONG    416100.000000
LAT_INC       30.000000
LONG_INC      30.000000
GS_COUNT   231
  0.084020  3.737300  0.005000  0.008000
  0.083029  3.738740  0.017000  0.011000
  0.082038  3.740180  0.029000  0.015000
. . .
```

22.5 SDO_CS.CONVERT_XML_TO_NADCON

Format

```
SDO_CS.CONVERT_XML_TO_NADCON(
     xml_grid  IN XMLTYPE,
     laa_clob  OUT CLOB,
     loa_clob  OUT CLOB);
```

Description

Converts an Oracle Spatial XML representation of a NADCON (North American Datum Conversion) grid to NADCON ASCII format.

Parameters

xml_grid
XML document containing the Oracle Spatial XML representation of the NADCON grid.

laa_clob
Output CLOB object containing the latitude values of the NADCON grid.

loa_clob
Output CLOB object containing the longitude values of the NADCON grid.

Usage Notes

To convert a NADCON grid in ASCII format to an Oracle Spatial XML representation, use the SDO_CS.CONVERT_NADCON_TO_XML procedure.

Examples

The following example converts a NADCON grid in ASCII format to an Oracle Spatial XML representation, converts the resulting XML representation back to a NADCON ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
  laa       CLOB;
  loa       CLOB;
  xml       XMLTYPE;
  laa_file  BFILE;
  loa_file  BFILE;
BEGIN
  laa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.laa');
  loa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.loa');
  DBMS_LOB.OPEN(laa_file, DBMS_LOB.LOB_READONLY);
  DBMS_LOB.OPEN(loa_file, DBMS_LOB.LOB_READONLY);

  DBMS_LOB.CREATETEMPORARY(laa, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.CREATETEMPORARY(loa, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.OPEN(laa, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.OPEN(loa, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.LOADCLOBFROMFILE(laa, laa_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.LOADCLOBFROMFILE(loa, loa_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.CLOSE(laa);
  DBMS_LOB.CLOSE(loa);
  DBMS_LOB.CLOSE(laa_file);
  DBMS_LOB.CLOSE(loa_file);

  SDO_CS.convert_NADCON_to_XML(laa, loa, xml);
  SDO_CS.convert_XML_to_NADCON(xml, laa, loa);
  DBMS_OUTPUT.PUT_LINE(SUBSTR(laa, 1, 32000));
  DBMS_OUTPUT.PUT_LINE(SUBSTR(loa, 1, 32000));
END;
/
```

```
NADCON EXTRACTED REGION                                 NADGRD
  33  49    1  -107.00000     .25000    25.00000      .25000      .00000
     .006731     .006444     .006208     .006036     .005935     .005904
     .005932     .006002     .006092     .006174     .006218     .006198
     .006087     .005867     .005522     .005045     .004432     .003688
     .002818     .001836     .000759    -.000385    -.001559    -.002704
. . .
NADCON EXTRACTED REGION                                 NADGRD
  33  49    1  -107.00000     .25000    25.00000      .25000      .00000
     .008509     .007147     .005756     .004331     .002879     .001410
    -.000060    -.001507    -.002904    -.004222    -.005431    -.006498
    -.007395    -.008095    -.008579    -.008832    -.008848    -.008632
    -.008200    -.007577    -.006800    -.005911    -.004957    -.003974
. . .
```

22.6 SDO_CS.CONVERT_XML_TO_NTV2

Format

```
SDO_CS.CONVERT_XML_TO_NTV2(
     xml_grid  IN XMLTYPE,
     ntv2_clob OUT CLOB);
```

Description

Converts an Oracle Spatial XML representation of an NTv2 (National Transformation Version 2) grid to NTv2 ASCII format.

Parameters

xml_grid
XML document containing the Oracle Spatial XML representation of the NTv2 grid.

ntv2_clob
Output CLOB object containing the values for the NTv2 grid.

Usage Notes

To convert an NTv2 grid in ASCII format to an Oracle Spatial XML representation, use the SDO_CS.CONVERT_NTV2_TO_XML procedure.

Examples

The following example converts an NTv2 grid in ASCII format to an Oracle Spatial XML representation, converts the resulting XML representation back to an NTv2 ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
  ntv2      CLOB;
  xml       XMLTYPE;
  ntv2_file BFILE;
BEGIN
  ntv2_file := BFILENAME('MY_WORK_DIR', 'samplentv2.gsa');
  DBMS_LOB.OPEN(ntv2_file, DBMS_LOB.LOB_READONLY);

  DBMS_LOB.CREATETEMPORARY(ntv2, TRUE, DBMS_LOB.SESSION);
  DBMS_LOB.OPEN(ntv2, DBMS_LOB.LOB_READWRITE);
  DBMS_LOB.LOADCLOBFROMFILE(ntv2, ntv2_file, DBMS_LOB.LOBMAXSIZE);
  DBMS_LOB.CLOSE(ntv2);
  DBMS_LOB.CLOSE(ntv2_file);

  SDO_CS.convert_NTv2_to_XML(ntv2, xml);
  SDO_CS.convert_XML_to_NTv2(xml, ntv2);
  DBMS_OUTPUT.PUT_LINE(SUBSTR(ntv2, 1, 32000));
END;
/
NUM_OREC 11
NUM_SREC 11
NUM_FILE  2
GS_TYPE SECONDS
VERSION NTv2.0
DATUM_F NAD27
DATUM_T NAD83
MAJOR_F  6378206.400
MINOR_F  6356583.800
MAJOR_T  6378137.000
MINOR_T  6356752.314
SUB_NAMEALbanff
PARENT  NONE
CREATED 95-06-29
UPDATED 95-07-04
S_LAT     183900.000000
N_LAT     184500.000000
E_LONG    415800.000000
W_LONG    416100.000000
LAT_INC       30.000000
LONG_INC      30.000000
GS_COUNT   231
  0.084020  3.737300  0.005000  0.008000
  0.083029  3.738740  0.017000  0.011000
  0.082038  3.740180  0.029000  0.015000
. . .
```

22.7 SDO_CS.CREATE_CONCATENATED_OP

Format

```
SDO_CS.CREATE_CONCATENATED_OP(
     op_id    IN NUMBER,
     op_name  IN VARCHAR2,
     use_plan IN TFM_PLAN);
```

Description

Creates a concatenated operation.

Parameters

op_id
ID number of the concatenated operation.

op_name
Name to be associated with the concatenated operation.

use_plan
Transformation plan. The TFM_PLAN object type is explained in TFM_PLAN Object Type.

Usage Notes

A concatenated operation is the concatenation (chaining) of two or more atomic operations.

To create a concatenated operation and make it preferred either systemwide or for a specified use case, you can use the SDO_CS.CREATE_PREF_CONCATENATED_OP convenience procedure.

Examples

The following example creates a concatenation operation with the operation ID 2999 and the name `CONCATENATED_OPERATION_2999`.

```
DECLARE
BEGIN
SDO_CS.CREATE_CONCATENATED_OP(
  2999,
  'CONCATENATED_OPERATION_2999',
  TFM_PLAN(SDO_TFM_CHAIN(4242, 19910, 24200, 1000000000, 24200)));
END;
/
```

22.8 SDO_CS.CREATE_OBVIOUS_EPSG_RULES

Format

```
SDO_CS.CREATE_OBVIOUS_EPSG_RULES(
     use_case  IN VARCHAR2 DEFAULT NULL);
```

Description

Creates a basic set of EPSG rules to be applied in certain transformations.

Parameters

use_case
Name of the use case to be associated with the application of the EPSG rules that are created. Must be a value from the USE_CASE column of the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

Usage Notes

This procedure creates rules to implement the main EPSG-defined transformations between specific coordinate reference systems. For transformations between some coordinate reference systems, EPSG has specified rules that should be applied. For any given transformation from one coordinate reference system to another, the EPSG rule might be different from the default Oracle Spatial rule. If you execute this procedure, the EPSG rules are applied in any such cases. If you do not execute this procedure, the default Spatial rules are used in such cases.

This procedure inserts many rows into the SDO_PREFERRED_OPS_SYSTEM table (see SDO_PREFERRED_OPS_SYSTEM Table).

To delete the EPSG rules created by this procedure, and thus cause the default Spatial rules to be used in all cases, use the SDO_CS.DELETE_ALL_EPSG_RULES procedure.

Examples

The following example creates a basic set of EPSG rules to be applied in certain transformations.

```
EXECUTE SDO_CS.CREATE_OBVIOUS_EPSG_RULES;
```

22.9 SDO_CS.CREATE_PREF_CONCATENATED_OP

Format

```
SDO_CS.CREATE_PREF_CONCATENATED_OP(
     op_id    IN NUMBER,
     op_name  IN VARCHAR2,
     use_plan IN TFM_PLAN,
     use_case IN VARCHAR2 DEFAULT NULL);
```

Description

Creates a concatenated operation, associating it with a transformation plan and making it preferred either systemwide or for a specified use case.

Parameters

op_id
ID number of the concatenated operation to be created.

op_name
Name to be associated with the concatenated operation.

use_plan
Transformation plan. The TFM_PLAN object type is explained in TFM_PLAN Object Type.

use_case
Use case to which this preferred concatenated operation applies. Must be a null or a value from the USE_CASE column of the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

Usage Notes

This convenience procedure combines the operations of the SDO_CS.CREATE_CONCATENATED_OP and SDO_CS.ADD_PREFERENCE_FOR_OP procedures.

A concatenated operation is the concatenation (chaining) of two or more atomic operations.

If `use_case` is null, the transformation plan associated with the operation is a systemwide preference, and a row is added (or two rows are added if a reverse operation exists) to the SDO_PREFERRED_OPS_SYSTEM table (described in SDO_PREFERRED_OPS_SYSTEM Table). If `use_case` is not null, the transformation plan associated with the operation is a preference associated with the specified use case, and a row is added (or two rows are added if a reverse operation exists) to the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

To create a concatenation without making it preferred either systemwide or for a specified use case, use the SDO_CS.CREATE_CONCATENATED_OP procedure

To delete a concatenated operation, use the SDO_CS.DELETE_OP procedure.

Examples

The following example creates a concatenation operation with the operation ID 300 and the name `MY_CONCATENATION_OPERATION`, and causes Spatial to use the specified transformation plan in all cases (because `use_case` is null) when this operation is used.

```
DECLARE
BEGIN
SDO_CS.CREATE_PREF_CONCATENATED_OP(
  300,
  'MY_CONCATENATED_OPERATION',
  TFM_PLAN(SDO_TFM_CHAIN(4242, 19910, 24200, 1000000000, 24200)),
  NULL);
END;
/
```

22.10 SDO_CS.DELETE_ALL_EPSG_RULES

Format

```
SDO_CS.DELETE_ALL_EPSG_RULES(
     use_case  IN VARCHAR2 DEFAULT NULL);
```

Description

Deletes the basic set of EPSG rules to be applied in certain transformations.

Parameters

use_case
Name of the use case to be associated with the application of the EPSG rules that are created. Must match the value that was used for the `use_case` parameter value (either null or a specified value) when the SDO_CS.CREATE_OBVIOUS_EPSG_RULES procedure was called.

Usage Notes

This procedure deletes the EPSG rules that were previously created by the SDO_CS.CREATE_OBVIOUS_EPSG_RULES procedure, and thus causes the default Spatial rules to be used in all cases. (See the Usage Notes for the SDO_CS.CREATE_OBVIOUS_EPSG_RULES procedure for more information.)

If `use_case` is null, this procedure deletes all rows from the SDO_PREFERRED_OPS_SYSTEM table (see SDO_PREFERRED_OPS_SYSTEM Table). If `use_case` is not null, this procedure deletes the rows associated with the specified use case from the SDO_PREFERRED_OPS_USER table (see SDO_PREFERRED_OPS_USER Table).

Examples

The following example deletes the basic set of EPSG rules to be applied in certain transformations.

```
EXECUTE SDO_CS.DELETE_ALL_EPSG_RULES;
```

22.11 SDO_CS.DELETE_OP

Format

```
SDO_CS.DELETE_OP(
     op_id  IN NUMBER);
```

Description

Deletes a concatenated operation.

Parameters

op_id
ID number of the operation to be deleted.

Usage Notes

To create a concatenated operation and make it preferred systemwide or only for a specified use case, use the SDO_CS.CREATE_CONCATENATED_OP procedure.

Examples

The following example deletes the operation with the ID number 300.

```
EXECUTE SDO_CS.DELETE_OP(300);
```

22.12 SDO_CS.DETERMINE_CHAIN

Format

```
SDO_CS.DETERMINE_CHAIN(
     transient_rule_set IN SDO_TRANSIENT_RULE_SET,
     use_case           IN VARCHAR2,
     source_srid        IN NUMBER,
     target_srid        IN NUMBER) RETURN TFM_PLAN;
```

Description

Returns the query chain, based on the system rule set, to be used in transformations from one coordinate reference system to another coordinate reference system.

Parameters

transient_rule_set
Rule set to be used for the transformation. If you specify a null value, the Oracle system rule set is used.

use_case
Use case for which to determine the query chain. Must be a null value or a value from the USE_CASE column of the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

source_srid
The SRID of the source coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

target_srid
The SRID of the target coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

This function returns an object of type TFM_PLAN, which is explained in TFM_PLAN Object Type.

The `transient_rule_set` parameter is of type SDO_TRANSIENT_RULE_SET, which has the following definition:

```
CREATE TYPE sdo_transient_rule_set AS OBJECT (
  source_srid  NUMBER,
  target_srid  NUMBER,
  tfm          NUMBER);
```

Examples

The following example returns the query chain based on the system rule set.

```
SELECT MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) FROM DUAL;

MDSYS.SDO_CS.DETERMINE_CHAIN(NULL,NULL,4804,4257)(THE_PLAN)
--------------------------------------------------------------------------------
TFM_PLAN(SDO_TFM_CHAIN(4804, -2, 4257))
```

The next example creates a preferred concatenated operation (with operation ID 300) with a specified chain for transformations from SRID 4804 to SRID 4257, and then calls the DETERMINE_CHAIN function, returning a different result. (The operation created in this example is not meaningful or useful, and it was created only for illustration.)

```
CALL SDO_CS.CREATE_PREF_CONCATENATED_OP(
    300,
    'CONCATENATED OPERATION',
    TFM_PLAN(
      SDO_TFM_CHAIN(
                    4804,
        1000000001, 4804,
        1000000002, 4804,
        1000000001, 4804,
        1000000001, 4804,
        1000000002, 4804,
        1000000002, 4804,
        1000000001, 4804,
        1000000001, 4804,
        1000000001, 4804,
        1000000002, 4804,
        1000000002, 4804,
        1000000002, 4257)),
    NULL);

SELECT MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) FROM DUAL;

MDSYS.SDO_CS.DETERMINE_CHAIN(NULL,NULL,4804,4257)(THE_PLAN)
--------------------------------------------------------------------------------
TFM_PLAN(SDO_TFM_CHAIN(4804, 300, 4257))
```

22.13 SDO_CS.DETERMINE_DEFAULT_CHAIN

Format

```
SDO_CS.DETERMINE_DEFAULT_CHAIN(
     source_srid  IN NUMBER,
     target_srid  IN NUMBER) RETURN SDO_SRID_CHAIN;
```

Description

Returns the default chain of SRID values in transformations from one coordinate reference system to another coordinate reference system.

Parameters

source_srid
The SRID of the source coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

target_srid
The SRID of the target coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

This function returns an object of type SDO_SRID_CHAIN, which is defined as `VARRAY(1048576) OF NUMBER`.

Examples

The following example returns the default chain of SRID values in transformations from SRID 4804 to SRID 4257.

```
SELECT MDSYS.SDO_CS.DETERMINE_DEFAULT_CHAIN(4804, 4257) FROM DUAL;

MDSYS.SDO_CS.DETERMINE_DEFAULT_CHAIN(4804,4257)
--------------------------------------------------------------------------------
SDO_SRID_CHAIN(NULL, 4804, 4257, NULL)
```

22.14 SDO_CS.FIND_GEOG_CRS

Format

```
SDO_CS.FIND_GEOG_CRS(
     reference_srid  IN NUMBER,
     is_legacy       IN VARCHAR2,
     max_rel_num_difference IN NUMBER DEFAULT 0.000001) RETURN SDO_SRID_LIST;
```

Description

Returns the SRID values of geodetic (geographic) coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.

Parameters

reference_srid
The SRID of the coordinate reference system for which to find all other geodetic coordinate reference systems that have the same WKT numeric values. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

is_legacy
`TRUE` limits the results to geodetic coordinate reference systems for which the IS_LEGACY column value is `TRUE` in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table); `FALSE` limits the results to geodetic coordinate reference systems for which the IS_LEGACY column value is `FALSE` in the SDO_COORD_REF_SYS table. If you specify a null value for this parameter, the IS_LEGACY column value in the SDO_COORD_REF_SYS table is ignored in determining the results.

max_rel_num_difference
A numeric value indicating how closely WKT values must match in order for a projected coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this function; and if the difference in all cases is less than or equal to the `max_rel_num_difference` value, the SRID for that coordinate reference system is included in the results.

Usage Notes

This function returns an object of type SDO_SRID_LIST, which is defined as `VARRAY(1048576) OF NUMBER`.

The well-known text (WKT) format is described in Well-Known Text (WKT).

Examples

The following examples show the effect of the `is_legacy` parameter value on the results. The first example returns the SRID values of all geodetic legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
  8307,
  'TRUE') FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307,'TRUE')
--------------------------------------------------------------------------------
SDO_SRID_LIST(8192, 8265, 8307, 8311, 8320, 524288, 2000002, 2000006, 2000012, 2
000015, 2000023, 2000028)
```

The next example returns the SRID values of all geodetic non-legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
  8307,
  'FALSE') FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307,'FALSE')
--------------------------------------------------------------------------------
SDO_SRID_LIST(4019, 4030, 4031, 4032, 4033, 4041, 4121, 4122, 4126, 4130, 4133,
4140, 4141, 4148, 4151, 4152, 4163, 4166, 4167, 4170, 4171, 4172, 4173, 4176, 41
80, 4189, 4190, 4258, 4269, 4283, 4318, 4319, 4326, 4610, 4612, 4617, 4619, 4624
, 4627, 4640, 4659, 4661, 4667, 4669, 4670)
```

The next example returns the SRID values of all geodetic coordinate reference systems (legacy and non-legacy) that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
  8307,
  NULL) FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307,NULL)
--------------------------------------------------------------------------------
SDO_SRID_LIST(4019, 4030, 4031, 4032, 4033, 4041, 4121, 4122, 4126, 4130, 4133,
4140, 4141, 4148, 4151, 4152, 4163, 4166, 4167, 4170, 4171, 4172, 4173, 4176, 41
80, 4189, 4190, 4258, 4269, 4283, 4318, 4319, 4326, 4610, 4612, 4617, 4619, 4624
, 4627, 4640, 4659, 4661, 4667, 4669, 4670, 8192, 8265, 8307, 8311, 8320, 524288
, 2000002, 2000006, 2000012, 2000015, 2000023, 2000028)
```

22.15 SDO_CS.FIND_PROJ_CRS

Format

```
SDO_CS.FIND_PROJ_CRS(
     reference_srid          IN NUMBER,
     is_legacy               IN VARCHAR2,
     max_rel_num_difference  IN NUMBER DEFAULT 0.000001) RETURN SDO_SRID_LIST;
```

Description

Returns the SRID values of projected coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.

Parameters

reference_srid
The SRID of the coordinate reference system for which to find all other projected coordinate reference systems that have the same WKT numeric values. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

is_legacy
`TRUE` limits the results to projected coordinate reference systems for which the IS_LEGACY column value is `TRUE` in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table); `FALSE` limits the results to projected coordinate reference systems for which the IS_LEGACY column value is `FALSE` in the SDO_COORD_REF_SYS table. If you specify a null value for this parameter, the IS_LEGACY column value in the SDO_COORD_REF_SYS table is ignored in determining the results.

max_rel_num_difference
A numeric value indicating how closely WKT values must match in order for a coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this function; and if the difference in all cases is less than or equal to the `max_rel_num_difference` value, the SRID for that coordinate reference system is included in the results.

Usage Notes

This function returns an object of type SDO_SRID_LIST, which is defined as `VARRAY(1048576) OF NUMBER`.

The well-known text (WKT) format is described in Well-Known Text (WKT).

Examples

The following examples show the effect of the `is_legacy` parameter value on the results. The first example returns the SRID values of all projected legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007. The returned result list is empty, because there are no legacy projected legacy coordinate reference systems that meet the search criteria.

```
SELECT SDO_CS.FIND_PROJ_CRS(
  2007,
  'TRUE') FROM DUAL;

SDO_CS.FIND_PROJ_CRS(2007,'TRUE')
--------------------------------------------------------------------------------
SDO_SRID_LIST()
```

The next example returns the SRID values of all projected non-legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007.

```
SELECT SDO_CS.FIND_PROJ_CRS(
  2007,
  'FALSE') FROM DUAL;

SDO_CS.FIND_PROJ_CRS(2007,'FALSE')
--------------------------------------------------------------------------------
SDO_SRID_LIST(2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 21291)
```

The next example returns the SRID values of all projected coordinate reference systems (legacy and non-legacy) that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007. The returned result list is the same as for the preceding example.

```
SELECT SDO_CS.FIND_PROJ_CRS(
  2007,
  NULL) FROM DUAL;

SDO_CS.FIND_PROJ_CRS(2007,NULL)
--------------------------------------------------------------------------------
SDO_SRID_LIST(2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 21291)
```

22.16 SDO_CS.FIND_SRID

Format

```
SDO_CS.FIND_SRID(
     srid              OUT NUMBER,
     epsg_srid_geog    IN NUMBER DEFAULT NULL,
     epsg_srid_proj    IN NUMBER DEFAULT NULL,
     datum_id          IN NUMBER DEFAULT NULL,
     pm_id             IN NUMBER DEFAULT NULL,
     proj_method_id    IN NUMBER DEFAULT NULL,
     coord_ref_sys_kind IN VARCHAR2 DEFAULT NULL,
     semi_major_axis    IN NUMBER DEFAULT NULL,
     semi_minor_axis    IN NUMBER DEFAULT NULL,
     inv_flattening     IN NUMBER DEFAULT NULL,
     params             IN EPSG_PARAMS DEFAULT NULL);
```

or

```
SDO_CS.FIND_SRID(
     srid               OUT NUMBER,
     epsg_srid_geog     IN NUMBER DEFAULT NULL,
     epsg_srid_proj     IN NUMBER DEFAULT NULL,
     datum_id           IN NUMBER DEFAULT NULL,
     pm_id              IN NUMBER DEFAULT NULL,
     proj_method_id     IN NUMBER DEFAULT NULL,
     proj_op_id         IN NUMBER DEFAULT NULL,
     coord_ref_sys_kind IN VARCHAR2 DEFAULT NULL,
     semi_major_axis    IN NUMBER DEFAULT NULL,
     semi_minor_axis    IN NUMBER DEFAULT NULL,
     inv_flattening     IN NUMBER DEFAULT NULL,
     params             IN EPSG_PARAMS DEFAULT NULL,
     max_rel_num_difference IN NUMBER DEFAULT 0.000001);
```

Description

Finds an SRID value for a coordinate system that matches information that you specify.

Parameters

srid
Output parameter; will contain either a numeric SRID value or a null value, as explained in the Usage Notes.

epsg_srid_geog
EPGS SRID value of a geographic coordinate system. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will either verify the existence of a coordinate system with this geographic SRID value, or will find an SRID value of a projected coordinate system based on a coordinate system with this SRID value.

epsg_srid_proj
EPGS SRID value of a projected coordinate system.

datum_id
Datum ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this datum.

ellipsoid_id
Ellipsoid ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this ellipsoid.

pm_id
Prime meridian ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this prime meridian.

proj_method_id
Projection method ID value. This procedure will look for the SRID of a projected coordinate system based on this projection method.

proj_op_id
Projection operation ID value. This procedure will look for the SRID of a projected coordinate system based on this projection operation. A projection operation is a projection method combined with specific projection parameters.

coord_ref_sys_kind
The kind or category of coordinate system. Must be a string value in the COORD_REF_SYS_KIND column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table). Examples: `GEOGRAPHIC2D` and `PROJECTED`

semi_major_axis
Semi-major axis ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will loo for the SRID of a geographic or projected coordinate system based on this semi-major axis.

semi_minor_axis
Semi-minor axis ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this semi-minor axis.

inv_flattening
Inverse flattening (unit "unity"). Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this inverse flattening.

params
Projection parameters. The parameters depend on the projection method. The EPSG_PARAMS type is defined as `VARRAY(1048576) OF EPSG_PARAM`, and the EPSG_PARAM type is defined as `(id NUMBER, val NUMBER, uom NUMBER)`. The format includes attributes for the parameter ID, value, and unit of measure ID, as shown in the following example:

```
epsg_params(
  epsg_param(8801,      0.0,    9102),
  epsg_param(8802,      9.0,    9102),
  epsg_param(8805,      0.9996, 9201),
  epsg_param(8806, 500000.0,    9001),
  epsg_param(8807,      0.0,    9001));
```

max_rel_num_difference
A numeric value indicating how closely WKT values must match in order for a coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this procedure; and if the difference in all cases is less than or equal to the `max_rel_num_difference` value, the SRID for that coordinate reference system is included in the results.

Usage Notes

This procedure places the result of its operation in the `srid` output parameter. The result is either a numeric SRID value or a null value.

This procedure has the following major uses:

- To check if a coordinate system with a specific SRID value exists. In this case, you specify a value for `epsg_srid_geog` or `epsg_srid_proj` (depending on whether the coordinate system is geographic or projected) and enough parameters for a valid PL/SQL statement. If the resulting `srid` parameter value is the same number as the value that you specified, the coordinate system with that SRID value exists; however, if the resulting `srid` parameter value is null, no coordinate system with that SRID value exists.
- To find the SRID value of a coordinate system based on information that you specify about it.

If multiple coordinate systems match the criteria specified in the input parameters, only one SRID value is returned in the `srid` parameter. This could be any one of the potential matching SRID values, and it is not guaranteed to be the same value in subsequent executions of this procedure with the same input parameters.

Examples

The following example finds an SRID value for a projected coordinate system that uses datum ID 6267 in its definition.

```
DECLARE
  returned_srid  NUMBER;
BEGIN
SDO_CS.FIND_SRID (
   srid               => returned_srid,
   epsg_srid_geog     => null,
   epsg_srid_proj     => null,
   datum_id           => 6267,
   ellips_id          => null,
   pm_id              => null,
   proj_method_id     => null,
   proj_op_id         => null,
   coord_ref_sys_kind => 'PROJECTED');
DBMS_OUTPUT.PUT_LINE('SRID = ' || returned_srid);
END;
/
SRID = 4267
```

22.17 SDO_CS.FROM_GEOHASH

Format

```
SDO_CS.FROM_GEOHASH(
     geohash  IN VARCHAR2,
     srid     IN NUMBER) RETURN SDO_GEOMETRY;
```

Description

Returns a spatial geometry (type SDO_GEOMETRY) representing a specified geohash.

Parameters

geohash
Geohash representation of a geometry.

srid
Coordinate system (spatial reference system) to be used in constructing the Oracle Spatial geometry.

Usage Notes

For information about geohash support in Oracle Spatial, see Geohash Support.

Examples

The following example “converts” a specified geohash value to a geometry of SRID 4326.

```
SELECT sdo_cs.from_GeoHash('u4pruydqqvj', 4326) FROM DUAL;

SDO_GEOMETRY(2002, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(10.407439, 57.64911, 10.4074404, 57.6491113))
```

22.18 SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS

Format

```
SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS(
     wkt  IN VARCHAR2) RETURN VARCHAR2;
```

Description

Converts a well-known text string from the Open Geospatial Consortium simple feature format without the `TOWGS84` keyword to the format that includes the `TOWGS84` keyword.

Parameters

wkt
Well-known text string.

Usage Notes

To convert a well-known text string from the Open Geospatial Consortium simple feature format that includes the `TOWGS84` keyword to the format without the `TOWGS84` keyword, use the SDO_CS.TO_OGC_SIMPLEFEATURE_SRS function.

Examples

The following example converts a well-known text string from the Open Geospatial Consortium simple feature format without the `TOWGS84` keyword to the format that includes the `TOWGS84` keyword.

```
SELECT sdo_cs.from_OGC_SimpleFeature_SRS('GEOGCS [ "Longitude / Latitude (DHDN)",
  DATUM ["", SPHEROID ["Bessel 1841", 6377397.155, 299.1528128],
  582.000000, 105.000000, 414.000000, -1.040000, -0.350000, 3.080000, 8.300000 ],
  PRIMEM [ "Greenwich", 0.000000 ], UNIT ["Decimal Degree", 0.01745329251994330]]')
FROM DUAL;

MDSYS.SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS('GEOGCS["LONGITUDE/LATITUDE(DHDN)",DATUM
--------------------------------------------------------------------------------
GEOGCS [ "Longitude / Latitude (DHDN)", DATUM ["", SPHEROID ["Bessel 1841", 6377
397.155, 299.1528128], TOWGS84[ 582.000000, 105.000000, 414.000000, -1.040000, -
0.350000, 3.080000, 8.300000]], PRIMEM [ "Greenwich", 0.000000 ], UNIT ["Decimal
 Degree", 0.01745329251994330]]
```

22.19 SDO_CS.FROM_USNG

Format

```
SDO_CS.FROM_USNG(
     usng   IN VARCHAR2,
     srid   IN NUMBER,
     datum  IN VARCHAR2 DEFAULT 'NAD83') RETURN SDO_GEOMETRY;
```

Description

Converts a point represented in U.S. National Grid format to a spatial point geometry object.

Parameters

usng
Well-known text string.

srid
The SRID of the coordinate system to be used for the conversion (that is, the SRID to be used in the returned geometry). Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

datum
The name of the datum on which the U.S. National Grid coordinate for the point is based. Must be either a value in the DATUM_NAME column of the SDO_DATUMS table (described in SDO_DATUMS Table) or null. The default value is `NAD83`.

Usage Notes

For information about Oracle Spatial support for the U.S. National Grid, see U.S. National Grid Support.

To convert a spatial point geometry to a point represented in U.S. National Grid format, use the SDO_CS.TO_USNG function.

Examples

The following example converts a point represented in U.S. National Grid format to a spatial geometry point object with longitude/latitude coordinates.

```
-- Convert US National Grid point to SDO_GEMETRY point using SRID 4326
-- (WGS 84, longitude/latitude).
SELECT SDO_CS.FROM_USNG(
  '18SUJ2348316806479498',
  4326) FROM DUAL;

WGS84(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(-77.03524, 38.8894673, NULL), NULL, NULL)
```

22.20 SDO_CS.GENERATE_SCRIPT_FROM_SRID

Format

```
GENERATE_SCRIPT_FROM_SRID(
     srid          IN NUMBER,
     offset        IN NUMBER DEFAULT 0,
     include_units IN NUMBER DEFAULT 1) RETURN CLOB;
```

Description

Returns a CLOB object that includes the SQL statements necessary to create the coordinate system with the specified SRID value.

Parameters

srid
The SRID of the coordinate reference system. Must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

offset
A number to be added to the SRID value of the coordinate system created by the generated script. For example, specifying `SDO_CS.GENERATE_SCRIPT_FROM_SRID(`**`27700, 50000`**`)` would cause the INSERT statements the resulting script to specify the SRID as **77700** (that is, 27700 + 50000). The purpose might be to ensure that a new unique SRID gets generated if you know that you do not have any current SRIDs equal to or greater than 77700.
The default offset value is 0 (zero).

include_units
The numeric value 0 means *not* to include units of measure in generated statements; the numeric value 1 (the default) means *to include* units of measure in generated statements.
The default value is recommended in virtually all cases. Exceptions, if any, should be rare, and only if there are “nonstandard” units of measure for attributes.

Usage Notes

Before using this function, you must use the SQL*Plus command SET LONG to increase the maximum width in bytes for column output. For example: `SET LONG 20000`

If you plan to use the output to help you modify a coordinate system definition or to create a new definition -- as opposed to just viewing the information -- you must edit the output as needed to ensure syntactic correctness (such as for the INSERT statements).

The script can be run on a different (target) database or on the same database on which you executed this function. In either case, there might be an existing coordinate system associated with the SRID in question; and in this case you might want to take action to deal with that scenario (such as using the `offeet` parameter).

You are discouraged from making changes to “standard” coordinate system definitions.

Examples

The following example returns a CLOB object that includes the statements necessary to define the coordinate system with the SRID value 27700.

```
SQL> SET LONG 20000

SQL> SELECT sdo_cs.GENERATE_SCRIPT_FROM_SRID(27700) FROM DUAL;

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
insert into mdsys.sdo_units_of_measure (
  UOM_ID,
  UNIT_OF_MEAS_NAME,
  SHORT_NAME,
  LEGACY_UNIT_NAME,
  UNIT_OF_MEAS_TYPE,
  TARGET_UOM_ID,
  FACTOR_B,
  FACTOR_C,
  INFORMATION_SOURCE,
  DATA_SOURCE,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  IS_LEGACY,
  LEGACY_CODE)
values (
  9001,
  'metre',
  'METRE_9001',
  'Meter',
  'length',
  9001,
  1,
  1,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'ISO 1000.',
  'EPSG',
  'FALSE',
  NULL);

insert into mdsys.sdo_units_of_measure (
  UOM_ID,
  UNIT_OF_MEAS_NAME,
  SHORT_NAME,
  LEGACY_UNIT_NAME,
  UNIT_OF_MEAS_TYPE,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  TARGET_UOM_ID,
  FACTOR_B,
  FACTOR_C,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE)
values (
  9102,
  'degree',
  'DEGREE_EPSG_9102',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'Decimal Degree',
  'angle',
  9101,
  3.14159265358979,
  180,
  NULL,
  'EPSG',
  'FALSE',
  NULL);

insert into mdsys.sdo_units_of_measure (
SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  UOM_ID,
  UNIT_OF_MEAS_NAME,
  SHORT_NAME,
  LEGACY_UNIT_NAME,
  UNIT_OF_MEAS_TYPE,
  TARGET_UOM_ID,
  FACTOR_B,
  FACTOR_C,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  LEGACY_CODE)
values (
  9110,
  'sexagesimal DMS',
  'SEXAGESIMAL_DMS_EPSG_9110',
  NULL,
  'angle',
  9101,
  3.14159265358979,
  180,
  'EPSG',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'EPSG',
  'FALSE',
  NULL);

insert into mdsys.sdo_units_of_measure (
  UOM_ID,
  UNIT_OF_MEAS_NAME,
  SHORT_NAME,
  LEGACY_UNIT_NAME,
  UNIT_OF_MEAS_TYPE,
  TARGET_UOM_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  FACTOR_B,
  FACTOR_C,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE)
values (
  9122,
  'degree (supplier to define representation)',
  'DEGREE_SUPPLIER_DEFINED_9122',
  'Decimal Degree',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'angle',
  9101,
  3.14159265358979,
  180,
  'EPSG',
  'EPSG',
  'FALSE',
  NULL);

insert into mdsys.sdo_units_of_measure (
  UOM_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  UNIT_OF_MEAS_NAME,
  SHORT_NAME,
  LEGACY_UNIT_NAME,
  UNIT_OF_MEAS_TYPE,
  TARGET_UOM_ID,
  FACTOR_B,
  FACTOR_C,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE)

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
values (
  9201,
  'unity',
  'UNITY_9201',
  NULL,
  'scale',
  9201,
  1,
  1,
  NULL,
  'EPSG',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'FALSE',
  NULL);

insert into mdsys.sdo_coord_ops (
  COORD_OP_ID,
  COORD_OP_NAME,
  COORD_OP_TYPE,
  SOURCE_SRID,
  TARGET_SRID,
  COORD_TFM_VERSION,
  COORD_OP_VARIANT,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_OP_METHOD_ID,
  UOM_ID_SOURCE_OFFSETS,
  UOM_ID_TARGET_OFFSETS,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  SHOW_OPERATION,
  IS_LEGACY,
  LEGACY_CODE,
  REVERSE_OP,
  IS_IMPLEMENTED_FORWARD,
  IS_IMPLEMENTED_REVERSE)

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
values (
  19916,
  'British National Grid (EPSG OP 19916)',
  'CONVERSION',
  NULL,
  NULL,
  NULL,
  NULL,
  9807,
  NULL,
  NULL,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'Ordnance Survey of Great Britain.  http://www.gps.gov.uk/additionalInfo/image
s/A_guide_to_coord.pdf',
  'EPSG',
  1,
  'FALSE',
  NULL,
  1,
  1,
  1);

insert into mdsys.sdo_coord_op_param_vals (

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  PARAM_VALUE_FILE,
  PARAM_VALUE_XML,
  UOM_ID)
values (
  19916,
  9807,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  8801,
  49,
  NULL,
  null,
  null,
  9102);

insert into mdsys.sdo_coord_op_param_vals (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  PARAM_VALUE_FILE,
  PARAM_VALUE_XML,
  UOM_ID)
values (
  19916,
  9807,
  8802,
  -2,
  NULL,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  null,
  null,
  9102);

insert into mdsys.sdo_coord_op_param_vals (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  PARAM_VALUE_FILE,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  PARAM_VALUE_XML,
  UOM_ID)
values (
  19916,
  9807,
  8805,
  .9996012717,
  NULL,
  null,
  null,
  9201);

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------

insert into mdsys.sdo_coord_op_param_vals (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  PARAM_VALUE_FILE,
  PARAM_VALUE_XML,
  UOM_ID)
values (

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  19916,
  9807,
  8806,
  400000,
  NULL,
  null,
  null,
  9001);

insert into mdsys.sdo_coord_op_param_vals (
  COORD_OP_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  PARAM_VALUE_FILE,
  PARAM_VALUE_XML,
  UOM_ID)
values (
  19916,
  9807,
  8807,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  -100000,
  NULL,
  null,
  null,
  9001);

insert into mdsys.sdo_ellipsoids (
  ELLIPSOID_ID,
  ELLIPSOID_NAME,
  SEMI_MAJOR_AXIS,
  UOM_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  INV_FLATTENING,
  SEMI_MINOR_AXIS,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE)
values (
  7001,
  'Airy 1830',
  6377563.396,
  9001,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  299.3249646,
  6356256.909237285120186730993436155241 43,
  'Ordnance Survey of Great Britain.',
  'EPSG',
  'FALSE',
  8001);

insert into mdsys.sdo_prime_meridians (
  PRIME_MERIDIAN_ID,
  PRIME_MERIDIAN_NAME,
  GREENWICH_LONGITUDE,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
```

```
--------------------------------------------------------------------------------
  UOM_ID,
  INFORMATION_SOURCE,
  DATA_SOURCE)
values (
  8901,
  'Greenwich 8901',
  0,
  9110,
  NULL,
  'EPSG');


SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
insert into mdsys.sdo_datums (
  DATUM_ID,
  DATUM_NAME,
  DATUM_TYPE,
  ELLIPSOID_ID,
  PRIME_MERIDIAN_ID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  SHIFT_X,
  SHIFT_Y,
  SHIFT_Z,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  ROTATE_X,
  ROTATE_Y,
  ROTATE_Z,
  SCALE_ADJUST,
  IS_LEGACY,
  LEGACY_CODE)
values (
  6277,
  'OSGB 1936',
  'GEODETIC',
  7001,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  8901,
  'Ordnance Survey of Great Britain',
  'EPSG',
  446.448,
  -125.157,
  542.06,
  .15,
  .247,
  .842,
  -20.489,
  'FALSE',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  NULL);

insert into mdsys.sdo_coord_sys (
  COORD_SYS_ID,
  COORD_SYS_NAME,
  COORD_SYS_TYPE,
  DIMENSION,
  INFORMATION_SOURCE,
  DATA_SOURCE)
values (
  6422,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'Ellipsoidal 2D CS. Axes: latitude, longitude. Orientations: north, east.  UoM
: deg 6422',
  'ellipsoidal',
  2,
  'EPSG',
  'EPSG');

insert into mdsys.sdo_coord_axes (
  COORD_SYS_ID,
  COORD_AXIS_NAME_ID,
  COORD_AXIS_ORIENTATION,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_AXIS_ABBREVIATION,
  UOM_ID,
  "ORDER")
values (
  6422,
  9901,
  'north',
  'Lat',
  9122,
  1);


SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
insert into mdsys.sdo_coord_axes (
  COORD_SYS_ID,
  COORD_AXIS_NAME_ID,
  COORD_AXIS_ORIENTATION,
  COORD_AXIS_ABBREVIATION,
  UOM_ID,
  "ORDER")
values (
  6422,
  9902,
  'east',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'Long',
  9122,
  2);

insert into mdsys.sdo_coord_ref_system (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS,
  IS_VALID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  SUPPORTS_SDO_GEOMETRY)
values (
  4277,
  'OSGB 1936',
  'GEOGRAPHIC2D',
  6422,
  6277,
  6277,
  NULL,
  NULL,
  NULL,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  NULL,
  NULL,
  'EPSG',
  'FALSE',
  NULL,
  NULL,
  null,
  'TRUE',
  'TRUE');

insert into mdsys.sdo_coord_sys (

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_SYS_ID,
  COORD_SYS_NAME,
  COORD_SYS_TYPE,
  DIMENSION,
  INFORMATION_SOURCE,
  DATA_SOURCE)
values (
  4400,
  'Cartesian 2D CS.  Axes: easting, northing (E,N). Orientations: east, north.
UoM: m. 4400',
  'Cartesian',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  2,
  'EPSG',
  'EPSG');
```

```
insert into mdsys.sdo_coord_axes (
  COORD_SYS_ID,
  COORD_AXIS_NAME_ID,
  COORD_AXIS_ORIENTATION,
  COORD_AXIS_ABBREVIATION,
  UOM_ID,
  "ORDER")

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
values (
  4400,
  9906,
  'east',
  'E',
  9001,
  1);

insert into mdsys.sdo_coord_axes (
  COORD_SYS_ID,
  COORD_AXIS_NAME_ID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  COORD_AXIS_ORIENTATION,
  COORD_AXIS_ABBREVIATION,
  UOM_ID,
  "ORDER")
values (
  4400,
  9907,
  'north',
  'N',
  9001,
  2);

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------

insert into mdsys.sdo_coord_ref_system (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS,
  IS_VALID,
  SUPPORTS_SDO_GEOMETRY)
```

```
values (
  27700,

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'OSGB 1936 / British National Grid',
  'PROJECTED',
  4400,
  NULL,
  6277,
  4277,
  19916,
  NULL,
  NULL,
  NULL,
  'EPSG',

SDO_CS.GENERATE_SCRIPT_FROM_SRID(27700)
--------------------------------------------------------------------------------
  'FALSE',
  NULL,
  NULL,
  null,
  'TRUE',
  'TRUE');
```

22.21 SDO_CS.GET_EPSG_DATA_VERSION

Format

```
SDO_CS.GET_EPSG_DATA_VERSION() RETURN VARCHAR2;
```

Description

Gets the version number of the EPSG dataset used by Spatial.

Parameters

None.

Usage Notes

The EPSG dataset is available from the European Petroleum Survey Group, and is distributed in a Microsoft Access 97 database and as SQL scripts.

Examples

The following example gets the version number of the EPSG dataset used by Spatial.

```
SELECT SDO_CS.GET_EPSG_DATA_VERSION FROM DUAL;

GET_EPSG_DATA_VERSION
--------------------------------------------------------------------------------
7.5
```

22.22 SDO_CS.GET_GEOHASH_CELL_HEIGHT

Format

```
SDO_CS.GET_GEOHASH_CELL_HEIGHT(
     geohash_length  IN NUMBER) RETURN SDO_NUMBER;
```

Description

Returns the cell height of a specified geohash.

Parameters

geohash_length
Length of the geohash.

Usage Notes

Depending on its length, a geohash can vary in its accuracy. A longer geohash defines a smaller (more accurate) coordinate cell. You can return the cell width and height in meters (assuming WGS84).

For information about geohash support in Oracle Spatial, see Geohash Support.

Examples

The following example returns the cell height in meters if the geohash length is 11..

```
SELECT sdo_cs.get_GeoHash_cell_height(11) FROM DUAL;

                        .149
```

22.23 SDO_CS.GET_GEOHASH_CELL_WIDTH

Format

```
SDO_CS.GET_GEOHASH_CELL_WIDTH(
     geohash_length  IN NUMBER) RETURN SDO_NUMBER;
```

Description

Returns the cell width of a specified geohash.

Parameters

geohash_length
Length of the geohash.

Usage Notes

Depending on its length, a geohash can vary in its accuracy. A longer geohash defines a smaller (more accurate) coordinate cell. You can return the cell width and height in meters (assuming WGS84).

For information about geohash support in Oracle Spatial, see Geohash Support.

Examples

The following example returns the cell width in meters if the geohash length is 11..

```
SELECT sdo_cs.get_GeoHash_cell_width(11) FROM DUAL;

                      .149
```

22.24 SDO_CS.INSERT_SRID

Format

```
SDO_CS.INSERT_SRID(
    srid                   IN NUMBER,
    coord_ref_sys_name     IN VARCHAR2,
    coord_ref_sys_kind     IN VARCHAR2,
    coord_sys_id           IN NUMBER,
    datum_id               IN NUMBER,
    source_geog_srid       IN NUMBER,
    projection_conv_id     IN NUMBER,
    cmpd_horiz_srid        IN NUMBER,
    cmpd_vert_srid         IN NUMBER,
    information_source     IN VARCHAR2,
    data_source            IN VARCHAR2,
    is_legacy              IN VARCHAR2,
    legacy_code            IN NUMBER,
    legacy_wktext          IN VARCHAR2,
    legacy_cs_bounds       IN MDSYS.SDO_GEOMETRY,
    or_replace             IN NUMBER DEFAULT 0);
```

Description

Inserts an SRID value for a coordinate reference system in MDSYS tables.

Parameters

srid
The ID of the coordinate reference system, such as in the tables CS_SRS and SDO_COORD_REF_SYS.

coord_ref_sys_name
The name of the coordinate reference system, such as in the table SDO_COORD_REF_SYS.

coord_ref_sys_kind
The type of the coordinate reference system, such as in the table SDO_COORD_REF_SYS.

coord_sys_id
The ID of the underlying coordinate system, such as in the table SDO_COORD_REF_SYS.

datum_id
The ID of the underlying datum, such as in the table SDO_COORD_REF_SYS.

source_geog_srid
The ID of the underlying geodetic SRID, such as in the table SDO_COORD_REF_SYS. This only applies to projected SRIDs.

projection_conv_id
The ID of the underlying projection operation, such as in the table SDO_COORD_REF_SYS. This only applies to projected SRIDs.

cmpd_horiz_srid
The ID of the underlying horizontal SRID, such as in the table SDO_COORD_REF_SYS. This only applies to compound SRIDs.

cmpd_vert_srid
The ID of the underlying vertical SRID, such as in the table SDO_COORD_REF_SYS. This only applies to compound SRIDs.

information_source
Provider of the definition for the coordinate system.

data_source
Organization that supplied the data for this record.

is_legacy
‘`TRUE`’ for OGC definitions based on WKT; ‘`FALSE`’ for EPSG definitions.

legacy_code
Optional code for an OGC definition that would be the equivalent for this EPSG definition.

legacy_wktext
OGC WKT, if this is an OGC definition.

legacy_cs_bounds
Optional boundaries of applicability of the coordinate reference system.

or_replace
The supported values are:

- `1`: Implies create or replace the SRID
- `0`: Implies create or raise exception if SRID already exists

Usage Notes

The procedure `SDO_CS.INSERT_SRID` is an alternative to directly inserting coordinate reference system definitions into tables. This can be more convenient, in general, because you need not verify whether the definition already exists (optional `OR_REPLACE`). Also, it can be important on platforms such as Autonomous Database, where the ADMIN user cannot otherwise directly insert definitions in certain MDSYS tables.

Examples

The following example inserts an SRID, `5007899`, for a projected coordinate system.

```
SQL> call
  2    mdsys.sdo_cs.insert_srid(
  3      srid                  => 5007899,
  4      coord_ref_sys_name => 'GDA2020 / Vicgrid',
  5      coord_ref_sys_kind => 'PROJECTED',
  6      coord_sys_id         => 4400,
  7      datum_id             => NULL,
  8      source_geog_srid   => 7844,
  9      projection_conv_id => 5017361,
 10      cmpd_horiz_srid    => null,
 11      cmpd_vert_srid     => null,
 12      information_source => 'Office of Surveyor-General Victoria',
 13      data_source        => 'EPSG',
 14      is_legacy          => 'FALSE',
 15      legacy_code        => NULL,
 16      legacy_wktext      => NULL,
 17      legacy_cs_bounds   => NULL);

Call completed.
```

22.25 SDO_CS.LOAD_EPSG_MATRIX

Format

```
SDO_CS.LOAD_EPSG_MATRIX(
     op_id        IN NUMBER,
     parameter_id IN NUMBER,
     directory    IN VARCHAR2,
     file_name    IN VARCHAR2);
```

Description

Loads an EPSG matrix of NADCON, NTv2, or VERTCON format.

Parameters

op_id
EPSG operation ID to which the matrix belongs.

parameter_id
EPSG parameter id identifying the matrix, if an operation has more than one matrix, such as NADCON.

directory
Name of the matrix file directory.

file_name
Matrix file name.

Usage Notes

To validate an EPSG matrix, use the SDO_CS.VALIDATE_EPSG_MATRIX function.

Examples

The following example loads an NTv2 matrix for operation 1703 ("NAD27 to WGS 84 (32)"). For an NTv2 operation, a single matrix is sufficient, assigned to parameter ID 8656.

```
CREATE OR REPLACE DIRECTORY work_dir AS '…';

EXECUTE sdo_cs.load_epsg_matrix(
    1703,
    8656,
    'WORK_DIR',
    'ntv2file.asc');
```

22.26 SDO_CS.MAKE_2D

Format

```
SDO_CS.MAKE_2D(
     geom3d      IN SDO_GEOMETRY,
     target_srid IN NUMBER DEFAULT NULL) RETURN SDO_GEOMETRY;
```

Description

Converts a three-dimensional (or more dimensions) geometry into a two-dimensional geometry.

Parameters

geom3d
Geometry object with more then two dimensions.

target_srid
The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table). If this parameter is null, a default SRID is used based on the SRID of the input geometry.

Usage Notes

This function returns a two-dimensional geometry object that removes the third (height) dimension value (and other dimension values if the input geometry has more than three dimensions) from each vertex in the input geometry.

For information about three-dimensional coordinate reference system support, see Three-Dimensional Coordinate Reference System Support.

Examples

The following example converts a three-dimensional geometry to a two-dimensional geometry by removing all the third (height) dimension values. (It uses as its input geometry the output geometry from the example for the SDO_CS.MAKE_3D function.)

```
SELECT SDO_CS.MAKE_2D(SDO_GEOMETRY(3003, 8307, NULL,
 SDO_ELEM_INFO_ARRAY(1, 1003, 1),
   SDO_ORDINATE_ARRAY(1, 1, 10, 5, 1, 10, 5, 7, 10, 1, 7, 10, 1, 1, 10)))
FROM DUAL;

SDO_CS.MAKE_2D(SDO_GEOMETRY(3003,8307,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SDO_ORD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 5, 1, 5, 7, 1, 7, 1, 1))
```

22.27 SDO_CS.MAKE_3D

Format

```
SDO_CS.MAKE_3D(
     geom2d      IN SDO_GEOMETRY,
     height      IN NUMBER DEFAULT 0,
     target_srid IN NUMBER DEFAULT NULL) RETURN SDO_GEOMETRY;
```

Description

Converts a two-dimensional geometry into a three-dimensional geometry.

Parameters

geom2d
Two-dimensional geometry object.

height
Height value to be used in the third dimension for all vertices in the returned geometry. If this parameter is null or not specified, a height of 0 (zero) is used for all vertices.

target_srid
The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

> **Note:**
>
> The SDO_CS.MAKE_3D function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

For information about using this function to simulate a cross-dimensionality transformation, see Cross-Dimensionality Transformations.

For information about three-dimensional coordinate reference system support, see Three-Dimensional Coordinate Reference System Support.

Examples

The following example converts the `cola_a` two-dimensional geometry to a three-dimensional geometry. (This example uses the definitions from the example in Example of Coordinate System Transformation.).

```
SELECT SDO_CS.MAKE_3D(c.shape, 10, 8307) FROM cola_markets_cs c
  WHERE c.name = 'cola_a';

SDO_CS.MAKE_3D(C.SHAPE,10,8307)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELE
--------------------------------------------------------------------------------
SDO_GEOMETRY(3003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 10, 5, 1, 10, 5, 7, 10, 1, 7, 10, 1, 1, 10))
```

22.28 SDO_CS.MAP_EPSG_SRID_TO_ORACLE

Format

```
SDO_CS.MAP_EPSG_SRID_TO_ORACLE(
     epsg_srid  IN NUMBER) RETURN NUMBER;
```

Description

Returns the Oracle Spatial SRID value corresponding to the specified EPSG SRID value.

Parameters

epsg_srid
The SRID of the EPSG coordinate reference system, as indicated in the COORD_REF_SYS_CODE field in the EPSG Coordinate Reference System table.

Usage Notes

This function returns a value that matches a value in the SRID column of the SDO_COORD_REF_SYS table (see SDO_COORD_REF_SYS Table).

To return the EPSG SRID value corresponding to the specified Oracle Spatial SRID value, use the SDO_CS.MAP_ORACLE_SRID_TO_EPSG function.

Examples

The following example returns the Oracle Spatial SRID value corresponding to EPSG SRID 23038.

```
SELECT SDO_CS.MAP_EPSG_SRID_TO_ORACLE(23038) FROM DUAL;

SDO_CS.MAP_EPSG_SRID_TO_ORACLE(23038)
-------------------------------------
                                82361
```

22.29 SDO_CS.MAP_ORACLE_SRID_TO_EPSG

Format

```
SDO_CS.MAP_ORACLE_SRID_TO_EPSG(
     legacy_srid  IN NUMBER) RETURN NUMBER;
```

Description

Returns the EPSG SRID value corresponding to the specified Oracle Spatial SRID value.

Parameters

legacy_srid
Oracle Spatial SRID value. Must match a value in the LEGACY_CODE column of the SDO_COORD_REF_SYS table (see SDO_COORD_REF_SYS Table).

Usage Notes

This function returns the SRID of an EPSG coordinate reference system. The EPSG SRID value for a coordinate reference system is indicated in the COORD_REF_SYS_CODE field in the EPSG Coordinate Reference System table.

To return the Oracle Spatial SRID value corresponding to a specified EPSG SRID value, use the SDO_CS.MAP_EPSG_SRID_TO_ORACLE function.

Examples

The following example returns the EPSG SRID value corresponding to Oracle Spatial SRID 82361.

```
SELECT SDO_CS.MAP_ORACLE_SRID_TO_EPSG(82361) FROM DUAL;

SDO_CS.MAP_ORACLE_SRID_TO_EPSG(82361)
-------------------------------------
                                23038
```

22.30 SDO_CS.REVOKE_PREFERENCE_FOR_OP

Format

```
SDO_CS.REVOKE_PREFERENCE_FOR_OP(
     op_id      IN NUMBER,
     source_crs IN NUMBER DEFAULT NULL,
     target_crs IN NUMBER DEFAULT NULL,
     use_case   IN VARCHAR2 DEFAULT NULL);
```

Description

Revokes a preference for an operation between a source coordinate system and a target coordinate system.

Parameters

op_id
ID number of the operation. Must match an `op_id` value that was specified in a call to the SDO_CS.ADD_PREFERENCE_FOR_OP procedure.

source_crs
The SRID of the source coordinate reference system. Must match the `source_crs` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the SDO_CS.ADD_PREFERENCE_FOR_OP procedure.

target_crs
The SRID of the target coordinate reference system. Must match the `target_crs` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the SDO_CS.ADD_PREFERENCE_FOR_OP procedure.

use_case
Name of the use case associated with the preference. Must match the `use_case` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the SDO_CS.ADD_PREFERENCE_FOR_OP procedure.

Usage Notes

This procedure reverses the effect of the SDO_CS.ADD_PREFERENCE_FOR_OP procedure.

If `use_case` is null, this procedure deletes one or more rows from the SDO_PREFERRED_OPS_SYSTEM table (described in SDO_PREFERRED_OPS_SYSTEM Table). If `use_case` is not null, this procedure deletes one or more rows from the SDO_PREFERRED_OPS_USER table (described in SDO_PREFERRED_OPS_USER Table).

Examples

The following example revokes a preference for operation ID 19777 to be used in transformations from SRID 4301 to SRID 4326 when use case `use_case_B` is specified for the transformation.

```
EXECUTE SDO_CS.REVOKE_PREFERENCE_FOR_OP(19977, 4301, 4326, 'use_case_B');
```

22.31 SDO_CS.TO_GEOHASH

Format

```
SDO_CS.TO_GEOHASH(
     geom           IN SDO_GEOMETRY,
     geohash_length IN NUMBER) RETURN VARCHAR2;
```

Description

Returns the geohash representation of a spatial geometry (type SDO_GEOMETRY).

Parameters

geom
Oracle Spatial geometry

geohash_length
Length of the geohash result.

Usage Notes

For information about geohash support in Oracle Spatial, see Geohash Support.

Examples

The following examples show the effect of the `is_legacy` parameter value on the results. The first example returns the SRID values of all geodetic legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT sdo_cs.to_GeoHash(sdo_geometry(2001, 4326, sdo_point_type(10.40744, 57.64911,
null), null, null), 11)
   FROM DUAL;from dual;

u4pruydqqvj
```

22.32 SDO_CS.TO_OGC_SIMPLEFEATURE_SRS

Format

```
SDO_CS.TO_OGC_SIMPLEFEATURE_SRS(
     wkt  IN VARCHAR2) RETURN VARCHAR2;
```

Description

Converts a well-known text string from the Open Geospatial Consortium simple feature format that includes the `TOWGS84` keyword to the format without the `TOWGS84` keyword.

Parameters

wkt
Well-known text string.

Usage Notes

To convert a well-known text string from the Open Geospatial Consortium simple feature format without the `TOWGS84` keyword to the format that includes the `TOWGS84` keyword, use the SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS procedure.

Examples

The following example converts a well-known text string from the Open Geospatial Consortium simple feature format that includes the `TOWGS84` keyword to the format without the `TOWGS84` keyword.

```
SELECT sdo_cs.to_OGC_SimpleFeature_SRS('GEOGCS [ "Longitude / Latitude (DHDN)",
  DATUM ["", SPHEROID ["Bessel 1841", 6377397.155, 299.1528128],
  TOWGS84 [582.000000, 105.000000, 414.000000, -1.040000, -0.350000, 3.080000,
    8.300000] ],
  PRIMEM [ "Greenwich", 0.000000 ], UNIT ["Decimal Degree", 0.01745329251994330]]')
FROM DUAL;

MDSYS.SDO_CS.TO_OGC_SIMPLEFEATURE_SRS('GEOGCS["LONGITUDE/LATITUDE(DHDN)",DATUM["
--------------------------------------------------------------------------------
GEOGCS [ "Longitude / Latitude (DHDN)", DATUM ["", SPHEROID ["Bessel 1841", 6377
397.155, 299.1528128], 582.000000, 105.000000, 414.000000, -1.040000, -0.350000,
3.080000, 8.300000 ], PRIMEM [ "Greenwich", 0.000000 ], UNIT ["Decimal Degree",
0.01745329251994330]]
```

22.33 SDO_CS.TO_USNG

Format

```
SDO_CS.TO_USNG(
     geom               IN SDO_GEOMETRY,
     accuracy_in_meters IN NUMBER,
     datum              IN VARCHAR2 DEFAULT 'NAD83') RETURN VARCHAR2;
```

Description

Converts a spatial point geometry object to a point represented in U.S. National Grid format.

Parameters

geom
Point geometry whose representation is to be converted to a point represented in U.S. National Grid format. The input geometry must have a valid non-null SRID, that is, a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

accuracy_in_meters
Accuracy of the point location in meters. Should be 1 raised to a negative or positive power of 10 (for example, 0.001, 0.01, 0.1, 1, 10, 100, or 1000). Any other specified values are adjusted internally by Spatial, and the result might not be what you expect.

datum
The name of the datum on which the U.S. National Grid coordinate for the point is to be based. Must be either `NAD83` or `NAD27`. The default value is `NAD83`.

Usage Notes

For information about Oracle Spatial support for the U.S. National Grid, see U.S. National Grid Support.

The `accuracy_in_meters` value affects the number of digits used to represent the accuracy in the returned U.S. National Grid string. For example, if you specify 0.000001, the string will contain many digits; however, depending on the source of the data, the digits might not accurately reflect geographical reality. Consider the following scenarios. If you create a U.S. National Grid string from a UTM geometry, you can get perfect accuracy, because no inherently inaccurate transformation is involved. However, transforming from a Lambert projection to the U.S. National Grid format involves an inverse Lambert projection and a forward UTM projection, each of which has some inherent inaccuracy. If you request the resulting U.S. National Grid string with 1 millimeter (0.001) accuracy, the string will contain all the digits, but the millimeter-level digit will probably be geographically inaccurate.

To convert a point represented in U.S. National Grid format to a spatial point geometry, use the SDO_CS.FROM_USNG function.

Examples

The following example converts a spatial geometry point object with longitude/latitude coordinates to a point represented in U.S. National Grid format using an accuracy of 0.001 meter (1 millimeter).

```
-- Convert longitude/latitude (WGS 84) point to US National Grid.
SELECT SDO_CS.TO_USNG(
  SDO_GEOMETRY(2001, 4326,
    SDO_POINT_TYPE(-77.0352402158258, 38.8894673086544, NULL),
    NULL, NULL),
  0.001) FROM DUAL;

SDO_CS.TO_USNG(SDO_GEOMETRY(2001,4326,SDO_POINT_TYPE(-77.0352402158258,38.889467
--------------------------------------------------------------------------------
18SUJ2348316806479498
```

22.34 SDO_CS.TRANSFORM

Format

```
SDO_CS.TRANSFORM(
     geom    IN SDO_GEOMETRY,
     to_srid IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(
     geom      IN SDO_GEOMETRY,
     to_srname IN VARCHAR2
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(
     geom      IN SDO_GEOMETRY,
     use_case  IN VARCHAR2,
     to_srid   IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(
     geom      IN SDO_GEOMETRY,
     use_plan  IN TFM_PLAN
     ) RETURN SDO_GEOMETRY;
```

Description

Transforms a geometry representation using a coordinate system (specified by SRID or name).

You can also associate a use case or a transformation plan with the transformation.

Parameters

geom
Geometry whose representation is to be transformed using another coordinate system. The input geometry must have a valid non-null SRID, that is, a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

to_srid
The SRID of the coordinate system to be used for the transformation. It must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

to_srname
The name of the coordinate system to be used for the transformation. It must be a value (specified exactly) in the COORD_REF_SYS_NAME column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

use_case
The name of the use case to be associated with the transformation. If you specify the string `USE_SPHERICAL`, the transformation uses spherical math instead of ellipsoidal math, thereby accommodating Google Maps and some other third-party tools that use projections based on spherical math. Use cases are explained in EPSG Model and Spatial. For considerations related to Google Maps, see Google Maps Considerations.

use_plan
Transformation plan. The TFM_PLAN object type is explained in TFM_PLAN Object Type.

Usage Notes

Transformation can be done only between two different georeferenced coordinate systems or between two different local coordinate systems.

Transformation of circles and arcs is not supported, regardless of the type of coordinate systems involved.

An exception is raised if `geom`, `to_srid`, or `to_srname` is invalid. For `geom` to be valid for this function, its definition must include an SRID value matching a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Examples

The following example transforms the `cola_c` geometry to a representation that uses SRID value 8199. (This example uses the definitions from the example in Example of Coordinate System Transformation.)

```
-- Return the transformation of cola_c using to_srid 8199
-- ('Longitude / Latitude (Arc 1950)')
```

```
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_CS.TRANSFORM(C.SHAPE,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

-- Same as preceding, but using to_srname parameter.
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
  FROM cola_markets_cs c  WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_CS.TRANSFORM(C.SHAPE,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, SDO_SRID, SDO
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))
```

22.35 SDO_CS.TRANSFORM_LAYER

Format

```
SDO_CS.TRANSFORM_LAYER(
     table_in  IN VARCHAR2,
    column_in IN VARCHAR2,
    table_out IN VARCHAR2,
    to_srid   IN NUMBER);
```

or

```
SDO_CS.TRANSFORM_LAYER(
     table_in  IN VARCHAR2,
    column_in IN VARCHAR2,
    table_out IN VARCHAR2,
    use_plan  IN TFM_PLAN);
```

or

```
SDO_CS.TRANSFORM_LAYER(
     table_in  IN VARCHAR2,
    column_in IN VARCHAR2,
    table_out  IN VARCHAR2,
    use_case  IN VARCHAR2,
    to_srid   IN NUMBER);
```

Description

Transforms an entire layer of geometries (that is, all geometries in a specified column in a table).

Parameters

table_in
Table containing the layer (`column_in`) whose geometries are to be transformed.

column_in
Column in `table_in` that contains the geometries to be transformed.

table_out
Table that will be created and that will contain the results of the transformation. See the Usage Notes for information about the format of this table.

to_srid
The SRID of the coordinate system to be used for the transformation. `to_srid` must be a value in the SRID column of the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

use_plan
Transformation plan. The TFM_PLAN object type is explained in TFM_PLAN Object Type.

use_case
Name of the use case whose transformation rules are to be applied in performing the transformation. Use cases are explained in EPSG Model and Spatial.

Usage Notes

Transformation can be done only between two different georeferenced coordinate systems or between two different local coordinate systems.

An exception is raised if any of the following occurs:

- `table_in` does not exist, or `column_in` does not exist in the table.
- The geometries in `column_in` have a null or invalid SDO_SRID value.
- `table_out` already exists.
- `to_srid` is invalid.

The `table_out` table is created by the procedure and is filled with one row for each transformed geometry. This table has the columns shown in Table 22-1.

Table 22-1   Table to Hold Transformed Layer

Column Name	Data Type	Description
SDO_ROWID	ROWID	Oracle ROWID (row address identifier). For more information about the ROWID data type, see *Oracle Database SQL Language Reference*.
GEOMETRY	SDO_GEOMETRY	Geometry object with coordinate values in the specified (`to_srid` parameter) coordinate system.

Examples

The following example transforms the geometries in the `shape` column in the COLA_MARKETS_CS table to a representation that uses SRID value 8199. The transformed geometries are stored in the newly created table named COLA_MARKETS_CS_8199. (This example uses the definitions from the example in Example of Coordinate System Transformation.)

```
-- Transform the entire SHAPE layer and put results in the table
-- named cola_markets_cs_8199, which the procedure will create.
CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',8199);
```

Example of Coordinate System Transformation includes a display of the geometry object coordinates in both tables (COLA_MARKETS_CS and COLA_MARKETS_CS_8199).

22.36 SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS

Format

```
SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS();
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems.

Parameters

None.

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS;
Updating SRID 4001...
Updating SRID 4002...
Updating SRID 4003...
. . .
Updating SRID 69036405...
Updating SRID 69046405...
```

22.37 SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS(
     srid IN NUMBER);
```

Description

Updates the well-known text (WKT) description for the EPSG coordinate reference system associated with a specified SRID.

Parameters

srid
The SRID of the coordinate system whose well-known text (WKT) description is to be updated. An entry for the specified value must exist in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

This procedure updates the WKT descriptions for the specified SRID and all dependent SRIDs. For example, for SRID 4326 (WGS84 geodetic system), all EPSG coordinate systems that use this geodetic system will also be updated.

For information about using procedures to update well-known text (WKT) descriptions, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for the EPSG coordinate reference system associated with SRID 4326.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS(4326);
```

22.38 SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM(
     datum_id  IN NUMBER);
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified datum.

Parameters

datum_id
The ID of the datum. Must match a value in the DATUM_ID column of the SDO_DATUMS table (described in SDO_DATUMS Table).

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with datum 5100.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM(5100);
Updating SRID 5714...
Updating SRID 5715...
```

22.39 SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS(
     ellipsoid_id  IN NUMBER);
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified ellipsoid.

Parameters

ellipsoid_id
The ID of the ellipsoid. Must match a value in the ELLIPSOID_ID column of the SDO_ELLIPSOIDS table (described in SDO_ELLIPSOIDS Table).

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with ellipsoid 7100.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS(7001);
Updating SRID 4001...
Updating SRID 4188...
Updating SRID 29901...
Updating SRID 61886405...
Updating SRID 4277...
Updating SRID 27700...
Updating SRID 62776405...
Updating SRID 4278...
Updating SRID 62786405...
Updating SRID 4279...
Updating SRID 62796405...
```

22.40 SDO_CS.UPDATE_WKTS_FOR_EPSG_OP

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_OP(
     coord_op_id  IN NUMBER);
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation.

Parameters

coord_op_id
The ID of the SRID of the coordinate transformation operation. Must match a value in the COORD_OP_ID column of the SDO_COORD_OP_PARAM_VALS table (described in SDO_COORD_OP_PARAM_VALS Table).

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with coordinate transformation operation 2000067.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_OP(2000067);
Updating SRID 20000671...
```

22.41 SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM(
     coord_op_id  IN NUMBER,
     parameter_id IN NUMBER);
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation and parameter for transformation operations.

Parameters

coord_op_id
The ID of the SRID of the coordinate transformation operation. Must match a value in the COORD_OP_ID column of the SDO_COORD_OP_PARAM_VALS table (described in SDO_COORD_OP_PARAM_VALS Table).

parameter_id
The ID of the SRID of the parameter for transformation operations. Must match a value in the PARAMETER_ID column of the SDO_COORD_OP_PARAM_VALS table (described in SDO_COORD_OP_PARAM_VALS Table) where the COORD_OP_ID column value is equal to the `coord_op_id` parameter value.

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with coordinate transformation operation 9601 and parameter 8602.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM(9601, 8602);
```

22.42 SDO_CS.UPDATE_WKTS_FOR_EPSG_PM

Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_PM(
     prime_meridian_id IN NUMBER);
```

Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified prime meridian.

Parameters

prime_meridian_id
The ID of the prime meridian. Must match a value in the PRIME_MERIDIAN_ID column in the SDO_PRIME_MERIDIANS table (described in SDO_PRIME_MERIDIANS Table).

Usage Notes

For information about using procedures to update well-known text (WKT) description, see Procedures for Updating the Well-Known Text.

Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with prime meridian 8902.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_PM(8902);
Updating SRID 4803...
Updating SRID 20790...
Updating SRID 20791...
Updating SRID 68036405...
Updating SRID 4904...
Updating SRID 2963...
Updating SRID 69046405...
```

22.43 SDO_CS.VALIDATE_EPSG_MATRIX

Format

```
SDO_CS.VALIDATE_EPSG_MATRIX(
     method_id    IN NUMBER,
     parameter_id IN NUMBER,
     matrix       IN CLOB
     ) RETURN VARCHAR2;
```

Description

Validates an EPSG matrix of NADCON, NTv2, or VERTCON format.

Parameters

method_id
EPSG method ID to which the matrix refers.

parameter_id
EPSG parameter id identifying the matrix, if an operation has more than one matrix, such as NADCON.

matrix
Matrix CLOB (loaded, using SDO_CS.LOAD_EPSG_MATRIX or manually).

Usage Notes

You can load an EPSG matrix using the SDO_CS.LOAD_EPSG_MATRIX procedure.

Examples

The following example loads an NTv2 matrix for operation 1703 ("NAD27 to WGS 84 (32)"). For an NTv2 operation, a single matrix is sufficient, assigned to parameter ID 8656.

```
SQL> select
  m.coord_op_method_name "Method",
  vals.parameter_id "Parameter",
  sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,
vals.param_value_file) "Valid",
  count(*) "#"
from
  sdo_coord_op_param_vals vals,
  sdo_coord_op_methods m
where
  m.coord_op_method_id = vals.coord_op_method_id and
  not(vals.param_value_file is null)
group by
  m.coord_op_method_name,
  vals.parameter_id,
  sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,
vals.param_value_file)
order by
  m.coord_op_method_name,
  vals.parameter_id,
  sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,
vals.param_value_file);

Method                                             Parameter Valid          #
-------------------------------------------------- ---------- ----- ----------
Geographic3D to Geographic2D+GravityRelatedHeight       8666 TRUE           2
Geographic3D to GravityRelatedHeight (OSGM02)           8666 TRUE          14
NADCON                                                  8657 TRUE         104
NADCON                                                  8658 TRUE         104
NTv2                                                    8656 TRUE           4
Ordnance Survey National Transformation                 8664 TRUE           3

6 rows selected.
```

22.44 SDO_CS.VALIDATE_WKT

Format

```
SDO_CS.VALIDATE_WKT(
     srid IN NUMBER
     ) RETURN VARCHAR2;
```

Description

Validates the well-known text (WKT) description associated with a specified SRID.

Parameters

srid
The SRID of the coordinate system whose well-known text (WKT) description is to be validated. An entry for the specified value must exist in the SDO_COORD_REF_SYS table (described in SDO_COORD_REF_SYS Table).

Usage Notes

This function returns the string 'TRUE' if the WKT description is valid. If the WKT description is invalid, this function returns a string in the format 'FALSE (<position-number>)', where *<position-number>* is the number of the character position in the WKT description where the first error occurs.

The WKT description is checked to see if it satisfies the requirements described in Well-Known Text (WKT).

Examples

The following example validates the WKT description of the coordinate system associated with SRID 81989000. The results show that the cause of the invalidity (or the first cause of the invalidity) starts at character position 181 in the WKT description. (SRID 81989000 is not associated with any established coordinate system. Rather, it is for a deliberately invalid coordinate system that was inserted into a test version of the MDSYS.CS_SRS table, and it is not included in the MDSYS.CS_SRS table that is shipped with Oracle Spatial.)

```
SELECT SDO_CS.VALIDATE_WKT(81989000) FROM DUAL;

SDO_CS.VALIDATE_WKT(81989000)
--------------------------------------------------------------------------------
FALSE (181)
```

23

SDO_CSW Package (Catalog Services for the Web)

The MDSYS.SDO_CSW package contains subprograms for various processing operations related to support for Catalog Services for the Web (CSW).

To use the subprograms in this chapter, you must understand the conceptual and usage information about Catalog Services for the Web in Catalog Services for the Web (CSW) Support.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_CSW.CREATE_SPATIAL_IDX
- SDO_CSW.CREATE_XQFT_IDX
- SDO_CSW.INITIALIZE_CSW
- SDO_CSW.SYNC_INDEX

23.1 SDO_CSW.CREATE_SPATIAL_IDX

Format

```
SDO_CSW.CREATE_SPATIAL_IDX(
    owner          IN VARCHAR2,
    csw_table_name IN VARCHAR2,
    srid           IN NUMBER);
```

Description

Creates a spatial index on the CSW table, if no spatial index already exists.

Parameters

owner
Name of the CSW schema for the table and spatial index.

csw_table_name
Name of the table that holds the CSW catalog data.

srid
The coordinate system (or SRID: spatial reference system) associated with the CSW catalog data. It should be the SRID in the geometry column of the CSW table. Example: `4326` (EPSG SRID value equivalent to Oracle SRID 8307).
You can specify a 2D or 3D SRID value, but the geometry column of the CSW table must have the appropriate number of dimensions for the specified SRID.

Usage Notes

If a spatial index already exists on `csw_table_name`, this procedure does nothing. If the spatial index already exists but needs to be re-created for CSW, you must drop the index, then create the index using this procedure. The USER_SDO_GEOM_METADATA view will be populated with the CSW table information.

This procedure uses the SDO_GEOMETRY objects from the XMLType column of the CSW table. These geometries are transformed into the coordinate reference system represented by the SRID parameter.

The created spatial index will have a name in the form *csw_table_name*`_IDX`.

For information about support for Catalog Services for the Web, see Catalog Services for the Web (CSW) Support.

Examples

The following example creates a spatial index on the SCOTT.MY_CSW_CATALOG TABLE table, and it associates SRID 4326 with the spatial data.

```
DECLARE
BEGIN
  sdo_csw.create_spatial_idx('SCOTT', 'MY_CSW_CATALOG_TABLE', 4326);
END;
/
```

23.2 SDO_CSW.CREATE_XQFT_IDX

Format

```
SDO_CSW.CREATE_XQFT_IDX(
    owner          IN VARCHAR2,
    csw_table_name IN VARCHAR2;
```

Description

Creates an XQFT (XML Search-XPath Query Full Text) index on the CSW table, if no such index already exists.

Parameters

owner
Name of the database schema for the CSW table and index.

csw_table_name
Name of the table that holds the CSW catalog data.

Usage Notes

If an XQFT index already exists on `csw_table_name` , and if you only need to update the index by synchronizing it with the current CSW data, you should instead use the SDO_CSW.SYNC_INDEX procedure, because that procedure takes less time to execute than SDO_CSW.CREATE_XQFT_IDX.

If an XQFT index already exists on `csw_table_name`, this procedure drops the existing one and re-creates the XQFT index. It also internally calls the CTX_DDL.DROP_PREFERENCE and CTX_DDL.DROP_SECTION_GROUP procedures.

This procedure internally calls the CTX_DDL.CREATE_PEREFERENCE procedure to create a BASIC_LEXER lexer named CSWLEX.

The created index will have a name in the form *csw_table_name*`_XQFT_IDX`.

For information about support for Catalog Services for the Web, see Catalog Services for the Web (CSW) Support.

Examples

The following example creates an XQFT index on the SCOTT.MY_CSW_CATALOG_TABLE table.

```
DECLARE
BEGIN
  sdo_csw.create_xqft_idx('SCOTT', 'MY_CSW_CATALOG_TABLE');
END;
/
```

23.3 SDO_CSW.INITIALIZE_CSW

Format

```
SDO_CSW.INITIALIZE_CSW(
    owner          IN VARCHAR2,
    csw_version    IN VARCHAR2,
    csw_xsd_id     IN NUMBER,
    csw_table_name IN VARCHAR2,
    srid           IN NUMBER,
    generate_index IN NUMBER);
```

Description

Initializes the Oracle Spatial Catalog Services for the Web (CSW) version 2.0.2 service database instance. This makes the schema of the current user the CSW schema, creates the CSW catalog table if it does not already exist, and prepares the indexes, as explained in the Usage Notes.

Parameters

owner
Name of the database schema to own the created table and indexes.

csw_version
CSW version number. Example: `2.0.2`.

csw_xsd_id
ID of the XSD in the MDSYS.SDO_XSD_TABLE table. Possible values: `1` for DCMI, `2` for ISO 19139.

csw_table_name
Name of the table to hold the CSW catalog data.

srid
The coordinate system (or SRID: spatial reference system) associated with the CSW data. It should be the SRID in the geometry column of the CSW table. Example: `4326` (EPSG SRID value equivalent to Oracle SRID 8307).
You can specify a 2D or 3D SRID value, but the geometry column of the CSW table must have the appropriate number of dimensions for the specified SRID.

generate_index
Determines whether to build indexes on the data in the `csw_table_name` table. `0` (zero) does not create any indexes on the table; `1` (or any positive nonzero value) builds all appropriate indexes on the table.

Usage Notes

This procedure lets you create the user table, specify an SRID value for the data, and control whether indexes are built on that table. It also populates the CSW metadata in the USER_CSW_SERVICE_INFO view to register the schema as the CSW schema. If `owner.csw_table_name` does not already exist, this procedure creates that table with the following columns:

```
(Metadata_Id          VARCHAR(4000) PRIMARY KEY,
 Record_Instance_Xml  XMLType,
 Record_Geometry      SDO_GEOMETRY,
 XMLTYPE COLUMN       Record_Instance_Xml STORE AS BINARY XML)
```

If the CSW catalog table (and any indexes) already exist, then this procedure can also be used just to register the CSW catalog table by setting SRID parameter to NULL and GENERATE_INDEX parameter to 0. It then only populates the CSW metadata in the USER_CSW_SERVICE_INFO view to register the schema as the CSW schema.

For information about support for Catalog Services for the Web, see Catalog Services for the Web (CSW) Support.

Examples

The following example uses the first format of the procedure. It makes SCOTT the CSW schema, associates SRID 4326 with the spatial data, and builds indexes on the data in the MY_CSW_CATALOG_TABLE table.

```
DECLARE
BEGIN
sdo_csw.initialize_csw(
        'SCOTT',
        '2.0.2', -- must be 2.0.2
        1, -- for DCMI
        'MY_CSW_CATALOG_TABLE',
        4326,
        1
    );
END;
/
```

23.4 SDO_CSW.SYNC_INDEX

Format

```
SDO_CSW.SYNC_INDEX(
    owner          IN VARCHAR2,
    csw_table_name IN VARCHAR2;
```

Description

Updates the XQFT (XML Search-XPath Query Full Text) index on the CSW user data table, by synchronizing the index with the data in the table.

Parameters

owner
Name of the database schema for the table and index.

csw_table_name
Name of the table that holds the CSW catalog data.

Usage Notes

This procedure should be run when there have been significant insert, update, or delete operations on the CSW user data table, because the existing XQFT nidex iautomaticallyically updated.

This procedure updates the index whose name is in the form *csw_table_name*`_XQFT_IDX`.

Examples

The following example updates the XQFT index on the MDMETT.CSW_TABLE table.

```
DECLARE
BEGIN
  sdo_csw.sync_index('MDMETT', 'CSW_TABLE');
END;
/
```

24

SDO_GCDR Package (Geocoding)

The MDSYS.SDO_GCDR package contains subprograms for performing geocoding.

To use the subprograms in this chapter, you must understand the conceptual and usage information about geocoding in Geocoding Address Data.

> **Note:**
>
> - SDO_GCDR.ELOC_GEOCODE and SDO_GCDR.ELOC_GEOCODE_AS_GEOM leverage a hosted geocoding service and are available on Oracle Autonomous Database.
> - With the exception of SDO_GCDR.ELOC_GEOCODE and SDO_GCDR.ELOC_GEOCODE_AS_GEOM, geocoding functions require the acquisition and loading of supporting reference data. See Data Structures for Geocoding for more information.
> - The following subprograms support Oracle Spatial routing capabilities and are available on Oracle Autonomous Database:
>   - SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON
>   - SDO_GCDR.ELOC_DRIVE_TIME_POLYGON
>   - SDO_GCDR.ELOC_ROUTE
>   - SDO_GCDR.ELOC_ROUTE_DISTANCE
>   - SDO_GCDR.ELOC_ROUTE_GEOM
>   - SDO_GCDR.ELOC_ROUTE_TIME

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_GCDR.CREATE_PROFILE_TABLES
- SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON
- SDO_GCDR.ELOC_DRIVE_TIME_POLYGON
- SDO_GCDR.ELOC_GEOCODE
- SDO_GCDR.ELOC_GEOCODE_AS_GEOM
- SDO_GCDR.ELOC_GRANT_ACCESS
- SDO_GCDR.ELOC_REVOKE_ACCESS
- SDO_GCDR.ELOC_ROUTE
- SDO_GCDR.ELOC_ROUTE_DISTANCE
- SDO_GCDR.ELOC_ROUTE_GEOM
- SDO_GCDR.ELOC_ROUTE_TIME

- SDO_GCDR.GEOCODE
- SDO_GCDR.GEOCODE_ADDR
- SDO_GCDR.GEOCODE_ADDR_ALL
- SDO_GCDR.GEOCODE_ALL
- SDO_GCDR.GEOCODE_AS_GEOMETRY
- SDO_GCDR.REVERSE_GEOCODE

24.1 SDO_GCDR.CREATE_PROFILE_TABLES

Format

```
SDO_GCDR.CREATE_PROFILE_TABLES;
```

Description

Creates the CG_COUNTRY_PROFILE, GC_PARSER_PROFILES, and GC_PARSER_PROFILEAFS tables in the caller's schema.

Parameters

None.

Usage Notes

Use this procedure only if your geocoding data provider does not supply the GC_PARSER_PROFILES and GC_PARSER_PROFILEAFS tables. See Installing the Profile Tables for more information.

Examples

The following example creates the GC_PARSER_PROFILES and GC_PARSER_PROFILEAFS tables in the caller's schema.

```
EXECUTE SDO_GCDR.CREATE_PROFILE_TABLES;
```

24.2 SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON

Format

```
SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON(
  start_address           IN  VARCHAR2,
  country                 IN  VARCHAR2,
  cost                    IN  NUMBER,
  cost_unit               IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON(
  longitude               IN  NUMBER,
  latitude                IN  NUMBER,
  cost                    IN  NUMBER,
  cost_unit               IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

Description

Computes the drive distance polygon around an input location for the specified distance cost, and returns the geometry of the polygon in `SDO_GEOMETRY` format.

The input location can either be a single-line address or be specified as longitude and latitude.

Parameters

start_address
Complete start address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

longitude
Longitude value of the starting point.

latitude
Latitude value of the starting point.

cost
Drive distance to use for the area of reachability from the starting point.
The output polygon is the area reachable from the start point within the specified distance.

cost_unit
Unit for cost.
Supported values are: *`mile`*, *`kilometer`*, *`Km`*, and *`meter`*.

vehicle_type
Type of vehicle considered for computing the distance.
Supported values are: *`auto`* and *`truck`*

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON` function can accept one of the following sets of input parameters to compute the drive distance polygon (as a geometry) around the specified location:

- **Using an unformatted address:** Provide the `start_address` parameter where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `longitude` and `latitude` parameters to determine the location.

Also, note that each parameter input can be a column from a table or view, or an explicit string or number value.

Example

The following example computes the drive distance polygon around a location specified using longitude and latitude for a truck:

```
SELECT SDO_GCDR.ELOC_DRIVE_DISTANCE_POLYGON(-71.47374, 42.75505, 500,
‘meter', 'truck') polygon FROM DUAL;

POLYGON(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----------------------------------------------------------------------------
------------
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(-71.47863,42.75343
-71.47793,42.75366 -71.47776,42.75372 -71.47763,42.75376 -71.47515,42.75458
-71.47316,42.75412 -71.47298,
42.75301 -71.47144,42.75279 -71.47056,42.75388 -71.47142,42.75415
-71.47282,42.75423 -71.47348,
42.75578 -71.47313,42.75671 -71.4738,42.75625 -71.47423,42.75609
-71.47478,42.75597 -71.47627,
42.75619 -71.4773,42.75562 -71.47819,42.75549 -71.47863,42.75343))
```

24.3 SDO_GCDR.ELOC_DRIVE_TIME_POLYGON

Format

```
SDO_GCDR.ELOC_DRIVE_TIME_POLYGON(
  start_address          IN  VARCHAR2,
  country                IN  VARCHAR2,
  cost                   IN  NUMBER,
  cost_unit              IN  VARCHAR2,
  vehicle_type           IN  VARCHAR2,
  print_request_response IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GCDR.ELOC_DRIVE_TIME_POLYGON(
  longitude              IN  NUMBER,
  latitude               IN  NUMBER,
  cost                   IN  NUMBER,
  cost_unit              IN  VARCHAR2,
  vehicle_type           IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

Description

Computes the drive time polygon around an input location for the specified time cost, and returns the geometry of the polygon in `SDO_GEOMETRY` format.

The input location can either be a single-line address or be specified as longitude and latitude.

Parameters

start_address
Complete start address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

longitude
Longitude value of the starting point.

latitude
Latitude value of the starting point.

cost
Drive time to use for the area of reachability from the starting point.
The output polygon is the area reachable from the start point within the specified time.

cost_unit
Unit for cost.
Supported values are: *`hour`*, *`minute`*, and *`second`*.

vehicle_type
Type of vehicle considered for computing the time.
Supported values are: *`auto`* and *`truck`*

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_DRIVE_TIME_POLYGON` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_DRIVE_TIME_POLYGON` function can accept one of the following sets of input parameters to compute the drive time polygon (as a geometry) around the specified location:

- **Using an unformatted address:** Provide the `start_address` parameter where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `longitude` and `latitude` parameters to determine the location.

Also, note that each parameter input can be a column from a table or view, or an explicit string or number value.

Example

The following example computes the drive time polygon around an address for a truck:

```
SELECT SDO_GCDR.ELOC_DRIVE_TIME_POLYGON('1 Oracle Dr, Nashua, NH', 'US', 1,
'minute', 'truck') polygon FROM DUAL;

POLYGON(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
------------
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(-71.46924,
 42.76051, -71.46928, 42.76, -71.46919, 42.75975, -71.46911, 42.75962,
-71.46899, 42.7594,
 -71.46974, 42.75638, -71.47012, 42.75626, -71.47038, 42.75617, -71.46688,
42.7552, -71.46602,
 42.75482, -71.46409, 42.75397, -71.46244, 42.75343, -71.4618, 42.75311,
-71.46102, 42.7542,
 -71.46054, 42.75496, -71.45947, 42.75647, -71.45924, 42.75761, -71.45815,
42.75858, -71.45741,
 42.75912, -71.45813, 42.75955, -71.45959, 42.76009, -71.46187, 42.76099,
-71.46227, 42.76177,
 -71.46266, 42.76243, -71.46354, 42.76268,-71.46447, 42.76344, -71.46639,
42.76425, -71.4668,
 42.76412, -71.46668, 42.76387, -71.46683, 42.7625, -71.46732, 42.76183,
-71.46924, 42.76051))
```

24.4 SDO_GCDR.ELOC_GEOCODE

Format

```
SDO_GCDR.ELOC_GEOCODE(
     street      IN VARCHAR2,
     city        IN VARCHAR2,
     region      IN VARCHAR2,
     postal_code IN VARCHAR2,
     cc2         IN VARCHAR2,
     match_mode  IN VARCHAR2 default 'DEFAULT'
) RETURN VARCHAR2;
```

or

```
SDO_GCDR.ELOC_GEOCODE(
     address IN VARCHAR2
) RETURN VARCHAR2;
```

or

```
SDO_GCDR.ELOC_GEOCODE(
     longitude IN NUMBER,
     latitude  IN NUMBER
) RETURN VARCHAR2;
```

Description

Geocodes a formatted (address parts in separate fields) or an unformatted (complete address in a single string field) address and returns the standardized address with geographic coordinates and geocoding metadata in JSON format.

For longitude and latitude input, the function reverse geocodes the location and returns the address in JSON format.

Parameters

street
Name of the street.

city
Name of the city.

region
Name of the region.

postal_code
Postal code.

cc2
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

match_mode
Match mode for the geocoding operation. Match modes are explained in Match Modes.

address
Complete address (not formatted into separate fields).

longitude
Longitude value for reverse geocoding operation.

latitude
Latitude value for reverse geocoding operation.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_GEOCODE` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

This function performs the following operations depending on the input parameters. Note that each parameter input can be a column from a table or view, or an explicit string or number value.

- **Geocoding a formatted address:** Provide the address fields corresponding to the parameters of the function (such as `street`, `city`, `region`, `postal_code`, and `cc2`). Note that the function uses `'DEFAULT'` as the default match mode for the geocoding operation. See Match Modes for more details.

  Refer to Example-1.
- **Geocoding an unformatted address:** If the complete address is stored in a single field (that is, unformatted), then provide the `address` field corresponding to the complete address.
  Refer to Example-2.
- **Reverse geocoding a location**: You must provide the longitude and latitude coordinates and the function returns the address in JSON format.
  Refer to Example-3.

Examples

Example-1

The following example geocodes a formatted address using the default match mode. It returns the longitude and latitude coordinates of this address as -71.07355166666666 and 42.355174166666664, respectively.

```
SELECT SDO_GCDR.ELOC_GEOCODE('123 Beacon St', 'Boston', 'MA', '02116' , 'US')
FROM DUAL;

[{"id":"0","matchCount":"1","matches":
[{"sequence":"0","x":-71.07355166666666,"y":42.355174166666664,
  "houseNumber":"123","street":"Beacon
St","settlement":"Boston","municipality":"Suffolk","region":"MA",

"postalCode":"02116","country":"US","language":"ENG","name":"","edgeId":946710
796,
  "percent":0.08333333333333333,"side":"R","matchCode":1,"matchVector":"???
10101010??000?"}]}]
```

Example-2

The following example geocodes an unformatted address. It returns the longitude and latitude coordinates of this address as -71.07355166666666 and 42.355174166666664, respectively.

```
SELECT SDO_GCDR.ELOC_GEOCODE('123 Beacon St, Boston MA, 02116, US') FROM DUAL;

[{"id":"0","matchCount":"1","matches":
[{"sequence":"0","x":-71.07355166666666,"y":42.355174166666664,
  "houseNumber":"123","street":"Beacon
St","settlement":"Boston","municipality":"Suffolk","region":"MA",

"postalCode":"02116","country":"US","language":"ENG","name":"","edgeId":946710
796,
  "percent":0.08333333333333333,"side":"R","matchCode":1,"matchVector":"???
10101010??000?"}]}]
```

Example-3

The following example reverse geocodes a geographic location. It returns the address for the longitude (`-71.073551`) and latitude (`42.355174`) coordinates.

```
SELECT SDO_GCDR.ELOC_GEOCODE(-71.073551, 42.355174) FROM DUAL;

[{"id":"0","matchCount":"1","matches":
[{"sequence":"0","x":-71.07355109772594,"y":42.35517433341787,
  "houseNumber":"123","street":"Beacon
St","settlement":"Boston","municipality":"Suffolk","region":"MA",

"postalCode":"02116","country":"US","language":"ENG","name":"","edgeId":946710
796,
  "percent":0.08431426223078922,"side":"R","matchCode":1,"matchVector":"???
14141414??404?"}]}]
```

24.5 SDO_GCDR.ELOC_GEOCODE_AS_GEOM

Format

```
SDO_GCDR.ELOC_GEOCODE_AS_GEOM(
     street      IN VARCHAR2,
     city        IN VARCHAR2,
     region      IN VARCHAR2,
     postal_code IN VARCHAR2,
     cc2         IN VARCHAR2,
     match_mode  IN VARCHAR2 default 'DEFAULT'
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GCDR.ELOC_GEOCODE_AS_GEOM(
     address IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

Description

Geocodes a formatted (address parts in separate fields) or an unformatted (complete address in a single string field) address and returns the standardized address with geographic coordinates and geocoding metadata as an SDO_GEOMETRY object.

Parameters

street
Name of the street.

city
Name of the city.

region
Name of the region.

postal_code
Postal code.

cc2
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

match_mode
Match mode for the geocoding operation. Match modes are explained in Match Modes.

address
Complete address (not formatted into separate fields).

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_GEOCODE_AS_GEOM` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

This function performs the following operations depending on the input parameters. Note that each parameter input can be a column from a table or view, or an explicit string or number value.

- **Geocoding a formatted address:** Provide the address fields corresponding to the parameters of the function (such as `street`, `city`, `region`, `postal_code`, and `cc2`). Note that the function uses `'DEFAULT'` as the default match mode for the geocoding operation. See Match Modes for more details.
- **Geocoding an unformatted address:** If the complete address is stored in a single field (that is, unformatted), then provide the `address` field corresponding to the complete address.

Examples

The following example geocodes a formatted address using the default match mode and returns the output as an `SDO_GEOMETRY` object.

```
SELECT SDO_GCDR.ELOC_GEOCODE_AS_GEOM('123 Beacon St', 'Boston', 'MA',
'02116' , 'US') FROM DUAL;

MDSYS.SDO_GEOMETRY(2001, 4326,
        MDSYS.SDO_POINT_TYPE(-71.07355166666666, 42.355174166666664, NULL),
NULL, NULL)
```

Note that if you are using the SQL Worksheet in Database Actions on your Autonomous Database instance, any object type (including `SDO_GEOMETRY`) is displayed as `[object Object]`. To display the result in the SQL Worksheet you can convert the result to a GeoJSON string by applying the `Get_GeoJSON( )` method as follows:

```
SELECT (SDO_GCDR.ELOC_GEOCODE_AS_GEOM('123 Beacon St', 'Boston', 'MA',
'02116' , 'US')).GET_GEOJSON() FROM DUAL;
```

```
{ "type": "Point", "coordinates": [-71.07355166666666, 42.355174166666664] }
```

24.6 SDO_GCDR.ELOC_GRANT_ACCESS

Format

```
SDO_GCDR.ELOC_GRANT_ACCESS(
     user_name IN VARCHAR2);
```

Description

Grants privileges for a user to call the Oracle Maps Geocoder on an Autonomous Database instance.

Parameters

user_name
Name of the user who requires access to the Oracle Maps cloud service.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_GRANT_ACCESS` function is only supported on Oracle Autonomous Database.

You must invoke the `SDO_GCDR.ELOC_GRANT_ACCESS` function as the ADMIN user in your Autonomous Database instance.

Examples

The following example grants the user `SCOTT` access to use the geocoder functionality on an Autonomous Database instance.

```
EXEC SDO_GCDR.ELOC_GRANT_ACCESS('SCOTT');

PL/SQL procedure successfully completed.
```

24.7 SDO_GCDR.ELOC_REVOKE_ACCESS

Format

```
SDO_GCDR.ELOC_REVOKE_ACCESS(
     user_name IN VARCHAR2);
```

Description

Revokes privileges for a user to call the Oracle Maps Geocoder on an Autonomous Database instance.

Parameters

user_name
Name of the user whose access to the Oracle Maps cloud service is to be revoked.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_REVOKE_ACCESS` function is only supported on Oracle Autonomous Database.

You must invoke the `SDO_GCDR.ELOC_REVOKE_ACCESS` function as the ADMIN user in your Autonomous Database instance.

Examples

The following example revokes the privileges for the user `SCOTT` to use the geocoder functionality on an Autonomous Database instance.

```
EXEC SDO_GCDR.ELOC_REVOKE_ACCESS('SCOTT');

PL/SQL procedure successfully completed.
```

24.8 SDO_GCDR.ELOC_ROUTE

Format

```
SDO_GCDR.ELOC_ROUTE(
  route_preference        IN  VARCHAR2,
  distance_unit           IN  VARCHAR2,
  time_unit               IN  VARCHAR2,
  start_address           IN  VARCHAR2,
  end_address             IN  VARCHAR2,
  country                 IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN CLOB;
```

or

```
SDO_GCDR.ELOC_ROUTE(
  route_preference        IN  VARCHAR2,
  distance_unit           IN  VARCHAR2,
  time_unit               IN  VARCHAR2,
  start_longitude         IN  NUMBER,
  start_latitude          IN  NUMBER,
  end_longitude           IN  NUMBER,
  end_latitude            IN  NUMBER,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN CLOB;
```

Description

Computes the route between two locations and returns a JSON CLOB object that includes the route distance, route time, and geometry of the route in GeoJSON format.

The input locations can either be single-line addresses or be specified by geographic coordinates.

Parameters

route_preference
Routing preference.
Supported values are: *`shortest`*, *`fastest`*, and *`traffic`*.

distance_unit
Unit of distance.
Supported values are: *`mile`*, *`kilometer`*, *`km`*, and *`meter`*.

time_unit
Unit of time.
Supported values are: *`hour`*, *`minute`*, and *`second`*.

start_address
Complete start address (not formatted into separate fields).

end_address
Complete end address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

start_longitude
Longitude value of the starting point.

start_latitude
Latitude value of the starting point.

end_longitude
Longitude value of the ending point.

end_latitude
Latitude value of the ending point.

vehicle_type
Type of vehicle considered for computing the distance.
Supported values are: *`auto`* and *`truck`*

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_ROUTE` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_ROUTE` function can accept one of the following sets of parameters to determine the route between two points:

- **Using unformatted addresses:** Provide the `start_address` and `end_address` parameters where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `start_longitude`, `start_latitude`, `end_longitude`, and `end_latitude` parameters to determine the start and end locations.

Note that each parameter input can be a column from a table or view, or an explicit string or number value.

The following describes the schema for the output JSON object:

```
{
 "type": "object",
  "properties": {
    "routeResponse": {
      "type": "object",
      "properties": {
        "route": {
          "type": "object",
          "properties": {
            "id": {
              "type": "string"
            },
            "distance": {
              "type": "string"
            },
            "distanceUnit": {
              "type": "string"
            },
            "time": {
              "type": "string"
            },
            "timeUnit": {
              "type": "string"
            },
            "geometry": {
              "type": "object",
              "properties": {
                "type": {
                  "type": "string"
                },
                "coordinates": {
                  "type": "array",
                  "items": {
                    "type": "array",
                    "items": {
                      "type": "number"
                    }
                  }
                }
              },
              "required": [. .]
            }
          },
          "required": [..]
        }
      },
      "required": [..]
    }
  },

  "required": [..]
}
```

Example

The following example calls the `SDO_GCDR.ELOC_ROUTE` function to compute the fastest route taken by an auto between two geographic coordinates. Note that the output values for route distance, travel time, and route geometry are extracted from the resulting JSON object using the `JSON_VALUE` and `JSON_QUERY` functions:

```
WITH x AS
(SELECT SDO_GCDR.ELOC_ROUTE('fastest', 'km', 'minute', -71.46439,
42.75875,-71.46278, 42.7553, 'auto') AS t FROM DUAL)
SELECT json_value(t, '$.routeResponse.route.time') AS TIME,
       json_value(t, '$.routeResponse.route.distance') AS DIST,
       json_query(t, '$.routeResponse.route.geometry' RETURNING CLOB
                  ) AS GEOM
FROM x;

TIME DIST
GEOM

---- ----
------------------------------------------------------------------------------
---------------------
0.7  0.41 {"type":"LineString","coordinates":[[-71.4643900005,42.7587499999],
[-71.46439,42.75875],
                                              [-71.46433,42.75862],
[-71.46431,42.75858],[-71.46421,42.75837],
                                              [-71.4641,42.75813],
[-71.46397,42.75785],[-71.46375,42.75739],
                                              [-71.4637,42.75728],
[-71.46368,42.75724],[-71.46359,42.75706],
                                              [-71.46351,42.75689],
[-71.46333,42.75656],[-71.46326,42.75639],
                                                    [-71.46312,42.75605],
[-71.46296,42.75568],[-71.46278,42.7553]]}
```

24.9 SDO_GCDR.ELOC_ROUTE_DISTANCE

Format

```
SDO_GCDR.ELOC_ROUTE_DISTANCE(
  route_preference        IN  VARCHAR2,
  distance_unit           IN  VARCHAR2,
  start_address           IN  VARCHAR2,
  end_address             IN  VARCHAR2,
  country                 IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN NUMBER;
```

or

```
SDO_GCDR.ELOC_ROUTE_DISTANCE(
  route_preference        IN  VARCHAR2,
  distance_unit           IN  VARCHAR2,
  start_longitude         IN  NUMBER,
  start_latitude          IN  NUMBER,
  end_longitude           IN  NUMBER,
  end_latitude            IN  NUMBER,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN NUMBER;
```

Description

Computes the route distance between two locations.

The input locations can either be single-line addresses or be specified by geographic coordinates.

Parameters

route_preference
Routing preference.
Supported values are: *`shortest`*, *`fastest`*, and *`traffic`*.

distance_unit
Unit of distance.
Supported values are: *`mile`*, *`kilometer`*, *`km`*, and *`meter`*.

start_address
Complete start address (not formatted into separate fields).

end_address
Complete end address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

start_longitude
Longitude value of the starting point.

start_latitude
Latitude value of the starting point.

end_longitude
Longitude value of the ending point.

end_latitude
Latitude value of the ending point.

vehicle_type
Type of vehicle considered for computing the distance.
Supported values are: *`auto`* and *`truck`*

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_ROUTE_DISTANCE` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_ROUTE_DISTANCE` function can accept one of the following sets of parameters to compute the distance between two points:

- **Using unformatted addresses:** Provide the `start_address` and `end_address` parameters where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `start_longitude`, `start_latitude`, `end_longitude`, and `end_latitude` parameters to determine the start and end locations.

Note that each parameter input can be a column from a table or view, or an explicit string or number value.

Examples

The following example computes the shortest route distance (in miles) for a truck between two address locations.

```
SELECT SDO_GCDR.ELOC_ROUTE_DISTANCE('shortest', 'mile', '1 Oracle Dr, Nashua,
NH', '77 Massachusetts Ave, Cambridge, MA', 'US', 'truck') route_dist FROM
DUAL;

ROUTE_DIST
```

```
----------
     33.22
```

The following example uses longitude and latitude coordinates to compute the fastest route distance (in miles) for an auto between two points.

```
SELECT SDO_GCDR.ELOC_ROUTE_DISTANCE('fastest', 'mile', -122.39436, 37.79579,
-122.40459, 37.74211,'auto') route_dist FROM DUAL;

ROUTE_DIST
----------
      4.51
```

24.10 SDO_GCDR.ELOC_ROUTE_GEOM

Format

```
SDO_GCDR.ELOC_ROUTE_GEOM(
  route_preference        IN  VARCHAR2,
  start_address           IN  VARCHAR2,
  end_address             IN  VARCHAR2,
  country                 IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GCDR.ELOC_ROUTE_GEOM(
  route_preference        IN  VARCHAR2,
  start_longitude         IN  NUMBER,
  start_latitude          IN  NUMBER,
  end_longitude           IN  NUMBER,
  end_latitude            IN  NUMBER,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN SDO_GEOMETRY;
```

Description

Computes the route between two locations and returns the geometry of the route in `SDO_GEOMETRY` format.

The input locations can either be single-line addresses or be specified by geographic coordinates.

Parameters

route_preference
Routing preference.
Supported values are: *`shortest`*, *`fastest`*, and *`traffic`*.

start_address
Complete start address (not formatted into separate fields).

end_address
Complete end address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

start_longitude
Longitude value of the starting point.

start_latitude
Latitude value of the starting point.

end_longitude
Longitude value of the ending point.

end_latitude
Latitude value of the ending point.

vehicle_type
Type of vehicle considered for computing the distance.
Supported values are: *`auto`* and *`truck`*

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_ROUTE_GEOM` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_ROUTE_GEOM` function can accept one of the following sets of parameters to determine the route geometry between two points:

- **Using unformatted addresses:** Provide the `start_address` and `end_address` parameters where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `start_longitude`, `start_latitude`, `end_longitude`, and `end_latitude` parameters to determine the start and end locations.

Note that each parameter input can be a column from a table or view, or an explicit string or number value.

Example

The following example computes the shortest route geometry taken by a truck between two geographic coordinates.

```
SELECT SDO_GCDR.ELOC_ROUTE_GEOM('shortest', -71.46439, 42.75875,-71.46278,
42.7553, 'truck') route_geom FROM DUAL;

ROUTE_GEOM
--------------------------------------------------------------------------------
---------------------------------------------------
```

```
MDSYS.SDO_GEOMETRY(2002, 4326, NULL, MDSYS.SDO_ELEM_INFO_ARRAY(1, 2, 1),
MDSYS.SDO_ORDINATE_ARRAY(-71.4643900005, 42.7587499999,
    -71.46439, 42.75875, -71.46433, 42.75862, -71.46431, 42.75858, -71.46421,
42.75837, -71.4641, 42.75813, -71.46397, 42.75785,
    -71.46375, 42.75739, -71.4637, 42.75728, -71.46368, 42.75724, -71.46359,
42.75706, -71.46351, 42.75689, -71.46333, 42.75656,
    -71.46326, 42.75639, -71.46312, 42.75605, -71.46296, 42.75568, -71.46278,
42.7553, -71.46278, 42.7553))
```

24.11 SDO_GCDR.ELOC_ROUTE_TIME

Format

```
SDO_GCDR.ELOC_ROUTE_TIME(
  route_preference        IN  VARCHAR2,
  time_unit               IN  VARCHAR2,
  start_address           IN  VARCHAR2,
  end_address             IN  VARCHAR2,
  country                 IN  VARCHAR2,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN NUMBER;
```

or

```
SDO_GCDR.ELOC_ROUTE_TIME(
  route_preference        IN  VARCHAR2,
  time_unit               IN  VARCHAR2,
  start_longitude         IN  NUMBER,
  start_latitude          IN  NUMBER,
  end_longitude           IN  NUMBER,
  end_latitude            IN  NUMBER,
  vehicle_type            IN  VARCHAR2,
  print_request_response  IN  VARCHAR2 DEFAULT 'FALSE'
) RETURN NUMBER;
```

Description

Computes the travel time between two locations.

The input locations can either be single-line addresses or be specified by geographic coordinates.

Parameters

route_preference
Routing preference.
Supported values are: `shortest`, `fastest`, and `traffic`.

time_unit
Unit of time.
Supported values are: `hour`, `minute`, and `second`.

start_address
Complete start address (not formatted into separate fields).

end_address
Complete end address (not formatted into separate fields).

country
ISO 2-character country code. See **Country codes** in ISO Online Browsing Platform (OBP) to view the list of supported codes.

start_longitude
Longitude value of the starting point.

start_latitude
Latitude value of the starting point.

end_longitude
Longitude value of the ending point.

end_latitude
Latitude value of the ending point.

vehicle_type
Type of vehicle considered for computing the distance.
Supported values are: `auto` and `truck`

print_request_response
Determines if the request sent and response received are to be printed.
By default, the parameter value is `'FALSE'`.

Usage Notes

> **Note:**
>
> The `SDO_GCDR.ELOC_ROUTE_TIME` function is only supported on Oracle Autonomous Database.

In order to use this function on your Autonomous Database instance, ensure that you have been granted the required permission. See SDO_GCDR.ELOC_GRANT_ACCESS for more information.

The `SDO_GCDR.ELOC_ROUTE_TIME` function can accept one of the following sets of parameters to compute the travel time between two points:

- **Using unformatted addresses:** Provide the `start_address` and `end_address` parameters where the complete address is stored in a single field (that is, unformatted).
- **Using geographic coordinates:** Provide the `start_longitude`, `start_latitude`, `end_longitude`, and `end_latitude` parameters to determine the start and end locations.

Note that each parameter input can be a column from a table or view, or an explicit string or number value.

Examples

The following example computes the travel time (in minutes) for a fastest route taken by an auto between two locations determined by the geographic coordinates.

```
SELECT SDO_GCDR.ELOC_ROUTE_TIME('fastest', 'minute', -122.39436, 37.79579,
-122.40459, 37.74211, 'auto') route_time FROM DUAL;

ROUTE_TIME
----------
      8.02
```

The following example computes the travel time (in minutes) for a fastest route taken by a truck between two address locations. Also, note that the query produces the request and response output as the `print_request_response` parameter is set to `TRUE`.

```
SELECT SDO_GCDR.ELOC_ROUTE_TIME('fastest', 'minute', '1 Oracle Dr, Nashua,
NH', '45 Middlesex road, Tyngborough, MA', 'US', 'truck', 'TRUE') route_time
FROM DUAL;

ROUTE_TIME
----------
     11.24

1 row selected.

REQUEST: xml_request=<route_request id="1" route_preference="fastest"
time_unit="minute" vehicle_type="truck"> <start_location> <input_location
```

```
id="1"> <input_address><unformatted country="US" > <address_line value="1
Oracle
Dr, Nashua, NH"/> </unformatted></input_address>
</input_location></start_location> <end_location> <input_location id="2">
<input_address><unformatted country="US" > <address_line value="45 Middlesex
road, Tyngborough, MA"/> </unformatted></input_address>
</input_location></end_location> </route_request>

RESPONSE: {
  "type" : "Feature",
  "geometry" :
{"type":"Polygon","coordinates":[]},
  "properties" : {
    "requestType" :
"route",
    "featureType" : "route",
    "stepCount" : "0",
    "dist" :
"6.3",
    "distUnit" : "mile",
    "time" : "11.24",
    "timeUnit" : "minute"

}
}
```

24.12 SDO_GCDR.GEOCODE

Format

```
SDO_GCDR.GEOCODE(
     username   IN VARCHAR2,
     addr_lines IN SDO_KEYWORDARRAY,
     country    IN VARCHAR2,
     match_mode IN VARCHAR2
     ) RETURN SDO_GEO_ADDR;
```

Description

Geocodes an unformatted address and returns the result as an SDO_GEO_ADDR object.

Parameters

username
Name of the user that owns the tables containing the geocoding data.

addr_lines
An array of quoted strings representing the unformatted address to be geocoded. The SDO_KEYWORDARRAY type is described in SDO_KEYWORDARRAY Type.

country
Country name or ISO country code.

match_mode
Match mode for the geocoding operation. Match modes are explained in Match Modes.

Usage Notes

This function returns an object of type SDO_GEOR_ADDR, which is described in SDO_GEO_ADDR Type. It performs the same operation as the SDO_GCDR.GEOCODE_AS_GEOMETRY function; however, that function returns an SDO_GEOMETRY object.

Examples

The following example geocodes the address of City Hall in San Francisco, California, using the `RELAX_BASE_NAME` match mode. It returns the longitude and latitude coordinates of this address as -122.41815 and 37.7784183, respectively.

```
SELECT SDO_GCDR.GEOCODE('SCOTT', SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl',
   'San Francisco, CA  94102'), 'US', 'RELAX_BASE_NAME') FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','SANFRANCISCO
--------------------------------------------------------------------------------
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'CARLTON B GOODLETT PL', NULL, NULL, '
SAN FRANCISCO', NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '1', 'CARLTON B
GOODLETT', 'PL', 'F', 'F', NULL, NULL, 'L', .01, 23614360, '????#ENUT?B281CP?',
1, 'RELAX_BASE_NAME', -122.41815, 37.7784183, '????0101010??000?')
```

24.13 SDO_GCDR.GEOCODE_ADDR

Format

```
SDO_GCDR.GEOCODE_ADDR(
     gc_username  IN VARCHAR2,
     address      IN SDO_GEO_ADDR
     ) RETURN SDO_GEO_ADDR;
```

Description

Geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns the first matched address as an SDO_GEO_ADDR object.

Parameters

gc_username
Name of the user that owns the tables containing the geocoding data.

address
An SDO_GEO_ADDR object with one or more attributes set. The SDO_GEO_ADDR type is described in SDO_GEO_ADDR Type.

Usage Notes

This function enables you to specify as many attributes in the input SDO_GEO_ADDR object as you can or want to set. It finds the first matching address, and returns an SDO_GEO_ADDR object with all possible attributes set.

Unlike the SDO_GCDR.GEOCODE function, which geocodes input addresses specified by unformatted address lines, the SDO_GCDR.GEOCODE_ADDR function input addresses specified by individual addressing fields defined in SDO_GEO_ADDR objects. When you use unformatted address lines, you rely on the geocoding software to parse the input address and decompose it into individual address fields. This process usually works well, but it can produce undesirable results if the input addresses are not well formatted. By contrast, when you specify parts of the input address as SDO_GEO_ADDR object attributes, you can reduce the chance of geocoding errors and produce more desirable results.

For examples of the SDO_GCDR.GEOCODE_ADDR function, see Example 12-2 and Example 12-3 in Geocoding from a Place Name.

See also the SDO_GCDR.GEOCODE_ADDR_ALL function, which performs the same operation as this function, but which can return more than one address.

Examples

The following example returns the geocoded result for a point of interest named `CALIFORNIA PACIFIC MEDICAL CTR`. The example uses a user-defined function named `create_addr_from_placename` (as defined in Example 12-2 in Geocoding from a Place Name) to construct the input SDO_GEO_ADDR object.

```
SELECT sdo_gcdr.geocode_addr('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'))
FROM DUAL;

SDO_GCDR.GEOCODE_ADDR('SCOTT',CREATE_ADDR_FROM_PLACENAME('CALIFORNIAPACIFICME
--------------------------------------------------------------------------------
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), 'CALIFORNIA PACIFIC MEDICAL CTR-SF', 'BUCHAN
AN ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', NULL, '94115', N
ULL, '2333', NULL, NULL, 'F', 'F', NULL, NULL, 'L', 0, 23599031, '??????????B281
CP?', 4, 'DEFAULT', -122.43097, 37.79138, '????414111??404?')
```

24.14 SDO_GCDR.GEOCODE_ADDR_ALL

Format

```
SDO_GCDR.GEOCODE_ADDR_ALL(
     gc_username   IN VARCHAR2,
     address       IN SDO_GEO_ADDR,
     max_res_num   IN NUMBER DEFAULT 4000
     ) RETURN SDO_ADDR_ARRAY;
```

Description

Geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns matching addresses as an SDO_ADDR_ARRAY object (described in SDO_ADDR_ARRAY Type).

Parameters

gc_username
Name of the user that owns the tables containing the geocoding data.

address
An SDO_GEO_ADDR object with one or more attributes set. The SDO_GEO_ADDR type is described in SDO_GEO_ADDR Type.

max_res_num
Maximum number of results to return in the SDO_ADDR_ARRAY object. The default value is 4000.

Usage Notes

This function enables you to specify as many attributes in the input SDO_GEO_ADDR object as you can or want to set. It finds matching addresses (up to 4000 or the limit specified in the `max_res_num` parameter), and returns an SDO_ADDR_ARRAY object in which each geocoded result has all possible attributes set.

This function performs the same operation as the SDO_GCDR.GEOCODE_ADDR function, except that it can return more than one address. See the Usage Notes for the SDO_GCDR.GEOCODE_ADDR function for more information.

Examples

The following example returns up to three geocoded results for a point of interest named `CALIFORNIA PACIFIC MEDICAL CTR`. (In this case only one result is returned, because the geocoding data contains only one address matching that point of interest.) The example uses a user-defined function named `create_addr_from_placename` (as defined in Example 12-2 in Geocoding from a Place Name) to construct the input SDO_GEO_ADDR object.

```
SELECT sdo_gcdr.geocode_addr_all('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'), 3)
FROM DUAL;

SDO_GCDR.GEOCODE_ADDR_ALL('SCOTT',CREATE_ADDR_FROM_PLACENAME('CALIFORNIAPACIF
--------------------------------------------------------------------------------
SDO_ADDR_ARRAY(SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), 'CALIFORNIA PACIFIC MEDICAL C
TR-SF', 'BUCHANAN ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', N
ULL, '94115', NULL, '2333', NULL, NULL, 'F', 'F', NULL, NULL, 'L', 0, 23599031,
'?????????B281CP?', 4, 'DEFAULT', -122.43097, 37.79138, '????4141114??404?'))
```

24.15 SDO_GCDR.GEOCODE_ALL

Format

```
SDO_GCDR.GEOCODE_ALL(
     gc_username   IN VARCHAR2,
     addr_lines    IN SDO_KEYWORDARRAY,
     country       IN VARCHAR2,
     match_mode    IN VARCHAR2
     ) RETURN SDO_ADDR_ARRAY;
```

Description

Geocodes all addresses associated with an unformatted address and returns the result as an SDO_ADDR_ARRAY object.

Parameters

gc_username
Name of the user that owns the tables containing the geocoding data.

addr_lines
An array of quoted strings representing the unformatted address to be geocoded. The SDO_KEYWORDARRAY type is described in SDO_KEYWORDARRAY Type.

country
Country name or ISO country code.

match_mode
Match mode for the geocoding operation. Match modes are explained in Match Modes.

Usage Notes

This function returns an object of type SDO_ADDR_ARRAY, which is described in SDO_ADDR_ARRAY Type. It performs the same operation as the SDO_GCDR.GEOCODE function; however, it can return results for multiple addresses, in which case the returned SDO_ADDR_ARRAY object contains multiple SDO_GEO_ADDR objects. If your application needs to select one of the addresses for some further operations, you can use the information about each returned address to help you make that selection.

Each SDO_GEO_ADDR object in the returned SDO_ADDR_ARRAY array represents the center point of each street segment that matches the criteria in the `addr_lines` parameter. For example, if Main Street extends into two postal codes, or if there are two separate streets named Main Street in two separate postal codes, and if you specify Main Street and a city and state for this function, the returned SDO_ADDR_ARRAY array contains two SDO_GEO_ADDR objects, each reflecting the center point of Main Street in a particular postal code. The house or building number in each SDO_GEO_ADDR object is the house or building number located at the center point of the street segment, even if the input address contains no house or building number or a nonexistent number.

Examples

The following example returns an array of geocoded results, each result reflecting the center point of Clay Street in all postal codes in San Francisco, California, in which the street extends. The resulting array includes four SDO_GEOR_ADDR objects, each reflecting the house at the center point of the Clay Street segment in each of the four postal codes (94108, 94115, 94118, and 94109) into which Clay Street extends.

```
SELECT SDO_GCDR.GEOCODE_ALL('SCOTT',
  SDO_KEYWORDARRAY('Clay St', 'San Francisco, CA'),
  'US', 'DEFAULT') FROM DUAL;

SDO_GCDR.GEOCODE_ALL('SCOTT',SDO_KEYWORDARRAY('CLAYST','SANFRANCISCO,CA'),'US
--------------------------------------------------------------------------------
SDO_ADDR_ARRAY(SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL,
'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109', NULL, '1698', 'CLAY',
 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600700, '????#ENUT?B281CP?', 1, 'DEFAULT'
, -122.42093, 37.79236, '????4101010??004?'), SDO_GEO_ADDR(1, SDO_KEYWORDARRAY()
, NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94111', NULL,
 '94111', NULL, '398', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600678, '??
??#ENUT?B281CP?', 1, 'DEFAULT', -122.40027, 37.79499, '????4101010??004?'), SDO_
GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NU
LL, 'CA', 'US', '94108', NULL, '94108', NULL, '978', 'CLAY', 'ST', 'F', 'F', NUL
L, NULL, 'L', 0, 23600689, '????#ENUT?B281CP?', 1, 'DEFAULT', -122.40904, 37.793
85, '????4101010??004?'), SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', N
ULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', NULL, '94115', NULL, '279
8', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600709, '????#ENUT?B281CP?', 1
, 'DEFAULT', -122.43909, 37.79007, '????4101010??004?'), SDO_GEO_ADDR(1, SDO_KEY
WORDARRAY(), NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94
118', NULL, '94118', NULL, '3698', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 2
3600718, '????#ENUT?B281CP?', 1, 'DEFAULT', -122.45372, 37.78822, '????4101010??
004?'))
```

24.16 SDO_GCDR.GEOCODE_AS_GEOMETRY

Format

```
SDO_GCDR.GEOCODE_AS_GEOMETRY(
     username    IN VARCHAR2,
     addr_lines  IN SDO_KEYWORDARRAY,
     country     IN VARCHAR2
     ) RETURN SDO_GEOMETRY;
```

Description

Geocodes an unformatted address and returns the result as an SDO_GEOMETRY object.

Parameters

username
Name of the user that owns the tables containing the geocoding data.

addr_lines
An array of quoted strings representing the unformatted address to be geocoded. The SDO_KEYWORDARRAY type is described in SDO_KEYWORDARRAY Type.

country
Country name or ISO country code.

Usage Notes

This function returns an object of type SDO_GEOMETRY. It performs the same operation as the SDO_GCDR.GEOCODE function; however, that function returns an SDO_GEOR_ADDR object.

This function uses a match mode of `'DEFAULT'` for the geocoding operation. Match modes are explained in Match Modes.

Examples

The following example geocodes the address of City Hall in San Francisco, California. It returns an SDO_GEOMETRY object in which the longitude and latitude coordinates of this address are -122.41815 and 37.7784183, respectively.

```
SELECT SDO_GCDR.GEOCODE_AS_GEOMETRY('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA  94102'),
  'US') FROM DUAL;

SDO_GCDR.GEOCODE_AS_GEOMETRY('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGOODLETTPL','
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, 8307, SDO_POINT_TYPE(-122.41815, 37.7784183, NULL), NULL, NUL
L)
```

24.17 SDO_GCDR.REVERSE_GEOCODE

Format

```
SDO_GCDR.REVERSE_GEOCODE(
     username IN VARCHAR2,
     location IN SDO_GEOMETRY,
     country  IN VARCHAR2
     ) RETURN SDO_GEO_ADDR;
```

Description

Reverse geocodes a location, specified by its spatial geometry object and country, and returns the result as an SDO_GEO_ADDR object.

Parameters

username
Name of the user that owns the tables containing the geocoding data.

location
An SDO_GEOMETRY object that specifies the point location to be reverse geocoded.

country
Country name or ISO country code.

Usage Notes

This function returns an object of type SDO_GEOR_ADDR, which is described in SDO_GEO_ADDR Type.

A spatial index must be created on the table GC_ROAD_SEGMENT_<*table-suffix*>.

Examples

The following example reverse geocodes a point with the longitude and latitude values (-122.41815, 37.7784183). For this example, a spatial index was created on the GEOMETRY column in the GC_ROAD_SEGMENT_US table.

```
SELECT SDO_GCDR.REVERSE_GEOCODE('SCOTT',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-122.41815, 37.7784183, NULL), NULL, NULL),
  'US') FROM DUAL;

SDO_GCDR.REVERSE_GEOCODE('SCOTT',SDO_GEOMETRY(2001,8307,SDO_POINT_TYPE(-122.4
--------------------------------------------------------------------------------
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'POLK ST', NULL, NULL, 'SAN FRANCISCO'
, NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '200', 'POLK', 'ST', 'F', 'F',
 NULL, NULL, 'R', .00966633, 23614360, '', 1, 'DEFAULT', -122.41815, 37.7784177,
 '????4141414??404?')
```

25

SDO_GEOM Package (Geometry)

The MDSIS.SDO_GEOM package contains subprograms for working with geometry objects.

This chapter contains descriptions of the geometry-related PL/SQL subprograms in the SDO_GEOM package, which can be grouped into the following categories:

- Relationship (True/False) between two objects: RELATE, WITHIN_DISTANCE
- Validation: VALIDATE_GEOMETRY_WITH_CONTEXT, VALIDATE_LAYER_WITH_CONTEXT, SDO_SELF_UNION
- Single-object operations: SDO_ALPHA_SHAPE, SDO_ARC_DENSIFY, SDO_AREA, SDO_BUFFER, SDO_CENTROID, SDO_CONVEXHULL, SDO_CONCAVEHULL, SDO_CONCAVEHULL_BOUNDARY, SDO_DIAMETER, SDO_DIAMETER_LINE, SDO_LENGTH, SDO_MBC, SDO_MBC_CENTER, SDO_MBC_RADIUS, SDO_MAX_MBR_ORDINATE, SDO_MIN_MBR_ORDINATE, SDO_MBR, SDO_POINTONSURFACE, SDO_TRIANGULATE, SDO_VOLUME, SDO_WIDTH, SDO_WIDTH_LINE
- Two-object operations: SDO_CLOSEST_POINTS, SDO_DISTANCE, SDO_DIFFERENCE, SDO_INTERSECTION, SDO_MAXDISTANCE, SDO_MAXDISTANCE_LINE, SDO_UNION, SDO_XOR

The following usage information applies to the geometry subprograms. (See also the Usage Notes under the reference information for each subprogram.)

- Certain combinations of input parameters and operations can return a null value, that is, an empty geometry. For example, requesting the intersection of two disjoint geometry objects returns a null value.
- A null value (empty geometry) as an input parameter to a geometry function (for example, SDO_GEOM.RELATE) produces an error.
- Certain operations can return a geometry of a different type than one or both input geometries. For example, the intersection of a line and an overlapping polygon returns a line; the intersection of two lines returns a point; and the intersection of two tangent polygons returns a line.
- SDO_GEOM subprograms are supported for two-dimensional geometries only, except for the following, which are supported for both two-dimensional and three-dimensional geometries:

  > **Note:**
  >
  > The listed SDO_GEOM subprograms for three-dimensional geometries are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

  - SDO_GEOM.RELATE with (A) the ANYINTERACT mask, or (B) the INSIDE mask (3D support for solid geometries only)

    - SDO_GEOM.SDO_AREA
    - SDO_GEOM.SDO_DISTANCE
    - SDO_GEOM.SDO_LENGTH
    - SDO_GEOM.SDO_MAX_MBR_ORDINATE
    - SDO_GEOM.SDO_MBR
    - SDO_GEOM.SDO_MIN_MBR_ORDINATE
    - SDO_GEOM.SDO_VOLUME
    - SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
    - SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
    - SDO_GEOM.WITHIN_DISTANCE
- SDO_GEOM.DTW_DISTANCE
- SDO_GEOM.RELATE
- SDO_GEOM.SDO_ALPHA_SHAPE
- SDO_GEOM.SDO_ARC_DENSIFY
- SDO_GEOM.SDO_AREA
- SDO_GEOM.SDO_BUFFER
- SDO_GEOM.SDO_CENTROID
- SDO_GEOM.SDO_CLOSEST_POINTS
- SDO_GEOM.SDO_CONCAVEHULL
- SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY
- SDO_GEOM.SDO_CONVEXHULL
- SDO_GEOM.SDO_DIAMETER
- SDO_GEOM.SDO_DIAMETER_LINE
- SDO_GEOM.SDO_DIFFERENCE
- SDO_GEOM.SDO_DISTANCE
- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_LENGTH
- SDO_GEOM.SDO_MAX_MBR_ORDINATE
- SDO_GEOM.SDO_MAXDISTANCE
- SDO_GEOM.SDO_MAXDISTANCE_LINE
- SDO_GEOM.SDO_MBC
- SDO_GEOM.SDO_MBC_CENTER
- SDO_GEOM.SDO_MBC_RADIUS
- SDO_GEOM.SDO_MBR
- SDO_GEOM.SDO_MIN_MBR_ORDINATE
- SDO_GEOM.SDO_POINTONSURFACE
- SDO_GEOM.SDO_SELF_UNION

- SDO_GEOM.SDO_TRIANGULATE
- SDO_GEOM.SDO_UNION
- SDO_GEOM.SDO_VOLUME
- SDO_GEOM.SDO_WIDTH
- SDO_GEOM.SDO_WIDTH_LINE
- SDO_GEOM.SDO_XOR
- SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
- SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
- SDO_GEOM.WITHIN_DISTANCE

25.1 SDO_GEOM.DTW_DISTANCE

Format

```
SDO_GEOM.DTW_DISTANCE(
  s    IN SDO_GEOMETRY,
  t    IN SDO_GEOMETRY,
  w_in IN NUMBER default NULL
) RETURN NUMBER;
```

Description

Compares two different spatial trajectories by measuring the distance between the two objects.

Parameters

s
The first two-dimensional line geometry.

t
The second two-dimensional line geometry.

w_in
Specifies how many vertices on the second line geometry need to be compared with a given vertex on the first line geometry.
For example, if `w_in = 2`, then the third vertex on the first line is compared to vertices 1, 2, 3, 4, and 5 on the second line; that is, using the vertex as the index, it determines the range for comparison as two points before and two after the vertex. Similarly, if `w_in = 1`, then the second vertex on the first line is compared to vertices 1, 2, 3, and 4 on the second line since there is only one prior vertex for index 2.
Also, note the following:

- In case the computed range is greater than the maximum number of vertices available in the second line geometry, then the comparison will be limited to the maximum number of vertices available in the second line.
- If `w_in = 0`, then the first vertex on the first line is compared with vertex 1, 2, and 3 of the second line as there are no prior vertices for index 1.
- If `w_in = NULL` (default), then each vertex (i) on the first line is only compared with vertex (i) on the second line.

Usage Notes

The `SDO_GEOM.DTW_DISTANCE` function is based on the **Dynamic Time Warping Algorithm** and measures the similarity between two spatial trajectories by computing the distance between them.

A spatial trajectory is represented by a two-dimensional line geometry. If the two lines are exactly the same, then the function returns zero. As the lines diverge, the resulting distance value grows higher.

Examples

The following example compares two spatial line trajectories with `w_in` distance as 2.

```
SQL>  select sdo_geom.dtw_distance(

    sdo_geometry(2002, NULL, NULL, sdo_elem_info_array(1,2,1),

    sdo_ordinate_array(1,1, 2,2, 3,3, 4,4, 5,5)),

    sdo_geometry(2002, NULL, NULL, sdo_elem_info_array(1,2,1),

    sdo_ordinate_array(2,2, 3,3, 4,4)),  2)

  from dual;

SDO_GEOM.DTW_DISTANCE(SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,2,1),S
DO

------------------------------------------------------------------------------
--


2.82842712
```

25.2 SDO_GEOM.RELATE

Format

```
SDO_GEOM.RELATE(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY,
  mask   IN VARCHAR2,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.RELATE(
  geom1  IN SDO_GEOMETRY,
  mask   IN VARCHAR2,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN VARCHAR2;
```

Description

Examines two geometry objects to determine their spatial relationship.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

mask
Specifies a list of relationships to check. See the list of keywords in the Usage Notes.

geom2
Geometry object.

dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

For better performance, use the SDO_RELATE operator or one of its convenience operator formats (all described in Spatial Operators) instead of the `SDO_GEOM.RELATE` function, unless you need to use the function. For example, the DETERMINE mask keyword does not apply with the SDO_RELATE operator. For more information about performance considerations with operators and functions, see Spatial Operators_ Procedures_ and Functions.

The `SDO_GEOM.RELATE` function can return the following types of answers:

- If you pass a `mask` listing one or more relationships, the function returns the specified `mask` value if one or more of the relationships are true for the pair of geometries. If all relationships are false, the procedure returns FALSE.
- If you pass the DETERMINE keyword in `mask`, the function returns the one relationship keyword that best matches the geometries.
- If you pass the ANYINTERACT keyword in `mask`, the function returns TRUE if the two geometries are not disjoint.

The following `mask` relationships can be tested:

- ANYINTERACT: Returns TRUE if the objects are not disjoint.
- CONTAINS: Returns CONTAINS if the second object is entirely within the first object and the object boundaries do not touch; otherwise, returns FALSE.
- COVEREDBY: Returns COVEREDBY if the first object is entirely within the second object and the object boundaries touch at one or more points; otherwise, returns FALSE.
- COVERS: Returns COVERS if the second object is entirely within the first object and the boundaries touch in one or more places; otherwise, returns FALSE.
- DISJOINT: Returns DISJOINT if the objects have no common boundary or interior points; otherwise, returns FALSE.

- EQUAL: Returns EQUAL if the boundaries and interior of the objects exactly overlap, including any holes (that is, if the two geometries are topologically equal); otherwise, returns FALSE.
- INSIDE: Returns INSIDE if the first object is entirely within the second object and the object boundaries do not touch; otherwise, returns FALSE.
- ON: Returns ON if the boundary and interior of a line (the first object) is completely on the boundary of a polygon (the second object); otherwise, returns FALSE.
- OVERLAPBDYDISJOINT: Returns OVERLAPBDYDISJOINT if the objects overlap, but their boundaries do not interact; otherwise, returns FALSE.
- OVERLAPBDYINTERSECT: Returns OVERLAPBDYINTERSECT if the objects overlap, and their boundaries intersect in one or more places; otherwise, returns FALSE.
- TOUCH: Returns TOUCH if the two objects share a common boundary point, but no interior points; otherwise, returns FALSE.

Values for `mask` can be combined using the logical Boolean operator OR. For example, 'INSIDE + TOUCH' returns `INSIDE+TOUCH` if the relationship between the geometries is INSIDE or TOUCH or both INSIDE and TOUCH; it returns `FALSE` if the relationship between the geometries is neither INSIDE nor TOUCH.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example finds the relationship between each geometry in the SHAPE column and the `cola_b` geometry. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. The output is reformatted for readability.)

```
SELECT c.name,
  SDO_GEOM.RELATE(c.shape, 'determine', c_b.shape, 0.005) relationship
  FROM cola_markets c, cola_markets c_b WHERE c_b.name = 'cola_b';

NAME     RELATIONSHIP
---------------------------                                  cola_a   TOUCH
cola_b   EQUAL
cola_c   OVERLAPBDYINTERSECT
cola_d   DISJOINT
```

Related Topics

- SDO_RELATE operator

25.3 SDO_GEOM.SDO_ALPHA_SHAPE

Format

```
SDO_GEOM.SDO_ALPHA_SHAPE(
  geom   IN SDO_GEOMETRY,
  tol    IN NUMBER,
  radius IN NUMBER DEFALT NULL,
  flag   IN BINARY_INTEGER DEFAULT 0
) RETURN SDO_GEOMETRY;
```

Description

Returns the alpha shape geometry of the input geometry, based on a specified radius value.

Parameters

geom
Geometry object.

tol
Tolerance value (see Tolerance).

radius
Radius to be used in calculating the alpha shape. If this parameter is null, the alpha shape is the convex hull of the input geometry.

flag
Determines whether isolated points and edges are included: `0` (the default) includes isolated points and edges, so that the alpha shape is returned; `1` does not include isolated points and edges, so that only the polygon portion of the alpha shape is returned.

Usage Notes

The **alpha shape** is a generalization of the convex hull. This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations and the alpha shape.

If you specify a value for the `radius` parameter, you may first want to call the SDO_GEOM.SDO_CONCAVEHULL function using the format with the `radius` output parameter.

An exception is raised if `geom` is of point type, has fewer than three points or vertices, or consists of multiple points all in a straight line, or if `radius` is less than 0.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Examples

The following example returns a geometry object that is the alpha shape of `cola_c`, which is also the convex hull of `cola_c` because the default value for the `radius` parameter (null) is used. (This simplified example uses a polygon as the input geometry; this function is normally used with a large set of point data. The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.name, SDO_GEOM.SDO_ALPHA_SHAPE(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

SDO_GEOM.SDO_ALPHA_SHAPE(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(4, 5, 3, 3, 6, 3, 6, 5, 4, 5))
```

Related Topics

SDO_GEOM.SDO_CONCAVEHULL

SDO_GEOM.SDO_CONVEXHULL

25.4 SDO_GEOM.SDO_ARC_DENSIFY

Format

```
SDO_GEOM.SDO_ARC_DENSIFY(
  geom    IN SDO_GEOMETRY,
  dim     IN SDO_DIM_ARRAY
  params  IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_ARC_DENSIFY(
  geom    IN SDO_GEOMETRY,
  tol     IN NUMBER
  params  IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry in which each circular arc in the input geometry is changed into an approximation of the circular arc consisting of straight lines, and each circle is changed into a polygon consisting of a series of straight lines that approximate the circle.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

params
A quoted string containing an arc tolerance value and optionally a unit value. See the Usage Notes for an explanation of the format and meaning.

Usage Notes

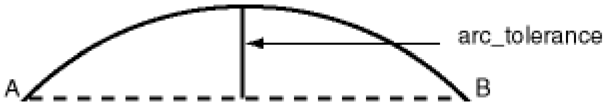
If you have geometries in a projected coordinate system that contain circles or circular arcs, you can use this function to densify them into regular polygons. You can then use the resulting straight-line polygon geometries for any spatial operations, or you can transform them to any projected or geodetic coordinate system.

The `params` parameter is a quoted string that can contain the `arc_tolerance` keyword, as well as the `unit` keyword to identify the unit of measurement associated with the `arc_tolerance` value. For example:

```
'arc_tolerance=0.05 unit=km'
```

The `arc_tolerance` keyword specifies, for each arc in the geometry, the maximum length of the perpendicular line between the surface of the arc and the straight line between the start and end points of the arc. Figure 25-1 shows a line whose length is the `arc_tolerance` value for the arc between points A and B.

Figure 25-1 Arc Tolerance



The `arc_tolerance` keyword value must be greater than the tolerance value associated with the geometry. (The default value for `arc_tolerance` is 20 times the tolerance value.) As you increase the `arc_tolerance` keyword value, the resulting polygon has fewer sides and a smaller area; as you decrease the `arc_tolerance` keyword value, the resulting polygon has more sides and a larger area (but never larger than the original geometry).

If the `unit` keyword is specified, the value must be an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). If the `unit` keyword is not specified, the unit of measurement associated with the geometry is used. See Unit of Measurement Support for more information about unit of measurement specification.

Examples

The following example returns the geometry that results from the arc densification of `cola_d`, which is a circle. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Arc densification of the circle cola_d
SELECT c.name, SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo,
                                       'arc_tolerance=0.05')
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';

NAME
--------------------------------
SDO_GEOM.SDO_ARC_DENSIFY(C.SHAPE,M.DIMINFO,'ARC_TOLERANCE=0.05')(SDO_GTYPE, SDO_
--------------------------------------------------------------------------------
cola_d
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(8, 7, 8.76536686, 7.15224093, 9.41421356, 7.58578644, 9.84775907, 8.23463314,
 10, 9, 9.84775907, 9.76536686, 9.41421356, 10.4142136, 8.76536686, 10.8477591,
8, 11, 7.23463314, 10.8477591, 6.58578644, 10.4142136, 6.15224093, 9.76536686, 6
, 9, 6.15224093, 8.23463314, 6.58578644, 7.58578644, 7.23463314, 7.15224093, 8,
7))
```

Related Topics

- Other Considerations and Requirements with Geodetic Data
- SDO_UTIL.DENSIFY_GEOMETRY

25.5 SDO_GEOM.SDO_AREA

Format

```
SDO_GEOM.SDO_AREA(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
  [, unit  IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_AREA(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit  IN VARCHAR2]
) RETURN NUMBER;
```

Description

Returns the area of a two-dimensional polygon.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_AREA_UNITS table (for example, 'unit=SQ_KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is square meters.

tol
Tolerance value (see Tolerance).

Usage Notes

This function works with any polygon, including polygons with holes.

Lines that close to form a ring have no area.

Examples

The following example returns the areas of geometry objects stored in the COLA_MARKETS table. The first statement returns the areas of all objects; the second returns just the area of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the areas of all cola markets.
SELECT name, SDO_GEOM.SDO_AREA(shape, 0.005) FROM cola_markets;

NAME                             SDO_GEOM.SDO_AREA(SHAPE,0.005)
-------------------------------- ------------------------------
cola_a                                                       24
cola_b                                                     16.5
cola_c                                                        5
cola_d                                               12.5663706

-- Return the area of just cola_a.
SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
   WHERE c.name = 'cola_a';

NAME                             SDO_GEOM.SDO_AREA(C.SHAPE,0.005)
-------------------------------- --------------------------------
cola_a                                                         24
```

Related Topics

None.

25.6 SDO_GEOM.SDO_BUFFER

Format

```
SDO_GEOM.SDO_BUFFER(
  geom   IN SDO_GEOMETRY,
  dim    IN SDO_DIM_ARRAY,
  dist   IN NUMBER
  [, params  IN VARCHAR2]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_BUFFER(
  geom   IN SDO_GEOMETRY,
  dist   IN NUMBER,
  tol    IN NUMBER
  [, params  IN VARCHAR2]
) RETURN SDO_GEOMETRY;
```

Description

Generates a buffer polygon around or inside a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

dist
Distance value. If the value is positive, the buffer is generated around the geometry; if the value is negative (valid only for polygons), the buffer is generated inside the geometry. The absolute value of this parameter must be greater than the tolerance value, as specified in the dimensional array (`dim` parameter) or in the `tol` parameter.

tol
Tolerance value (see Tolerance).

params
A quoted string that can contain one or both of the following keywords:

- `unit` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table. It identifies the unit of measurement associated with the `dist` parameter value, and also with the arc tolerance value if the `arc_tolerance` keyword is specified. See Unit of Measurement Support for more information about unit of measurement specification.

- `arc_tolerance` and an arc tolerance value. See the Usage Notes for the SDO_GEOM.SDO_ARC_DENSIFY function in this chapter for more information about the `arc_tolerance` keyword.

For example: `'unit=km arc_tolerance=0.05'`
If the input geometry is geodetic data and if `arc_tolerance` is not specified, the default value is the tolerance value multiplied by 20. Spatial uses the `arc_tolerance` value to perform arc densification in computing the result. If the input geometry is Cartesian or projected data, `arc_tolerance` has no effect and should not be specified.
If this parameter is not specified for a Cartesian or projected geometry, or if the `arc_tolerance` keyword is specified for a geodetic geometry but the `unit` keyword is not specified, the unit of measurement associated with the data is assumed.

Usage Notes

This function returns a geometry object representing the buffer polygon.

This function creates a rounded buffer around a point, line, or polygon, or inside a polygon. The buffer within a void is also rounded, and is the same distance from the inner boundary as the outer buffer is from the outer boundary. (For an illustration, see the distance buffers figure in Spatial Relationships and Filtering.)

If the buffer polygon geometry is in a projected coordinate system, it will contain arcs; and if you want to transform that geometry to a geodetic coordinate system, you must first densify it using the SDO_GEOM.SDO_ARC_DENSIFY function, and then transform the densified geometry.

If the input geometry has more than 50 ordinates, and the buffer width is less than 0.1 percent (0.001) of the root-mean-square spacing between consecutive coordinates, then the original geometry is returned unchanged.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

With geodetic data, this function should be used only for relatively small geometries: geometries for which the local tangent plane projection that is used for internal computations does not introduce significant distortions or errors. This limits the applicable domain of source geometries, whether line strings or polygons, to approximately the area of Texas (United States), France, or Manchuria province (China).

Examples

The following example returns a polygon representing a buffer of 1 around `cola_a`. Note the rounded corners (for example, at .292893219,.292893219) in the returned polygon. (The example uses the non-geodetic definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Generate a buffer of 1 unit around a geometry.
SELECT c.name, SDO_GEOM.SDO_BUFFER(c.shape, m.diminfo, 1)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS'  AND m.column_name = 'SHAPE'
  AND c.name = 'cola_a';

NAME
--------------------------------
SDO_GEOM.SDO_BUFFER(C.SHAPE,M.DIMINFO,1)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1005, 8, 1, 2, 2, 5, 2, 1,
 7, 2, 2, 11, 2, 1, 13, 2, 2, 17, 2, 1, 19, 2, 2, 23, 2, 1), SDO_ORDINATE_ARRAY(
0, 1, .292893219, .292893219, 1, 0, 5, 0, 5.70710678, .292893219, 6, 1, 6, 7, 5.
70710678, 7.70710678, 5, 8, 1, 8, .292893219, 7.70710678, 0, 7, 0, 1))
```

The following example returns a polygon representing a buffer of 1 around `cola_a` using the geodetic definitions and data from Example of Coordinate System Transformation.

```
-- Generate a buffer of 1 kilometer around a geometry.
SELECT c.name, SDO_GEOM.SDO_BUFFER(c.shape, m.diminfo, 1,
                                  'unit=km arc_tolerance=0.05')
 FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS'
 AND m.column_name = 'SHAPE' AND c.name = 'cola_a';

NAME
--------------------------------
SDO_GEOM.SDO_BUFFER(C.SHAPE,M.DIMINFO,1,'UNIT=KMARC_TOLERANCE=0.05')(SDO_GTYPE,
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(.991023822, 1.00002073, .992223711, .995486419, .99551726, .99217077, 1.00001
929, .990964898, 4.99998067, .990964929, 5.00448268, .9921708, 5.00777624, .9954
86449, 5.00897618, 1.00002076, 5.00904194, 6.99997941, 5.00784065, 7.00450033, 5
.00454112, 7.00781357, 5.00002479, 7.009034, .999975166, 7.00903403, .995458814,
 7.00781359, .992159303, 7.00450036, .990958058, 6.99997944, .991023822, 1.00002
073))
```

Related Topics

- SDO_GEOM.SDO_UNION
- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_XOR

25.7 SDO_GEOM.SDO_CENTROID

Format

```
SDO_GEOM.SDO_CENTROID(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CENTROID(
  geom1  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a point geometry that is the centroid of a polygon, multipolygon, point, or point cluster. (The centroid is also known as the "center of gravity.")

For an input geometry consisting of multiple objects, the result is weighted by the area of each polygon in the geometry objects. If the geometry objects are a mixture of polygons and points, the points are not used in the calculation of the centroid. If the geometry objects are all points, the points have equal weight.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

The function returns a null value if `geom1` is not a polygon, multipolygon, point, or point cluster, as identified by the SDO_GTYPE value in the SDO_GEOMETRY object.

If `geom1` is a point, the function returns the point (the input geometry).

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Depending on the shape and complexity of the input geometry, the returned point might not be on the surface of the input geometry.

Examples

The following example returns a geometry object that is the centroid of `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the centroid of a geometry.
SELECT c.name, SDO_GEOM.SDO_CENTROID(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_c';

NAME
--------------------------------
SDO_GEOM.SDO_CENTROID(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
4.73333333, 3.93333333))
```

Related Topics

None.

25.8 SDO_GEOM.SDO_CLOSEST_POINTS

Format

```
SDO_GEOM.SDO_CLOSEST_POINTS(
  geom1          IN SDO_GEOMETRY,
  geom2          IN SDO_GEOMETRY,
  tolerance      IN NUMBER,
  unit           IN VARCHAR2
  [, ellipsoidal IN VARCHAR2 DEFAULT NULL]
) RETURN SDO_CLOSEST_POINTS_TYPE;
```

Description

Returns an object containing the computed minimum distance between two geometries and the points (one on each geometry) that are minimum distance apart.

Parameters

geom1
Geometry object.

geom2
Geometry object.

tolerance
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed.

ellipsoidal
Specifies if ellipsoidal distance is always used with geodetic data (`true`), or if spherical distance is used in some cases (`false`, the default). See Distance: Spherical versus Ellipsoidal with Geodetic Data.

Usage Notes

This function returns an output object of type `SDO_CLOSEST_POINTS_TYPE`, that contains the computed minimum distance (`DIST`) and the output point geometries (`GEOMA` and `GEOMB`) associated with the minimum distance. Oracle Spatial defines the object type `SDO_CLOSEST_POINTS_TYPE` as:

```
CREATE TYPE sdo_closest_points_type AS OBJECT (
    dist   NUMBER,
    geoma  SDO_GEOMETRY,
    geomb  SDO_GEOMETRY
);
```

If the distance between the two points is 0 (zero), the output geometries (`GEOMA` and `GEOMB`) will be as follows:

- For two-dimensional (2D) geometries, if one of the input geometries is a point geometry, each output geometry is that point; otherwise, each output geometry is the first point in the first element of the intersection of the input geometries.
- For three-dimensional (3D) geometries, if one of the input geometries is a point geometry, each output geometry is that point; otherwise, the output geometries are null.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

If the input data is three-dimensional and geodetic, a 3D SRID must be used for the geometries; otherwise, the results will be incorrect.

Examples

The following example computes the minimum distance between geometries `cola_c` and `cola_d`, as well as the one point on each input geometry associated with the minimum distance.

The resulting `SDO_CLOSEST_POINTS_TYPE` object, shows the minimum distance of `2.47213595` between the two input geometries along with the two output point geometries. The closest point on `cola_c` is at (6,5), and the closest point on `cola_d` is at (7.10557281, 7.21114562). (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT sdo_geom.sdo_closest_points (c1.shape, c2.shape, 0.5, null) cp
FROM cola_markets c1, cola_markets c2
WHERE c1.name = 'cola_c'
AND c2.name = 'cola_d';

CP(DIST, GEOMA(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES),
GEOMB(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES))
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
----------------------
SDO_CLOSEST_POINTS_TYPE(2.47213595, SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(6, 5, NULL),
NULL, NULL), SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(7.10557281, 7.21114562, NULL),
NULL, NULL))
```

Related Topics

None.

25.9 SDO_GEOM.SDO_CONCAVEHULL

Format

```
SDO_GEOM.SDO_CONCAVEHULL(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONCAVEHULL(
  geom   IN SDO_GEOMETRY,
  tol    IN NUMBER,
  radius OUT NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONCAVEHULL(
  geom  IN SDO_GEOMETRY_ARRAY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONCAVEHULL(
  geom   IN SDO_GEOMETRY_ARRAY,
  tol    IN NUMBER,
  radius OUT NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a polygon-type object that represents the concave hull of a geometry object or of an array of geometry objects.

Parameters

geom
Geometry object (type SDO_GEOMETRY), or array of geometry objects (type SDO_GEOMETRY_ARRAY, which is defined as `VARRAY OF SDO_GEOMETRY`).

tol
Tolerance value (see Tolerance).

radius
Output parameter to hold the radius of the circumcircle of the triangles created internally (using Delaunay triangulations) in computing the concave hull.

Usage Notes

The **concave hull** is a polygon that represents the area of the input geometry, such as a collection of points. With complex input geometries, the concave hull is typically significantly smaller in area than the convex hull.

This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations, and computes a concave hull. It returns only an exterior ring; any interior rings are discarded.

This function uses the alpha shape in computing the concave hull. By contrast, the SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY function uses exterior boundary points.

The format with the `radius` parameter returns a radius value that can be useful if you plan to call the SDO_GEOM.SDO_ALPHA_SHAPE function.

An exception is raised if `geom` has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Examples

The following example returns a geometry object that is the concave hull of `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.

```
-- Return the concave hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONCAVEHULL(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_GEOM.SDO_CONCAVEHULL(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

The following example returns a geometry that is the concave hull of an array of three geometry objects.

```
SELECT sdo_geom.sdo_concavehull(SDO_GEOMETRY_ARRAY(
   SDO_GEOMETRY(2005, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 4),
      SDO_ORDINATE_ARRAY(6, 3, 6, 5, 4, 5, 3, 3)),
   SDO_GEOMETRY(2005, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 4),
      SDO_ORDINATE_ARRAY(16, 13, 16, 15, 14, 15, 13, 13)),
   SDO_GEOMETRY(2005, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 4),
      SDO_ORDINATE_ARRAY(26, 23, 26, 25, 24, 25, 23, 23))), 0.000005)
FROM dual;

SDO_GEOM.SDO_CONCAVEHULL(SDO_GEOMETRY_ARRAY(SDO_GEOMETRY(2005,NULL,NULL,SDO_ELEM
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 16, 13, 16, 15, 26, 23, 26, 25, 24, 25, 23, 23, 14, 15, 13, 13, 4
, 5, 3, 3, 6, 3))
```

Related Topics

SDO_GEOM.SDO_ALPHA_SHAPE

SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY

SDO_AGGR_CONCAVEHULL

25.10 SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY

Format

```
SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(
  geom   IN SDO_GEOMETRY,
  tol    IN NUMBER,
  length IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

Description

Returns a polygon-type object that represents the concave hull of a geometry object, based on boundary points rather than the alpha shape.

Parameters

geom
Geometry object.

tol
Tolerance value (see Tolerance).

length
A value to control the size of the concave hull: specifically, computation of the concave hull is stopped when the longest edge in the concave hull is shorter than the `length` value. Thus, the larger the `length` value, the larger the concave hull will probably be. If you do not specify this parameter, computation continues as described in the Usage Notes.

Usage Notes

The **concave hull** is a polygon that represents the area of the input geometry, such as a collection of points. With complex input geometries, the concave hull is typically significantly smaller in area than the convex hull.

Like the SDO_GEOM.SDO_CONCAVEHULL function, this function takes all coordinates from the input geometry, and uses them to compute Delaunay triangulations. But after that, it computes a convex hull, puts all boundary edges into a priority queue based on the lengths of these edges, and then removes edges one by one as long as the shape is still a single connected polygon (unless stopped by a specified `length` parameter value). If an edge is removed during the computation, the other two edges of its triangle will be on the boundary.

An exception is raised if `geom` has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Examples

The following example returns a geometry object that is the concave hull of `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the concave hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

Related Topics

SDO_GEOM.SDO_ALPHA_SHAPE

SDO_GEOM.SDO_CONCAVEHULL

SDO_GEOM.SDO_CONVEXHULL

25.11 SDO_GEOM.SDO_CONVEXHULL

Format

```
SDO_GEOM.SDO_CONVEXHULL(
  geom1   IN SDO_GEOMETRY,
  dim1    IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONVEXHULL(
  geom1   IN SDO_GEOMETRY,
  tol     IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a polygon-type object that represents the convex hull of a geometry object.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

The **convex hull** is a simple convex polygon that completely encloses the geometry object. Spatial uses as few straight-line sides as possible to create the smallest polygon that completely encloses the specified object. A convex hull is a convenient way to get an approximation of a complex geometry object.

If the geometry (`geom1`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the convex hull of the geometry. If the geometry object (`geom1`) is a circle, the function returns a square that minimally encloses the circle.

The function returns a null value if `geom1` is of point type, has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Examples

The following example returns a geometry object that is the convex hull of `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. This specific example, however, does not produce useful output—the returned polygon has the same vertices as the input polygon—because the input polygon is already a simple convex polygon.)

```
-- Return the convex hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONVEXHULL(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_c';

NAME
--------------------------------
SDO_GEOM.SDO_CONVEXHULL(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

Related Topics

SDO_GEOM.SDO_CONCAVEHULL

25.12 SDO_GEOM.SDO_DIAMETER

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_DIAMETER(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
  [, unit  IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DIAMETER(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit  IN VARCHAR2]
) RETURN NUMBER;
```

Description

Returns the length of the diameter of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

Usage Notes

This function can be used for circle and non-circle geometry objects. The input geometry does not need to contain any curves.

The returned diameter length is the maximum distance between any two points in the geometry object. (For a formal definition of *diameter*, see a college-level mathematics textbook or other appropriate reference source.)

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

Examples

The following example returns the diameter length of all geometry objects stored in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT name, SDO_GEOM.SDO_DIAMETER(shape, 0.005) Diameter
  FROM cola_markets;

NAME                               DIAMETER
-------------------------------- ----------
cola_a                           7.21110255
cola_b                           6.70820393
cola_c                           3.60555128
cola_d                                    4
```

Related Topics

SDO_GEOM.SDO_DIAMETER_LINE

SDO_GEOM.SDO_WIDTH

25.13 SDO_GEOM.SDO_DIAMETER_LINE

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_DIAMETER_LINE(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DIAMETER_LINE(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN NUMBER;
```

Description

Returns a line string geometry reflecting the length of the diameter of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

This function can be used for circle and non-circle geometry objects. The input geometry does not need to contain any curves.

The returned diameter length is the maximum distance between any two points in the geometry object. (For a formal definition of *diameter*, see a college-level mathematics textbook or other appropriate reference source.)

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

Examples

The following example returns line strings reflecting diameter length of each geometry object stored in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT name, SDO_GEOM.SDO_DIAMETER_LINE(shape, 0.005)
  FROM cola_markets;

NAME
--------------------------------
SDO_GEOM.SDO_DIAMETER_LINE(SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
1, 1, 5, 7))

cola_b
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 1, 5, 7))

cola_c
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
3, 3, 6, 5))

cola_d
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 7, 8, 11))
```

Related Topics

SDO_GEOM.SDO_DIAMETER

SDO_GEOM.SDO_WIDTH

25.14 SDO_GEOM.SDO_DIFFERENCE

Format

```
SDO_GEOM.SDO_DIFFERENCE(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_DIFFERENCE(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the topological difference (MINUS operation) of two geometry objects.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object.

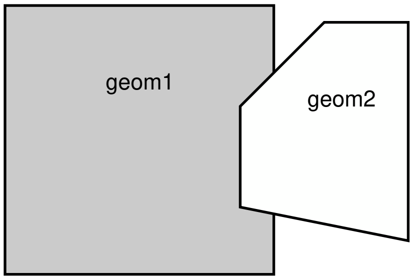
dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

In Figure 25-2, the shaded area represents the polygon returned when SDO_DIFFERENCE is used with a square (`geom1`) and another polygon (`geom2`).

Figure 25-2 SDO_GEOM.SDO_DIFFERENCE



An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example returns a geometry object that is the topological difference (MINUS operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from Simple Example: Inserting, Indexing, and Querying Spatial Data.)

```
-- Return the topological difference of two geometries.
SELECT SDO_GEOM.SDO_DIFFERENCE(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_DIFFERENCE(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 7, 1, 1, 5, 1, 5, 3, 3, 3, 4, 5, 5, 5, 5, 7, 1, 7)
```

Note that in the returned polygon, the SDO_ORDINATE_ARRAY starts and ends at the same point (1, 7).

Related Topics

- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_UNION
- SDO_GEOM.SDO_XOR

25.15 SDO_GEOM.SDO_DISTANCE

Format

```
SDO_GEOM.SDO_DISTANCE(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
  [, unit         IN VARCHAR2]
  [, ellipsoidal  IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DISTANCE(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit         IN VARCHAR2]
  [, ellipsoidal  IN VARCHAR2]
) RETURN NUMBER;
```

Description

Computes the minimum distance between two geometry objects, which is the distance between the closest pair of points or segments of the two objects.

Parameters

geom1
Geometry object whose distance from `geom2` is to be computed.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object whose distance from `geom1` is to be computed.

dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed.

ellipsoidal
Specifies if ellipsoidal distance is always used with geodetic data (`true`), or if spherical distance is used in some cases (`false`, the default). See Distance: Spherical versus Ellipsoidal with Geodetic Data.

tol
Tolerance value (see Tolerance).

Usage Notes

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

If the input data is three-dimensional and geodetic, a 3D SRID must be used for the geometries; otherwise, the results will be incorrect.

Examples

The following example returns the shortest distance between `cola_b` and `cola_d`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the distance between two geometries.
SELECT SDO_GEOM.SDO_DISTANCE(c_b.shape, c_d.shape, 0.005)
   FROM cola_markets c_b, cola_markets c_d
   WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.SDO_DISTANCE(C_B.SHAPE,C_D.SHAPE,0.005)
------------------------------------------------
                                      .846049894
```

Related Topics

- SDO_GEOM.SDO_MAXDISTANCE
- SDO_GEOM.WITHIN_DISTANCE

25.16 SDO_GEOM.SDO_INTERSECTION

Format

```
SDO_GEOM.SDO_INTERSECTION(
  geom1   IN SDO_GEOMETRY,
  dim1    IN SDO_DIM_ARRAY,
  geom2   IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_INTERSECTION(
  geom1  IN SDO_GEOMETRY,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the topological intersection (AND operation) of two geometry objects.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object.

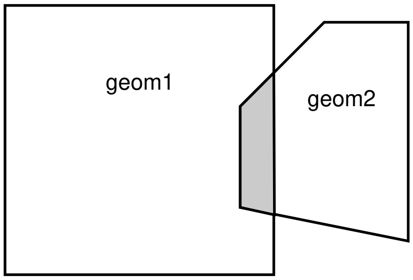
dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

In Figure 25-3, the shaded area represents the polygon returned when SDO_INTERSECTION is used with a square (`geom1`) and another polygon (`geom2`).

Figure 25-3 SDO_GEOM.SDO_INTERSECTION



An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example returns a geometry object that is the topological intersection (AND operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the topological intersection of two geometries.
SELECT SDO_GEOM.SDO_INTERSECTION(c_a.shape, c_c.shape, 0.005)
   FROM cola_markets c_a, cola_markets c_c
   WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_INTERSECTION(C_A.SHAPE,C_C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_PO
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(4, 5, 3, 3, 5, 3, 5, 5, 4, 5))
```

Note that in the returned polygon, the SDO_ORDINATE_ARRAY starts and ends at the same point (4, 5).

Related Topics

- SDO_GEOM.SDO_DIFFERENCE
- SDO_GEOM.SDO_UNION
- SDO_GEOM.SDO_XOR

25.17 SDO_GEOM.SDO_LENGTH

Format

```
SDO_GEOM.SDO_LENGTH(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
  [, unit  IN VARCHAR2]
  [, count_shared_edges  IN NUMBER]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_LENGTH(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit  IN VARCHAR2]
  [, count_shared_edges  IN NUMBER]
) RETURN NUMBER;
```

Description

Returns the length or perimeter of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

count_shared_edges
For three-dimensional geometries only: the number of times to count the length of shared parts of edges if the input geometry contains any edges that are fully or partially shared. If specified, must be 1 (count each once) or 2 (count each twice). The default is 1.
This parameter is ignored for two-dimensional input geometries.

Usage Notes

If the input polygon contains one or more holes, this function calculates the perimeters of the exterior boundary and all holes. It returns the sum of all perimeters.

Examples

The following example returns the perimeters of geometry objects stored in the COLA_MARKETS table. The first statement returns the perimeters of all objects; the second returns just the perimeter of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the perimeters of all cola markets.
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE';

NAME                             SDO_GEOM.SDO_LENGTH(C.SHAPE,M.DIMINFO)
-------------------------------- --------------------------------------
cola_a                                                               20
cola_b                                                       17.1622777
cola_c                                                       9.23606798
cola_d                                                       12.5663706

-- Return the perimeter of just cola_a.
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_a';

NAME                             SDO_GEOM.SDO_LENGTH(C.SHAPE,M.DIMINFO)
-------------------------------- --------------------------------------
cola_a                                                               20
```

Related Topics

None.

25.18 SDO_GEOM.SDO_MAX_MBR_ORDINATE

Format

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  ordinate_pos IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  dim           IN SDO_DIM_ARRAY,
  ordinate_pos IN NUMBER
) RETURN NUMBER;
```

Description

Returns the maximum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

ordinate_pos
Position of the ordinate (dimension) in the definition of the geometry object: 1 for the first ordinate, 2 for the second ordinate, and so on. For example, if `geom` has X, Y ordinates, 1 identifies the X ordinate and 2 identifies the Y ordinate.

Usage Notes

None.

Examples

The following example returns the maximum X (first) ordinate value of the minimum bounding rectangle of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. The minimum bounding rectangle of `cola_d` is returned in the example for the SDO_GEOM.SDO_MBR function.)

```
SELECT SDO_GEOM.SDO_MAX_MBR_ORDINATE(c.shape, m.diminfo, 1)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';

SDO_GEOM.SDO_MAX_MBR_ORDINATE(C.SHAPE,M.DIMINFO,1)
--------------------------------------------------
                                                10
```

Related Topics

- SDO_GEOM.SDO_MBR
- SDO_GEOM.SDO_MIN_MBR_ORDINATE

25.19 SDO_GEOM.SDO_MAXDISTANCE

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_MAXDISTANCE(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MAXDISTANCE(
  geom1  IN SDO_GEOMETRY,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

Description

Computes the maximum distance between two geometry objects. The maximum distance between two geometry objects is the distance between the farthest pair of points or segments of the two objects.

Parameters

geom1
Geometry object whose distance from `geom2` is to be computed.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object whose distance from `geom1` is to be computed.

dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed.

tol
Tolerance value (see Tolerance).

Usage Notes

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

The input geometries can have no more than two dimensions.

Examples

The following example returns the maximum distance between `cola_b` and `cola_d`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_GEOM.SDO_MAXDISTANCE(c_b.shape, c_d.shape, 0.005)
  FROM cola_markets c_b, cola_markets c_d
  WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.SDO_MAXDISTANCE(C_B.SHAPE,C_D.SHAPE,0.005)
---------------------------------------------------
                                         10.5440037
```

Related Topics

- SDO_GEOM.SDO_MAXDISTANCE_LINE
- SDO_GEOM.SDO_DISTANCE
- SDO_GEOM.WITHIN_DISTANCE

25.20 SDO_GEOM.SDO_MAXDISTANCE_LINE

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_MAXDISTANCE_LINE(
  geom1   IN SDO_GEOMETRY,
  dim1    IN SDO_DIM_ARRAY,
  geom2   IN SDO_GEOMETRY,
  dim2    IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MAXDISTANCE_LINE(
  geom1   IN SDO_GEOMETRY,
  geom2   IN SDO_GEOMETRY,
  tol     IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Computes the maximum distance between two geometry objects, and returns the line string geometry reflecting the maximum distance. The maximum distance between two geometry objects is the distance between the farthest pair of points or segments of the two objects. The returned geometry is a straight line between this farthest pair of points or segments.

Parameters

geom1
Geometry object whose distance from `geom2` is to be computed.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object whose distance from `geom1` is to be computed.

dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

The input geometries can have no more than two dimensions.

Examples

The following example returns the line string reflecting the maximum distance between `cola_b` and `cola_d`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_GEOM.SDO_MAXDISTANCE_LINE(c_b.shape, c_d.shape, 0.005)
  FROM cola_markets c_b, cola_markets c_d
  WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.SDO_MAXDISTANCE_LINE(C_B.SHAPE,C_D.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 1, 8.70224688, 10.8726584))
```

Related Topics

- SDO_GEOM.SDO_MAXDISTANCE
- SDO_GEOM.SDO_DISTANCE
- SDO_GEOM.WITHIN_DISTANCE

25.21 SDO_GEOM.SDO_MBC

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_MBC(
  geom          IN SDO_GEOMETRY,
  dim           IN SDO_DIM_ARRAY,
  arc_tolerance IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MBC(
  geom          IN SDO_GEOMETRY,
  tol           IN NUMBER,
  arc_tolerance IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

Description

Returns a circle object that represents the minimum bounding circle (MBC) of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

arc_tolerance
Arc tolerance value (see the explanation of the `arc_tolerance` keyword in the Usage Notes for SDO_GEOM.SDO_ARC_DENSIFY). This parameter is mainly used for densifying geodetic arcs.

Usage Notes

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (`geom`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry. Thus, for example, if the input geometry is a circle, the computed MBC will be larger than the input geometry.

Examples

The following example returns a geometry object that is the minimum bounding circle of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the MBC of cola_a.
SELECT c.name, SDO_GEOM.SDO_MBC(c.shape, 0.005) FROM cola_markets c
  WHERE c.name = 'cola_a';

NAME
--------------------------------
SDO_GEOM.SDO_MBC(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELE
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 4), SDO_ORDINATE_ARR
AY(3, .394448725, 6.60555128, 4, 3, 7.60555128))
```

Related Topics

SDO_GEOM.SDO_MBC_CENTER

SDO_GEOM.SDO_MBC_RADIUS

SDO_GEOM.SDO_MBR

25.22 SDO_GEOM.SDO_MBC_CENTER

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_MBC_CENTER(
  geom    IN SDO_GEOMETRY,
  dim     IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MBC_CENTER(
  geom    IN SDO_GEOMETRY,
  tol     IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns the center of the minimum bounding circle (MBC) of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (`geom`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry.

Examples

The following example returns a point geometry object that is the center of the minimum bounding circle of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the MBC center of cola_a.
SQL> SELECT c.name, SDO_GEOM.SDO_MBC_CENTER(c.shape, 0.005) FROM cola_markets c
  2       WHERE c.name = 'cola_a';

NAME
--------------------------------
SDO_GEOM.SDO_MBC_CENTER(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
3, 4))
```

Related Topics

SDO_GEOM.SDO_MBC

SDO_GEOM.SDO_MBC_RADIUS

SDO_GEOM.SDO_MBR

25.23 SDO_GEOM.SDO_MBC_RADIUS

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_MBC_RADIUS(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY,
  unit  IN VARCHAR2 DEFAULT NULL
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MBC_RADIUS(
  geom   IN SDO_GEOMETRY,
  tol    IN NUMBER,
  unit   IN VARCHAR2 DEFAULT NULL
) RETURN NUMBER;
```

Description

Returns the length of the radius of the minimum bounding circle (MBC) of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

Usage Notes

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (`geom`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry. Thus, for example, if the input geometry is a circle, the length of the radius of the computed MBC will be greater than that of the input geometry.

Examples

The following example returns the length of the radius of the minimum bounding circle of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the MBC radius of cola_a.
SELECT c.name, SDO_GEOM.SDO_MBC_RADIUS(c.shape, 0.005) FROM cola_markets c
  WHERE c.name = 'cola_a';

NAME                             SDO_GEOM.SDO_MBC_RADIUS(C.SHAPE,0.005)
-------------------------------- --------------------------------------
cola_a                                                       3.60555128
```

Related Topics

SDO_GEOM.SDO_MBC

SDO_GEOM.SDO_MBC_CENTER

SDO_GEOM.SDO_MBR

25.24 SDO_GEOM.SDO_MBR

Format

```
SDO_GEOM.SDO_MBR(
  geom   IN SDO_GEOMETRY
  [, dim IN SDO_DIM_ARRAY]
) RETURN SDO_GEOMETRY;
```

Description

Returns the minimum bounding rectangle of a geometry object, that is, a single rectangle that minimally encloses the geometry.

> **Note:**
>
> SDO_GEOM_MBR is a SQL operator that is functionally identical to this function, but provides better performance. See SDO_GEOM_MBR for more information.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function does not return an MBR geometry if a proper MBR cannot be constructed. Specifically:

- If the input geometry is null, the function returns a null geometry.
- If the input geometry is a point, the function returns the point.
- If the input geometry consists of points all on a straight line, the function returns a two-point line.
- If the input geometry has three dimensions but all Z dimension values are the same, the function returns a three-dimensional line.

Examples

The following example returns the minimum bounding rectangle of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. Because `cola_d` is a circle, the minimum bounding rectangle in this case is a square.)

```
-- Return the minimum bounding rectangle of cola_d (a circle).
SELECT SDO_GEOM.SDO_MBR(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';
```

```
SDO_GEOM.SDO_MBR(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(6, 7, 10, 11))
```

Related Topics

- SDO_GEOM.SDO_MAX_MBR_ORDINATE
- SDO_GEOM.SDO_MIN_MBR_ORDINATE

25.25 SDO_GEOM.SDO_MIN_MBR_ORDINATE

Format

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  ordinate_pos IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  dim           IN SDO_DIM_ARRAY,
  ordinate_pos IN NUMBER
) RETURN NUMBER;
```

Description

Returns the minimum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

ordinate_pos
Position of the ordinate (dimension) in the definition of the geometry object: 1 for the first ordinate, 2 for the second ordinate, and so on. For example, if `geom` has X, Y ordinates, 1 identifies the X ordinate and 2 identifies the Y ordinate.

Usage Notes

None.

Examples

The following example returns the minimum X (first) ordinate value of the minimum bounding rectangle of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data. The minimum bounding rectangle of `cola_d` is returned in the example for the SDO_GEOM.SDO_MBR function.)

```
SELECT SDO_GEOM.SDO_MIN_MBR_ORDINATE(c.shape, m.diminfo, 1)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';

SDO_GEOM.SDO_MIN_MBR_ORDINATE(C.SHAPE,M.DIMINFO,1)
--------------------------------------------------
                                                 6
```

Related Topics

- SDO_GEOM.SDO_MAX_MBR_ORDINATE
- SDO_GEOM.SDO_MBR

25.26 SDO_GEOM.SDO_POINTONSURFACE

Format

```
SDO_GEOM.SDO_POINTONSURFACE(
  geom1   IN SDO_GEOMETRY,
  dim1    IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_POINTONSURFACE(
  geom1   IN SDO_GEOMETRY,
  tol     IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a point that is guaranteed to be on the surface of a polygon geometry object.

Parameters

geom1
Polygon geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

This function returns a point geometry object representing a point that is guaranteed to be on the surface of `geom1`; however, it is not guaranteed to be an interior point. (That is, it can be on the boundary or edge of `geom1`.)

The returned point can be any point on the surface. You should not make any assumptions about where on the surface the returned point is, or about whether the point is the same or different when the function is called multiple times with the same input parameter values.

In most cases this function is less useful than the SDO_UTIL.INTERIOR_POINT function, which returns a point that is guaranteed to be an interior point.

Examples

The following example returns a geometry object that is a point on the surface of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return a point on the surface of a geometry.
SELECT SDO_GEOM.SDO_POINTONSURFACE(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_a';

SDO_GEOM.SDO_POINTONSURFACE(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
1, 1))
```

Related Topics

None.

25.27 SDO_GEOM.SDO_SELF_UNION

Format

```
SDO_GEOM.SDO_SELF_UNION(
  geom1   IN SDO_GEOMETRY,
  dim1    IN SDO_DIM_ARRAY,
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_SELF_UNION(
  geom1   IN SDO_GEOMETRY,
  tol     IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a valid geometry object that is the topological self union of one geometry object, which can be invalid.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

This function can be used to fix the following problems that can make a geometry invalid:

- Polygon boundary intersecting itself

- Incorrect orientation of exterior or interior rings (or both) of a polygon

Examples

The following example returns a valid geometry object that is the topological self union of an invalid polygon.

```
-- Return the topological self union of an invalid geometry.
SELECT SDO_GEOM.SDO_SELF_UNION(
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
    SDO_ORDINATE_ARRAY(1, 1, 1, 4, 4, 4, 4, 1, 1, 1)),
  0.00005)
FROM dual;

SDO_GEOM.SDO_SELF_UNION(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(1, 4,
1, 1, 4, 1, 4, 4, 1, 4))
```

Related Topics

- SDO_GEOM.SDO_UNION
- SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
- SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
- SDO_UTIL.RECTIFY_GEOMETRY

25.28 SDO_GEOM.SDO_TRIANGULATE

Format

```
SDO_GEOM.SDO_TRIANGULATE(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry with triangular elements that result from Delaunay triangulation of the input geometry.

Parameters

geom
Geometry object.

tol
Tolerance value (see Tolerance).

Usage Notes

This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations, and returns a geometry object, each element of which is a triangle.

An exception is raised if `geom` has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in Functions Supported by Approximations with Geodetic Data.

Examples

The following example returns a geometry object that consists of triangular elements (two in this case) comprising the `cola_c` polygon geometry. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.

```
-- Return triangles comprising a specified polygon.
SELECT c.name, SDO_GEOM.SDO_TRIANGULATE(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_GEOM.SDO_TRIANGULATE(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1, 9, 1003, 1), SDO_
ORDINATE_ARRAY(3, 3, 6, 3, 4, 5, 3, 3, 4, 5, 6, 3, 6, 5, 4, 5))
```

Related Topics

SDO_GEOM.SDO_ALPHA_SHAPE

25.29 SDO_GEOM.SDO_UNION

Format

```
SDO_GEOM.SDO_UNION(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_UNION(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the topological union (OR operation) of two geometry objects.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object.

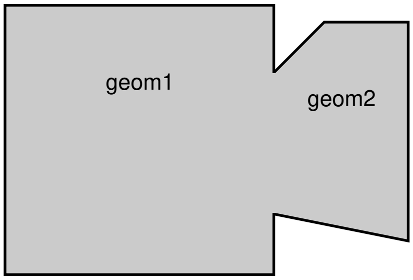
dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

In Figure 25-4, the shaded area represents the polygon returned when SDO_UNION is used with a square (`geom1`) and another polygon (`geom2`).

Figure 25-4 SDO_GEOM.SDO_UNION



If it is sufficient to append one geometry to another geometry without performing a topological union operation, and if both geometries are disjoint, using the SDO_UTIL.APPEND function (described in SDO_LRS Package (Linear Referencing System)) is faster than using the SDO_UNION function.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example returns a geometry object that is the topological union (OR operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the topological union of two geometries.
SELECT SDO_GEOM.SDO_UNION(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_UNION(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 5, 5, 7, 1, 7, 1, 1, 5, 1, 5, 3, 6, 3, 6, 5, 5, 5))
```

Note that in the returned polygon, the SDO_ORDINATE_ARRAY starts and ends at the same point (5, 5).

Related Topics

- SDO_GEOM.SDO_DIFFERENCE
- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_XOR

- SDO_GEOM.SDO_SELF_UNION

25.30 SDO_GEOM.SDO_VOLUME

Format

```
SDO_GEOM.SDO_VOLUME(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

Description

Returns the volume of a three-dimensional solid.

Parameters

geom
Geometry object.

tol
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and volume unit (for example, `'unit=CUBIC_FOOT'` or `'unit=CUBIC_METER'`). For a list of volume units, enter the following query:

```
SELECT short_name FROM mdsys.sdo_units_of_measure WHERE unit_of_meas_type = 'volume';
```

See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed.

Usage Notes

This function works with any solid, including solids with holes.

This function is not supported with geodetic data.

For information about support for three-dimensional geometries, see Three-Dimensional Spatial Objects.

Examples

The following example returns the volume of a solid geometry object.

```
-- Return the volume of a solid geometry.
SELECT p.id, SDO_GEOM.SDO_VOLUME(p.geometry, 0.005) FROM polygons3d p
  WHERE p.id = 12;

        ID SDO_GEOM.SDO_VOLUME(P.GEOMETRY,0.005)
---------- -------------------------------------
        12                                     6
```

Related Topics

None.

25.31 SDO_GEOM.SDO_WIDTH

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_WIDTH(
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_WIDTH(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

Description

Returns the width of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

unit
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.
If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

Usage Notes

For a convex polygon, the width is the minimum distance between parallel lines of support.

For a non-convex geometry, this function determines its convex geometry and returns the width of that convex geometry.

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

Examples

The following example returns the width of all geometry objects stored in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT name, SDO_GEOM.SDO_WIDTH(shape, 0.005) Width
  FROM cola_markets;

NAME                                  WIDTH
-------------------------------- ----------
cola_a                                    4
cola_b                                    3
cola_c                                    2
cola_d                                    4
```

Related Topics

SDO_GEOM.SDO_WIDTH_LINE

SDO_GEOM.SDO_DIAMETER

25.32 SDO_GEOM.SDO_WIDTH_LINE

> **Note:**
>
> This feature is available starting with Oracle Database 12*c* Release 1 (12.1.0.2).

Format

```
SDO_GEOM.SDO_WIDTH(_LINE
  geom  IN SDO_GEOMETRY,
  dim   IN SDO_DIM_ARRAY
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_WIDTH_LINE(
  geom  IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN NUMBER;
```

Description

Returns a line string geometry reflecting the width of a geometry object.

Parameters

geom
Geometry object.

dim
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

For a convex polygon, the width is the minimum distance between parallel lines of support.

For a non-convex geometry, this function determines its convex geometry and returns the width of that convex geometry.

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

Examples

The following example returns line strings reflecting width of each geometry object stored in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT name, SDO_GEOM.SDO_WIDTH_LINE(shape, 0.005)
  FROM cola_markets;

NAME
--------------------------------
SDO_GEOM.SDO_WIDTH_LINE(SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SD
--------------------------------------------------------------------------------
cola_a
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 7, 1, 7))

cola_b
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 7, 5, 7))

cola_c
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
3, 5, 3, 3))

cola_d
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
10, 11, 6, 11))
```

Related Topics

SDO_GEOM.SDO_WIDTH

SDO_GEOM.SDO_DIAMETER_LINE

25.33 SDO_GEOM.SDO_XOR

Format

```
SDO_GEOM.SDO_XOR(
  geom1  IN SDO_XOR,
  dim1   IN SDO_DIM_ARRAY,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_XOR(
  geom1  IN SDO_GEOMETRY,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object that is the topological symmetric difference (XOR operation) of two geometry objects.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom2
Geometry object.

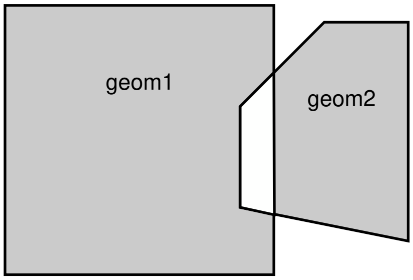
dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

Usage Notes

In Figure 25-5, the shaded area represents the polygon returned when SDO_XOR is used with a square (`geom1`) and another polygon (`geom2`).

Figure 25-5 SDO_GEOM.SDO_XOR



An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example returns a geometry object that is the topological symmetric difference (XOR operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Return the topological symmetric difference of two geometries.
SELECT SDO_GEOM.SDO_XOR(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_XOR(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, S
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1, 19, 1003, 1), SDO
_ORDINATE_ARRAY(1, 7, 1, 1, 5, 1, 5, 3, 3, 3, 4, 5, 5, 5, 5, 7, 1, 7, 5, 5, 5, 3
, 6, 3, 6, 5, 5, 5))
```

Note that the returned polygon is a multipolygon (SDO_GTYPE = 2007), and the SDO_ORDINATE_ARRAY describes two polygons: one starting and ending at (1, 7) and the other starting and ending at (5, 5).

Related Topics

- SDO_GEOM.SDO_DIFFERENCE
- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_UNION

25.34 SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT

Format

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(
  theGeometry  IN SDO_GEOMETRY,
  theDimInfo   IN SDO_DIM_ARRAY,
  conditional  IN VARCHAR2 DEFAULT 'TRUE' ,
  flag10g      IN VARCHAR2 DEFAULT 'FALSE'
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(
  theGeometry  IN SDO_GEOMETRY,
  tolerance    IN NUMBER,
  conditional  IN VARCHAR2 DEFAULT 'TRUE' ,
  flag10g      IN VARCHAR2 DEFAULT 'FALSE'
) RETURN VARCHAR2;
```

Description

Performs a consistency check for valid geometry types and returns context information if the geometry is invalid. The function checks the representation of the geometry from the tables against the element definitions.

Parameters

theGeometry
Geometry object.

theDimInfo
Dimensional information array corresponding to `theGeometry`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tolerance
Tolerance value (see Tolerance).

conditional
Conditional flag; relevant only for a three-dimensional composite surface or composite solid. A string value of `TRUE` (the default) causes validation to fail if two outer rings are on the same plane and share an edge; a string value of `FALSE` does not cause validation to fail if two outer rings are on the same plane and share an edge.

flag10g
Oracle Database 10*g* compatibility flag. A string value of `TRUE` causes only validation checks specific to two-dimensional geometries to be performed, and no 3D-specific validation checks to be performed. A string value of `FALSE` (the default) performs all validation checks that are relevant for the geometry. (See the Usage Notes for more information about the `flag10g` parameter.)

Usage Notes

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data, as explained in Recommendations for Loading and Validating Spatial Data.

If the geometry is valid, this function returns TRUE. (For a user-defined geometry, that is, a geometry with an SDO_GTYPE value of 2000, this function returns the string NULL.)

If the geometry is not valid, this function returns the following:

- An Oracle error message number based on the specific reason the geometry is invalid, or FALSE if the geometry fails for some other reason
- The context of the error (the coordinate, edge, or ring that causes the geometry to be invalid). (See Context of Errors: Details in this section.)

This function checks for type consistency and geometry consistency.

For type consistency, the function checks for the following:

- The SDO_GTYPE is valid.
- The SDO_ETYPE values are consistent with the SDO_GTYPE value. For example, if the SDO_GTYPE is 2003, there should be at least one element of type POLYGON in the geometry.
- The SDO_ELEM_INFO_ARRAY has valid triplet values.

For geometry consistency, the function checks for the following, as appropriate for the specific geometry type:

- Polygons have at least four points, which includes the point that closes the polygon. (The last point is the same as the first.)
- Polygons are not self-crossing.
- No two consecutive vertices on a line or polygon are the same.
- Polygons are oriented correctly. (Exterior ring boundaries must be oriented counterclockwise, and interior ring boundaries must be oriented clockwise.)
- The interior of a polygon is connected.
- Line strings have at least two points.
- SDO_ETYPE 1-digit and 4-digit values are not mixed (that is, both used) in defining polygon ring elements.
- Points on an arc are not colinear (that is, are not on a straight line) and are not the same point.

- Geometries are within the specified bounds of the applicable DIMINFO column value (from the USER_SDO_GEOM_METADATA view).
- LRS geometries (see Linear Referencing System) have three or four dimensions and a valid measure dimension position (3 or 4, depending on the number of dimensions).

For COLLECTION type geometries, some of the preceding checks mentioned above are not performed. Specifically, interior ring checks and polygon-polygon overlap checks are not performed for polygon elements of the COLLECTION type geometry.

For multipoint geometries, this function checks for duplicate vertices with three-dimensional geometries, but not with two-dimensional geometries.

For three-dimensional geometries, this function also performs the checks described in Validation Checks for Three-Dimensional Geometries.

In checking for geometry consistency, the function considers the geometry's tolerance value in determining if lines touch or if points are the same.

If the function format with `tolerance` is used, no checking is done to validate that the geometry is within the coordinate system bounds as stored in the DIMINFO field of the USER_SDO_GEOM_METADATA view. If this check is required for your usage, use the function format with `theDimInfo`.

Setting the `flag10g` parameter value to `TRUE` causes the validation logic for Oracle Spatial Release 10.2 to be used, irrespective of the dimensionality of the geometry. This can be useful for allowing three-dimensional geometries that contain geometries in pre-Release 11.1 format to pass the validation check when they would otherwise fail. For example, a three-dimensional line is not valid if it contains circular arcs; and setting `flag10g` to `TRUE` will allow such geometries to avoid being considered invalid solely because of the circular arcs. (You should later make these geometries valid according to the criteria for the current release, such as by densifying the circular arcs.)

You can use this function in a PL/SQL procedure as an alternative to using the SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT procedure. See the Usage Notes for SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT for more information.

Context of Errors: Details

If a geometry is invalid, the result can include information about a combination of the following: coordinates, elements, rings, and edges.

- **Coordinates**: A coordinate refers to a vertex in a geometry. In a two-dimensional geometry, a vertex is two numbers (X and Y, or Longitude and Latitude). In a three-dimensional geometry, a vertex is defined using three numbers; and in a four-dimensional geometry, a vertex is defined using four numbers. (You can use the SDO_UTIL.GETVERTICES function to return the coordinates in a geometry.)

  If you receive a geometry validation error such as 13356 (adjacent points in a geometry are redundant), you can call the SDO_UTIL.GETVERTICES function, specifying a rownum stopping condition to include the coordinate one greater than the coordinate indicated with the error. The last two coordinates shown in the output are the redundant coordinates. These coordinates may be exactly the same, or they may be within the user-specified tolerance and thus are considered the same point. You can remove redundant coordinates by using the SDO_UTIL.REMOVE_DUPLICATE_VERTICES function.
- **Elements**: An element is a point, a line string, or an exterior polygon with zero or more corresponding interior polygons. (That is, a polygon element includes the exterior ring and all interior rings associated with that exterior ring.) If a geometry is a multi-element geometry (for example, multiple points, lines, or polygons), the first element is element 1, the second element is element 2, and so on.

- **Rings**: A ring is only used with polygon elements. Exterior rings in a polygon are considered polygon elements, and an exterior ring can include zero or more interior rings (or holes). Each interior ring has its own ring designation, but Ring 1 is associated with the exterior polygon itself. For example, Element 1, Ring 1 refers to the first exterior polygon in a geometry; Element 1, Ring 2 refers to the first interior polygon of the first exterior polygon; and Element 1, Ring 3 refers to the second interior polygon. If the geometry is a multipolygon, Element 2, Ring 1 is used to refers to the second exterior polygon. If there are interior polygons associated with it, Element 2, Ring 2 refers to the first interior polygon of the second exterior polygon.
- **Edges**: An edge refers to a line segment between two coordinates. Edge 1 refers to the segment between coordinate 1 and coordinate 2, Edge 2 refers to the line segment between coordinates 2 and 3, and so on. The most common place to see edge errors when validating geometries is with self-intersecting polygons. (The Open Geospatial Consortium simple features specification does not allow a polygon to self-intersect.) In such cases, Oracle reports error 13349 (polygon boundary crosses itself), including the Element, Ring, and Edge numbers where self-intersection occurs.

  If error 13351 (shared edge) is returned for an optimized rectangle that spans more than 119 degrees in longitude, some queries on this rectangle will return correct results, as explained in Geodetic MBRs.

Examples

The following example validates a geometry (deliberately created as invalid) named `cola_invalid_geom`.

```
-- Validate; provide context if invalid
SELECT c.name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(c.shape, 0.005)
   FROM cola_markets c WHERE c.name = 'cola_invalid_geom';

NAME
--------------------------------
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(C.SHAPE,0.005)
--------------------------------------------------------------------------------
cola_invalid_geom
13349 [Element <1>] [Ring <1>][Edge <1>][Edge <3>]
```

In the output for this example, 13349 indicates the error `ORA-13349: polygon boundary crosses itself`. The first ring of the first element has edges that intersect. The edges that intersect are edge 1 (the first and second vertices) and edge 3 (the third and fourth vertices).

Related Topics

- SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
- SDO_GEOM.SDO_SELF_UNION

25.35 SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT

Format

```
SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT(
  geom_table      IN VARCHAR2,
  geom_column     IN VARCHAR2,
  result_table    IN VARCHAR2,
  commit_interval IN NUMBER DEFAULT -1,
  conditional     IN VARCHAR2 DEFAULT 'TRUE' ,
  flag10g         IN VARCHAR2 DEFAULT 'FALSE',
  geom_schema     IN VARCHAR2 DEFAULT NULL);
```

Description

Examines a geometry column to determine if the stored geometries follow the defined rules for geometry objects, and returns context information about any invalid geometries.

Parameters

geom_table
Spatial geometry table. Can be specified in *schema.table* format (for example, `scott.shapes`), unless the `geom_schema` parameter is specified.

geom_column
Geometry object column to be examined.

result_table
Result table to hold the validation results. A row is added to `result_table` for each invalid geometry. If there are no invalid geometries, one or more (depending on the `commit_interval` value) rows with a result of DONE are added.

commit_interval
Number of geometries to validate before Spatial performs an internal commit operation and writes a row with a result of DONE to `result_table` (if no rows for invalid geometries have been written since the last commit operation). If `commit_interval` is not specified, no internal commit operations are performed during the validation.
The `commit_interval` option is helpful if you want to look at the contents of `result_table` while the validation is in progress.

conditional
Conditional flag; relevant only for a three-dimensional composite surface or composite solid. A string value of `TRUE` (the default) causes validation to fail if two outer rings are on the same plane and share an edge; a string value of `FALSE` does not cause validation to fail if two outer rings are on the same plane and share an edge.

flag10g
Oracle Database 10*g* compatibility flag. A string value of `TRUE` causes only validation checks specific to two-dimensional geometries to be performed, and no 3D-specific validation checks to be performed. A string value of `FALSE` (the default) performs all validation checks that are relevant for the geometries. (See the Usage Notes for the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function for more information about the `flag10g` parameter.)

geom_schema
Specifies the schema of the `geom_table` table, if it differs from the current schema. If `geom_schema` is specified, the `geom_table` parameter cannot be specified in *schema.table* format.

Usage Notes

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data, as explained in Recommendations for Loading and Validating Spatial Data.

This procedure loads the result table with validation results.

An empty result table (`result_table` parameter) should be created before calling this procedure. The format of the result table is: (sdo_rowid ROWID, result VARCHAR2(2000)). If `result_table` is not empty, it is automatically truncated by the procedure before any rows are added.

The result table contains one row for each invalid geometry. A row is not written if a geometry is valid, except as follows:

- If `commit_interval` is not specified (or if the `commit_interval` value is greater than the number of geometries in the layer) and no invalid geometries are found, a single row with a RESULT value of DONE is written.
- If `commit_interval` is specified and if no invalid geometries are found between an internal commit and the previous internal commit (or start of validation for the first internal commit), a single row with the primary key of the last geometry validated and a RESULT value of DONE is written. (If there have been no invalid geometries since the last internal commit operation, this row replaces the previous row that had a result of DONE.)

In each row for an invalid geometry, the SDO_ROWID column contains the ROWID value of the row containing the invalid geometry, and the RESULT column contains an Oracle error message number and the context of the error (the coordinate, edge, or ring that causes the geometry to be invalid). You can then look up the error message for more information about the cause of the failure.

This procedure performs the following checks on each geometry in the layer (`geom_column`):

- All type consistency and geometry consistency checks that are performed by the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function (see the Usage Notes for that function).
- The geometry's SRID value (coordinate system) is the same as the one specified in the applicable DIMINFO column value (from the USER_SDO_GEOM_METADATA view, which is described in Geometry Metadata Views).

Examples

The following example validates the geometry objects stored in the SHAPE column of the COLA_MARKETS table. The example includes the creation of the result table. For this example, a deliberately invalid geometry was inserted into the table before the validation was performed.

```
-- Is a layer valid? (First, create the result table.)
CREATE TABLE val_results (sdo_rowid ROWID, result varchar2(1000));
-- (Next statement must be on one command line.)
CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS','SHAPE','VAL_RESULTS');

Call completed.

SQL> SELECT * from val_results;

SDO_ROWID
------------------
RESULT
--------------------------------------------------------------------------------

Rows Processed <12>

AAABXNAABAAAK+YAAC
13349 [Element <1>] [Ring <1>][Edge <1>][Edge <3>]
```

Related Topics

- SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT

- SDO_GEOM.SDO_SELF_UNION

25.36 SDO_GEOM.WITHIN_DISTANCE

Format

```
SDO_GEOM.WITHIN_DISTANCE(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY,
  dist   IN NUMBER,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
  [, units       IN VARCHAR2]
  [, ellipsoidal IN VARCHAR2]
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.WITHIN_DISTANCE(
  geom1  IN SDO_GEOMETRY,
  dist   IN NUMBER,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
  [, units       IN VARCHAR2]
  [, ellipsoidal IN VARCHAR2]
) RETURN VARCHAR2;
```

Description

Determines if two spatial objects are within some specified distance from each other.

Parameters

geom1
Geometry object.

dim1
Dimensional information array corresponding to `geom1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

dist
Distance value.

geom2
Geometry object.

dim2
Dimensional information array corresponding to `geom2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tol
Tolerance value (see Tolerance).

units
Unit of measurement: a quoted string with `unit=` and an SDO_UNIT value from the MDSYS.SDO_AREA_UNITS table (for example, 'unit=KM'). See Unit of Measurement Support for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

ellipsoidal
Specifies if ellipsoidal distance is always used with geodetic data (`true`), or if spherical distance is used in some cases (`false`, the default). See Distance: Spherical versus Ellipsoidal with Geodetic Data.

Usage Notes

For better performance, use the SDO_WITHIN_DISTANCE operator (described in Spatial Operators) instead of the `SDO_GEOM.WITHIN_DISTANCE` function. For more information about performance considerations with operators and functions, see Spatial Operators_ Procedures_ and Functions.

This function returns TRUE for object pairs that are within the specified distance, and FALSE otherwise.

The distance between two extended objects (for example, nonpoint objects such as lines and polygons) is defined as the minimum distance between these two objects. Thus the distance between two adjacent polygons is zero.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

Examples

The following example checks if `cola_b` and `cola_d` are within 1 unit apart at the shortest distance between them. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Are two geometries within 1 unit of distance apart?
SELECT SDO_GEOM.WITHIN_DISTANCE(c_b.shape, m.diminfo, 1,
     c_d.shape, m.diminfo)
  FROM cola_markets c_b, cola_markets c_d, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.WITHIN_DISTANCE(C_B.SHAPE,M.DIMINFO,1,C_D.SHAPE,M.DIMINFO)
--------------------------------------------------------------------------------
TRUE
```

Related Topics

- SDO_GEOM.SDO_DISTANCE

26

SDO_LRS Package (Linear Referencing System)

The MDSYS.SDO_LRS package contains subprograms that create, modify, query, and convert linear referencing elements.

These subprograms do not change the state of the database. Most LRS subprograms are functions.

To use the subprograms in this chapter, you must understand the linear referencing system (LRS) concepts and techniques described in Linear Referencing System.

> **Note:**
>
> The SDO_LRS subprograms for three-dimensional geometries are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

Table 26-1 lists subprograms related to creating and editing geometric segments.

Table 26-1 Subprograms for Creating and Editing Geometric Segments

Subprogram	Description
SDO_LRS.DEFINE_GEOM_SEGMENT	Defines a geometric segment.
SDO_LRS.REDEFINE_GEOM_SEGMENT	Populates the measures of all shape points of a geometric segment based on the start and end measures, overriding any previously assigned measures between the start point and end point.
SDO_LRS.CLIP_GEOM_SEGMENT	Clips a geometric segment (synonym of SDO_LRS.DYNAMIC_SEGMENT).
SDO_LRS.DYNAMIC_SEGMENT	Clips a geometric segment (synonym of SDO_LRS.CLIP_GEOM_SEGMENT).
SDO_LRS.CONCATENATE_GEOM_SEGMENTS	Concatenates two geometric segments into one segment.
SDO_LRS.LRS_INTERSECTION	Returns an LRS geometry object that is the topological intersection (AND operation) of two geometry objects where one or both are LRS geometries.
SDO_LRS.OFFSET_GEOM_SEGMENT	Returns the geometric segment at a specified offset from a geometric segment.
SDO_LRS.SPLIT_GEOM_SEGMENT	Splits a geometric segment into two segments.
SDO_LRS.RESET_MEASURE	Sets all measures of a geometric segment, including the start and end measures, to null values, overriding any previously assigned measures.

Table 26-1 (Cont.) Subprograms for Creating and Editing Geometric Segments

Subprogram	Description
SDO_LRS.SCALE_GEOM_SEGMENT	Returns the geometry object resulting from a measure scaling operation on a geometric segment.
SDO_LRS.SET_PT_MEASURE	Sets the measure value of a specified point.
SDO_LRS.REVERSE_MEASURE	Returns a new geometric segment by reversing the measure values, but not the direction, of the original geometric segment.
SDO_LRS.TRANSLATE_MEASURE	Returns a new geometric segment by translating the original geometric segment (that is, shifting the start and end measures by a specified value).
SDO_LRS.REVERSE_GEOMETRY	Returns a new geometric segment by reversing the measure values and the direction of the original geometric segment.

Table 26-2 lists subprograms related to querying geometric segments.

Table 26-2 Subprograms for Querying and Validating Geometric Segments

Subprogram	Description
SDO_LRS.VALID_GEOM_SEGMENT	Checks if a geometric segment is valid.
SDO_LRS.VALID_LRS_PT	Checks if an LRS point is valid.
SDO_LRS.VALID_MEASURE	Checks if a measure falls within the measure range of a geometric segment.
SDO_LRS.CONNECTED_GEOM_SEGMENTS	Checks if two geometric segments are spatially connected.
SDO_LRS.GEOM_SEGMENT_LENGTH	Returns the length of a geometric segment.
SDO_LRS.GEOM_SEGMENT_START_PT	Returns the start point of a geometric segment.
SDO_LRS.GEOM_SEGMENT_END_PT	Returns the end point of a geometric segment.
SDO_LRS.GEOM_SEGMENT_START_MEASURE	Returns the start measure of a geometric segment.
SDO_LRS.GEOM_SEGMENT_END_MEASURE	Returns the end measure of a geometric segment.
SDO_LRS.GET_MEASURE	Returns the measure of an LRS point.
SDO_LRS.GET_NEXT_SHAPE_PT	Returns the next shape point on a geometric segment after a specified measure value or LRS point.
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE	Returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.
SDO_LRS.GET_PREV_SHAPE_PT	Returns the previous shape point on a geometric segment before a specified measure value or LRS point.
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE	Returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.
SDO_LRS.IS_GEOM_SEGMENT_DEFINED	Checks if an LRS segment is defined correctly.

Table 26-2 (Cont.) Subprograms for Querying and Validating Geometric Segments

Subprogram	Description
SDO_LRS.IS_MEASURE_DECREASING	Checks if the measure values along an LRS segment are decreasing (that is, descending in numerical value).
SDO_LRS.IS_MEASURE_INCREASING	Checks if the measure values along an LRS segment are increasing (that is, ascending in numerical value).
SDO_LRS.IS_SHAPE_PT_MEASURE	Checks if a specified measure value is associated with a shape point on a geometric segment.
SDO_LRS.MEASURE_RANGE	Returns the measure range of a geometric segment, that is, the difference between the start measure and end measure.
SDO_LRS.MEASURE_TO_PERCENTAGE	Returns the percentage (0 to 100) that a specified measure is of the measure range of a geometric segment.
SDO_LRS.PERCENTAGE_TO_MEASURE	Returns the measure value of a specified percentage (0 to 100) of the measure range of a geometric segment.
SDO_LRS.LOCATE_PT	Returns the point located at a specified distance from the start of a geometric segment.
SDO_LRS.PROJECT_PT	Returns the projection point of a specified point. The projection point is on the geometric segment.
SDO_LRS.FIND_LRS_DIM_POS	Returns the position of the measure dimension within the SDO_DIM_ARRAY structure for a specified SDO_GEOMETRY column.
SDO_LRS.FIND_MEASURE	Returns the measure of the closest point on a segment to a specified projection point.
SDO_LRS.FIND_OFFSET	Returns the signed offset (shortest distance) from a point to a geometric segment.
SDO_LRS.VALIDATE_LRS_GEOMETRY	Checks if an LRS geometry is valid.

Table 26-3 lists subprograms related to converting geometric segments.

Table 26-3 Subprograms for Converting Geometric Segments

Subprogram	Description
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY	Converts a standard dimensional array to an LRS dimensional array by creating a measure dimension.
SDO_LRS.CONVERT_TO_LRS_GEOM	Converts a standard SDO_GEOMETRY line string to an LRS geometric segment by adding measure information.
SDO_LRS.CONVERT_TO_LRS_LAYER	Converts all geometry objects in a column of type SDO_GEOMETRY from standard line string geometries without measure information to LRS geometric segments with measure information, and updates the metadata.
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY	Converts an LRS dimensional array to a standard dimensional array by removing the measure dimension.

Table 26-3 (Cont.) Subprograms for Converting Geometric Segments

Subprogram	Description
SDO_LRS.CONVERT_TO_STD_GEOM	Converts an LRS geometric segment to a standard SDO_GEOMETRY line string by removing measure information.
SDO_LRS.CONVERT_TO_STD_LAYER	Converts all geometry objects in a column of type SDO_GEOMETRY from LRS geometric segments with measure information to standard line string geometries without measure information, and updates the metadata.

For more information about conversion subprograms, see Converting LRS Geometries.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_LRS.CLIP_GEOM_SEGMENT
- SDO_LRS.CONCATENATE_GEOM_SEGMENTS
- SDO_LRS.CONNECTED_GEOM_SEGMENTS
- SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY
- SDO_LRS.CONVERT_TO_LRS_GEOM
- SDO_LRS.CONVERT_TO_LRS_LAYER
- SDO_LRS.CONVERT_TO_STD_DIM_ARRAY
- SDO_LRS.CONVERT_TO_STD_GEOM
- SDO_LRS.CONVERT_TO_STD_LAYER
- SDO_LRS.DEFINE_GEOM_SEGMENT
- SDO_LRS.DYNAMIC_SEGMENT
- SDO_LRS.FIND_LRS_DIM_POS
- SDO_LRS.FIND_MEASURE
- SDO_LRS.FIND_OFFSET
- SDO_LRS.GEOM_SEGMENT_END_MEASURE
- SDO_LRS.GEOM_SEGMENT_END_PT
- SDO_LRS.GEOM_SEGMENT_LENGTH
- SDO_LRS.GEOM_SEGMENT_START_MEASURE
- SDO_LRS.GEOM_SEGMENT_START_PT
- SDO_LRS.GET_MEASURE
- SDO_LRS.GET_NEXT_SHAPE_PT
- SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE
- SDO_LRS.GET_PREV_SHAPE_PT
- SDO_LRS.GET_PREV_SHAPE_PT_MEASURE
- SDO_LRS.IS_GEOM_SEGMENT_DEFINED

- SDO_LRS.IS_MEASURE_DECREASING
- SDO_LRS.IS_MEASURE_INCREASING
- SDO_LRS.IS_SHAPE_PT_MEASURE
- SDO_LRS.LOCATE_PT
- SDO_LRS.LRS_INTERSECTION
- SDO_LRS.MEASURE_RANGE
- SDO_LRS.MEASURE_TO_PERCENTAGE
- SDO_LRS.OFFSET_GEOM_SEGMENT
- SDO_LRS.PERCENTAGE_TO_MEASURE
- SDO_LRS.PROJECT_PT
- SDO_LRS.REDEFINE_GEOM_SEGMENT
- SDO_LRS.RESET_MEASURE
- SDO_LRS.REVERSE_GEOMETRY
- SDO_LRS.REVERSE_MEASURE
- SDO_LRS.SCALE_GEOM_SEGMENT
- SDO_LRS.SET_PT_MEASURE
- SDO_LRS.SPLIT_GEOM_SEGMENT
- SDO_LRS.TRANSLATE_MEASURE
- SDO_LRS.VALID_GEOM_SEGMENT
- SDO_LRS.VALID_LRS_PT
- SDO_LRS.VALID_MEASURE
- SDO_LRS.VALIDATE_LRS_GEOMETRY

26.1 SDO_LRS.CLIP_GEOM_SEGMENT

Format

```
SDO_LRS.CLIP_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     tolerance     IN NUMBER DEFAULT 1.0e-8
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CLIP_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     dim_array     IN SDO_DIM_ARRAY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the geometry object resulting from a clip operation on a geometric segment.

> **Note:**
>
> SDO_LRS.CLIP_GEOM_SEGMENT and SDO_LRS.DYNAMIC_SEGMENT are synonyms: both functions have the same parameters, behavior, and return value.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Start measure of the geometric segment.

end_measure
End measure of the geometric segment.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

`start_measure` and `end_measure` can be any points on the geometric segment. They do not have to be in any specific order. For example, `start_measure` and `end_measure` can be 5 and 10, respectively, or 10 and 5, respectively.

The direction and measures of the resulting geometric segment are preserved (that is, they reflect the original segment).

The *_3D* format of this function (SDO_LRS.CLIP_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about clipping geometric segments, see Clipping a Geometric Segment.

Examples

The following example clips the geometric segment representing Route 1, returning the segment from measures 5 through 10. This segment might represent a construction zone. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.CLIP_GEOM_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))
```

26.2 SDO_LRS.CONCATENATE_GEOM_SEGMENTS

Format

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(
     geom_segment_1  IN SDO_GEOMETRY,
     geom_segment_2  IN SDO_GEOMETRY,
     tolerance       IN NUMBER DEFAULT 1.0e-8
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(
     geom_segment_1  IN SDO_GEOMETRY,
     dim_array_1     IN SDO_DIM_ARRAY,
     geom_segment_2  IN SDO_GEOMETRY,
     dim_array_2     IN SDO_DIM_ARRAY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the geometry object resulting from the concatenation of two geometric segments.

Parameters

geom_segment_1
First geometric segment (LRS segment containing measure information) to be concatenated.

dim_array_1
Dimensional information array corresponding to `geom_segment_1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom_segment_2
Second geometric segment (LRS segment containing measure information) to be concatenated.

dim_array_2
Dimensional information array corresponding to `geom_segment_2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

An exception is raised if `geom_segment_1` or `geom_segment_2` has an invalid geometry type or dimensionality, or if `geom_segment_1` and `geom_segment_2` are based on different coordinate systems.

The direction of the first geometric segment is preserved, and all measures of the second segment are shifted so that its start measure is the same as the end measure of the first segment.

The geometry type of `geom_segment_1` and `geom_segment_2` must be line or multiline. Neither can be a polygon.

The *_3D* format of this function (SDO_LRS.CONCATENATE_GEOM_SEGMENTS_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about concatenating geometric segments, see Concatenating Geometric Segments.

Examples

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in Example of LRS Functions. The definitions of `result_geom_1`, `result_geom_2`, and `result_geom_3` are displayed in Example 7-3.)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0,    -- Zero starting measure: LRS segment starts at start of route.
  27);  -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Insert geometries into table, to display later.
INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);
```

```
END;
/
```

26.3 SDO_LRS.CONNECTED_GEOM_SEGMENTS

Format

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(
     geom_segment_1  IN SDO_GEOMETRY,
     geom_segment_2  IN SDO_GEOMETRY,
     tolerance       IN NUMBER DEFAULT 1.0e-8
     ) RETURN VARCHAR2;
```

or

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(
     geom_segment_1  IN SDO_GEOMETRY,
     dim_array_1     IN SDO_DIM_ARRAY,
     geom_segment_2  IN SDO_GEOMETRY,
     dim_array_2     IN SDO_DIM_ARRAY
     ) RETURN VARCHAR2;
```

Description

Checks if two geometric segments are spatially connected.

Parameters

geom_segment_1
First of two geometric segments (LRS segments containing measure information) to be checked.

dim_array_1
Dimensional information array corresponding to `geom_segment_1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom_segment_2
Second of two geometric segments (LRS segments containing measure information) to be checked.

dim_array_2
Dimensional information array corresponding to `geom_segment_2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

This function returns TRUE if the geometric segments are spatially connected and FALSE if the geometric segments are not spatially connected.

An exception is raised if `geom_segment_1` or `geom_segment_2` has an invalid geometry type or dimensionality, or if `geom_segment_1` and `geom_segment_2` are based on different coordinate systems.

The *_3D* format of this function (SDO_LRS.CONNECTED_GEOM_SEGMENTS_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if two geometric segments (results of a previous split operation) are spatially connected.

```
-- Are result_geom_1 and result_geom2 connected?
SELECT  SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
           b.route_geometry, 0.005)
  FROM lrs_routes a, lrs_routes b
  WHERE a.route_id = 11 AND b.route_id = 12;

SDO_LRS.CONNECTED_GEOM_SEGMENTS(A.ROUTE_GEOMETRY,B.ROUTE_GEOMETRY,0.005)
--------------------------------------------------------------------------------
TRUE
```

26.4 SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY

Format

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
     dim_array      IN SDO_DIM_ARRAY
     [, lower_bound IN NUMBER,
     upper_bound    IN NUMBER,
     tolerance      IN NUMBER]
     ) RETURN SDO_DIM_ARRAY;

or

SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
     dim_array      IN SDO_DIM_ARRAY,
     dim_name       IN VARCHAR2
     [, lower_bound IN NUMBER,
     upper_bound    IN NUMBER,
     tolerance      IN NUMBER]
     ) RETURN SDO_DIM_ARRAY;

or

SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
     dim_array      IN SDO_DIM_ARRAY,
     dim_name       IN VARCHAR2,
     dim_pos        IN INTEGER
     [, lower_bound IN NUMBER,
     upper_bound    IN NUMBER,
     tolerance      IN NUMBER]
     ) RETURN SDO_DIM_ARRAY;
```

Description

Converts a standard dimensional array to an LRS dimensional array by creating a measure dimension.

Parameters

dim_array
Dimensional information array corresponding to the layer (column of geometries) to be converted, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

dim_name
Name of the measure dimension (`M`, if not otherwise specified).

dim_pos
Position of the measure dimension (the last SDO_DIM_ELEMENT object position in the SDO_DIM_ARRAY, if not otherwise specified).

lower_bound
Lower bound (SDO_LB value in the SDO_DIM_ELEMENT definition) of the ordinate in the measure dimension.

upper_bound
Upper bound (SDO_UB value in the SDO_DIM_ELEMENT definition) of the ordinate in the measure dimension.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

This function converts a standard dimensional array to an LRS dimensional array by creating a measure dimension. Specifically, it adds an SDO_DIM_ELEMENT object at the end of the current SDO_DIM_ELEMENT objects in the SDO_DIM_ARRAY for the dimensional array (unless another `dim_pos` is specified), and sets the SDO_DIMNAME value in this added SDO_DIM_ELEMENT to M (unless another `dim_name` is specified). It sets the other values in the added SDO_DIM_ELEMENT according to the values of the `upper_bound`, `lower_bound`, and `tolerance` parameter values.

If `dim_array` already contains dimensional information, the `dim_array` is returned.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the dimensional array for the LRS_ROUTES table to LRS format. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(m.diminfo)
   FROM user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(M.DIMINFO)(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOL
--------------------------------------------------------------------------------
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .00
5), SDO_DIM_ELEMENT('M', 0, 20, .005))
```

26.5 SDO_LRS.CONVERT_TO_LRS_GEOM

Format

```
SDO_LRS.CONVERT_TO_LRS_GEOM(
     standard_geom    IN SDO_GEOMETRY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]
     ) RETURN SDO_GEOMETRY;

or

SDO_LRS.CONVERT_TO_LRS_GEOM(
     standard_geom    IN SDO_GEOMETRY,
     dim_array        IN SDO_DIM_ARRAY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]
     ) RETURN SDO_GEOMETRY;

or

SDO_LRS.CONVERT_TO_LRS_GEOM(
     standard_geom    IN SDO_GEOMETRY,
     m_pos            IN INTEGER
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]
    ) RETURN SDO_GEOMETRY;
```

Description

Converts a standard SDO_GEOMETRY line string to an LRS geometric segment by adding measure information.

Parameters

standard_geom
Line string geometry that does not contain measure information.

dim_array
Dimensional information array corresponding to `standard_geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

m_pos
Position of the measure dimension. If specified, must be 3 or 4. By default, the measure dimension is the last dimension in the SDO_DIM_ARRAY.

start_measure
Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is 0.

end_measure
Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the cartographic length (for example, 75 if the cartographic length is 75 and the unit of measure is miles).

Usage Notes

This function returns an LRS geometric segment with measure information, with measure information provided for all shape points.

An exception is raised if `standard_geom` has an invalid geometry type or dimensionality, if `m_pos` is less than 3 or greater than 4, or if `start_measure` or `end_measure` is out of range.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_LRS_GEOM_3D) is available; however, the `m_pos` parameter is not available for SDO_LRS.CONVERT_TO_LRS_GEOM_3D. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the geometric segment representing Route 1 to LRS format. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.CONVERT_TO_LRS_GEOM(a.route_geometry, m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.CONVERT_TO_LRS_GEOM(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, NULL, 8, 10, 22, 5, 14, 27))
```

26.6 SDO_LRS.CONVERT_TO_LRS_LAYER

Format

```
SDO_LRS.CONVERT_TO_LRS_LAYER(
     table_name      IN VARCHAR2,
     column_name     IN VARCHAR2
     [, lower_bound IN NUMBER,
     upper_bound     IN NUMBER,
     tolerance       IN NUMBER]
     ) RETURN VARCHAR2;
```

or

```
SDO_LRS.CONVERT_TO_LRS_LAYER(
     table_name      IN VARCHAR2,
     column_name     IN VARCHAR2,
     dim_name        IN VARCHAR2,
     dim_pos         IN INTEGER
     [, lower_bound IN NUMBER,
     upper_bound     IN NUMBER,
     tolerance       IN NUMBER]
     ) RETURN VARCHAR2;
```

Description

Converts all geometry objects in a column of type SDO_GEOMETRY (that is, converts a layer) from standard line string geometries without measure information to LRS geometric segments with measure information, and updates the metadata in the USER_SDO_GEOM_METADATA view.

Parameters

table_name
Table containing the column with the SDO_GEOMETRY objects.

column_name
Column in `table_name` containing the SDO_GEOMETRY objects.

dim_name
Name of the measure dimension. If this parameter is null, `M` is assumed.

dim_pos
Position of the measure dimension within the SDO_DIM_ARRAY structure for the specified SDO_GEOMETRY column. If this parameter is null, the number corresponding to the last position is assumed.

lower_bound
Lower bound (SDO_LB value in the SDO_DIM_ELEMENT definition) of the ordinate in the measure dimension.

upper_bound
Upper bound (SDO_UB value in the SDO_DIM_ELEMENT definition) of the ordinate in the measure dimension.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

This function returns TRUE if the conversion was successful or if the layer already contains measure information, and the function returns an exception if the conversion was not successful.

An exception is raised if the existing dimensional information for the table is invalid.

The measure values are assigned based on a start measure of zero and an end measure of the cartographic length.

If a spatial index already exists on `column_name`, you must delete (drop) the index before converting the layer and create a new index after converting the layer. For information about deleting and creating indexes, see the DROP INDEX and CREATE INDEX statements in SQL Statements for Indexing Spatial Data.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_LRS_LAYER_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the geometric segments in the ROUTE_GEOMETRY column of the LRS_ROUTES table to LRS format. (This example uses the definitions from the example in Example of LRS Functions.) The SELECT statement shows that dimensional information has been added (that is, `SDO_DIM_ELEMENT('M', NULL, NULL, NULL)` is included in the definition).

```
BEGIN
  IF (SDO_LRS.CONVERT_TO_LRS_LAYER('LRS_ROUTES', 'ROUTE_GEOMETRY') =  'TRUE')
```

```
    THEN
      DBMS_OUTPUT.PUT_LINE('Conversion from STD_LAYER to LRS_LAYER succeeded.');
    ELSE
      DBMS_OUTPUT.PUT_LINE('Conversion from STD_LAYER to LRS_LAYER failed.');
  END IF;
END;
.
/
Conversion from STD_LAYER to LRS_LAYER succeeded.

PL/SQL procedure successfully completed.

SQL> SELECT diminfo FROM user_sdo_geom_metadata WHERE table_name = 'LRS_ROUTES' AND
column_name = 'ROUTE_GEOMETRY';

DIMINFO(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOLERANCE)
--------------------------------------------------------------------------------
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .00
5), SDO_DIM_ELEMENT('M', NULL, NULL, NULL))
```

26.7 SDO_LRS.CONVERT_TO_STD_DIM_ARRAY

Format

```
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(
     dim_array IN SDO_DIM_ARRAY
     [, m_pos   IN INTEGER]
     ) RETURN SDO_DIM_ARRAY;
```

Description

Converts an LRS dimensional array to a standard dimensional array by removing the measure dimension.

Parameters

dim_array
Dimensional information array corresponding to the layer (column of geometries) to be converted, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

m_pos
Position of the measure dimension. If specified, must be 3 or 4. By default, the measure dimension is the last dimension in the SDO_DIM_ARRAY.

Usage Notes

This function converts an LRS dimensional array to a standard dimensional array by removing the measure dimension. Specifically, it removes the SDO_DIM_ELEMENT object at the end of the current SDO_DIM_ELEMENT objects in the SDO_DIM_ARRAY for the `dim_array`.

An exception is raised if `m_pos` is invalid (less than 3 or greater than 4).

If `dim_array` is already a standard dimensional array (that is, does not contain dimensional information), the `dim_array` is returned.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_STD_DIM_ARRAY_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the dimensional array for the LRS_ROUTES table to standard format. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(m.diminfo)
   FROM user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(M.DIMINFO)(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOL
--------------------------------------------------------------------------------
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .00
5))
```

26.8 SDO_LRS.CONVERT_TO_STD_GEOM

Format

```
SDO_LRS.CONVERT_TO_STD_GEOM(
     lrs _geom    IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

Description

Converts an LRS geometric segment to a standard SDO_GEOMETRY line string by removing measure information.

Parameters

lrs_geom
LRS geometry that contains measure information.

dim_array
Dimensional information array corresponding to `lrs_geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns an SDO_GEOMETRY object in which all measure information is removed.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_STD_GEOM_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the geometric segment representing Route 1 to standard format. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.CONVERT_TO_STD_GEOM(a.route_geometry, m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.CONVERT_TO_STD_GEOM(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 2, 4, 8, 4, 12, 4, 12, 10, 8, 10, 5, 14))
```

26.9 SDO_LRS.CONVERT_TO_STD_LAYER

Format

```
SDO_LRS.CONVERT_TO_STD_LAYER(
     table_name  IN VARCHAR2,
     column_name IN VARCHAR2
     ) RETURN VARCHAR2;
```

Description

Converts all geometry objects in a column of type SDO_GEOMETRY (that is, converts a layer) from LRS geometric segments with measure information to standard line string geometries without measure information, and updates the metadata in the USER_SDO_GEOM_METADATA view.

Parameters

table_name
Table containing the column with the SDO_GEOMETRY objects.

column_name
Column in `table_name` containing the SDO_GEOMETRY objects.

Usage Notes

This function returns TRUE if the conversion was successful or if the layer already is a standard layer (that is, contains geometries without measure information), and the function returns an exception if the conversion was not successful.

If a spatial index already exists on `column_name`, you must delete (drop) the index before converting the layer and create a new index after converting the layer. For information about deleting and creating indexes, see the DROP INDEX and CREATE INDEX statements in SQL Statements for Indexing Spatial Data.

The *_3D* format of this function (SDO_LRS.CONVERT_TO_STD_LAYER_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about conversion functions, see Converting LRS Geometries.

Examples

The following example converts the geometric segments in the ROUTE_GEOMETRY column of the LRS_ROUTES table to standard format. (This example uses the definitions from the example in Example of LRS Functions.) The SELECT statement shows that dimensional information has been removed (that is, no `SDO_DIM_ELEMENT('M', NULL, NULL, NULL)` is included in the definition).

```
BEGIN
  IF (SDO_LRS.CONVERT_TO_STD_LAYER('LRS_ROUTES', 'ROUTE_GEOMETRY') =  'TRUE')
    THEN
      DBMS_OUTPUT.PUT_LINE('Conversion from LRS_LAYER to STD_LAYER succeeded.');
    ELSE
      DBMS_OUTPUT.PUT_LINE('Conversion from LRS_LAYER to STD_LAYER failed.');
  END IF;
```

```
END;
.
/
Conversion from LRS_LAYER to STD_LAYER succeeded.

PL/SQL procedure successfully completed.

SELECT diminfo FROM user_sdo_geom_metadata
   WHERE table_name = 'LRS_ROUTES' AND column_name = 'ROUTE_GEOMETRY';

DIMINFO(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOLERANCE)
--------------------------------------------------------------------------------
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .00
5))
```

26.10 SDO_LRS.DEFINE_GEOM_SEGMENT

Format

```
SDO_LRS.DEFINE_GEOM_SEGMENT(
     geom_segment     IN OUT SDO_GEOMETRY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]);
```

or

```
SDO_LRS.DEFINE_GEOM_SEGMENT(
     geom_segment     IN OUT SDO_GEOMETRY,
     dim_array        IN SDO_DIM_ARRAY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]);
```

Description

Defines a geometric segment by assigning start and end measures to a geometric segment, and assigns values to any null measures.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is 0.

end_measure
Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is the cartographic length of the segment.

Usage Notes

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `start_measure` or `end_measure` is out of range.

All unassigned measures of the geometric segment will be populated automatically.

To store the resulting geometric segment (`geom_segment`) in the database, you must execute an UPDATE or INSERT statement, as appropriate.

The *_3D* format of this procedure (SDO_LRS.DEFINE_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions and procedures, see 3D Formats of LRS Functions.

For more information about defining a geometric segment, see Defining a Geometric Segment .

Examples

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in Example of LRS Functions. The definitions of `result_geom_1`, `result_geom_2`, and `result_geom_3` are displayed in Example 7-3.)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1. This will populate any null measures.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0,    -- Zero starting measure: LRS segment starts at start of route.
  27);  -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
   WHERE a.route_id = 1;

INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);

END;
/
```

26.11 SDO_LRS.DYNAMIC_SEGMENT

Format

```
SDO_LRS.DYNAMIC_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     tolerance     IN NUMBER DEFAULT 1.0e-8
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.DYNAMIC_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     dim_array     IN SDO_DIM_ARRAY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the geometry object resulting from a clip operation on a geometric segment.

> **Note:**
>
> SDO_LRS.CLIP_GEOM_SEGMENT and SDO_LRS.DYNAMIC_SEGMENT are synonyms: both functions have the same parameters, behavior, and return value.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Start measure of the geometric segment.

end_measure
End measure of the geometric segment.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

The direction and measures of the resulting geometric segment are preserved.

For more information about clipping a geometric segment, see Clipping a Geometric Segment.

Examples

The following example clips the geometric segment representing Route 1, returning the segment from measures 5 through 10. This segment might represent a construction zone. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.DYNAMIC_SEGMENT(route_geometry, 5, 10)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.DYNAMIC_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))
```

26.12 SDO_LRS.FIND_LRS_DIM_POS

Format

```
SDO_LRS.FIND_LRS_DIM_POS(
     table_name  IN VARCHAR2,
     column_name IN VARCHAR2
     ) RETURN INTEGER;
```

Description

Returns the position of the measure dimension within the SDO_DIM_ARRAY structure for a specified SDO_GEOMETRY column.

Parameters

table_name
Table containing the column with the SDO_GEOMETRY objects.

column_name
Column in `table_name` containing the SDO_GEOMETRY objects.

Usage Notes

None.

Examples

The following example returns the position of the measure dimension within the SDO_DIM_ARRAY structure for geometries in the ROUTE_GEOMETRY column of the LRS_ROUTES table. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES', 'ROUTE_GEOMETRY') FROM DUAL;

SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES','ROUTE_GEOMETRY')
-------------------------------------------------------
                                                      3
```

26.13 SDO_LRS.FIND_MEASURE

Format

```
SDO_LRS.FIND_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

or

```
SDO_LRS.FIND_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

Description

Returns the measure of the closest point on a segment to a specified projection point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

point
Projection point. This function returns the measure of the point on `geom_segment` that is closest to the projection point.

Usage Notes

This function returns the measure of the point on `geom_segment` that is closest to the projection point. For example, if the projection point represents a shopping mall, the function could be used to find how far from the start of the highway is the point on the highway that is closest to the shopping mall.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `geom_segment` and `point` are based on different coordinate systems.

The *_3D* format of this function (SDO_LRS.FIND_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example finds the measure for the point on the geometric segment representing Route 1 that is closest to the point (10, 7). (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Find measure for point on segment closest to 10,7.
-- Should return 15 (for point 12,7).
SELECT  SDO_LRS.FIND_MEASURE(a.route_geometry, m.diminfo,
  SDO_GEOMETRY(3001, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(10, 7, NULL)) )
 FROM lrs_routes a, user_sdo_geom_metadata m
 WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
   AND a.route_id = 1;

SDO_LRS.FIND_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOMETRY(3001,NULL,NUL
--------------------------------------------------------------------------------
                                                                              15
```

26.14 SDO_LRS.FIND_OFFSET

Format

```
SDO_LRS.FIND_OFFSET(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY,
     tolerance    IN NUMBER DEFAULT 1.0e-8
     ) RETURN NUMBER;
```

or

```
SDO_LRS.FIND_OFFSET(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     [, point_dim_array  IN SDO_GEOMETRY]
     ) RETURN NUMBER;
```

Description

Returns the signed offset (shortest distance) from a point to a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

point
Point whose shortest distance from `geom_segment` is to be returned.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

point_dim_array
Dimensional information array corresponding to `point`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function calls the SDO_LRS.PROJECT_PT function format that includes the `offset` output parameter: it passes in the geometric segment and point information, and it returns the SDO_LRS.PROJECT_PT `offset` parameter value. Thus, to find the offset of a point from a geometric segment, you can use either this function or the SDO_LRS.PROJECT_PT function with the `offset` parameter.

An exception is raised if `geom_segment` or `point` has an invalid geometry type or dimensionality, or if `geom_segment` and `point` are based on different coordinate systems.

For more information about offsets to a geometric segment, see Offset.

Examples

The following example returns the offset of point (9,3,NULL) from the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.) As you can see from Example of LRS Functions, the point at (9,3,NULL) is on the right side along the segment, and therefore the offset has a negative value, as explained in Offset. The point at (9,3.NULL) is one distance unit away from the point at (9,4,NULL), which is on the segment.

```
-- Find the offset of point (9,3,NULL) from the road; should return -1.
SELECT  SDO_LRS.FIND_OFFSET(route_geometry,
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(9, 3, NULL)) )
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.FIND_OFFSET(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARR
--------------------------------------------------------------------------------
                                                                              -1
```

26.15 SDO_LRS.GEOM_SEGMENT_END_MEASURE

Format

```
SDO_LRS.GEOM_SEGMENT_END_MEASURE(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN NUMBER;
```

Description

Returns the end measure of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the end measure of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.GEOM_SEGMENT_END_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the end measure of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_MEASURE(ROUTE_GEOMETRY)
------------------------------------------------
                                              27
```

26.16 SDO_LRS.GEOM_SEGMENT_END_PT

Format

```
SDO_LRS.GEOM_SEGMENT_END_PT(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the end point of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the end point of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.GEOM_SEGMENT_END_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the end point of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
5, 14, 27))
```

26.17 SDO_LRS.GEOM_SEGMENT_LENGTH

Format

```
SDO_LRS.GEOM_SEGMENT_LENGTH(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN NUMBER;
```

Description

Returns the length of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the length of `geom_segment`. The length is the geometric length, which is not the same as the total of the measure unit values. To determine how long a segment is in terms of measure units, subtract the result of an SDO_LRS.GEOM_SEGMENT_START_MEASURE operation from the result of an SDO_LRS.GEOM_SEGMENT_END_MEASURE operation.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.GEOM_SEGMENT_LENGTH_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the length of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_LENGTH(ROUTE_GEOMETRY)
-------------------------------------------
                                         27
```

26.18 SDO_LRS.GEOM_SEGMENT_START_MEASURE

Format

```
SDO_LRS.GEOM_SEGMENT_START_MEASURE(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN NUMBER;
```

Description

Returns the start measure of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the start measure of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.GEOM_SEGMENT_START_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the start measure of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_MEASURE(ROUTE_GEOMETRY)
--------------------------------------------------
                                                 0
```

26.19 SDO_LRS.GEOM_SEGMENT_START_PT

Format

```
SDO_LRS.GEOM_SEGMENT_START_PT(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the start point of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the start point of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.GEOM_SEGMENT_START_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the start point of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
2, 2, 0))
```

26.20 SDO_LRS.GET_MEASURE

Format

```
SDO_LRS.GET_MEASURE(
     point        IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN NUMBER;
```

Description

Returns the measure of an LRS point.

Parameters

point
Point whose measure is to be returned.

dim_array
Dimensional information array corresponding to `point`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns the measure of an LRS point.

If `point` is not valid, an "invalid LRS point" exception is raised.

Contrast this function with SDO_LRS.PROJECT_PT, which accepts as input a point that is not necessarily on the geometric segment, but which returns a point that is on the geometric segment, as opposed to a measure value. As the following example shows, the SDO_LRS.GET_MEASURE function can be used to return the measure of the projected point returned by SDO_LRS.PROJECT_PT.

The *_3D* format of this function (SDO_LRS.GET_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the measure of a projected point. In this case, the point resulting from the projection is 9 units from the start of the segment.

```
SELECT SDO_LRS.GET_MEASURE(
   SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,
    SDO_GEOMETRY(3001, NULL, NULL,
       SDO_ELEM_INFO_ARRAY(1, 1, 1),
       SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
   m.diminfo )
   FROM lrs_routes a, user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
       AND a.route_id = 1;

SDO_LRS.GET_MEASURE(SDO_LRS.PROJECT_PT(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOM
--------------------------------------------------------------------------------
                                                                               9
```

26.21 SDO_LRS.GET_NEXT_SHAPE_PT

Format

```
SDO_LRS.GET_NEXT_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the next shape point on a geometric segment after a specified measure value or LRS point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

measure
Measure value on the geometric segment for which to return the next shape point.

point
Point for which to return the next shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the next shape point after that point is returned.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

If `measure` or `point` identifies the end point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with SDO_LRS.GET_PREV_SHAPE_PT, which returns the previous shape point on a geometric segment before a specified measure value or LRS point.

The *_3D* format of this function (SDO_LRS.GET_NEXT_SHAPE_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the next shape point after measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.GET_NEXT_SHAPE_PT(a.route_geometry, 14)
   FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_NEXT_SHAPE_PT(A.ROUTE_GEOMETRY,14)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
12, 10, 18))
```

26.22 SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE

Format

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

Description

Returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

measure
Measure value on the geometric segment for which to return the measure value of the next shape point.

point
Point for which to return the measure value of the next shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the measure value of the next shape point after that point is returned.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

If `measure` or `point` identifies the end point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with SDO_LRS.GET_PREV_SHAPE_PT_MEASURE, which returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.

The *_3D* format of this function (SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the measure value of the next shape point after measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(a.route_geometry, 14)
   FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
------------------------------------------------------
                                                    18
```

26.23 SDO_LRS.GET_PREV_SHAPE_PT

Format

```
SDO_LRS.GET_PREV_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the previous shape point on a geometric segment before a specified measure value or LRS point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

measure
Measure value on the geometric segment for which to return the previous shape point.

point
Point for which to return the previous shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the closest shape point before that point is returned.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

If `measure` or `point` identifies the start point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with SDO_LRS.GET_NEXT_SHAPE_PT, which returns the next shape point on a geometric segment after a specified measure value or LRS point.

The *_3D* format of this function (SDO_LRS.GET_PREV_SHAPE_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the closest shape point to measure 14 and before measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.GET_PREV_SHAPE_PT(a.route_geometry, 14)
   FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_PREV_SHAPE_PT(A.ROUTE_GEOMETRY,14)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
12, 4, 12))
```

26.24 SDO_LRS.GET_PREV_SHAPE_PT_MEASURE

Format

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

Description

Returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

measure
Measure value on the geometric segment for which to return the measure value of the previous shape point.

point
Point for which to return the measure value of the previous shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the measure value of the closest shape point before that point is returned.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

If `measure` or `point` identifies the start point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE, which returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.

The *_3D* format of this function (SDO_LRS.GET_PREV_SHAPE_PT_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the measure value of the closest shape point to measure 14 and before measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(a.route_geometry, 14)
   FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
------------------------------------------------------
                                                    12
```

26.25 SDO_LRS.IS_GEOM_SEGMENT_DEFINED

Format

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if an LRS segment is defined correctly.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if `geom_segment` is defined correctly and FALSE if `geom_segment` is not defined correctly.

The start and end measures of `geom_segment` must be defined (cannot be null), and any measures assigned must be in an ascending or descending order along the segment direction.

The *_3D* format of this function (SDO_LRS.IS_GEOM_SEGMENT_DEFINED_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

See also the SDO_LRS.VALID_GEOM_SEGMENT function.

Examples

The following example checks if the geometric segment representing Route 1 is defined. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.IS_GEOM_SEGMENT_DEFINED(ROUTE_GEOMETRY)
--------------------------------------------------------------------------------
TRUE
```

26.26 SDO_LRS.IS_MEASURE_DECREASING

Format

```
SDO_LRS.IS_MEASURE_DECREASING(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if the measure values along an LRS segment are decreasing (that is, descending in numerical value).

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if the measure values along an LRS segment are decreasing and FALSE if the measure values along an LRS segment are not decreasing.

The start and end measures of `geom_segment` must be defined (cannot be null).

The *_3D* format of this function (SDO_LRS.IS_MEASURE_DECREASING_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

See also the SDO_LRS.IS_MEASURE_INCREASING function.

Examples

The following example checks if the measure values along the geometric segment representing Route 1 are decreasing. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.IS_MEASURE_DECREASING(a.route_geometry, m.diminfo)
   FROM lrs_routes a, user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
   AND a.route_id = 1;

SDO_LRS.IS_MEASURE_DECREASING(A.ROUTE_GEOMETRY,M.DIMINFO)
--------------------------------------------------------------------------------
FALSE
```

26.27 SDO_LRS.IS_MEASURE_INCREASING

Format

```
SDO_LRS.IS_MEASURE_INCREASING(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if the measure values along an LRS segment are increasing (that is, ascending in numerical value).

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if the measure values along an LRS segment are increasing and FALSE if the measure values along an LRS segment are not increasing.

The start and end measures of `geom_segment` must be defined (cannot be null).

The *_3D* format of this function (SDO_LRS.IS_MEASURE_INCREASING_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

See also the SDO_LRS.IS_MEASURE_DECREASING function.

Examples

The following example checks if the measure values along the geometric segment representing Route 1 are increasing. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.IS_MEASURE_INCREASING(a.route_geometry, m.diminfo)
   FROM lrs_routes a, user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
   AND a.route_id = 1;

SDO_LRS.IS_MEASURE_INCREASING(A.ROUTE_GEOMETRY,M.DIMINFO)
--------------------------------------------------------------------------------
TRUE
```

26.28 SDO_LRS.IS_SHAPE_PT_MEASURE

Format

```
SDO_LRS.IS_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN VARCHAR2;
```

or

```
SDO_LRS.IS_SHAPE_PT_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN VARCHAR2;
```

Description

Checks if a specified measure value is associated with a shape point on a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

measure
Measure value on the geometric segment to check if it is a shape point.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if the specified measure value is associated with a shape point and FALSE if the measure value is not associated with a shape point.

An exception is raised if `measure` is not a valid value for `geom_segment`.

The *_3D* format of this function (SDO_LRS.IS_SHAPE_PT_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if measure 14 on the geometric segment representing Route 1 is a shape point. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.IS_SHAPE_PT_MEASURE(a.route_geometry, 14)
  FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.IS_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
--------------------------------------------------------------------------------
FALSE
```

26.29 SDO_LRS.LOCATE_PT

Format

```
SDO_LRS.LOCATE_PT(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     [, offset    IN NUMBER]
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.LOCATE_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     [, offset    IN NUMBER]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the point located at a specified distance from the start of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

measure
Distance to measure from the start point of `geom_segment`.

offset
Distance to measure perpendicularly from the point that is located at `measure` units from the start point of `geom_segment`. The default is 0 (that is, the point is on `geom_segment`).

Usage Notes

This function returns the referenced point. For example, on a highway, the point might represent the location of an accident.

The unit of measurement for `offset` is the same as for the coordinate system associated with `geom_segment`. For geodetic data, the default unit of measurement is meters.

With geodetic data using the WGS 84 coordinate system, this function can be used to return the longitude and latitude coordinates of any point on or offset from the segment.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if the location is out of range.

The *_3D* format of this function (SDO_LRS.LOCATE_PT_3D) is available; however, the `offset` parameter is not available for SDO_LRS.LOCATE_PT_3D. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about locating a point on a geometric segment, see Locating a Point on a Geometric Segment.

Examples

The following example creates a table for automobile accident data, inserts a record for an accident at the point at measure 9 and on (that is, offset 0) the geometric segment representing Route 1, and displays the data. (The accident table is deliberately oversimplified. This example also uses the route definition from the example in Example of LRS Functions.)

```
-- Create a table for accidents.
CREATE TABLE accidents (
  accident_id  NUMBER PRIMARY KEY,
  route_id  NUMBER,
  accident_geometry  SDO_GEOMETRY);

-- Insert an accident record.
DECLARE
geom_segment SDO_GEOMETRY;

BEGIN

SELECT  SDO_LRS.LOCATE_PT(a.route_geometry, 9, 0) into geom_segment
  FROM lrs_routes a WHERE a.route_name = 'Route1';

INSERT INTO accidents VALUES(1, 1, geom_segment);
```

```
END;
/

SELECT * from accidents;

ACCIDENT_ID   ROUTE_ID
----------- ----------
ACCIDENT_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_OR
--------------------------------------------------------------------------------
          1          1
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

26.30 SDO_LRS.LRS_INTERSECTION

Format

```
SDO_LRS.LRS_INTERSECTION(
     geom_1      IN SDO_GEOMETRY,
     dim_array_1 IN SDO_DIM_ARRAY,
     geom_2      IN SDO_GEOMETRY,
     dim_array_2 IN SDO_DIM_ARRAY
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.LRS_INTERSECTION(
     geom_1    IN SDO_GEOMETRY,
     geom_2    IN SDO_GEOMETRY,
     tolerance IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns an LRS geometry object that is the topological intersection (AND operation) of two geometry objects where one or both are LRS geometries.

Parameters

geom_1
Geometry object.

dim_array_1
Dimensional information array corresponding to `geom_1`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

geom_2
Geometry object.

dim_array_2
Dimensional information array corresponding to `geom_2`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

tolerance
Tolerance value (see Tolerance).

Usage Notes

This function performs essentially the same intersection operation as the SDO_GEOM.SDO_INTERSECTION function (described in SDO_GEOM Package (Geometry)), except that SDO_LRS.LRS_INTERSECTION is designed to return a valid LRS geometry (point, line string, or multiline string) where one or both of the geometry-related input parameters are LRS geometries. (If neither input geometry is an LRS geometry, this function operates the same as the SDO_GEOM.SDO_INTERSECTION function.).

The returned geometry is an LRS line string, multiline string, or point geometry that includes measure dimension information. The measure values reflect those in the first LRS geometry specified as an input parameter.

The first LRS geometry specified as an input parameter must not be a polygon; it must be a line string, multiline string, or point.

If an LRS line string (geometric segment) intersects a line string (LRS or standard), the result is an LRS point; if an LRS line string intersects a polygon, the result is an LRS line string.

An exception is raised if `geom_1` and `geom_2` are based on different coordinate systems.

Examples

The following example shows an LRS geometric segment (illustrated in Figure 7-20 in Example of LRS Functions) intersected by a vertical line from (8,2) to (8,6). The result is an LRS point geometry, in which the measure value (8) reflects the measure for that point (designated as Exit 3 in Figure 7-20) in the `geom_1` geometry. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Intersection of LRS segment and standard line segment
SELECT SDO_LRS.LRS_INTERSECTION(route_geometry,
  SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
    SDO_ORDINATE_ARRAY(8,2, 8,6)), 0.005)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.LRS_INTERSECTION(ROUTE_GEOMETRY,SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INF
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
8, 4, 8))
```

The following example shows an LRS geometric segment (illustrated in Figure 7-20 in Example of LRS Functions) intersected by a vertical line from (12,2) to (12,6). The result is an LRS line string geometry, in which the measure values (12 and 14) reflect measures for points (the first of which is designated as Exit 4 in Figure 7-20) in the `geom_1` geometry. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.LRS_INTERSECTION(route_geometry,
  SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
   SDO_ORDINATE_ARRAY(12,2, 12,6)), 0.005)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.LRS_INTERSECTION(ROUTE_GEOMETRY,SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INF
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
12, 4, 12, 12, 6, 14))
```

26.31 SDO_LRS.MEASURE_RANGE

Format

```
SDO_LRS.MEASURE_RANGE(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN NUMBER;
```

Description

Returns the measure range of a geometric segment, that is, the difference between the start measure and end measure.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function subtracts the start measure of `geom_segment` from the end measure of `geom_segment`.

The *_3D* format of this function (SDO_LRS.MEASURE_RANGE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example returns the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.MEASURE_RANGE(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.MEASURE_RANGE(ROUTE_GEOMETRY)
-------------------------------------
                                   27
```

26.32 SDO_LRS.MEASURE_TO_PERCENTAGE

Format

```
SDO_LRS.MEASURE_TO_PERCENTAGE(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.MEASURE_TO_PERCENTAGE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN NUMBER;
```

Description

Returns the percentage (0 to 100) that a specified measure is of the measure range of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

measure
Measure value. This function returns the percentage that this measure value is of the measure range.

Usage Notes

This function returns a number (0 to 100) that is the percentage of the measure range that the specified measure represents. (The measure range is the end measure minus the start measure.) For example, if the measure range of `geom_segment` is 50 and `measure` is 20, the function returns 40 (because 20/50 = 40%).

This function performs the reverse of the SDO_LRS.PERCENTAGE_TO_MEASURE function, which returns the measure that corresponds to a percentage value.

An exception is raised if `geom_segment` or `measure` is invalid.

Examples

The following example returns the percentage that 5 is of the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.) The measure range of this segment is 27, and 5 is approximately 18.5 percent of 27.

```
SELECT SDO_LRS.MEASURE_TO_PERCENTAGE(a.route_geometry, m.diminfo, 5)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.MEASURE_TO_PERCENTAGE(A.ROUTE_GEOMETRY,M.DIMINFO,5)
-----------------------------------------------------------
                                                 18.5185185
```

26.33 SDO_LRS.OFFSET_GEOM_SEGMENT

Format

```
SDO_LRS.OFFSET_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     offset        IN NUMBER,
     tolerance     IN NUMBER DEFAULT 1.0e-8
     [, unit       IN VARCHAR2]
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.OFFSET_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     dim_array     IN SDO_DIM_ARRAY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     offset        IN NUMBER
     [, unit       IN VARCHAR2]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the geometric segment at a specified offset from a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Start measure of `geom_segment` at which to start the offset operation.

end_measure
End measure of `geom_segment` at which to start the offset operation.

offset
Distance to measure perpendicularly from the points along `geom_segment`. Positive offset values are to the left of `geom_segment`; negative offset values are to the right of `geom_segment`.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

unit
Unit of measurement specification: a quoted string with one or both of the following keywords:

- `unit` and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table. See Unit of Measurement Support for more information about unit of measurement specification.
- `arc_tolerance` and an arc tolerance value. See the Usage Notes for the SDO_GEOM.SDO_ARC_DENSIFY function in SDO_GEOM Package (Geometry) for more information about the `arc_tolerance` keyword.

For example: 'unit=km arc_tolerance=0.05'

If the input geometry is geodetic data, this parameter is required, and `arc_tolerance` must be specified. If the input geometry is Cartesian or projected data, `arc_tolerance` has no effect and should not be specified.

If this parameter is not specified for a Cartesian or projected geometry, or if the `arc_tolerance` keyword is specified for a geodetic geometry but the `unit` keyword is not specified, the unit of measurement associated with the data is assumed.

Usage Notes

`start_measure` and `end_measure` can be any points on the geometric segment. They do not have to be in any specific order. For example, `start_measure` and `end_measure` can be 5 and 10, respectively, or 10 and 5, respectively.

The direction and measures of the resulting geometric segment are preserved (that is, they reflect the original segment).

The geometry type of `geom_segment` must be line or multiline. For example, it cannot be a polygon.

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

Examples

The following example returns the geometric segment 2 distance units to the left (positive offset 2) of the segment from measures 5 through 10 of Route 1. Note in SDO_ORDINATE_ARRAY of the returned segment that the Y values (6) are 2 greater than the Y values (4) of the relevant part of the original segment. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Create a segment offset 2 to the left from measures 5 through 10.
-- First, display the original segment; then, offset.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SELECT  SDO_LRS.OFFSET_GEOM_SEGMENT(a.route_geometry, m.diminfo, 5, 10, 2)
    FROM lrs_routes a, user_sdo_geom_metadata m
    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
      AND a.route_id = 1;

SDO_LRS.OFFSET_GEOM_SEGMENT(A.ROUTE_GEOMETRY,M.DIMINFO,5,10,2)(SDO_GTYPE, SDO_SR
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 6, 5, 10, 6, 10))
```

26.34 SDO_LRS.PERCENTAGE_TO_MEASURE

Format

```
SDO_LRS.PERCENTAGE_TO_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     percentage   IN NUMBER
     ) RETURN NUMBER;
```

or

```
SDO_LRS.PERCENTAGE_TO_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     percentage   IN NUMBER
     ) RETURN NUMBER;
```

Description

Returns the measure value of a specified percentage (0 to 100) of the measure range of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

percentage
Percentage value. Must be from 0 to 100. This function returns the measure value corresponding to this percentage of the measure range.

Usage Notes

This function returns the measure value corresponding to the specified percentage of the measure range. (The measure range is the end measure minus the start measure.) For example, if the measure range of `geom_segment` is 50 and `percentage` is 40, the function returns 20 (because 40% of 50 = 20).

This function performs the reverse of the SDO_LRS.MEASURE_TO_PERCENTAGE function, which returns the percentage value that corresponds to a measure.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `percentage` is less than 0 or greater than 100.

Examples

The following example returns the measure that is 50 percent of the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.) The measure range of this segment is 27, and 50 percent of 27 is 13.5.

```
SELECT SDO_LRS.PERCENTAGE_TO_MEASURE(a.route_geometry, m.diminfo, 50)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.PERCENTAGE_TO_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,50)
------------------------------------------------------------
                                                        13.5
```

26.35 SDO_LRS.PROJECT_PT

Format

```
SDO_LRS.PROJECT_PT(
     geom_segment IN SDO_GEOMETRY,
     point        IN SDO_GEOMETRY,
     tolerance    IN NUMBER DEFAULT 1.0e-8
     [, offset    OUT NUMBER]
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.PROJECT_PT(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY
     [, point_dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.PROJECT_PT(
     geom_segment    IN SDO_GEOMETRY,
     dim_array       IN SDO_DIM_ARRAY,
     point           IN SDO_GEOMETRY,
     point_dim_array IN SDO_DIM_ARRAY
     [, offset       OUT NUMBER]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the projection point of a specified point. The projection point is on the geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

point
Point on `geom_segment` to be projected.

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

point_dim_array
Dimensional information array corresponding to `point`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

offset
Offset (shortest distance) from the point to the geometric segment.

Usage Notes

This function returns the projection point (including its measure) of a specified point (`point`). The projection point is on the geometric segment.

If multiple projection points exist, the first projection point encountered from the start point is returned.

If you specify the output parameter `offset`, the function stores the signed offset (shortest distance) from the point to the geometric segment. For more information about the offset to a geometric segment, see Offset.

An exception is raised if `geom_segment` or `point` has an invalid geometry type or dimensionality, or if `geom_segment` and `point` are based on different coordinate systems.

The *_3D* format of this function (SDO_LRS.PROJECT_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

For more information about projecting a point onto a geometric segment, see Projecting a Point onto a Geometric Segment.

Examples

The following example returns the point (9,4,9) on the geometric segment representing Route 1 that is closest to the specified point (9,3,NULL). (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Point 9,3,NULL is off the road; should return 9,4,9.
SELECT  SDO_LRS.PROJECT_PT(route_geometry,
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(9, 3, NULL)) )
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_EL
--------------------------------------------------------------------------------
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

26.36 SDO_LRS.REDEFINE_GEOM_SEGMENT

Format

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(
     geom_segment     IN OUT SDO_GEOMETRY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]);
```

or

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(
     geom_segment     IN OUT SDO_GEOMETRY,
     dim_array        IN SDO_DIM_ARRAY
     [, start_measure IN NUMBER,
     end_measure      IN NUMBER]);
```

Description

Populates the measures of all shape points based on the start and end measures of a geometric segment, overriding any previously assigned measures between the start point and end point.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is 0.

end_measure
Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is the cartographic length of the segment.

Usage Notes

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `start_measure` or `end_measure` is out of range.

The *_3D* format of this procedure (SDO_LRS.REDEFINE_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions and procedures, see 3D Formats of LRS Functions.

For more information about redefining a geometric segment, see Redefining a Geometric Segment.

Examples

The following example redefines a geometric segment, effectively converting miles to kilometers in the measure values. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- First, display the original segment; then, redefine.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

-- Redefine geometric segment to "convert" miles to kilometers.
DECLARE
geom_segment SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
   0,    -- Zero starting measure: LRS segment starts at start of route.
   43.443);  -- End of LRS segment. 27 miles = 43.443 kilometers.

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
   WHERE a.route_id = 1;

END;
/
```

```
PL/SQL procedure successfully completed.

-- Display the redefined segment, with all measures "converted."
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 3.218, 8, 4, 12.872, 12, 4, 19.308, 12, 10, 28.962, 8, 10, 35.398
, 5, 14, 43.443))
```

26.37 SDO_LRS.RESET_MEASURE

Format

```
SDO_LRS.RESET_MEASURE(
     geom_segment  IN OUT SDO_GEOMETRY
     [, dim_array  IN SDO_DIM_ARRAY]);
```

Description

Sets all measures of a geometric segment, including the start and end measures, to null values, overriding any previously assigned measures.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

Examples

The following example sets all measures of a geometric segment to null values. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- First, display the original segment; then, redefine.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

-- Reset geometric segment measures.
DECLARE
geom_segment SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
```

```
SDO_LRS.RESET_MEASURE (geom_segment);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
   WHERE a.route_id = 1;

END;
/

PL/SQL procedure successfully completed.

-- Display the segment, with all measures set to null.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, NULL, 2, 4, NULL, 8, 4, NULL, 12, 4, NULL, 12, 10, NULL, 8, 10, NULL, 5, 1
4, NULL))
```

26.38 SDO_LRS.REVERSE_GEOMETRY

Format

```
SDO_LRS.REVERSE_GEOMETRY(
     geom         IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a new geometric segment by reversing the measure values and the direction of the original geometric segment.

Parameters

geom
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function:

- Reverses the measure values of `geom`

  That is, the start measure of `geom` is the end measure of the returned geometric segment, the end measure of `geom` is the start measure of the returned geometric segment, and all other measures are adjusted accordingly.
- Reverses the direction of `geom`

Compare this function with SDO_LRS.REVERSE_MEASURE, which reverses only the measure values (not the direction) of a geometric segment.

To reverse the vertices of a non-LRS line string geometry, use the SDO_UTIL.REVERSE_LINESTRING function, which is described in SDO_LRS Package (Linear Referencing System).

An exception is raised if `geom` has an invalid geometry type or dimensionality. The geometry type must be a line or multiline, and the dimensionality must be 3 (two dimensions plus the measure dimension).

The *_3D* format of this function (SDO_LRS.REVERSE_GEOMETRY_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example reverses the measure values and the direction of the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Reverse direction and measures (for example, to prepare for
-- concatenating with another road).
-- First, display the original segment; then, reverse.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))


SELECT  SDO_LRS.REVERSE_GEOMETRY(a.route_geometry, m.diminfo)
    FROM lrs_routes a, user_sdo_geom_metadata m
    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
      AND a.route_id = 1;

SDO_LRS.REVERSE_GEOMETRY(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_PO
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 14, 27, 8, 10, 22, 12, 10, 18, 12, 4, 12, 8, 4, 8, 2, 4, 2, 2, 2, 0))
```

Note in the returned segment that the M values (measures) now go in descending order from 27 to 0, and the segment start and end points have the opposite X and Y values as in the original segment (5,14 and 2,2 here, as opposed to 2,2 and 5,14 in the original).

26.39 SDO_LRS.REVERSE_MEASURE

Format

```
SDO_LRS.REVERSE_MEASURE(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a new geometric segment by reversing the measure values, but not the direction, of the original geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function:

- Reverses the measure values of `geom_segment`

  That is, the start measure of `geom_segment` is the end measure of the returned geometric segment, the end measure of `geom_segment` is the start measure of the returned geometric segment, and all other measures are adjusted accordingly.
- Does not affect the direction of `geom_segment`

Compare this function with SDO_LRS.REVERSE_GEOMETRY, which reverses both the direction and the measure values of a geometric segment.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.REVERSE_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

> **Note:**
>
> The behavior of the SDO_LRS.REVERSE_MEASURE function changed after release 8.1.7. In release 8.1.7, REVERSE_MEASURE reversed both the measures and the segment direction. However, if you want to have this same behavior with subsequent releases, you must use the SDO_LRS.REVERSE_GEOMETRY function.

Examples

The following example reverses the measure values of the geometric segment representing Route 1, but does not affect the direction. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- First, display the original segment; then, reverse.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))


SELECT SDO_LRS.REVERSE_MEASURE(a.route_geometry, m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.REVERSE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POI
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 27, 2, 4, 25, 8, 4, 19, 12, 4, 15, 12, 10, 9, 8, 10, 5, 5, 14, 0))
```

Note in the returned segment that the M values (measures) now go in descending order from 27 to 0, but the segment start and end points have the same X and Y values as in the original segment (2,2 and 5,14).

26.40 SDO_LRS.SCALE_GEOM_SEGMENT

Format

```
SDO_LRS.SCALE_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     shift_measure IN NUMBER,
     tolerance     IN NUMBER DEFAULT 1.0e-8
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.SCALE_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     dim_array     IN SDO_DIM_ARRAY,
     start_measure IN NUMBER,
     end_measure   IN NUMBER,
     shift_measure IN NUMBER,
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the geometry object resulting from a measure scaling operation on a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

start_measure
Start measure of the geometric segment.

end_measure
End measure of the geometric segment.

shift_measure
Amount to be added to each measure value after the initial scaling. A value of 0 (zero) means that nothing is added (no shifting of measure values).

tolerance
Tolerance value (see Tolerance and Tolerance Values with LRS Functions). The default value is 0.00000001.

Usage Notes

This function performs the following actions:

1. It redistributes the measure values of the LRS geometric segment, using between `start_measure` for the start point and `end_measure` for the end point, and adjusting (scaling) the measure values in between accordingly.
2. If `shift_measure` is not 0 (zero), it translates (shifts) each measure value computed in step 1 by adding the `shift_measure` value.

The action of this function is sometimes referred to as "stretching" the measure values. The function affects only the measure values; the other coordinates of the geometry are not changed.

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

The direction of the resulting geometric segment is preserved (that is, it reflects the original segment).

For more information about scaling geometric segments, see Scaling a Geometric Segment .

Examples

The following example scales the geometric segment representing Route 1, returning a segment in which the start measure is specified as100, the end measure is specified 200, with a shift measure value of 10. Consequently, after all measure values are scaled according to the start and end measure values, 10 is added to all measure values. Thus, for example, the start point measure is 110 and the end point measure is 210 in the returned geometry. (This example uses the definitions from the example in Example of LRS Functions.)

```
SQL> SELECT  SDO_LRS.SCALE_GEOM_SEGMENT(route_geometry, 100, 200, 10)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.SCALE_GEOM_SEGMENT(ROUTE_GEOMETRY,100,200,10)(SDO_GTYPE, SDO_SRID, SDO_P
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 110, 2, 4, 117.407407, 8, 4, 139.62963, 12, 4, 154.444444, 12, 10, 176.666
667, 8, 10, 191.481481, 5, 14, 210))
```

26.41 SDO_LRS.SET_PT_MEASURE

Format

```
SDO_LRS.SET_PT_MEASURE(
     geom_segment IN OUT SDO_GEOMETRY,
     point        IN SDO_GEOMETRY,
     measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
     geom_segment IN OUT SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     point        IN SDO_GEOMETRY,
     pt_dim_array IN SDO_DIM_ARRAY,
     measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
     point   IN OUT SDO_GEOMETRY,
     measure IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
     point     IN OUT SDO_GEOMETRY,
     dim_array IN SDO_DIM_ARRAY,
     measure   IN NUMBER) RETURN VARCHAR2;
```

Description

Sets the measure value of a specified point.

Parameters

geom_segment
Geometric segment (LRS segment containing measure information) that contains the point.

dim_array
Dimensional information array corresponding to `geom_segment` (in the second format) or `point` (in the fourth format), usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

point
Point for which the measure value is to be set.

pt_dim_array
Dimensional information array corresponding to `point` (in the second format), usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

measure
Measure value to be assigned to the specified point.

Usage Notes

The function returns TRUE if the measure value was successfully set, and FALSE if the measure value was not set.

If both `geom_segment` and `point` are specified, the behavior of the procedure depends on whether or not `point` is a shape point on `geom_segment`:

- If `point` is a shape point on `geom_segment`, the measure value of `point` is set.
- If `point` is not a shape point on `geom_segment`, the shape point on `geom_segment` that is nearest to `point` is found, and the measure value of that shape point is set.

The *_3D* format of this function (SDO_LRS.SET_PT_MEASURE_3D) is available; however, only the formats that include the `geom_segment` parameter are available for SDO_LRS.SET_PT_MEASURE_3D. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

An exception is raised if `geom_segment` or `point` is invalid.

Examples

The following example sets the measure value of point (8,10) to 20. (This example uses the definitions from the example in Example of LRS Functions.)

```
-- Set the measure value of point 8,10 to 20 (originally 22).
DECLARE
geom_segment SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result VARCHAR2(32);
```

```
BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Set the measure value of point 8,10 to 20 (originally 22).
result := SDO_LRS.SET_PT_MEASURE (geom_segment,
  SDO_GEOMETRY(3301, NULL, NULL,
     SDO_ELEM_INFO_ARRAY(1, 1, 1),
     SDO_ORDINATE_ARRAY(8, 10, 22)),
  20);

-- Display the result.
DBMS_OUTPUT.PUT_LINE('Returned value = ' || result);

END;
/
Returned value = TRUE

PL/SQL procedure successfully completed.
```

26.42 SDO_LRS.SPLIT_GEOM_SEGMENT

Format

```
SDO_LRS.SPLIT_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     split_measure IN NUMBER,
     segment_1     OUT SDO_GEOMETRY,
     segment_2     OUT SDO_GEOMETRY);
```

or

```
SDO_LRS.SPLIT_GEOM_SEGMENT(
     geom_segment  IN SDO_GEOMETRY,
     dim_array     IN SDO_DIM_ARRAY,
     split_measure IN NUMBER,
     segment_1     OUT SDO_GEOMETRY,
     segment_2     OUT SDO_GEOMETRY);
```

Description

Splits a geometric segment into two geometric segments.

Parameters

geom_segment
Input geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

split_measure
Distance measured from the start point of a geometric segment to the split point.

segment_1
First geometric segment: from the start point of `geom_segment` to the split point.

segment_2
Second geometric segment: from the split point to the end point of `geom_segment`.

Usage Notes

An exception is raised if `geom_segment` or `split_measure` is invalid.

The directions and measures of the resulting geometric segments are preserved.

The *_3D* format of this procedure (SDO_LRS.SPLIT_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions and procedures, see 3D Formats of LRS Functions.

For more information about splitting a geometric segment, see Splitting a Geometric Segment.

Examples

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in Example of LRS Functions. The definitions of `result_geom_1`, `result_geom_2`, and `result_geom_3` are displayed in Example 7-3.)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0,    -- Zero starting measure: LRS segment starts at start of route.
  27);  -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Insert geometries into table, to display later.
INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);

END;
/
```

26.43 SDO_LRS.TRANSLATE_MEASURE

Format

```
SDO_LRS.TRANSLATE_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     translate_m  IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.TRANSLATE_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     translate_m  IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a new geometric segment by translating the original geometric segment (that is, shifting the start and end measures by a specified value).

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

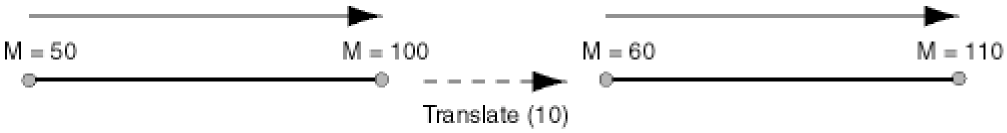
dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

translate_m
Distance measured from the start point of a geometric segment to the start point of the linear feature.

Usage Notes

This function adds `translate_m` to the start and end measures of `geom_segment`. For example, if `geom_segment` has a start measure of 50 and an end measure of 100, and if `translate_m` is 10, the returned geometric segment has a start measure of 60 and an end measure of 110, as shown in th following figure.

Figure 26-1   Translating a Geometric Segment



An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.TRANSLATE_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example translates (shifts) by 10 the geometric segment representing Route 1. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.TRANSLATE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,10)(SDO_GTYPE, SDO_SRID, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 10, 2, 4, 12, 8, 4, 18, 12, 4, 22, 12, 10, 28, 8, 10, 32, 5, 14, 37))
```

26.44 SDO_LRS.VALID_GEOM_SEGMENT

Format

```
SDO_LRS.VALID_GEOM_SEGMENT(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if a geometry object is a valid geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if `geom_segment` is valid and FALSE if `geom_segment` is not valid.

Measure information is assumed to be stored in the last element of the SDO_DIM_ARRAY in the Oracle Spatial metadata.

This function only checks for geometry type and number of dimensions of the geometric segment. To further validate measure information, use the SDO_LRS.IS_GEOM_SEGMENT_DEFINED function.

The *_3D* format of this function (SDO_LRS.VALID_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if the geometric segment representing Route 1 is valid. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.VALID_GEOM_SEGMENT(ROUTE_GEOMETRY)
--------------------------------------------------------------------------------
TRUE
```

26.45 SDO_LRS.VALID_LRS_PT

Format

```
SDO_LRS.VALID_LRS_PT(
     point        IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if an LRS point is valid.

Parameters

point
Point to be checked for validity.

dim_array
Dimensional information array corresponding to `point`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if `point` is valid and FALSE if `point` is not valid.

This function checks if `point` is a point with measure information, and it checks for the geometry type and number of dimensions for the point geometry.

All LRS point data must be stored in the SDO_ELEM_INFO_ARRAY and SDO_ORDINATE_ARRAY, and cannot be stored in the SDO_POINT field in the SDO_GEOMETRY definition of the point.

The *_3D* format of this function (SDO_LRS.VALID_LRS_PT_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if point (9,3,NULL) is a valid LRS point. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.VALID_LRS_PT(
    SDO_GEOMETRY(3301, NULL, NULL,
       SDO_ELEM_INFO_ARRAY(1, 1, 1),
       SDO_ORDINATE_ARRAY(9, 3, NULL)),
    m.diminfo)
    FROM lrs_routes a, user_sdo_geom_metadata m
    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
      AND a.route_id = 1;

SDO_LRS.VALID_LRS_PT(SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1,1),SDO_
--------------------------------------------------------------------------------
TRUE
```

26.46 SDO_LRS.VALID_MEASURE

Format

```
SDO_LRS.VALID_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     measure      IN NUMBER
     ) RETURN VARCHAR2;
```

or

```
SDO_LRS.VALID_MEASURE(
     geom_segment IN SDO_GEOMETRY,
     dim_array    IN SDO_DIM_ARRAY,
     measure      IN NUMBER
     ) RETURN VARCHAR2;
```

Description

Checks if a measure falls within the measure range of a geometric segment.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

measure
Measure value to be checked to see if it falls within the measure range of `geom_segment`.

Usage Notes

This function returns TRUE if `measure` falls within the measure range of `geom_segment` and FALSE if `measure` does not fall within the measure range of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *_3D* format of this function (SDO_LRS.VALID_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if 50 is a valid measure on the Route 1 segment. The function returns FALSE because the measure range for that segment is 0 to 27. For example, if the route is 27 miles long with mile markers at 1-mile intervals, there is no 50-mile marker because the last marker is the 27-mile marker. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT  SDO_LRS.VALID_MEASURE(route_geometry, 50)
  FROM lrs_routes WHERE route_id = 1;

SDO_LRS.VALID_MEASURE(ROUTE_GEOMETRY,50)
--------------------------------------------------------------------------------
FALSE
```

26.47 SDO_LRS.VALIDATE_LRS_GEOMETRY

Format

```
SDO_LRS.VALIDATE_LRS_GEOMETRY(
     geom_segment IN SDO_GEOMETRY
     [, dim_array IN SDO_DIM_ARRAY]
     ) RETURN VARCHAR2;
```

Description

Checks if an LRS geometry is valid.

Parameters

geom_segment
Geometric segment (LRS segment) containing measure information.

dim_array
Dimensional information array corresponding to `geom_segment`, usually selected from one of the xxx_SDO_GEOM_METADATA views (described in Geometry Metadata Views).

Usage Notes

This function returns TRUE if `geom_segment` is valid and one of the following errors if `geom_segment` is not valid:

- ORA-13331 (invalid LRS segment)
- ORA-13335 (measure information not defined)

The *_3D* format of this function (SDO_LRS.VALIDATE_LRS_GEOMETRY_3D) is available. For information about *_3D* formats of LRS functions, see 3D Formats of LRS Functions.

Examples

The following example checks if the Route 1 segment is a valid LRS geometry. (This example uses the definitions from the example in Example of LRS Functions.)

```
SELECT SDO_LRS.VALIDATE_LRS_GEOMETRY(a.route_geometry, m.diminfo)
   FROM lrs_routes a, user_sdo_geom_metadata m
   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
   AND a.route_id = 1;

SDO_LRS.VALIDATE_LRS_GEOMETRY(A.ROUTE_GEOMETRY,M.DIMINFO)
--------------------------------------------------------------------------------
TRUE
```

27

SDO_MIGRATE Package (Upgrading)

The MDSYS.SDO_MIGRATE package contains a single subprogram, SDO_MIGRATE.TO_CURRENT.

The SDO_MIGRATE.TO_CURRENT subprogram described in this chapter has both procedure and function interfaces. As a procedure, it lets you upgrade spatial geometry tables from previous releases of Spatial; and as a function, it lets you upgrade a single SDO_GEOMETRY object.

This subprogram has very limited uses, as explained in the Usage Notes for its documentation.

- SDO_MIGRATE.TO_CURRENT

27.1 SDO_MIGRATE.TO_CURRENT

Format (Any Object-Relational Model Implementation to Current)

```
SDO_MIGRATE.TO_CURRENT(
     tabname         IN VARCHAR2
     [, column_name  IN VARCHAR2]);
```

or

```
SDO_MIGRATE.TO_CURRENT(
     tabname       IN VARCHAR2,
     column_name   IN VARCHAR2
     [, commit_int IN NUMBER]);
```

Format (Single Object-Relational Model Geometry to Current)

```
SDO_MIGRATE.TO_CURRENT(
     geom  IN SDO_GEOMETRY,
     dim   IN SDO_DIM_ARRAY

) RETURN SDO_GEOMETRY;
```

Format (Any Relational Model Implementation to Current)

```
SDO_MIGRATE.TO_CURRENT(
     layer       IN VARCHAR2,
     newtabname  IN VARCHAR2,
     gidcolumn   IN VARCHAR2,
     geocolname  IN VARCHAR2,
     layer_gtype IN VARCHAR2,
     updateflag  IN VARCHAR2);
```

Description

Upgrades data from the obsolete Spatial relational model (release 8.1.5 or earlier) to the current release, or upgrades one or more object-relational model (release 8.1.6 or later) geometries that need to be upgraded (as explained in the Usage Notes). As a procedure, TO_CURRENT upgrades an entire layer (all geometries in a column); as a function, TO_CURRENT upgrades a single geometry object, which must be of type SDO_GEOMETRY.

For upgrading a layer, the procedure format depends on whether you are upgrading from the Spatial relational model (release 8.1.5 or earlier) or object-relational model (release 8.1.6 or later). See the Usage Notes for the model that applies to you.

> **Note:**
>
> This procedure applies to two-dimensional geometries only. It is not supported for three-dimensional geometries.

Parameters

tabname
Table with geometry objects.

column_name
Column in `tabname` that contains geometry objects. If `column_name` is not specified or is specified as null, the column containing geometry objects is upgraded.

commit_int
Number of geometries to upgrade before Spatial performs an internal commit operation. If `commit_int` is not specified, no internal commit operations are performed during the upgrade. If you specify a `commit_int` value, you can use a smaller rollback segment than would otherwise be needed.

geom
Single geometry object to be upgraded to the current release.

dim
Dimensional information array for the geometry object to be upgraded. The SDO_DIM_ARRAY type is explained in DIMINFO.

layer
Name of the layer to be upgraded.

newtabname
Name of the new table to which you are upgrading the data.

gidcolumn
Name of the column in which to store the GID from the old table.

geocolname
Name of the column in the new table where the geometry objects will be inserted.

layer_gtype
One of the following values: POINT or NOTPOINT (default).
If the layer you are upgrading is composed solely of point data, set this parameter to POINT for optimal performance; otherwise, set this parameter to NOTPOINT. If you set the value to POINT and the layer contains any nonpoint geometries, the upgrade might produce invalid data.

updateflag
One of the following values: UPDATE or INSERT (default).
If you are upgrading the layer into an existing populated attribute table, set this parameter to UPDATE; otherwise, set this parameter to INSERT.

Usage Notes for Object-Relational Model Layer and Single Geometry Upgrade

This subprogram is not needed for normal upgrades of Oracle Spatial. It is sometimes needed if spatial data is loaded using a third-party loader and if the resulting geometries have the wrong orientation or invalid ETYPE or GTYPE values. For information about using this subprogram as part of the recommended procedure for loading and validating spatial data, see Recommendations for Loading and Validating Spatial Data.

This subprogram upgrades the specified geometry or all geometry objects in the specified layer so that their SDO_GTYPE and SDO_ETYPE values are in the format of the current release:

- SDO_GTYPE values of 4 digits are created, using the format (*DLTT*) shown in SDO_GTYPE.
- SDO_ETYPE values are as discussed in SDO_ELEM_INFO.

Geometries are ordered so that exterior rings are followed by their interior rings, and coordinates are saved in the correct rotation (counterclockwise for exterior rings, and clockwise for interior rings).

Usage Notes for Relational Model Upgrade

If you are you upgrading from the Spatial relational model (release 8.1.5 or earlier), consider the following when using this procedure:

- The new table must be created before you call this procedure.
- If the data to be upgraded is geodetic, the tolerance value (SDO_TOLERANCE column value in the <*layername*>_SDODIM table or view) must be expressed in decimal degrees (for example, 0.00000005).
- The procedure converts geometries from the relational model to the object-relational model.
- A commit operation is performed by this procedure.
- If any of the upgrade steps fails, nothing is upgraded for the layer.
- `layer` is the underlying layer name, without the _SDOGEOM suffix.
- The old SDO_GID is stored in `gidcolumn`.
- SDO_GTYPE values of 4 digits are created, using the format (*DLTT*) shown in SDO_GTYPE.
- SDO_ETYPE values are created, using the values discussed in SDO_ELEM_INFO.
- The procedure orders geometries so that exterior rings are followed by their interior rings, and it saves coordinates in the correct rotation (counterclockwise for exterior rings, and clockwise for interior rings).

Examples

The following example changes the definitions of geometry objects in the ROADS table from the format of a release later than 8.1.5 to the format of the current release.

```
EXECUTE SDO_MIGRATE.TO_CURRENT('ROADS');
```

28

SDO_OLS Package (OpenLS)

The MDSYS.SDO_OLS package contains subprograms for Spatial OpenLS support.

To use the subprograms in this chapter, you must understand the conceptual and usage information about OpenLS in OpenLS Support.

> **Note:**
>
> The SDO_OLS subprograms are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_OLS.MakeOpenLSClobRequest
- SDO_OLS.MakeOpenLSRequest

28.1 SDO_OLS.MakeOpenLSClobRequest

Format

```
SDO_OLS.MakeOpenLSClobRequest(
     request  IN CLOB
     ) RETURN CLOB;
```

Description

Submits an OpenLS request using a CLOB object, and returns the result as a CLOB object.

Parameters

request
OpenLS request in the form of a CLOB object.

Usage Notes

To specify the input request as an XMLType object to return an XMLType object, use the SDO_OLS.MakeOpenLSRequest function.

For information about OpenLS support, see OpenLS Support.

Examples

The following example requests the nearest business, in a specified category (that is, with specified `SIC_code` value), to a specified location (longitude: -122.4083257, latitude: 37.788208).

```
DECLARE
  request CLOB;
  result CLOB;
BEGIN
request := TO_CLOB(
'<?xml version="1.0" encoding="UTF-8"?>
<XLS xmlns="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.1">
 <RequestHeader clientName="someName" clientPassword="password"/>
 <Request requestID="123" maximumResponses="100" version="1.1"
      methodName="DirectoryRequest">
  <DirectoryRequest>
   <POILocation>
    <Nearest nearestCriterion="Proximity">
     <Position>
      <gml:Point xmlns:gml="http://www.opengis.net/gml">
       <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
      </gml:Point>
     </Position>
    </Nearest>
   </POILocation>
   <POIProperties>
    <POIProperty name="SIC_code" value="1234567890"/>
   </POIProperties>
  </DirectoryRequest>
 </Request>
</XLS>');

result := SDO_OLS.makeOpenLSClobRequest(request);

END;
/
```

28.2 SDO_OLS.MakeOpenLSRequest

Format

```
SDO_OLS.MakeOpenLSRequest(
     request  IN XMLTYPE
     ) RETURN XMLTYPE;
```

Description

Submits an OpenLS request using an XMLType object, and returns the result as an XMLType object.

Parameters

request
OpenLS request in the form of an XMLType object.

Usage Notes

To specify the input request as a CLOB and to return a CLOB, use the SDO_OLS.MakeOpenLSClobRequest function.

For information about OpenLS support, see OpenLS Support.

Examples

The following example requests the nearest business, in a specified category (that is, with specified `SIC_code` value), to a specified location (longitude: -122.4083257, latitude: 37.788208).

```
SELECT SDO_OLS.makeOpenLSRequest(XMLTYPE(
'<?xml version="1.0" encoding="UTF-8"?>
<XLS xmlns="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.1">
 <RequestHeader clientName="someName" clientPassword="password"/>
 <Request requestID="123" maximumResponses="100" version="1.1"
      methodName="DirectoryRequest">
  <DirectoryRequest>
   <POILocation>
    <Nearest nearestCriterion="Proximity">
     <Position>
      <gml:Point xmlns:gml="http://www.opengis.net/gml">
       <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
      </gml:Point>
     </Position>
    </Nearest>
   </POILocation>
   <POIProperties>
    <POIProperty name="SIC_code" value="1234567890"/>
   </POIProperties>
  </DirectoryRequest>
 </Request>
</XLS>')) "OpenLS Response" FROM DUAL;
```

29

SDO_PC_PKG Package (Point Clouds)

The MDSYS.SDO_PC_PKG package contains subprograms to support working with point clouds.

To use the subprograms in this package, you must understand the main concepts related to three-dimensional geometries, including the use of point clouds to model solids. Three-Dimensional Spatial Objects describes support for three-dimensional geometries, Modeling Solids describes the use of point clouds to model solids, and Point Cloud-Related Object Types describes data types related to point clouds.

> **Note:**
>
> The SDO_PC_PKG subprograms are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

- SDO_PC_PKG.CLIP_PC
- SDO_PC_PKG.CLIP_PC_FLAT
- SDO_PC_PKG.CLIP_PC_FLAT_STRING
- SDO_PC_PKG.CLIP_PC_INTO_TABLE
- SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES
- SDO_PC_PKG.CREATE_PC
- SDO_PC_PKG.CREATE_PC_UNIFIED
- SDO_PC_PKG.DROP_DEPENDENCIES
- SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS
- SDO_PC_PKG.GET_PT_IDS
- SDO_PC_PKG.HAS_PYRAMID
- SDO_PC_PKG.INIT
- SDO_PC_PKG.PC_DIFFERENCE
- SDO_PC_PKG.PC2DEM
- SDO_PC_PKG.PRESERVES_LEVEL1
- SDO_PC_PKG.SDO_PC_NN
- SDO_PC_PKG.SDO_PC_NN_FOR_EACH
- SDO_PC_PKG.TO_GEOMETRY

29.1 SDO_PC_PKG.CLIP_PC

Format

```
SDO_PC_PKG.CLIP_PC(
     inp           IN SDO_PC,
     ind_dim_qry   IN SDO_GEOMETRY,
     other_dim_qry IN SDO_MBR,
     qry_min_res   IN NUMBER,
     qry_max_res   IN NUMBER,
     blkno         IN NUMBER DEFAULT NULL,
     include_custom_dims IN NUMBER DEFAULT 0
     ) RETURN SDO_PC_BLK_TYPE;
```

Description

Performs a clip operation on a point cloud.

Parameters

inp
Point cloud on which to perform the clip operation.

ind_dimqry
For querying the indexed dimensions of the point cloud: window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries.

other_dimqry
For querying the nonindexed dimensions of the point cloud: window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries. The nonindexed dimensions are those that are included in the total dimensionality but are not indexed. For an explanation of index dimensionality and total dimensionality, see the explanation of the `pc_tot_dimensions` parameter of the SDO_PC_PKG.INIT function.
The SDO_MBR type is defined as `(LOWER_LEFT SDO_VPOINT_TYPE, UPPER_RIGHT SDO_VPOINT_TYPE)` and SDO_V_POINT_TYPE is defined as V`ARRAY(64) OF NUMBER`.

qry_min_res
Minimum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

qry_max_res
Maximum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

blkid
Block ID number of the block to which to restrict the objects returned by the clip operation. If this parameter is null, all objects that satisfy the other parameters are returned.

include_custom_dims
Numeric value 0 or 1, which determines whether the point cloud blocks returned by the function contain only the regular (type NUMBER) dimensions, as included in the PC_TOT_DIMENSIONS count of SDO_PC. If only these regular dimensions should be returned, then `include_custom_dims=0` (the default). The stored point cloud blocks in the

block table still contain any additional custom dimensions, but this individual CLIP_PC query then does not return them.
`include_custom_dims=1` includes both regular and custom dimensions.
See the Usage Notes for more information about custom dimensions.

Usage Notes

This function returns points from a point cloud that are within a specified query window and that satisfy any other requirements specified by the parameters. A common use of this function is to perform queries on point clouds. You can maximize the performance of a point cloud query by minimizing the number of objects that the function needs to consider for the operation.

The SDO_PC and SDO_PC_BLK_TYPE data types are described in Point Cloud-Related Object Types.

This function supports the storage and querying of custom dimensions. Custom dimensions can be of type NUMBER or other types, and they are not included in the PC_TOT_DIMENSIONS count of SDO_PC. If `include_custom_dims=1`, the custom dimensions can be part of a query result, but they cannot be part of the query restriction, either in the `ind_dimqry` or `other_dimqry` parameters, because custom dimensions might not be of numeric type (and thus cannot be represented in the numeric interface of `ind_dimqry` or `other_dimqry`).

Custom dimensions cannot be created using the SDO_PC_PKG.CREATE_PC procedure.

Contrast this function with SDO_PC_PKG.CLIP_PC_FLAT, which takes as input point cloud data stored in a flat table (as opposed to an SDO_PC object).

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example performs a clip operation on a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
declare
  inp  sdo_pc;
begin
  select pc INTO inp  from base where rownum=1;
  insert into restst
    select * from
      table(sdo_pc_pkg.clip_pc
           (
            inp,  -- Input point cloud object
            sdo_geometry(2003, 8307, null,
              sdo_elem_info_array(1, 1003, 3),
              sdo_ordinate_array(-175.86157, -14.60521, 0,0)), -- Query
              null, null, null));
end;
/
. . .
```

29.2 SDO_PC_PKG.CLIP_PC_FLAT

Format

```
SDO_PC_PKG.CLIP_PC_FLAT(
     geometry       IN SDO_GEOMETRY,
     table_name     IN VARCHAR2,
     tolerance      IN NUMBER,
     other_dim_qry  IN SDO_MBR,
     mask           IN VARCHAR2 DEFAULT NULL
     ) RETURN REF CURSOR;
```

Description

Performs a clip operation on a flat-format point cloud, in which the point cloud data is stored in a flat table.

Parameters

geometry
Two-dimensional geometry to serve as the clip window. For example:

```
geometry =>
  SDO_GEOMETRY(
    2003,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 3),
    SDO_ORDINATE_ARRAY(
      0.75, 0.75,
      1.25, 1.25))
```

table_name
Name of the table or view containing the point cloud data. The first two columns in the table or view must be named X and Y and be of type Oracle NUMBER. Optionally, following X and Y, the table or view can contain a Z column of type NUMBER, and additional nonspatial point cloud attributes. The additional nonspatial point cloud attributes can be any data type, but must be type Oracle NUMBER if they will participate as constraints in the `other_dim_qry` parameter.

tolerance
Tolerance value for objects in the point cloud (see Tolerance for information about spatial tolerance). If this parameter is null, the default value is 0.0000000000005

other_dim_qry
Minimum bounding rectangle (MBR) to provide a user defined query ranges for any Oracle NUMBER type columns (not including the X and Y columns).
The SDO_MBR type is defined as `(LOWER_LEFT SDO_VPOINT_TYPE, UPPER_RIGHT SDO_VPOINT_TYPE)` and SDO_V_POINT_TYPE is defined as V`ARRAY(64) OF NUMBER`.
Specify NULL in the SDO_V_POINT_TYPE array for Oracle NUMBER type columns that are not constrained by a query range.

mask
The topological relationship of interest, as applicable to points interacting with polygons. Valid values are `'mask=<value>'` where `<value>` is one or more of the mask values valid for the SDO_RELATE operator (`TOUCH`, `OVERLAPBDYDISJOINT`, `OVERLAPBDYINTERSECT`, `EQUAL`, `INSIDE`,

`COVEREDBY`, `CONTAINS`, `COVERS`, `ANYINTERACT`, `ON`), or `FILTER`, which performs an approximate check. `FILTER` will return all the candidates that intersect the polygon, and possibly a few more. Multiple masks are combined with the logical Boolean operator `OR` (for example, `'mask=inside+touch'`); however, `FILTER` cannot be combined with any other mask.
If this parameter is null or contains an empty string, `mask=ANYINTERACT` is assumed.

Usage Notes

This function works with flat-format point clouds, in contrast to SDO_PC_PKG.CLIP_PC, which works with input point cloud data stored in an SDO_PC object. The flat format has been added to point cloud support to offer an alternative to SDO_PC, depending on hardware environment and usage patterns. One advantage of the flat format is its dynamic nature, since updates to the point data do not require reblocking.

In environments other than Exadata, it is highly recommended that you create a compound B-tree index on the X, Y columns. In the compound B-tree index, also include any other Oracle NUMBER columns that will constrained with user-defined query ranges described for the `other_dim_qry` parameter. Any point cloud data update will result in an automatic update of that B-tree index.

Contrast this function with SDO_PC_PKG.CLIP_PC, which takes as input point cloud data stored in an SDO_PC object.

Modeling Solids describes how to use point clouds to model solids. It includes some discussion of the SDO_PC and flat table approaches for storing point cloud data.

Examples

The following example creates a view named INPTAB2 from the first three columns of a table named INPPTAB. It then performs a clip operation on the point cloud date.

```
CREATE VIEW inptab2 AS (select x x, y y, z z from inptab);

DECLARE
  my_cursor sys_refcursor;
  TYPE rec IS RECORD(x NUMBER, y NUMBER, z number);
  TYPE lst IS TABLE OF rec;
  result_list lst;
BEGIN
  my_cursor :=
    SDO_PC_PKG.CLIP_PC_FLAT(
      geometry =>
        MDSYS.SDO_GEOMETRY(
          2003,
          NULL,
          NULL,
          MDSYS.SDO_ELEM_INFO_ARRAY(1, 1003, 3),
          MDSYS.SDO_ORDINATE_ARRAY(
            0.75, 0.75,
            1.25, 1.25)),
      table_name    => 'INPTAB2',
      tolerance     => 0.05,
      other_dim_qry => null,
      mask          => null);

  FETCH my_cursor BULK COLLECT INTO result_list;
  FOR I in 1 .. result_list.COUNT LOOP
    dbms_output.put_line(
      '(' || result_list(i).x || ', ' ||
             result_list(i).y || ', ' ||
             result_list(i).z || ')');
  END LOOP;
  CLOSE my_cursor;
END;
/
```

29.3 SDO_PC_PKG.CLIP_PC_FLAT_STRING

Format

```
SDO_PC_PKG.CLIP_PC_FLAT_STRING(
     geometry       IN SDO_GEOMETRY,
     table_name     IN VARCHAR2,
     tolerance      IN NUMBER,
     other_dim_qry  IN SDO_MBR,
     mask           IN VARCHAR2 DEFAULT NULL,
     dop            IN NUMBER DEFAULT NULL,
     sdo_level      IN NUMBER DEFAULT 4,
     sdo_ntiles     IN NUMBER DEFAULT 100
     ) RETURN CLOB;
```

Description

Generates a SQL query string to perform a clip operation on a flat-format point cloud, in which the point cloud data is stored in a flat table. The query is not executed, but merely generated for either subsequent execution or inspection.

Parameters

geometry
Two-dimensional geometry to serve as the clip window. For example:

```
geometry =>
  SDO_GEOMETRY(
    2003,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 3),
    SDO_ORDINATE_ARRAY(
      0.75, 0.75,
      1.25, 1.25))
```

table_name
Name of the table or view containing the point cloud data. The first two columns in the table or view must be named X and Y and be of type Oracle NUMBER. Optionally, following X and Y, the table or view can contain a Z column of type NUMBER, and additional nonspatial point cloud attributes. The additional nonspatial point cloud attributes can be any data type, but must be type Oracle NUMBER if they will participate as constraints in the `other_dim_qry` parameter.

tolerance
Tolerance value for objects in the point cloud (see Tolerance for information about spatial tolerance). If this parameter is null, the default value is 0.0000000000005

other_dim_qry
Minimum bounding rectangle (MBR) to provide a user defined query ranges for any Oracle NUMBER type columns (not including the X and Y columns).
The SDO_MBR type is defined as `(LOWER_LEFT SDO_VPOINT_TYPE, UPPER_RIGHT SDO_VPOINT_TYPE)` and SDO_V_POINT_TYPE is defined as V`ARRAY(64) OF NUMBER`.

Specify NULL in the SDO_V_POINT_TYPE array for Oracle NUMBER type columns that are not constrained by a query range.
As an example:

```
other_dim_qry => MDSYS.SDO_MBR(
                     SDO_VPOINT_TYPE(10, 81),
                     SDO_VPOINT_TYPE(11, 82))
```

means that the third value (x and y being first and second) is between 10 and 11. The fourth value should be between 81 and 82.

mask
The topological relationship of interest, as applicable to points interacting with polygons. Valid values are `'mask=<value>'` where `<value>` is one or more of the mask values valid for the SDO_RELATE operator (`TOUCH`, `OVERLAPBDYDISJOINT`, `OVERLAPBDYINTERSECT`, `EQUAL`, `INSIDE`, `COVEREDBY`, `CONTAINS`, `COVERS`, `ANYINTERACT`, `ON`), or `FILTER`, which performs an approximate check. `FILTER` will return all the candidates that intersect the polygon, and possibly a few more. Multiple masks are combined with the logical Boolean operator `OR` (for example, `'mask=inside+touch'`); however, `FILTER` cannot be combined with any other mask.
If this parameter is null or contains an empty string, `mask=ANYINTERACT` is assumed.

dop
Degree of parallelism for the clip operation. This may appear in the generated SQL statement, for example, as: `select /*+ PARALLEL ( 16 )*/ * from "LIDAR_DATA" …`

sdo_level
Specifies the level of tessellation. A value between 1 and 5 is common, and 4 is the default. This affects the generated tiles, for example, (x >= 2.2500000125 and x < 2.500000025 and y >= 2.12500000625 and y < 2.7500000375).

sdo_ntiles
Specifies the maximum number of tiles to generate. A value between 1 and 200 is common, and 100 is the default. This affects the generated tiles.

Usage Notes

This function is similar to the SDO_PC_PKG.CLIP_PC_FLAT function, except that it:

- Does not execute the query, but merely generates a SQL query string.
- Provides more tuning capability with the `sdo_level` and `sdo_ntiles` parameters. For most queries, the values `sdo_level=1` and `sdo_ntiles=10` are optimal.

See also the Usage Notes for SDO_PC_PKG.CLIP_PC_FLAT.

Examples

The following example creates a table named LIDAR_DATA, with columns X, Y, Z, and VAL (for some values). It then generates, and subsequently even executes (in a separate statement), a clip operation SQL statement on the point cloud.

```
SQL> create table lidar_data(x number, y number, z number, val number);

Table created.

SQL>
SQL> begin
  2    for y in 1..1024 loop
  3      for x in 1..1024 loop
  4        insert into lidar_data (x, y, z, val) values (x, y, x + y, x * y);
  5      end loop;
  6    end loop;
  7  end;
  8  /

PL/SQL procedure successfully completed.

SQL> SELECT
  2    sdo_pc_pkg.clip_pc_flat_string (
  3      geometry      => SDO_GEOMETRY(
  4                         2003,
  5                         8307,
  6                         NULL,
  7                         SDO_ELEM_INFO_ARRAY(1, 1003, 1),
  8                         SDO_ORDINATE_ARRAY(
  9                           1, 1,
 10                           2, 1,
 11                           2, 2,
 12                           3, 2,
 13                           3, 3,
 14                           1, 3,
 15                           1, 1)),
 16      table_name    => 'LIDAR_DATA',
 17      tolerance     => .00000005,
 18      other_dim_qry => MDSYS.SDO_MBR(
 19                         SDO_VPOINT_TYPE(0, 0),
 20                         SDO_VPOINT_TYPE(1000, 1000000)),
 21      mask          => 'FILTER',
 22      dop           => 16,
 23      sdo_level     => 4,
 24      sdo_ntiles    => 100) "Query"
 25  FROM
 26    dual;

Query
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------
----------------------
select  /*+ PARALLEL ( 16 )*/ * from "LIDAR_DATA" WHERE  (
  (x >= 1.2499999625 and x <  1.37499996875 and y >= 1.2499999625 and y <  2.7500000375)
OR
  (x >= 2.7500000375 and x <  2.87500004375 and y >= 2.12500000625 and y <
2.87500004375) OR
  (x >= 1.37499996875 and x <  1.499999975 and y >= 1.2499999625 and y <  2.7500000375)
OR
  (x >= 2.2500000125 and x <  2.500000025 and y >= 2.12500000625 and y <  2.7500000375)
OR
  (x >= 2.500000025 and x <  2.7500000375 and y >= 2.12500000625 and y <  2.7500000375)
OR
  (x >= 1.12499995625 and x <  1.87499999375 and y >= 1.12499995625 and y <
1.2499999625) OR
  (x >= 1.7499999875 and x <  2 and y >= 2.12500000625 and y <  2.7500000375) OR
  (x >= 1.12499995625 and x <  1.2499999625 and y >= 1.2499999625 and y <
2.87500004375) OR
  (x >= 2 and x <  2.2500000125 and y >= 2.12500000625 and y <  2.7500000375) OR
  (x >= 1.7499999875 and x <  1.87499999375 and y >= 1.2499999625 and y <
2.12500000625) OR
  (x >= 1.2499999625 and x <  2.7500000375 and y >= 2.7500000375 and y <  2.87500004375)
OR
  (x >= 1.499999975 and x <  1.62499998125 and y >= 1.2499999625 and y <  2.7500000375)
OR
```

```
  (x >= 1.62499998125 and x <  1.7499999875 and y >= 1.2499999625 and y <
2.7500000375))  AND ( "Z" BETWEEN 0 AND 1000 )  AND ( "VAL" BETWEEN 0 AND 1000000 )
UNION ALL select  * from "LIDAR_DATA" W
HERE  (
  (x >= .99999995 and x <  1.87499999375 and y >= .99999995 and y <  1.12499995625) OR
  (x >= .99999995 and x <  1.12499995625 and y >= 1.12499995625 and y <  2.87500004375)
OR
  (x >= .99999995 and x <  2.87500004375 and y >= 2.87500004375 and y <
3.0000000500000001402157) OR
  (x >= 2 and x <  2.12500000625 and y >= .99999995 and y <  1.87499999375) OR
  (x >= 1.87499999375 and x <  2 and y >= .99999995 and y <  2.12500000625) OR
  (x >= 2.87500004375 and x <  3.0000000500000001402157 and y >= 1.87499999375 and y <
3.0000000500000001402157) OR
  (x >= 2 and x <  2.87500004375 and y >= 2 and y <  2.12500000625) OR
  (x >= 2 and x <  2.87500004375 and y >= 1.87499999375 and y <  2))  AND ("Z" BETWEEN 0
AND 1000 )  AND ("VAL" BETWEEN 0 AND 1000000 )


1 row selected.

SQL>
SQL> declare
  2    stm varchar2(4096);
  3  begin
  4    SELECT
  5      sdo_pc_pkg.clip_pc_flat_string (
  6        geometry      => SDO_GEOMETRY(
  7                           2003,
  8                           8307,
  9                           NULL,
 10                           SDO_ELEM_INFO_ARRAY(1, 1003, 1),
 11                           SDO_ORDINATE_ARRAY(
 12                             1, 1,
 13                             2, 1,
 14                             2, 2,
 15                             3, 2,
 16                             3, 3,
 17                             1, 3,
 18                             1, 1)),
 19        table_name    => 'LIDAR_DATA',
 20        tolerance     => .00000005,
 21        other_dim_qry => MDSYS.SDO_MBR(
 22                           SDO_VPOINT_TYPE(0, 0),
 23                           SDO_VPOINT_TYPE(1000, 1000000)),
 24        mask          => 'FILTER',
 25        dop           => 16,
 26        sdo_level     => 4,
 27        sdo_ntiles    => 100) "Query"
 28    into
 29      stm
 30    FROM
 31      dual;
 32
 33    execute immediate 'create table result as (' || stm || ')';
 34  end;
 35  /

PL/SQL procedure successfully completed.

SQL>
SQL> select * from result order by x, y;
```

```
         X          Y          Z        VAL
---------- ---------- ---------- ----------
         1          1          2          1
         1          2          3          2
         1          3          4          3
         2          1          3          2
         2          2          4          4
         2          3          5          6
         3          2          5          6
         3          3          6          9

8 rows selected.

SQL>
SQL> drop table result;

Table dropped.

SQL> drop table lidar_data;

Table dropped.

SQL> SQL>
```

29.4 SDO_PC_PKG.CLIP_PC_INTO_TABLE

Format

```
SDO_PC_PKG.CLIP_PC_INTO_TABLE(
  pc_table                VARCHAR2,
  pc_column               VARCHAR2,
  id_column               VARCHAR2,
  id                      VARCHAR2,
  query                   MDSYS.SDO_GEOMETRY,
  where_clause            VARCHAR2,
  result_table_name       VARCHAR2,
  lods                    MDSYS.SDO_LODS_TYPE,
  category_table          VARCHAR2 DEFAULT NULL,
  category_match          VARCHAR2 DEFAULT NULL,
  category_query          VARCHAR2 DEFAULT NULL,
  include_unblocked_table NUMBER DEFAULT 0
) PARALLEL_ENABLE;
```

Description

Queries point clouds of any model and stores the result in a table.

Parameters

pc_table
Name of the table where the `SDO_PC` object is stored.

pc_column
Name of the column where the `SDO_PC` object is stored.

id_column
Name of the `ID` column in the `pc_table`.

id
`ID` value of the `ID` column identifying the `SDO_PC` object.

query
`SDO_GEOMETRY` representing the geometric query.

where_clause
Not currently used.

result_table_name
Name of the output table that stores the results.
This table is automatically created.

lods
List of level of details (LODs) for point clouds with pyramiding enabled.
This is an optional parameter.

category_table
Not currently used.

category_match
Not currently used.

category_query
Not currently used.

include_unblocked_table
Not currently used.

Usage Notes

The SDO_PC_PKG.CLIP_PC_INTO_TABLE function supports all point cloud models, whereas SDO_PC_PKG.CLIP_PC supports only the blocked models. Also, the result is stored in a table, whereas SDO_PC_PKG.CLIP_PC returns a query result without materializing a table.

Examples

The following example queries a point cloud object in table `PCS`. The `PC` table column contains the `SDO_PC` object, and the ID column value is `12345`. The example uses a a simple rectangular query window and the results are stored in table `QUERY_RESULT_1`.

```
call
  sdo_pc_pkg.clip_pc_into_table(
    pc_table          => 'PCS',
    pc_column         => 'PC',
    id_column         => 'ID',
    id                => '12345',
    query             => mdsys.sdo_geometry(
                           SDO_POLYGON2D,
                           27700,
                           null,
                           mdsys.sdo_elem_info_array(1, 1003, 3),
                           mdsys.sdo_ordinate_array(
                              1,  1,
                             10, 10)),
    where_clause      => null,
    result_table_name => 'QUERY_RESULT_1',
    lods              => sdo_lods_type(1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
  );
```

29.5 SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES

Format

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES(
     pc                  IN SDO_PC,
     sampling_resolution IN NUMBER,
     elevations          IN SDO_ORDINATE_ARRAY,
     region              IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY_ARRAY;
```

or

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES(
     pc_flat_table       IN VARCHAR2,
     srid                IN NUMBER,
     sampling_resolution IN NUMBER,
     elevations          IN SDO_ORDINATE_ARRAY,
     region              IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY_ARRAY;
```

or

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES(
     pc                  IN SDO_PC,
     sampling_resolution IN NUMBER,
     elevations_min      IN NUMBER,
     elevations_interval IN NUMBER,
     elevations_max      IN NUMBER,
     region              IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY_ARRAY;
```

or

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES(
     pc_flat_table       IN VARCHAR2,
     srid                IN SDO_PC,
     sampling_resolution IN NUMBER,
     elevations_min      IN NUMBER,
     elevations_interval IN NUMBER,
     elevations_max      IN NUMBER,
     region              IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY_ARRAY;
```

Description

Generates contour lines for a point cloud.

Parameters

pc
Point cloud object for which to generate contour lines.

sampling_resolution
A numeric value that determines the grid cell height and width in the coordinate reference system of the point cloud. The smaller the number, the more detailed are the resulting contour geometries.

The process of the contour generation is grid-based. The points within a grid cell get averaged. This means:

- Two slightly different point clouds may result in the same contours, as long as the grid cells yield the same averages.
- The number of vertices and smoothness of the contour lines is a direct function of the resolution.

elevations
An array of elevations for which contours should be generated.

elevations_min
The starting elevation value in a set of equidistant elevations for which contours should be generated.

elevations_interval
The interval to use for elevation values between `elevations_min` and `elevations_max` when generating coutours.
For example, if `elevations_min` is 100, `elevations_max` is 150, and `elevations_interval` is 10, then coutours are generated for elevations 100, 110, 120, 130, 140, and 150.

elevations_max
The ending elevation value in a set of equidistant elevations for which contours should be generated.

region
A window (within the extent of the point cloud) further restricting the region within which the contour lines should be generated.

Usage Notes

This function returns an array of SDO_GEOMETRY contours. The sequence of contours within the array is the same as the sequence in the `elevations` input parameter or in the computed values based on the `elevations_min` , `elevations_max`, and `elevations_interval` input parameters. Each contour is a multiline string.

Contours enclosing higher elevations are oriented counterclockwise (like outer rings). Contours enclosing lower elevations are oriented clockwise (like inner rings).

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example creates contour lines from a a specified a point cloud object.

```
SELECT sdo_pc_pkg.create_contour_geometries(
  (SELECT pc FROM pcs WHERE pc_id = 1),
  sampling_resolution => 50,
  elevations => sdo_ordinate_array(100, 101, 102, 103, 104, 105, 106, 107, 108, 109),
  region => mdsys.sdo_geometry(2003, null, null, mdsys.sdo_elem_info_array(1, 1003, 3),
mdsys.sdo_ordinate_array(-1000, 0, 999, 100)))
  FROM DUAL;

SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES((SELECTPCFROMPCSWHEREPC_ID=1),SAMPLING_RESO
--------------------------------------------------------------------------------
SDO_GEOMETRY_ARRAY(SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 5
, 2, 1), SDO_ORDINATE_ARRAY(-75.5, 24.5, -25.5, 74.5, 25.5, 74.5, 74.5, 25.5, 75
.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 7, 2, 1)
, SDO_ORDINATE_ARRAY(-76.5, 24.5, -75.5, 25.5, -26.5, 74.5, 26.5, 74.5, 74.5, 26
.5, 76.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 7,
 2, 1), SDO_ORDINATE_ARRAY(-77.5, 24.5, -75.5, 26.5, -27.5, 74.5, 27.5, 74.5, 74
.5, 27.5, 77.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2,
 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-78.5, 24.5, -75.5, 27.5, -28.5, 74.5, 28.5, 74
.5, 74.5, 28.5, 78.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY
(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-79.5, 24.5, -75.5, 28.5, -29.5, 74.5, 29
.5, 74.5, 74.5, 29.5, 79.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO
_ARRAY(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-80.5, 24.5, -75.5, 29.5, -30.5, 74
.5, 30.5, 74.5, 74.5, 30.5, 80.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELE
M_INFO_ARRAY(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-81.5, 24.5, -75.5, 30.5, -31
.5, 74.5, 31.5, 74.5, 74.5, 31.5, 81.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, S
DO_ELEM_INFO_ARRAY(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-82.5, 24.5, -75.5, 31.
5, -32.5, 74.5, 32.5, 74.5, 74.5, 32.5, 82.5, 24.5)), SDO_GEOMETRY(2002, NULL, N
ULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-83.5, 24.5, -75.
5, 32.5, -33.5, 74.5, 33.5, 74.5, 74.5, 33.5, 83.5, 24.5)), SDO_GEOMETRY(2002, N
ULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 7, 2, 1), SDO_ORDINATE_ARRAY(-84.5, 24.5
, -75.5, 33.5, -34.5, 74.5, 34.5, 74.5, 74.5, 34.5, 84.5, 24.5)))

1 row selected.
```

29.6 SDO_PC_PKG.CREATE_PC

Format

```
SDO_PC_PKG.CREATE_PC(
     inp           IN SDO_PC,
     inptable      IN VARCHAR2,
     clstPcdataTbl IN VARCHAR2 DEFAULT NULL);
```

Description

Creates a point cloud using the points specified in the `inptable` parameter.

Parameters

inp
SDO_PC object to be used. This object must have been created by the SDO_PC_PKG.INIT function.

inptable
Name of the table or view containing the input point cloud data. This table or view should have the following columns:

- RID (VARCHAR2(24)): Unique ID for each point
- VAL_D1 (NUMBER): Ordinate in dimension 1
- VAL_D2 (NUMBER): Ordinate in dimension 2
- . . .
- VAL_D*n* (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `pc_tot_dimensions` parameter value in the call to the SDO_PC_PKG.INIT function when the point cloud was initialized.

clstPcdataTbl
Name of the table for storing the resulting point data. If you do not specify a value, this table is not created. For more information about the table, see the Usage Notes.

Usage Notes

The first few dimensions of the point cloud are indexed and can later be searched using the SDO_PC_PKG.CLIP_PC function. The exact number of dimensions to index is determined by the dimensionality of the point cloud extent in the initialized point cloud object, specifically: `inp.pc_extent.sdo_gtype/1000`

If you specify a view name in the `inptable` parameter, the query `SELECT ROWID FROM <view-name>` must not return any errors.

If you specify a table name in the `clstPcdataTbl` parameter, the table must exist and have the following columns:

- PTN_ID (NUMBER)
- POINT_ID (NUMBER)
- RID (VARCHAR2(24): Unique ID for each point
- VAL_D1 (NUMBER): Ordinate in dimension 1
- VAL_D2 (NUMBER): Ordinate in dimension 2
- . . .
- VAL_D*n* (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `pc_tot_dimensions` parameter value in the call to the SDO_PC_PKG.INIT function when the point cloud was initialized.

If a value is specified for the `clstPcdataTbl` parameter, this function populates the table by assigning appropriate values for PTN_ID and POINT_ID and by copying the values from the `inptable` table or view for other attributes. This table can be created as an index organized table. It can be used in applications for searching using SQL queries on dimensions other than those reflected in the index dimensionality. (For an explanation of index dimensionality and total dimensionality, see the explanation of the `pc_tot_dimensions` parameter of the SDO_PC_PKG.INIT function.)

The SDO_PC and SDO_PC_BLK_TYPE data types are described in Point Cloud-Related Object Types.

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example creates a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Create the blocks for the point cloud.
sdo_pc_pkg.create_pc(
  pc,       -- Initialized PointCloud object
  'INPTAB', -- Name of input table to ingest into the pointcloud
  'RES'     -- Name of output table that stores the points (with ptn_id,pt_id)
  );
. . .
```

29.7 SDO_PC_PKG.CREATE_PC_UNIFIED

Format

```
CREATE_PC_UNIFIED(
  pc_type                   VARCHAR2,
  inp_table                 VARCHAR2,
  base_table                VARCHAR2,
  data_table                VARCHAR2,
  pc_id                     NUMBER,
  pc_tol                    NUMBER,
  blk_size                  NUMBER,
  srid                      NUMBER       DEFAULT NULL,
  sfc_domain                SDO_GEOMETRY DEFAULT NULL,
  sfc_type                  VARCHAR2     DEFAULT '2D Hilbert as NUMBER', -- ('2D Hilbert
as NUMBER', '2D Hilbert as RAW')
  pc_extent                 SDO_GEOMETRY DEFAULT NULL,
  feature_table             VARCHAR2     DEFAULT NULL,
  feature_block_link_table VARCHAR2     DEFAULT NULL,
  feature_buffer            NUMBER       DEFAULT NULL,
  drop_non_interacting_pts NUMBER       DEFAULT 0,
  create_unblocked_table    NUMBER       DEFAULT 0,
  create_pyramid            NUMBER       DEFAULT 1,
  preserve_pyramid_leaves   NUMBER       DEFAULT 0
);
```

Description

Creates a point cloud of a configurable model (such as Hilbert R-tree blocked, R-tree blocked, Flat, or Hybrid).

Parameters

pc_type
Point cloud type or model.
Supported point cloud types are:

- **R-tree:** Points are partitioned into geographic blocks, and this model is a variation of the R-tree structure.
- **Hilbert R-tree:** Points are partitioned into geographic blocks, and this model is a variation of the Hilbert R-tree structure.
- **Feature-Blocked:** Points are partitioned into geographic blocks, and this model is based on a given list of features (such as roads, postal codes, or building blocks).
- **Flat:** Points are directly stored in a plain or flat database table. In this case, Exadata uses Exadata Smart Scan, while non-Exadata uses a B-tree on (VAL_D1, VAL_D2) or (VAL_D1, VAL_D2, VAL_D3). Also, on non-Exadata platforms, the flat model slows down queries beyond point cloud sizes of one billion points.
- **Hybrid or Hybrid Hilbert R-tree:** Points are stored similarly to the flat model, except in an index-organized table using logical blocks similar to the Hilbert R-tree blocked model.

inp_table
Name of the table or view containing the input point cloud data.
This table or view must have the following columns:

- `VAL_D1 (NUMBER)`: Ordinate in dimension 1
- `VAL_D2 (NUMBER)`: Ordinate in dimension 2
- ...
- `VAL_Dn (NUMBER)`: Ordinate in dimension `n`, where `n` is the highest-numbered dimension. `n` must match the `pc_tot_dimensions` parameter value in the call to the SDO_PC_PKG.INIT function when the point cloud was initialized.

base_table
Name of the table in which the point cloud object will be stored.
The following shows an example DDL statement for creating this table:
`CREATE TABLE pcs (id NUMBER, pc SDO_PC);`

data_table
Name of the table in which the point cloud data will be stored.
The following shows an example DDL statement for creating this table for a blocked model:
`CREATE TABLE blocks AS SELECT * FROM mdsys.sdo_pc_blk_table WHERE rownum < 0;`
For a flat or hybrid model, the table will be automatically created in the database schema.

pc_id
Numerical point cloud `ID`.

pc_tol
Tolerance used in the point cloud.

blk_size
Size of a block in points.
This applies when R-tree blocked, Hilbert R-tree blocked, or Hybrid are used.

srid
SRID coordinate system used for the point cloud.

sfc_domain
Not currently used.

sfc_type
Not currently used.

pc_extent
Geographic extent of the point cloud.

feature_table
Name of the feature table used for feature blocking.
Points are blocked around the given features.

feature_block_link_table
Table created to provide the foreign key links between the feature table (`feature_table`) and the point cloud block table (`data_table`).
For example:

```
SQL> desc feature_block_links;
 Name                                      Null?    Type
 ----------------------------------------- -------- ---------
 FEATURE_ID                                         NUMBER
 OBJ_ID                                             NUMBER
 BLK_ID                                             NUMBER
```

feature_buffer
Geographic buffer around each feature, such as a highway.

drop_non_interacting_pts
Not currently used.

create_unblocked_table
Not currently used.

create_pyramid
Determines whether the point cloud can be organized in a pyramid, if blocked.

preserve_pyramid_leaves
Determines whether all points must be only stored in one of the pyramid blocks, or whether non-leaf points can also be stored in the leaves.

Usage Notes

The CREATE_PC_UNIFIED function supports all point cloud models, in contrast to CREATE_PC, which supports only the R-tree blocked model. The query equivalent to this function is SDO_PC_PKG.CLIP_PC_INTO_TABLE, which also supports all models. The function SDO_PC_PKG.CLIP_PC only works on blocked models.

Examples

The following example creates a Hilbert R-tree blocked point cloud with `ID` value `12345` and block size `10000`.

```
call
  sdo_pc_pkg.create_pc_unified(
    pc_type    => 'Hilbert R-tree',
    inp_table  => 'INPTAB',
    base_table => 'PCS',
    data_table => 'BLOCKS',
    pc_id      => 12345,
    pc_tol     => 0.05,
    blk_size   => 10000,
    srid       => 27700,
    create_pyramid => 0
  );
```

The following example creates a feature-blocked point cloud. It is blocked based on the number of given features, rather than automatic clustering.

```
create table features (
  feature_id number,
  geom sdo_geometry);

call
  sdo_pc_pkg.create_pc_unified(
    pc_type                  => 'Feature-Blocked',
    inp_table                => 'INPTAB',
    base_table               => 'PCS',
    data_table               => 'BLOCKS',
    pc_id                    => 1,
    pc_tol                   => 0.05,
    blk_size                 => 10000,
    srid                     => null,
    feature_table            => 'FEATURES',
    feature_block_link_table => 'FEATURE_BLOCK_LINKS',
    feature_buffer           => 1,
    create_pyramid          => 0
  );
```

29.8 SDO_PC_PKG.DROP_DEPENDENCIES

Format

```
SDO_PC_PKG.DROP_DEPENDENCIES(
     basetable IN VARCHAR2,
     col       IN VARCHAR2);
```

Description

Drops the dependencies between a point cloud block table and a specified base table and column.

Parameters

basetable
Name of a base table that was specified (in the `basetable` parameter of the SDO_PC_PKG.INIT function) when the point cloud was initialized.

col
Name of a column in base table that was specified in the `basecol` parameter of the SDO_PC_PKG.INIT function.

Usage Notes

This procedure truncates the point cloud block table and removes the association between the block table and the base table and column combination.

After you execute this procedure, you can drop the point cloud block table or associate the table with another base table and column combination. For more information, see the Usage Notes for the SDO_PC_PKG.INIT function.

Examples

The following example drops the dependencies between a point cloud block table and a base table and column named BASE and PC, respectively.

```
. . .
declare
begin
  mdsys.sdo_pc_pkg.drop_dependencies('BASE', 'PC');
end;
/
```

29.9 SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS

Format

```
SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS(
    pc_table             IN VARCHAR2,
    pc_column            IN VARCHAR2,
    id_column            IN VARCHAR2,
    id                    IN VARCHAR2,
    cross_section_line2d IN MDSYS.SDO_GEOMETRY,
    buffer                IN NUMBER,
    false_x               IN NUMBER,
    result_table_2d       IN VARCHAR2,
    result_table_2d_mp    IN VARCHAR2,
    result_table_3d       IN VARCHAR2
);
```

Description

Computes a cross section of a point cloud in 3D and on a vertical 2D plane.

Parameters

pc_table
Name of the table that has the `SDO_POINT_CLOUD` column and `ID` column defined.

pc_column
Column name of the `SDO_POINT_CLOUD` object in the table provided for `pc_table` parameter.

id_column
Column name for the `ID` column in the table provided for `pc_table` parameter.

id
`ID` value.

cross_section_line2d
A 2D line string, with only two vertices, representing a vertical cross section.

buffer
A buffer width in the unit of length of the SRID.

false_x
Value assigned to the starting point of the 2D cross section in the SRID of the 2D representation of the cross section.

result_table_2d
Output table name for the 2D representation of the point set.

result_table_2d_mp
Output table name for the 2D multipoint representation of the point set.

result_table_3d
Output table name for the 3D representation of the point set.

Usage Notes

The `SDO_PC_PKG.GENERATE_CROSS_SECTION_AS_GEOMS` procedure clips the input point cloud with the `cross_section_line2d` parameter string and projects the resulting point set onto a vertical plane. The following outputs are generated for the cross section:

- A 2D point set on a vertical plane with columns `VAL_Di` for `x`, `y`. Note that the 2D point set has no explicit SRID as the coordinate reference system is understood to be the vertical plane.
- Alternatively, a cross section may also be represented as a multipoint of the same 2D set on the plane as it tends to only involve limited number of points.

- A 3D point set in the same coordinate reference system as the input point cloud. The 3D point set is stored in a simple table with columns `VAL_Di` for `x`, `y`, `z`.

Examples

The following example computes the cross section of a point cloud as shown:

```
CALL SDO_PC_PKG.generate_cross_section_as_geoms(
    pc_table             => 'PCS',
    pc_column            => 'PC',
    id_column            => 'ID',
    id                   => '12345',
    cross_section_line2d => mdsys.sdo_geometry(
                              2003,
                              27700,
                              null,
                              mdsys.sdo_elem_info_array(1, 2, 1),
                              mdsys.sdo_ordinate_array(
                                 1,   1,
                                10,  10)),
    buffer               => 0.5,
    false_x              => 100,
    result_table_2d      => 'CROSS_SECTION_2D',
    result_table_2d_mp   => 'CROSS_SECTION_2D_MP',
    result_table_3d      => 'CROSS_SECTION_3D');
```

29.10 SDO_PC_PKG.GET_PT_IDS

Format

```
SDO_PC_PKG.GET_PT_IDS(
     pts          IN BLOB,
     num_pts      IN NUMBER,
     pc_tot_dim   IN NUMBER,
     blk_domain   IN SDO_ORGSCL_TYPE DEFAULT NULL,
     ) RETURN SDO_NUMBER_ARRAY;
```

Description

Returns the block ID and point ID values of the points in a block in a point cloud.

Parameters

pts
Binary large object (BLOB) containing the point cloud block.

num_pts
Number of points in the point cloud block. For a point cloud block, the number of points is stored in the NUM_POINTS column of the point cloud block table, which is described in Table 2-9 in SDO_PC Object Type.

pc_tot_dim
Number of dimensions for the points in the point cloud block.

blk_domain
(Not currently used.)

Usage Notes

This function returns an SDO_NUMBER_ARRAY object. The array contains multiple pairs of numbers, with each pair identifying the block ID and point ID of a point. For any specific call to this function, the block ID values associated with all points in the returned array will be the same. The SDO_NUMBER_ARRAY type is defined as `VARRAY(1048576) OF NUMBER`.

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example returns the block ID and point ID values of points in a point cloud block. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
SELECT SDO_PC_PKG.GET_PT_IDS(
    a.points,   -- LOB containing the points
    a.num_points, -- # of points in the LOB
    3 -- Total dimensionality of the points in the LOB
) FROM restst a WHERE num_points >0;
```

29.11 SDO_PC_PKG.HAS_PYRAMID

Format

```
SDO_PC_PKG.HAS_PYRAMID(
     inp  IN SDO_PC
     ) RETURN NUMBER;
```

Description

Returns 1 if the specified point cloud object has a pyramid, or 0 is it does not have a pyramid (that is, if it has just a single level of blocks).

Parameters

inp
Input point cloud object. (The SDO_PC data type is described in Point Cloud-Related Object Types.)

Usage Notes

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example checks if the point cloud objects in column PC of table PCS have pyramids. The result shows that SDO_PC object in the only row in the table does not have a pyramid.

```
SELECT id, sdo_pc_pkg.has_pyramid(pc) "Has Pyramid" FROM pcs ORDER BY id;

        ID Has Pyramid
---------- -----------
         2           0
```

29.12 SDO_PC_PKG.INIT

Format

```
SDO_PC_PKG.INIT(
     basetable          IN VARCHAR2,
     basecol            IN VARCHAR2,
     blktable           IN VARCHAR2,
     ptn_params         IN VARCHAR2,
     pc_extent          IN SDO_GEOMETRY,
     pc_tol             IN NUMBER DEFAULT 0.0000000000005,
     pc_tot_dimensions  IN NUMBER DEFAULT 2,
     pc_domain          IN SDO_ORGSCL_TYPE DEFAULT NULL,
     pc_val_attr_tables IN SDO_STRING_ARRAY DEFAULT NULL,
     pc_other_attrs     IN XMLTYPE DEFAULT NULL
     ) RETURN SDO_PC;
```

Description

Initializes a point cloud by creating an SDO_PC object.

Parameters

basetable
Name of the base table containing a column of type SDO_PC.

basecol
Name of the column of type SDO_PC in the base table.

blktable
Name of the point cloud block table, which is used for storing the blocks of point cloud. This table must exist, and must have been created by a statement in the following form: `CREATE TABLE <table-name> AS select * from mdsys.sdo_pc_blk_table;`
Each point cloud block table can only be associated with only one `basetable` and `basecol` combination.

ptn_params
Parameters for partitioning the point cloud, specified as a quoted string with keywords delimited by commas. For example: '`blk_capacity=1000,work_tablespace=my_work_ts`'. If this parameter is null, the point cloud is not partitioned. The following keywords are permitted:

- `blk_capacity=n`, where *n* is the maximum number of rows in each partition. The default value is 5000. If specified, must be a number greater than or equal to 50.
- `work_tablespace=x`, where *x* is the name of the tablespace in which to create temporary tables during the partitioning operations.

pc_extent
SDO_GEOMETRY object representing the spatial extent of the point cloud (the minimum bounding object enclosing all objects in the point cloud). This parameter must not be null.
For geodetic data, this geometry must have two dimensions; otherwise, it can have up to four dimensions. The dimensionality of this geometry is used as the minimum value permitted for the `pc_tot_dimensions` parameter, as explained in the description of that parameter.

pc_tol
Tolerance value for objects in the point cloud. (For information about spatial tolerance, see Section 1.5.5.) If this parameter is null, the default value is 0.0000000000005.

pc_tot_dimensions
A number specifying the *total dimensionality* of the point cloud object. For each point in the point cloud blocks, `pc_tot_dimensions` ordinates (values) are stored.
The total dimensionality must be greater than or equal to the index dimensionality, which is the number of dimensions in the `pc_extent` geometry. Specifying total dimensionality greater than index dimensionality enables necessary nonspatial attributes to be retrieved in the same fetch operation with spatial data. The maximum total dimensionality value is 8. The default value for this parameter is 2.

pc_domain
(Not currently used.)

pc_val_attr_tables
SDO_STRING_ARRAY object specifying the names of any value attribute tables for the point cloud. If this parameter is null, the point cloud has no associated value attribute tables. Type SDO_STRING_ARRAY is defined as VARRAY(1048576) OF VARCHAR2(32).

pc_other_attrs
XMLTYPE object specifying any other attributes of the point cloud. If this parameter is null, the point cloud has no other attributes.
This parameter can include metadata on point cloud pyramiding, as explained in the Usage Notes.

Usage Notes

After you use this function to initialize an SDO_PC object, you can create a point cloud by specifying this object as input to the SDO_PC_PKG.CREATE_PC procedure.

The SDO_PC data type is described in Point Cloud-Related Object Types.

Modeling Solids describes how to use point clouds to model solids.

After you use this function, the `blktable` table is kept in synchronization with the base table. For example, if a row is deleted from the basetable, the corresponding blocks of the point cloud object in that row are also deleted from the block table; and if the base table base table is truncated, the block table is truncated also.

The block table can be dropped only after either of the following occurs: the base table is dropped, or the SDO_PC_PKG.DROP_DEPENDENCIES procedure is executed.

The `pc_other_attrs` parameter can be used to specify metadata for point cloud pyramiding, for example:

```
xmltype(
 '<opc:sdoPcObjectMetadata
    xmlns:opc="http://xmlns.oracle.com/spatial/vis3d/2011/sdovis3d.xsd"
    xmlns:las="http://liblas.org/schemas/LAS/1.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <opc:sdoPcPyramid preserveLevel1="true"/>
  </opc:sdoPcObjectMetadata>')
```

The XML Schema Definition (XSD) for the `pc_other_attrs` parameter can be viewed by entering the following statements:

```
SET LONG 40000
SELECT xmlschema FROM sdo_xml_schemas WHERE description = 'EPSG  sdo3d.xsd';
```

Point cloud pyramiding creates multiple pyramid levels from level 1 (leaves) to level *n* (root). Generally, points already stored at level *i* are not repeated, at any of the more detailed levels. Any point is physically stored, exactly once. The leaf level 1 can be exempted from this rule by specifying `preserveLevel1="true"` (as in the preceding example), so that applications that are not pyramiding-compliant do not need to adapt. However, this `preserveLevel1="true"` option (of exempting and thus preserving level 1) doubles the space requirement, because each point is then stored twice: once at root level 1, and once in the rest of the pyramid.

Examples

The following example initializes a point cloud by creating an SDO_PC object, and it displays the ID of the object. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
declare
  pc sdo_pc;
begin
  -- Initialize the point cloud object.
  pc := sdo_pc_pkg.init(
          'BASE', -- Table that has the SDO_POINT_CLOUD column defined
          'PC',   -- Column name of the SDO_POINT_CLOUD object
          'BLKTAB', -- Table to store blocks of the point cloud
          'blk_capacity=1000', -- max # of points per block
          mdsys.sdo_geometry(2003, 8307, null,
              mdsys.sdo_elem_info_array(1,1003,3),
              mdsys.sdo_ordinate_array(-180, -90, 180, 90)),  -- Extent
              0.5, -- Tolerance for point cloud
              3, -- Total number of dimensions
              null);
. . .
```

29.13 SDO_PC_PKG.PC_DIFFERENCE

Format

```
SDO_PC_PKG.PC_DIFFERENCE(
     pc_table1            IN  VARCHAR2,
     pc_column1           IN  VARCHAR2,
     id_column1           IN  VARCHAR2,
     id1                  IN  VARCHAR2,
     pc_table2            IN  VARCHAR2,
     pc_column2           IN  VARCHAR2,
     id_column2           IN  VARCHAR2,
     id2                  IN  VARCHAR2,
     result_table_name    IN  VARCHAR2,
     tol                  IN  NUMBER,
     query_geom           IN  MDSYS.SDO_GEOMETRY DEFAULT NULL
     ) DETERMINISTIC PARALLEL_ENABLE;
```

Description

Compares two point clouds, that may or may not have neighbors in the other point cloud, and returns the output difference as a new point cloud.

Parameters

pc_table1
Name of the table that has the `SDO_POINT_CLOUD` column and `ID` column defined for the first point cloud.

pc_column1
Column name of the `SDO_POINT_CLOUD` object in the table provided for `pc_table1` parameter.

id_column1
Column name for the `ID` column in the table provided for `pc_table1` parameter.

id1
`ID` value.

pc_table2
Name of the table that has the `SDO_POINT_CLOUD` column and `ID` column defined for the second point cloud.

pc_column2
Column name of the `SDO_POINT_CLOUD` object in the table provided for `pc_table2` parameter.

id_column2
Column name for the `ID` column in the table provided for `pc_table2` parameter.

id2
`ID` value.

result_table_name
Name of the table for storing the output difference as a new point cloud data.

tol
A length unit of measure that determines the neighborhood of a point.

query_geom
Query geometry.

Usage Notes

The procedure `SDO_PC_PKG.PC_DIFFERENCE` can be used to compare two point clouds by identifying points in either without close neighbors in the other.
For example, consider two point clouds, *A* and *B*. A point in point cloud *A* without a geometric neighbor in point cloud *B* may signify:

- A real change, such as a car that was not there, previously.
- A change due to an obstructed spot not reached by the laser.
- Combination of the preceding two scenarios - a newly arrived car may register in the second point cloud, while it obscures a section of the building wall or a light pole. A portion of the wall may appear to have disappeared.
- Growing canopy cover can make some points disappear, to essentially reappear a meter higher. Difference detection may consider them as one feature disappearing and another appearing.

Therefore, in the context of multiple point clouds, detecting differences between two point clouds can be very useful to determine:

- Weekly progress at a development or infrastructure project.
- Damage from natural or man-made disasters.
- Change in canopy cover or other slow-moving processes.
- Discovery of human activity, such as real estate changes or tree felling.

In the procedure `SDO_PC_PKG.PC_DIFFERENCE`, the two point clouds, *A* and *B*, are identified by the following input parameters:

- Point Cloud *A*: `pc_table1`, `pc_column1`, `id_column1`, `id1`
- Point Cloud *B*: `pc_table2`, `pc_column2`, `id_column2`, `id2`

It is important that the two point clouds have the same SRID. A coordinate transformation between SRIDs is supported.

The output difference is a new point cloud which is a simple table with columns `VAL_Di`.

Examples

The following example generates the difference between two point clouds and the output point cloud data is stored in the table `PC1M2_B`.

```
SQL> call
  2    sdo_pc_pkg.pc_difference(
  3      pc_table1         => 'PCS',
  4      pc_column1        => 'PC',
  5      id_column1        => 'ID',
  6      id1               => '1',
  7      pc_table2         => 'PCS',
  8      pc_column2        => 'PC',
  9      id_column2        => 'ID',
 10      id2               => '2',
 11      result_table_name => 'PC1M2_B',
 12      tol               => 1,
 13      query_geom        => SDO_GEOMETRY(
 14                             2003,
 15                             27700,
 16                             NULL,
 17                             SDO_ELEM_INFO_ARRAY(
 18                               1, 1003, 3),
 19                             SDO_ORDINATE_ARRAY(
 20                               0, 0,
 21                               1000, 1000))
);
Call completed.
```

You can then query the ordinates as shown:

```
SQL> select * from pc1m2_b order by val_d1, val_d2, val_d3;

    VAL_D1     VAL_D2     VAL_D3
---------- ---------- ----------
         1          1          5
```

```
1 row selected.
```

29.14 SDO_PC_PKG.PC2DEM

Format

```
SDO_PC_PKG.PC2DEM(
      geor        IN OUT SDO_GEORASTER,
      pc          IN SDO_PC,
      mbr2d       IN SDO_GEOMETRY,
      resolution  IN NUMBER,
      blocksize   IN NUMBER);
```

or

```
SDO_PC_PKG.PC2DEM(
      geor            IN OUT SDO_GEORASTER,
      pc              IN SDO_PC,
      mbr2d           IN SDO_GEOMETRY,
      resolutionVert  IN NUMBER,
      resolutionHoriz IN NUMBER,
      blocksizeVert   IN NUMBER);
      blocksizeHoriz  IN NUMBER);
```

Description

Creates a DEM (Digital Elevation Model) GeoRaster object from an existing (blocked model) point cloud object..

Parameters

geor
GeoRaster object. (The SDO_GEORASTER data type is described in *Oracle Spatial GeoRaster Developer's Guide*.)

pc
Point cloud object. (The SDO_PC data type is described in Point Cloud-Related Object Types.)

mbr2d
The two-dimensional minimum bounding rectangle (MBR) within which the DEM should be generated.

resolution
Resolution in coordinate reference system units per pixel, such as meters per pixel or degrees per pixel.

blockSize
Block size in pixels.

resolutionVert
If the horizontal and vertical resolutions differ: the vertical resolution in coordinate reference system units per pixel, such as meters per pixel or degrees per pixel.

resolutionHoriz
If the horizontal and vertical resolutions differ: the horizontal resolution in coordinate reference system units per pixel, such as meters per pixel or degrees per pixel.

blockSizeVert
If the horizontal and vertical block sizes differ: the vertical block size.

blockSizeHoriz
If the horizontal and vertical block sizes differ: the horizontal block size.

Usage Notes

This procedure modifies the specified GeoRaster object (`geor` parameter) based on information in the input point cloud.

The `pc` and `geor` objects must have the same coordinate reference system (SRID).

For the `geor` parameter, the input SDO_GEORASTER object can be obtained by inserting a GeoRaster object into a table and returning the GeoRaster object into a variable; for example:

```
INSERT INTO raster_table VALUES (1, sdo_geor.init('raster_data_table'))
   RETURNING raster_image INTO geor;
```

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example creates a DEM from a point cloud.

```
DECLARE
pc   sdo_pc;
geor sdo_georaster;
mbr  sdo_geometry :=
  SDO_GEOMETRY(
    2003,
    27700,
    NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 3),
    SDO_ORDINATE_ARRAY(
      668000, 5535000,
      672000, 5539000));
BEGIN
  select pc INTO pc from pcs where id = 2;

  insert into raster (id, raster)
     values(2, sdo_geor.init('raster_data', 2))
     returning raster into geor;

  sdo_pc_pkg.pc2dem(
    geor         => geor,
    pc           => pc,
    mbr2d        => mbr,
    resolution   => 1.0,
    blockSize    => 512);

  sdo_geor.generatePyramid(
    georaster     => geor,
    pyramidParams => 'rLevel=7, resampling=BILINEAR');

  update raster set raster = geor where id = 2;
  commit;
```

```
END;
/
```

For additional examples, see the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

29.15 SDO_PC_PKG.PRESERVES_LEVEL1

Format

```
SDO_PC_PKG.PRESERVES_LEVEL1(
     inp  IN SDO_PC
     ) RETURN NUMBER;
```

Description

Returns 1 if the specified point cloud object has a single block level containing all the points; otherwise, returns 0.

Parameters

inp
Input point cloud object. (The SDO_PC data type is described in Point Cloud-Related Object Types.)

Usage Notes

A point cloud object can have a single block level containing all the points in either of the following cases:

- There is no pyramid, and all points are at the same level. In this case, the function returns 1.
- There is a pyramid, but the leaf level repeats one or more points from any other pyramid levels (in addition to containing points not already in other levels). In this case, the function returns 1. However, if there was a pyramid and the leaf level did *not* repeat any points from other pyramid levels, the function would return 0.

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example checks if the point cloud objects in column PC of table PCS have pyramids, and if each SDO_PC object has a single block level containing all the points for that object. The result shows that SDO_PC object in the only row in the table does not have a pyramid, and that this object does have a single block level containing all the points.

```
SELECT id, sdo_pc_pkg.has_pyramid(pc) "Has Pyramid",
   sdo_pc_pkg.preserves_level1(pc) "Preserves Level 1"
   FROM pcs ORDER BY id;

        ID Has Pyramid Preserves Level 1
---------- ----------- -----------------
         2           0                 1
```

29.16 SDO_PC_PKG.SDO_PC_NN

Format

```
SDO_PC_PKG.SDO_PC_NN(
     pc     IN SDO_PC,
     center IN SDO_GEOMETRY,
     n      IN NUMBER
     ) RETURN BLOB;
```

Description

Returns the nearest *n* points in the input point cloud object to the specified 3D point.

Parameters

pc
Point cloud object of type SDO_PC.

center
A 3D point representing the center around which we are looking for the nearest N points.

n
The number of nearest points to be found.

Usage Notes

The SDO_PC data type is described in Point Cloud-Related Object Types.

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example returns the 3200 closest points from a specified “center” point within a specified point cloud object.

```
select
  rownum pt_pos,
  sdo_geometry(
    3001,
    null,
    sdo_point_type(x, y, z),
    null,
    null) pts
from
  table(
    sdo_util.getvertices(
      geometry => sdo_pc_pkg.to_geometry(
                    pts => sdo_pc_pkg.sdo_pc_nn(
                             pc     => (select pc from pcs where id = 1),
                             center => sdo_geometry(
                                         3001,
                                         null,
                                         sdo_point_type(15, 15, 30),
                                         null,
                                         null),
                             n      => 3200),
                    num_pts    => 3200,
                    pc_tot_dim => 3,
                    srid       => null,
                    blk_domain => null,
                    get_ids    => 1)))
order by
  sqrt(
    (x - 15) * (x - 15) +
    (y - 15) * (y - 15) +
    (z - 30) * (z - 30)),
  x,
  y,
  z;

    PT_POS
----------
PTS(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------
----------------------
         1
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(15, 15, 30), NULL, NULL)

         2
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(15, 15, 30), NULL, NULL)

         4
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(14, 15, 29), NULL, NULL)

        10
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(14, 15, 29), NULL, NULL)

         5
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(14, 16, 30), NULL, NULL)

        11
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(14, 16, 30), NULL, NULL)

         3
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(15, 14, 29), NULL, NULL)

...

      3200
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(33, 28, 61), NULL, NULL)

      3199
SDO_GEOMETRY(3001, NULL, SDO_POINT_TYPE(46, 2, 48), NULL, NULL)


3200 rows selected.

Elapsed: 00:00:15.57
```

29.17 SDO_PC_PKG.SDO_PC_NN_FOR_EACH

Format

```
SDO_PC_PKG.SDO_PC_NN_FOR_EACH(
     blocks     IN SIMPLE_BLK_REF,
     pc          IN SDO_PC,
     n           IN NUMBER,
     max_dist    IN NUMBER,
     qry_min_res IN NUMBER,
     qry_max_res IN NUMBER
     ) RETURN POINT_NEIGHBOR_PAIR_TAB;
```

Description

Returns the nearest *n* points, for each point within a query range.

Parameters

blocks
A table of PC blocks, individual query windows, and non-spatial query constraints.

pc
Point cloud object of type SDO_PC.

n
Number of nearest points to find for each point in the query range.

max_dist
Maximum distance to check for neighbors.

qry_min_res
Minimum pyramid level for point clouds with pyramids. (As shown in the Example, different query windows (closer to or farther from the beholder) can be used for different pyramid levels.

qry_max_res
Maximum pyramid level for point clouds with pyramids. (As shown in the Example, different query windows (closer to or farther from the beholder) can be used for different pyramid levels.

Usage Notes

The types related to this function are defined as follows.

```
TYPE SIMPLE_BLK_REF is RECORD (
  blk_id        number,
  ind_dim_qry   MDSYS.sdo_geometry,
  other_dim_qry MDSYS.sdo_mbr);

TYPE POINT_NEIGHBOR_PAIR_ROW is RECORD (
  obj_id          number,
  blk_id          number,
  pt_id           number,
  pt_x            number,
  pt_y            number,
  pt_z            number,
  neighbor_rank   number,
  neighbor_dist   number,
  neighbor_blk_id number,
  neighbor_pt_id  number,
  neighbor_x      number,
  neighbor_y      number,
  neighbor_z      number);

TYPE POINT_NEIGHBOR_PAIR_TAB is TABLE of POINT_NEIGHBOR_PAIR_ROW;
```

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example returns the nearest 10 points, for each point within the specified query range.

```
define query_window =
SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,3),SDO_ORDINATE_ARRAY(100,100,102,
102));

with
  candidates AS (
    select
      blocks.blk_id,
      SDO_GEOM.SDO_INTERSECTION(subqueries.ind_dim_qry, blocks.blk_extent, 0.05),
      subqueries.other_dim_qry
    from
      blocks blocks,
      (
        select 1 min_res, 1 max_res, &query_window ind_dim_qry, cast(null as sdo_mbr)
other_dim_qry from dual union all
        select 2 min_res, 5 max_res, &query_window ind_dim_qry, cast(null as sdo_mbr)
other_dim_qry from dual
      ) subqueries
    where
      blocks.obj_id = 1 and
      blocks.pcblk_min_res <= max_res and
      blocks.pcblk_max_res >= min_res and
      SDO_ANYINTERACT(blocks.blk_extent, subqueries.ind_dim_qry) = 'TRUE')
select /*+ parallel (2) */
  *
from
  table(
    sdo_pc_pkg.sdo_pc_nn_for_each(
      blocks       => cursor(select * from candidates),
      pc           => (select pc from pcs where id = 1),
      n            => 10,
      max_dist     => 10,
      qry_min_res => 1,
      qry_max_res => 1))
order by
  obj_id,
  blk_id,
  pt_id,
  neighbor_rank;

old  10:         select 1 min_res, 1 max_res, &query_window ind_dim_qry, cast(null as
sdo_mbr) other_dim_qry from dual union all
new  10:         select 1 min_res, 1 max_res,
SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,3),SDO_ORDINATE_ARRAY(100,100,102,
102)) ind_dim_qry, cast(null as sdo_mbr) other_dim_qry from dual union all
old  11:         select 2 min_res, 5 max_res, &query_window ind_dim_qry, cast(null as
sdo_mbr) other_dim_qry from dual
new  11:         select 2 min_res, 5 max_res,
SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,3),SDO_ORDINATE_ARRAY(100,100,102,
102)) ind_dim_qry, cast(null as sdo_mbr) other_dim_qry from dual

    OBJ_ID     BLK_ID      PT_ID       PT_X       PT_Y       PT_Z NEIGHBOR_RANK
NEIGHBOR_DIST NEIGHBOR_BLK_ID NEIGHBOR_PT_ID NEIGHBOR_X NEIGHBOR_Y NEIGHBOR_Z
---------- ---------- ---------- ---------- ---------- ---------- -------------
------------- --------------- -------------- ---------- ---------- ----------
         1          2        272        100        100        200
```

```
1             0               2             272        100        100        200
         1          2        272        100        100        200              2
1.41421356               2            268         99        101        200
         1          2        272        100        100        200              3
1.41421356               2            271         99        100        199
         1          2        272        100        100        200              4
1.41421356               2            293        100         99        199
         1          2        272        100        100        200              5
1.41421356               2            275        100        101        201
         1          2        272        100        100        200              6
1.41421356               2            273        101        100        201
         1          2        272        100        100        200              7
1.41421356               2            292        101         99        200
         1          2        272        100        100        200              8
2.44948974               2            269         98        101        199
         1          2        272        100        100        200              9
2.44948974               2            250         99         99        198
         1          2        272        100        100        200             10
2.44948974               2            267         99        102        201
         1          2        273        101        100        201
1             0               2             273        101        100        201
         1          2        273        101        100        201              2
1.41421356               2            272        100        100        200
         1          2        273        101        100        201              3
1.41421356               2            275        100        101        201
         1          2        273        101        100        201              4
1.41421356               2            292        101         99        200
         1          2        273        101        100        201              5
1.41421356               2            274        101        101        202
         1          2        273        101        100        201              6
1.41421356               2            291        102         99        201
         1          2        273        101        100        201              7
1.41421356               2            286        102        100        202
         1          2        273        101        100        201              8
2.44948974               2            268         99        101        200
         1          2        273        101        100        201              9
2.44948974               2            293        100         99        199
         1          2        273        101        100        201             10
2.44948974               2            276        100        102        202
         1          2        274        101        101        202
1             0               2             274        101        101        202
         1          2        274        101        101        202              2
1.41421356               2            276        100        102        202
         1          2        274        101        101        202              3
1.41421356               2            275        100        101        201
         1          2        274        101        101        202              4
1.41421356               2            273        101        100        201
         1          2        274        101        101        202              5
1.41421356               2            279        101        102        203
         1          2        274        101        101        202              6
1.41421356               2            286        102        100        202
         1          2        274        101        101        202              7
1.41421356               2            285        102        101        203
         1          2        274        101        101        202              8
2.44948974               2            267         99        102        201
         1          2        274        101        101        202              9
2.44948974               2            272        100        100        200
         1          2        274        101        101        202             10
2.44948974               2            277        100        103        203
         1          2        275        100        101        201
1             0               2             275        100        101        201
         1          2        275        100        101        201              2
```

```
1.41421356               2            267         99        102        201
         1          2        275        100        101        201             3
1.41421356               2            268         99        101        200
         1          2        275        100        101        201             4
1.41421356               2            272        100        100        200
         1          2        275        100        101        201             5
1.41421356               2            276        100        102        202
         1          2        275        100        101        201             6
1.41421356               2            273        101        100        201
         1          2        275        100        101        201             7
1.41421356               2            274        101        101        202
         1          2        275        100        101        201             8
2.44948974               2            264         98        102        200
         1          2        275        100        101        201             9
2.44948974               2            266         99        103        202
         1          2        275        100        101        201            10
2.44948974               2            271         99        100        199
         1          2        276        100        102        202
1             0               2            276        100        102        202
         1          2        276        100        102        202             2
1.41421356               2            266         99        103        202
         1          2        276        100        102        202             3
1.41421356               2            267         99        102        201
         1          2        276        100        102        202             4
1.41421356               2            277        100        103        203
         1          2        276        100        102        202             5
1.41421356               2            275        100        101        201
         1          2        276        100        102        202             6
1.41421356               2            274        101        101        202
         1          2        276        100        102        202             7
1.41421356               2            279        101        102        203
         1          2        276        100        102        202             8
2.44948974               2            265         98        103        201
         1          2        276        100        102        202             9
2.44948974               2            469         99        104        203
         1          2        276        100        102        202            10
2.44948974               2            268         99        101        200
         1          2        279        101        102        203
1             0               2            279        101        102        203
         1          2        279        101        102        203             2
1.41421356               2            277        100        103        203
         1          2        279        101        102        203             3
1.41421356               2            276        100        102        202
         1          2        279        101        102        203             4
1.41421356               2            274        101        101        202
         1          2        279        101        102        203             5
1.41421356               2            278        101        103        204
         1          2        279        101        102        203             6
1.41421356               2            280        102        102        204
         1          2        279        101        102        203             7
1.41421356               2            285        102        101        203
         1          2        279        101        102        203             8
2.44948974               2            266         99        103        202
         1          2        279        101        102        203             9
2.44948974               2            458        100        104        204
         1          2        279        101        102        203            10
2.44948974               2            275        100        101        201
         1          2        280        102        102        204
1             0               2            280        102        102        204
         1          2        280        102        102        204             2
1.41421356               2            278        101        103        204
         1          2        280        102        102        204             3
```

```
1.41421356               2            279        101        102        203
         1          2        280        102        102        204               4
1.41421356               2            285        102        101        203
         1          2        280        102        102        204               5
1.41421356               2            281        102        103        205
         1          2        280        102        102        204               6
1.41421356               2            283        103        102        205
         1          2        280        102        102        204               7
1.41421356               2            284        103        101        204
         1          2        280        102        102        204               8
2.44948974               2            277        100        103        203
         1          2        280        102        102        204               9
2.44948974               2            457        101        104        205
         1          2        280        102        102        204              10
2.44948974               2            274        101        101        202
         1          2        285        102        101        203
1             0               2            285        102        101        203
         1          2        285        102        101        203               2
1.41421356               2            274        101        101        202
         1          2        285        102        101        203               3
1.41421356               2            279        101        102        203
         1          2        285        102        101        203               4
1.41421356               2            280        102        102        204
         1          2        285        102        101        203               5
1.41421356               2            286        102        100        202
         1          2        285        102        101        203               6
1.41421356               2            284        103        101        204
         1          2        285        102        101        203               7
1.41421356               2            287        103        100        203
         1          2        285        102        101        203               8
2.44948974               2            276        100        102        202
         1          2        285        102        101        203               9
2.44948974               2            273        101        100        201
         1          2        285        102        101        203              10
2.44948974               2            278        101        103        204
         1          2        286        102        100        202
1             0               2            286        102        100        202
         1          2        286        102        100        202               2
1.41421356               2            273        101        100        201
         1          2        286        102        100        202               3
1.41421356               2            274        101        101        202
         1          2        286        102        100        202               4
1.41421356               2            291        102         99        201
         1          2        286        102        100        202               5
1.41421356               2            285        102        101        203
         1          2        286        102        100        202               6
1.41421356               2            287        103        100        203
         1          2        286        102        100        202               7
1.41421356               2            288        103         99        202
         1          2        286        102        100        202               8
2.44948974               2            275        100        101        201
         1          2        286        102        100        202               9
2.44948974               2            292        101         99        200
         1          2        286        102        100        202              10
2.44948974               2            279        101        102        203

90 rows selected.

Elapsed: 00:00:03.02
```

29.18 SDO_PC_PKG.TO_GEOMETRY

Format

```
SDO_PC_PKG.TO_GEOMETRY(
     pts        IN BLOB,
     num_pts    IN NUMBER,
     pc_tot_dim IN NUMBER,
     srid       IN NUMBER DEFAULT NULL,
     blk_domain IN SDO_ORGSCL_TYPE DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object representing all or part of a point cloud.

Parameters

pts
BLOB containing the points.

num_pts
Maximum number of points to be included in the resulting geometry.

pc_tot_dim
Number of spatial dimensions defined for the data.

srid
Spatial reference (coordinate system) ID associated with the data. If this parameter is null, no SRID value is associated with the data.

blk_domain
(Not currently used.)

Usage Notes

This function returns a single multipoint SDO_GEOMETRY object that represents all point geometries in the `pts` parameter. For example, the points could reflect the result of a clip operation or the contents of an entire block.

Modeling Solids describes how to use point clouds to model solids.

Examples

The following example returns a multipoint collection geometry object representing a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Return points in blk_id of the point cloud as a multipoint collection.
select sdo_pc_pkg.to_geometry(
                    a.points,   -- point LOB
                    a.num_points, -- # of points in the LOB
                    3,  -- total dimensionality
                    8307 -- SRID
                    ) from blktab a where blk_id=0;
. . .
```

30

SDO_SAM Package (Spatial Analysis and Mining)

The MDSYS.SDO_SAM package contains subprograms for spatial analysis and data mining.

To use the subprograms in this chapter, you must understand the conceptual information about spatial analysis and data mining in Spatial Analysis and Mining.

> **Note:**
>
> SDO_SAM subprograms are supported for two-dimensional geometries only. They are not supported for three-dimensional geometries.

The rest of this chapter provides reference information on the spatial analysis and mining subprograms, listed in alphabetical order.

- SDO_SAM.AGGREGATES_FOR_GEOMETRY
- SDO_SAM.AGGREGATES_FOR_LAYER
- SDO_SAM.BIN_GEOMETRY
- SDO_SAM.BIN_LAYER
- SDO_SAM.COLOCATED_REFERENCE_FEATURES
- SDO_SAM.SIMPLIFY_GEOMETRY
- SDO_SAM.SIMPLIFY_LAYER
- SDO_SAM.SPATIAL_CLUSTERS
- SDO_SAM.TILED_AGGREGATES
- SDO_SAM.TILED_BINS

30.1 SDO_SAM.AGGREGATES_FOR_GEOMETRY

Format

```
SDO_SAM.AGGREGATES_FOR_GEOMETRY(
     theme_name       IN VARCHAR2,
     theme_colname    IN VARCHAR2,
     aggr_type_string IN VARCHAR2,
     aggr_col_string  IN VARCHAR2,
     geom             IN SDO_GEOMETRY,
     dst_spec         IN VARCHAR2 DEFAULT NULL
     ) RETURN NUMBER;
```

Description

Computes the thematic aggregate for a geometry.

Parameters

theme_name
Name of the theme table.

theme_colname
Name of the geometry column in `theme_name`.

aggr_type_string
Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as `SUM`, `MIN`, `MAX`, or `AVG`.

aggr_col_string
Name of a column in `theme_name` on which to compute aggregate values, as explained in the Usage Notes. An example might be a POPULATION column.

geom
Geometry object.

dst_spec
A quoted string specifying either a distance buffer or a number of nearest neighbor geometries to consider. See the Usage Notes for an explanation of the format and meaning.

Usage Notes

For a specific geometry, this function identifies the geometries in the `theme_name` table, finds their intersection ratio, multiplies the specified aggregate using this intersection ratio, and aggregates it for the geometry. Specifically, for all rows of the `theme_name` table that intersect with the specified geometry, it returns the value from the following function:

```
aggr_type_string(aggr_col_string * proportional_area_of_intersection(geometry,
theme_name.theme_colname))
```

The `theme_colname` column must have a spatial index defined on it. For best performance, insert simplified geometries into this column.

The `dst_spec` parameter, if specified, is a quoted string that must contain either of the following:

- The `distance` keyword and optionally the `unit` keyword (unit of measurement associated with the distance value), to specify a buffer around the geometry. For example, `'distance=2 unit=km'` specifies a 2-kilometer buffer around the input geometry. If `dst_spec` is not specified, no buffer is used.

  If the `unit` keyword is specified, the value must be an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, `'unit=km'`). If the `unit` keyword is not specified, the unit of measurement associated with the geometry is used. See Unit of Measurement Support for more information about unit of measurement specification.
- The `sdo_num_res` keyword, to specify the number of nearest-neighbor geometries to consider, without considering proportional coverage. For example, `'sdo_num_res=5'` could be used in a query that asks for the populations of the five cities that are nearest to a specified point.

Examples

The following example computes the thematic aggregate for an area with a 3-mile radius around a specified point geometry. In this case, the total population of the area is computed based on the proportion of the circle's area within different counties, assuming uniform distribution of population within the counties.

```
SELECT sdo_sam.aggregates_for_geometry(
  'GEOD_COUNTIES', 'GEOM',
  'sum', 'totpop',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-73.943849, 40.6698,NULL),
    NULL, NULL),
  'distance=3 unit=mile')
FROM DUAL a ;
```

30.2 SDO_SAM.AGGREGATES_FOR_LAYER

Format

```
SDO_SAM.AGGREGATES_FOR_LAYER(
     theme_name       IN VARCHAR2,
     theme_colname    IN VARCHAR2,
     aggr_type_string IN VARCHAR2,
     aggr_col_string  IN VARCHAR2,
     tablename        IN VARCHAR2,
     colname          IN VARCHAR2,
     dst_spec         IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_REGAGGRSET;
```

Description

Computes thematic aggregates for a layer of geometries.

Parameters

theme_name
Name of the theme table.

theme_colname
Name of the geometry column in `theme_name`.

aggr_type_string
Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as `SUM`, `MIN`, `MAX`, or `AVG`.

aggr_col_string
Name of a column in `theme_name` on which to compute aggregate values, as explained in the Usage Notes. An example might be a POPULATION column.

tablename
Name of the data mining table.

colname
Name of the column in `tablename` that holds the geometries.

dst_spec
A quoted string specifying either a distance buffer or a number of nearest neighbor geometries to consider. See the Usage Notes for the SDO_SAM.AGGREGATES_FOR_GEOMETRY function in this chapter for an explanation of the format and meaning.

Usage Notes

For each geometry in `tablename`, this function identifies the geometries in the `theme_name` table, finds their intersection ratio, multiplies the specified aggregate using this intersection ratio, and aggregates it for each geometry in `tablename`. Specifically, for all rows of the `theme_name` table, it returns the value from the following function:

```
aggr_type_string(aggr_col_string * proportional_area_of_intersection(geometry,
theme_name.theme_colname))
```

This function returns an object of type SDO_REGAGGRSET. The SDO_REGAGGRSET object type is defined as:

```
TABLE OF SDO_REGAGGR
```

The SDO_REGAGGR object type is defined as:

```
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 REGION_ID                                          VARCHAR2(24)
 GEOMETRY                                           MDSYS.SDO_GEOMETRY
 AGGREGATE_VALUE                                    NUMBER
```

The `theme_colname` column must have a spatial index defined on it. For best performance, insert simplified geometries into this column.

Examples

The following example computes the thematic aggregates for all geometries in a table named TEST_TAB for an area with a 3-mile radius around a specified point geometry. In this case, the total population of each area is computed based on the proportion of the circle's area within different counties, assuming uniform distribution of population within the counties.

```
SELECT a.aggregate_value FROM TABLE(sdo_sam.aggregates_for_layer(
  'GEOD_COUNTIES', 'GEOM', 'SUM', TOTPOP', TEST_TAB', 'GEOM'
    'distance=3 unit=mile')) a;
```

30.3 SDO_SAM.BIN_GEOMETRY

Format

```
SDO_SAM.BIN_GEOMETRY(
     geom          IN SDO_GEOMETRY,
     tol           IN SDO_DIM_ARRAY,
     bin_tablename IN VARCHAR2,
     bin_colname   IN VARCHAR2
     ) RETURN NUMBER;
```

or

```
SDO_SAM.BIN_GEOMETRY(
     geom           IN SDO_GEOMETRY,
      dim           IN SDO_DIM_ARRAY,
      bin_tablename IN VARCHAR2,
      bin_colname   IN VARCHAR2
     ) RETURN NUMBER;
```

Description

Computes the most-intersecting tile for a geometry.

Parameters

geom
Geometry for which to compute the bin.

tol
Tolerance value (see Tolerance).

dim
Dimensional array for the table that holds the geometries for the bins.

bin_tablename
Name of the table that holds the geometries for the bins.

bin_colname
Column in `bin_tablename` that holds the geometries for the bins.

Usage Notes

This function returns the bin that intersects most with the specified geometry. If multiple bins intersect to the same extent with the specified geometry, the bin with the smallest area is returned.

To perform this operation on all rows in the data mining table, using the specified `bin_tablename`, you can use the SDO_SAM.BIN_LAYER procedure.

Examples

The following example computes the bin for a specified geometry.

```
SELECT sdo_sam.bin_geometry(a.geometry, 0.0000005, 'BINTBL', 'GEOMETRY')
  FROM poly_4pt a, user_sdo_geom_metadata b
  WHERE b.table_name='POLY_4PT' AND a.gid=1;

SDO_SAM.BIN_GEOMETRY(A.GEOMETRY,0.0000005,'BINTBL','GEOMETRY')
--------------------------------------------------------------
                                                            43

1 row selected.
```

30.4 SDO_SAM.BIN_LAYER

Format

```
SDO_SAM.BIN_LAYER(
     tablename       IN VARCHAR2,
     colname         IN VARCHAR2,
     bin_tablename   IN VARCHAR2,
     bin_colname     IN VARCHAR2,
     bin_id_colname  IN VARCHAR2,
     commit_interval IN NUMBER DEFAULT 20);
```

Description

Assigns each location (and the corresponding row) in a data mining table to a spatial bin.

Parameters

tablename
Name of the data mining table.

colname
Name of the column in `table_name` that holds the location coordinates.

bin_tablename
Name of the table that contains information (precomputed for the entire two-dimensional space) about the spatial bins.

bin_colname
Column in `bin_tablename` that holds the geometries for the bins.

bin_id_colname
Name of the column in the data mining table that holds the bin ID value of each geometry added to a bin. (Each affected row in the data mining table is updated with the ID value of the bin geometry in `bin_tablename`.)

commit_interval
Number of bin insert operations to perform before Spatial performs an internal commit operation. If `commit_interval` is not specified, a commit is performed after every 20 insert operations.

Usage Notes

This procedure computes the most-intersecting tile for each geometry in a specified layer using the bins in `bin_tablename`. The bin ID value for each geometry is added in `bin_id_colname`.

Using this procedure achieves the same result as using the SDO_SAM.BIN_GEOMETRY function on each row in the data mining table, using the specified `bin_tablename`.

Examples

The following example assigns each GEOMETRY column location and corresponding row in the POLY_4PT_TEMP data mining table to a spatial bin, and performs an internal commit operation after each bin table insertion.

```
CALL SDO_SAM.BIN_LAYER('POLY_4PT_TEMP', 'GEOMETRY', 'BINTBL', 'GEOMETRY', 'BIN_ID', 1);
```

30.5 SDO_SAM.COLOCATED_REFERENCE_FEATURES

Format

```
SDO_SAM.COLOCATED_REFERENCE_FEATURES(
     theme_tablename  IN VARCHAR2,
     theme_colname    IN VARCHAR2,
     theme_predicate  IN VARCHAR2,
     tablename        IN VARCHAR2,
     colname          IN VARCHAR2,
     ref_predicate    IN VARCHAR2,
     dst_spec         IN VARCHAR2,
     result_tablename IN VARCHAR2,
     commit_interval  IN NUMBER DEFAULT 100);
```

Description

Performs a partial predicate-based join of tables, and materializes the join results into a table.

Parameters

theme_tablename
Name of the table with which to join `tablename`.

theme_colname
Name of the geometry column in `theme_tablename`.

theme_predicate
Qualifying WHERE clause predicate to be applied to `theme_tablename`.

tablename
Name of the data mining table.

colname
Name of the column in `tablename` that holds the location coordinates.

ref_predicate
Qualifying WHERE clause predicate to be applied to `tablename`. Must a null or non-null value: if null, no predicate is applied; if non-null, it must be a single table predicate, such as `'country_code=10'`.

dst_spec
A quoted string containing a distance value and optionally a unit value for a buffer around the geometries. See the Usage Notes for an explanation of the format and meaning.

result_tablename
The table in which materialized join results are stored. This table must exist and must have the following definition: `(tid NUMBER, rid1 VARCHAR2(24), rid2 VARCHAR2(24))`

commit_interval
Number of internal join operations to perform before Spatial performs an internal commit operation. If `commit_interval` is not specified, a commit is performed after every 100 internal join operations.

Usage Notes

This procedure materializes each pair of rowids returned from a predicate-based join operation, and stores them in the `rid1, rid2` columns of `result_tablename`. The `tid` is a unique generated "interaction" number corresponding to each `rid1` value.

The `dst_spec` parameter, if specified, is a quoted string containing the `distance` keyword and optionally the `unit` keyword (unit of measurement associated with the distance value), to specify a buffer around the geometry. For example, `'distance=2 unit=km'` specifies a 2-kilometer buffer around the input geometry. If `dst_spec` is not specified, no buffer is used.

If the `unit` keyword is specified, the value must be an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, `'unit=KM'`). If the `unit` keyword is not specified, the unit of measurement associated with the geometry is used. See Unit of Measurement Support for more information about unit of measurement specification.

Examples

The following example identifies cities with a 1990 population (POP90 column value) greater than 120,000 that are located within 20 kilometers of interstate highways (GEOM column in the GEOD_INTERSTATES table). It stores the results in a table named COLOCATION_TABLE, and performs an internal commit operation after each 20 internal operations.

```
EXECUTE SDO_SAM.COLOCATED_REFERENCE_FEATURES(
  'geod_cities', 'location', 'pop90 > 120000',
  'geod_interstates', 'geom', null,
  'distance=20 unit=km', 'colocation_table', 20);
```

30.6 SDO_SAM.SIMPLIFY_GEOMETRY

Format

```
SDO_SAM.SIMPLIFY_GEOMETRY(
     geom                   IN SDO_GEOMETRY,
     dim                    IN SDO_DIM_ARRAY,
     pct_area_change_limit  IN NUMBER DEFAULT 2
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_SAM.SIMPLIFY_GEOMETRY(
     geom                   IN SDO_GEOMETRY,
     tol                    IN NUMBER,
     pct_area_change_limit  IN NUMBER DEFAULT 2
     ) RETURN SDO_GEOMETRY;
```

Description

Simplifies a geometry.

Parameters

geom
Geometry to be simplified.

dim
Dimensional array for the geometry to be simplified.

tol
Tolerance value (see Tolerance).

pct_area_change_limit
The percentage of area changed to be used for each simplification iteration, as explained in the Usage Notes.

Usage Notes

This function reduces the number of vertices in a geometry by internally applying the SDO_UTIL.SIMPLIFY function (documented in SDO_LRS Package (Linear Referencing System)) with an appropriate threshold value.

Reducing the number of vertices may result in a change in the area of the geometry. The `pct_area_change_limit` parameter specifies how much area change can be tolerated while simplifying the geometry. It is usually a number from 1 to 100. The default value is 2; that is, the area of the geometry can either increase or decrease by at most two percent compared to the original geometry as a result of the geometry simplification.

Examples

The following example simplifies the geometries in the GEOMETRY column of the POLY_4PT_TEMP table.

```
SELECT sdo_sam.simplify_geometry(a.geometry, 0.00000005)
  FROM poly_4pt_temp a, user_sdo_geom_metadata b
  WHERE b.table_name='POLY_4PT_TEMP' ;

SDO_SAM.SIMPLIFY_GEOMETRY(A.GEOMETRY,0.00000005)(ORIG_AREA, CUR_AREA, ORIG_LEN,
--------------------------------------------------------------------------------
SDO_SMPL_GEOMETRY(28108.5905, 28108.5905, 758.440118, 758.440118, SDO_GEOMETRY(2
003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(-122.4215,
37.7862, -122.422, 37.7869, -122.421, 37.789, -122.42, 37.7866, -122.4215, 37.78
62)))

SDO_SMPL_GEOMETRY(4105.33806, 4105.33806, 394.723053, 394.723053, SDO_GEOMETRY(2
003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(-122.4019,
37.8052, -122.4027, 37.8055, -122.4031, 37.806, -122.4012, 37.8052, -122.4019, 3
7.8052)))
   .
   .
   .
50 rows selected.
```

30.7 SDO_SAM.SIMPLIFY_LAYER

Format

```
SDO_SAM.SIMPLIFY_LAYER(
     theme_tablename       IN VARCHAR2,
     theme_colname         IN VARCHAR2,
     smpl_geom_colname     IN VARCHAR2,
     commit_interval       IN NUMBER DEFAULT 10,
     pct_area_change_limit IN NUMBER DEFAULT 2);
```

Description

Simplifies a geometry layer.

Parameters

theme_tablename
Name of the table containing the geometry layer to be simplified.

theme_colname
Column in `theme_tablename` of type SDO_GEOMETRY containing the geometries to be simplified.

smpl_geom_colname
Column in `theme_tablename` of type SDO_GEOMETRY into which the simplified geometries are to be placed by this procedure.

commit_interval
Number of geometries to simplify before Spatial performs an internal commit operation. If `commit_interval` is not specified, a commit is performed after every 10 simplification operations.

pct_area_change_limit
The percentage of area changed to be used for each simplification iteration, as explained in the Usage Notes for the SDO_SAM.SIMPLIFY_GEOMETRY function.

Usage Notes

This procedure simplifies all geometries in a layer. It is equivalent to calling the SDO_SAM.SIMPLIFY_GEOMETRY function for each geometry in the layer, except that each simplified geometry is put in a separate column in the table instead of being returned to the caller. See also the Usage Notes for the SDO_SAM.SIMPLIFY_GEOMETRY function.

Examples

The following example adds a column named SMPL_GEOM to the POLY_4PT_TEMP table, then simplifies all geometries in the GEOMETRY column of the POLY_4PT_TEMP table, placing each simplified geometry in the SMPL_GEOM column in the same row with its associated original geometry.

```
ALTER TABLE poly_4pt_temp ADD (smpl_geom mdsys.sdo_geometry);

Table altered.

EXECUTE sdo_sam.simplify_layer('POLY_4PT_TEMP', 'GEOMETRY', 'SMPL_GEOM');

PL/SQL procedure successfully completed.
```

30.8 SDO_SAM.SPATIAL_CLUSTERS

Format

```
SDO_SAM.SPATIAL_CLUSTERS(
     tablename      IN VARCHAR2,
     colname        IN VARCHAR2,
     max_clusters   IN NUMBER,
     allow_outliers IN VARCHAR2 DEFAULT 'TRUE',
     tablepartition IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_REGIONSET;
```

Description

Computes clusters using the existing R-tree index, and returns a set of SDO_REGION objects where the geometry column specifies the boundary of each cluster and the `geometry_key` value is set to null.

Parameters

tablename
Name of the data mining table.

colname
Name of the column in `tablename` that holds the location coordinates.

max_clusters
Maximum number of clusters to obtain.

allow_outliers
`TRUE` (the default) causes outlying values (isolated instances) to be included in the spatial clusters; `FALSE` causes outlying values not to be included in the spatial clusters. (`TRUE` accommodates all data and may result in larger clusters; `FALSE` may exclude some data and may result in smaller clusters.)

tablepartition
Name of the partition in `tablename`.

Usage Notes

The clusters are computed using the spatial R-tree index on `tablename`.

Examples

The following example clusters the locations in cities into at most three clusters, and includes outlying values in the clusters.

```
SELECT * FROM
  TABLE(sdo_sam.spatial_clusters('PROJ_CITIES', 'LOCATION', 3, 'TRUE'));
```

30.9 SDO_SAM.TILED_AGGREGATES

Format

```
SDO_SAM.TILED_AGGREGATES(
     theme_name       IN VARCHAR2,
     theme_colname    IN VARCHAR2,
     aggr_type_string IN VARCHAR2,
     aggr_col_string  IN VARCHAR2,
     tiling_level     IN NUMBER DEFAULT NULL,
     tiling_domain    IN SDO_DIM_ARRAY DEFAULT NULL,
     zero_agg_tiles   IN NUMBER DEFAULT 0,
     xdivs            IN NUMBER DEFAULT NULL,
     ydivs            IN NUMBER DEFAULT NULL
     ) RETURN SDO_REGAGGRSET;
```

Description

Tiles aggregates for a domain. For each tile, computes the intersecting geometries from the theme table; the values in the `aggr_col_string` column are weighted proportionally to the area of the intersection, and aggregated according to `aggr_col_string`.

Parameters

theme_name
Table containing theme information (for example, demographic information).

theme_colname
Name of the column in the `theme_name` table that contains geometry objects.

aggr_type_string
Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as `SUM`, `MIN`, `MAX`, or `AVG`.

aggr_col_string
Name of a column in the `theme_name` table on which to compute aggregate values. An example might be a POPULATION column.

tiling_level
Level to be used to create tiles. If you specify this parameter, the extent of each dimension is divided into 2^`tiling_level` parts, resulting in at most 4*`tiling_level` tiles. (Specify either this parameter or the combination of the `xdivs` and `ydivs` parameters.)

tiling_domain
Domain for the tiling level. The parameter is not required, and if you do not specify it, the extent associated with the `theme_name` table is used.

zero_agg_tiles
Specify 0 to exclude tiles that have a value of 0 for the computed aggregate, or specify 1 to return all tiles. The default value is 0, which ensures that only tiles with a nonzero aggregate value are returned.

xdivs
The number of times that the extent in the first dimension is divided, such that the total number of parts is `xdivs` + 1. For example, if you specify 10 for `xdivs`, the extent of the first dimension is divided into 11 parts.

ydivs
The number of times that the extent in the second dimension is divided, such that the total number of parts is `ydivs` + 1. For example, if you specify 10 for `ydivs`, the extent of the second dimension is divided into 11 parts.

Usage Notes

This function is similar to SDO_SAM.AGGREGATES_FOR_LAYER, but the results are dynamically generated using tiling information. Given a `theme_name` table, the tiling domain is determined. Based on the `tiling_level` value or the `xdivs` and `ydivs` values, the necessary tiles are generated. For each tile geometry, thematic aggregates are computed as described in the Usage Notes for SDO_SAM.AGGREGATES_FOR_LAYER.

You must specify either the `tiling_level` parameter or both the `xdivs` and `ydivs` parameters. If you specify all three of these parameters, the `tiling_level` parameter is ignored and the `xdivs` and `ydivs` parameters are used.

If you specify the `xdivs` and `ydivs` parameters, the total number of grids (tiles) returned is `(xdivs+1)*(ydivs+1)`.

This function returns an object of type SDO_REGAGGRSET. The SDO_REGAGGRSET object type is defined as:

```
TABLE OF SDO_REGAGGR
```

The SDO_REGAGGR object type is defined as:

```
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 REGION_ID                                          VARCHAR2(24)
 GEOMETRY                                           MDSYS.SDO_GEOMETRY
 AGGREGATE_VALUE                                    NUMBER
```

Examples

The following example computes the sum of the population rows of POLY_4PT_TEMP table intersecting with each tile. The extent of the POLY_4PT_TEMP table stored in the USER_SDO_GEOM_METADATA view is used as the domain, and a tiling level of 2 is used (that is, the domain is divided into 16 tiles).

```
SELECT a.geometry, a.aggregate_value
  from TABLE(sdo_sam.tiled_aggregates('POLY_4PT_TEMP',
                        'GEOMETRY', 'SUM', 'POPULATION', 2)) a;

GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
AGGREGATE_VALUE
---------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, -90, -90, -45))
     .007150754

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, -45, -90, 0))
     .034831005

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, 0, -90, 45))
     7.73307783

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, -90, 0, -45))
     .019498368

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, -45, 0, 0))
     .939061456

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, 0, 0, 45))
     1.26691592

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(0, 0, 90, 45))
             40

7 rows selected.
```

30.10 SDO_SAM.TILED_BINS

Format

```
SDO_SAM.TILED_BINS(
     l1           IN NUMBER,
     u1           IN NUMBER,
     l2           IN NUMBER,
     u2           IN NUMBER,
     tiling_level IN NUMBER DEFAULT NULL,
     srid         IN NUMBER DEFAULT NULL,
     xdivs        IN NUMBER DEFAULT NULL,
     ydivs        IN NUMBER DEFAULT NULL
     ) RETURN SDO_REGIONSET;
```

Description

Tiles a two-dimensional space and returns geometries corresponding to those tiles.

Parameters

l1
Lower bound of the extent in the first dimension.

u1
Upper bound of the extent in the first dimension.

l2
Lower bound of the extent in the second dimension.

u2
Upper bound of the extent in the second dimension.

tiling_level
Level to be used to tile the specified extent. If you specify this parameter, the extent of each dimension is divided into 2^`tiling_level` parts, resulting in at most 4*`tiling_level` tiles. (Specify either this parameter or the combination of the `xdivs` and `ydivs` parameters.)

srid
SRID value to be included for the coordinate system in the returned tile geometries.

xdivs
The number of times that the extent in the first dimension is divided, such that the total number of parts is `xdivs` + 1. For example, if you specify 10 for `xdivs`, the extent of the first dimension is divided into 11 parts.

ydivs
The number of times that the extent in the second dimension is divided, such that the total number of parts is `ydivs` + 1. For example, if you specify 10 for `ydivs`, the extent of the second dimension is divided into 11 parts.

Usage Notes

You must specify either the `tiling_level` parameter or both the `xdivs` and `ydivs` parameters. If you specify all three of these parameters, the `tiling_level` parameter is ignored and the `xdivs` and `ydivs` parameters are used.

If you specify the `xdivs` and `ydivs` parameters, the total number of grids (tiles) returned is `(xdivs+1)*(ydivs+1)`.

This function returns an object of type SDO_REGIONSET. The SDO_REGIONSET object type is defined as:

```
TABLE OF SDO_REGION
```

The SDO_REGION object type is defined as:

```
Name                                       Null?    Type
 ----------------------------------------- -------- ----------------------------
 ID                                                 NUMBER
 GEOMETRY                                           MDSYS.SDO_GEOMETRY
```

Examples

The following example tiles the entire Earth's surface at the first tiling level, using the standard longitude and latitude coordinate system (SRID 8307). The resulting SDO_REGIONSET object contains four SDO_REGION objects, one for each tile.

```
SELECT * FROM TABLE(sdo_sam.tiled_bins(-180, 180, -90, 90, 1, 8307))
  ORDER BY id;

        ID
----------
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
--------------------------------------------------------------------------------
         0
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, -90, 0, 0))

         1
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, 0, 0, 90))

         2
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(0, -90, 180, 0))

         3
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(0, 0, 180, 90))

4 rows selected.
```

31

SDO_TIN_PKG Package (TINs)

The MDSYS.SDO_TIN_PKG package contains subprograms to support working with triangulated irregular networks (TINs).

> **Note:**
>
> The SDO_TIN_PKG subprograms are supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

To use the subprograms in this package, you must understand the main concepts related to three-dimensional geometries, including the use of triangulated irregular networks (TINs) to model surfaces. Three-Dimensional Spatial Objects describes support for three-dimensional geometries, Modeling Surfaces describes the use of TINs to model surfaces, and TIN-Related Object Types describes data types related to TINs.

- SDO_TIN_PKG.CLIP_TIN
- SDO_TIN_PKG.CREATE_MESHES
- SDO_TIN_PKG.CREATE_TIN
- SDO_TIN_PKG.DROP_DEPENDENCIES
- SDO_TIN_PKG.GET_BLOCKING_METHOD
- SDO_TIN_PKG.GET_NUM_POINTS
- SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER
- SDO_TIN_PKG.INIT
- SDO_TIN_PKG.LIST_TIN_COLUMNS
- SDO_TIN_PKG.LIST_TINS
- SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN
- SDO_TIN_PKG.TO_DEM
- SDO_TIN_PKG.TO_GEOMETRY

31.1 SDO_TIN_PKG.CLIP_TIN

Format

```
SDO_TIN_PKG.CLIP_TIN(
     inp         IN SDO_TIN,
     qry         IN SDO_GEOMETRY,
     qry_min_res IN NUMBER,
     qry_max_res IN NUMBER,
     blkid       IN NUMBER DEFAULT NULL
     ) RETURN SDO_TIN_BLK_TYPE;
```

Description

Performs a clip operation on a TIN.

Parameters

inp
TIN on which to perform the clip operation.

qry
Window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries.

qry_min_res
Minimum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

qry_max_res
Maximum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

blkid
Block ID number of the block to which to restrict the objects returned by the clip operation. If this parameter is null, all objects that satisfy the other parameters are returned.

Usage Notes

This function returns triangles from a TIN that are within a specified query window and that satisfy any other requirements specified by the parameters. A common use of this function is to perform queries on TINs. You can maximize the performance of a TIN query by minimizing the number of objects that the function needs to consider for the operation.

The SDO_TIN and SDO_TIN_BLK_TYPE data types are described in TIN-Related Object Types.

Modeling Surfaces describes how to use TINs to model surfaces.

Examples

The following example performs a clip operation on a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
declare
  inp  sdo_tin;
begin
  select tin INTO inp  from base where rownum=1;
  insert into restst
  select * from
    table(sdo_tin_pkg.clip_tin
           (
            inp,  -- Input TIN object
            sdo_geometry(2003, null, null,
              mdsys.sdo_elem_info_array(1, 1003, 3),
              mdsys.sdo_ordinate_array(-74.1, -73.9, 39.99999,40.00001)), -- Query
            null, null));
```

```
end;
. . .
```

31.2 SDO_TIN_PKG.CREATE_MESHES

Format

```
SDO_TIN_PKG.CREATE_MESHES(
     base_table          IN  VARCHAR2,
     data_table          IN  VARCHAR2,
     tin_id              IN  NUMBER,
     tin_tol             IN  NUMBER,
     blk_size            IN  NUMBER DEFAULT NULL,
     inptab              IN  VARCHAR2,
     srid                IN  NUMBER,
     feature_size        IN  NUMBER,
     max_angle           IN  NUMBER DEFAULT 90.0,
     blocking            IN  VARCHAR2 DEFAULT 'Consecutive-Mesh-Based',
     batch_size_pts      IN  NUMBER DEFAULT 100000
     );
```

Description

Generates a 3D mesh from a set of three-dimensional points.

Parameters

base_table
Name of the destination object table containing the new `MDSYS.SDO_TIN` object.

data_table
Name of the destination data table containing the mesh blocks.

tin_id
`ID` value of the new mesh.

tin_tol
Tolerance value for the resulting mesh of type SDO_TIN.

blk_size
(Not currently used.)

inptab
Name of the table containing the input point data with numeric columns `VAL_Di` for `x`, `y`, and `z`.

srid
The coordinate reference system of the point data.

feature_size
The size of the kind of feature that should remain recognizable in the mesh resolution. Small feature size implies more details. But it also means that there would be more voids in the mesh, if the point distribution is not dense enough.

max_angle
The maximum admissible angle (in degrees) between neighboring triangles.

blocking
Currently, the only supported option is 'Consecutive-Mesh-Based'.

batch_size_pts
The batch size of points read, internally, while generating the mesh.

Usage Notes

The procedure `SDO_TIN_PKG.CREATE_MESHES` can be used to generate a 3D mesh from the points specified in the `inptab` parameter. This 3D mesh computation is similar to the computation of a TIN. But unlike TINs which represent only 2 ½ D surfaces, a mesh can much more represent 3D structures, including closed volumes.

The `max_angle` parameter specifies the maximum cutoff angle, when generating consecutive meshes. Two parallel triangles have angle zero, unless they have opposing normals (right-handed rule), in which case they have angle 180 degrees. A surface facing up has opposing normal with a surface facing down. In a mesh, the surface normal should face outside from a solid.

The output of the mesh processing is stored as a new `SDO_TIN` object in the destination tables specified by `base_table` and `data_table` parameters.

See 3D Mesh Modeling for more concepts.

Examples

The following example generates a 3D mesh as shown:

```
SQL> call
  2    sdo_tin_pkg.create_meshes(
  3      base_table   => 'MESHES',
  4      data_table   => 'BLOCKS',
  5      tin_id       => 3,
  6      tin_tol      => 0.05,
  7      blk_size     => null,
  8      inptab       => 'INPTAB3',
  9      srid         => 27700,
 10      feature_size => 2,
 11      max_angle    => 120);
```

31.3 SDO_TIN_PKG.CREATE_TIN

Format

```
SDO_TIN_PKG.CREATE_TIN(
     inp           IN SDO_TIN,
     inptable      IN VARCHAR2,
     clstPcdataTbl IN VARCHAR2 DEFAULT NULL);
```

Description

Creates a TIN using the points specified in the `inptable` parameter.

Parameters

inp
SDO_TIN object to be used. This object must have been created by the SDO_TIN_PKG.INIT function

inptable
Name of the table or view containing the input TIN data. This table or view should have the following columns:

- RID (VARCHAR2(24)): Unique ID for each point
- VAL_D1 (NUMBER): Ordinate in dimension 1
- VAL_D2 (NUMBER): Ordinate in dimension 2
- . . .
- VAL_D*n* (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `tin_tot_dimensions` parameter value in the call to the SDO_TIN_PKG.INIT function when the TIN was initialized.

clstPcdataTbl
Name of the table for storing the resulting point data. If you do not specify a value, this table is not created. For more information about the table, see the Usage Notes.

Usage Notes

The first few dimensions of the TIN are indexed and can later be searched using the SDO_TIN_PKG.CLIP_TIN function. The exact number of dimensions to index is determined by the dimensionality of the TIN extent in the initialized TIN object, specifically: `inp.tin_extent.sdo_gtype/1000`

If you specify a view name in the `inptable` parameter, the query `SELECT ROWID FROM <view-name>` must not return any errors.

If you specify a table name in the `clstPcdataTbl` parameter, the table must exist and have the following columns:

- PTN_ID (NUMBER)
- POINT_ID (NUMBER)
- RID (VARCHAR2(24): Unique ID for each point
- VAL_D1 (NUMBER): Ordinate in dimension 1
- VAL_D2 (NUMBER): Ordinate in dimension 2
- . . .
- VAL_D*n* (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `tin_tot_dimensions` parameter value in the call to the SDO_TIN_PKG.INIT function when the TIN was initialized.

If a value is specified for the `clstPcdataTbl` parameter, this function populates the table by assigning appropriate values for PTN_ID and POINT_ID and by copying the values from the `inptable` table or view for other attributes. This table can be created as an index organized table. It can be used in applications for searching using SQL queries on dimensions other than those reflected in the index dimensionality. (For an explanation of index dimensionality and total dimensionality, see the explanation of the `tin_tot_dimensions` parameter of the SDO_TIN_PKG.INIT function.)

The SDO_TIN data type is described in TIN-Related Object Types.

Modeling Surfaces describes how to use TINs to model surfaces.

Examples

The following example creates a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Create the blocks for the TIN.
sdo_tin_pkg.create_tin(
  tin,        -- Initialized TIN object
  'INPTAB', -- Name of input table to ingest into the pointcloud
  'RES'     -- Name of output table that stores the points (with ptn_id,pt_id)
);
/
. . .
```

31.4 SDO_TIN_PKG.DROP_DEPENDENCIES

Format

```
SDO_TIN_PKG.DROP_DEPENDENCIES(
     basetable  IN VARCHAR2,
     col        IN VARCHAR2);
```

Description

Drops the dependencies between a TIN block table and a specified base table and column.

Parameters

basetable
Name of a base table that was specified (in the `basetable` parameter of the SDO_TIN_PKG.INIT function) when the TIN was initialized.

col
Name of a column in base table that was specified in the `basecol` parameter of the SDO_TIN_PKG.INIT function.

Usage Notes

This procedure truncates the TIN block table and removes the association between the block table and the base table and column combination.

After you execute this procedure, you can drop the TIN block table or associate the table with another base table and column combination. For more information, see the Usage Notes for the SDO_TIN_PKG.INIT function.

Examples

The following example drops the dependencies between a TIN block table and a base table and column named BASE and TIN, respectively.

```
. . .
declare
begin
  mdsys.sdo_tin_pkg.drop_dependencies('BASE', 'TIN');
```

```
end;
/
```

31.5 SDO_TIN_PKG.GET_BLOCKING_METHOD

Format

```
SDO_TIN_PKG.GET_BLOCKING_METHOD(
     inp IN MDSYS.SDO_TIN
   ) RETURN VARCHAR2;
```

Description

Gets the blocking option specified in the `SDO_TIN` object.

Parameters

inp
`SDO_TIN` object to be used for analysis.

Usage Notes

The supported blocking option values for a `SDO_TIN` object are:

- **TIN** - Represents a TIN object
- **Mesh** - Represents a 3D Mesh

Examples

The following example retrieves the blocking method for the input `tin` object as shown:

```
SQL> SELECT sdo_tin_pkg.get_blocking_method(tin) FROM tins WHERE tin_id=1;
```

The output obtained is as shown:

```
SDO_TIN_PKG.GET_BLOCKING_METHOD
--------------------------------
TIN
```

31.6 SDO_TIN_PKG.GET_NUM_POINTS

Format

```
SDO_TIN_PKG.GET_NUM_POINTS(
     tin IN MDSYS.SDO_TIN
   ) RETURN NUMBER DETERMINISTIC;
```

Description

Gets the total number of points specified in the TIN block table for a `SDO_TIN` object.

Parameters

tin
`SDO_TIN` object to be used for analysis.

Usage Notes

The `SDO_TIN` object may represent either a TIN or a 3D mesh.

Examples

The following example retrieves the total number of points for the input `tin` object as shown:

```
SQL> SELECT SDO_TIN_PKG.GET_NUM_POINTS(tin) FROM tins WHERE tin_id=1;
```

The output obtained is as shown:

```
SDO_TIN_PKG.GET_NUM_POINTS(TIN)
-------------------------------
                        1065690
```

31.7 SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER

Format

```
SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER(
     tin IN MDSYS.SDO_TIN
   ) RETURN VARCHAR2;
```

Description

Gets the blocking type as determined by the algorithm for the `SDO_TIN` object.

Parameters

tin
`SDO_TIN` object to be used for analysis.

Usage Notes

The output of the `SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER` function can be one of the following values:

- **TIN by Delaunay triangulation** - This is for a TIN object.
- **Mesh by consecutive submesh** - This is for a 3D mesh.

Examples

The following example retrieves the blocking type as determined by the algorithm for the input `tin` object as shown:

```
SQL> SELECT SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER(tin) FROM tins WHERE
tin_id=1;
```

The output obtained is as shown:

```
SDO_TIN_PKG.GET_TIN_BLOCK_SORT_ORDER(TIN)
-----------------------------------------
TIN by Delaunay triangulation
```

31.8 SDO_TIN_PKG.INIT

Format

```
SDO_TIN_PKG.INIT(
     basetable           IN VARCHAR2,
     basecol             IN VARCHAR2,
     blktable            IN VARCHAR2,
     ptn_params          IN VARCHAR2,
     tin_extent          IN SDO_GEOMETRY,
     tin_tol             IN NUMBER DEFAULT 0.000000000000005,
     tin_tot_dimensions  IN NUMBER DEFAULT 2,
     tin_domain          IN SDO_ORGSCL_TYPE DEFAULT NULL,
     tin_break_lines     IN SDO_GEOMETRY DEFAULT NULL,
     tin_stop_lines      IN SDO_GEOMETRY DEFAULT NULL,
     tin_void_rgns       IN SDO_GEOMETRY DEFAULT NULL,
     tin_val_attr_tables IN SDO_STRING_ARRAY DEFAULT NULL,
     tin_other_attrs     IN XMLTYPE DEFAULT NULL,
     ) RETURN SDO_TIN;
```

Description

Initializes a TIN by creating an SDO_TIN object.

Parameters

basetable
Name of the base table containing a column of type SDO_TIN.

basecol
Name of the column of type SDO_TIN in the base table.

blktable
Name of the TIN block table, which is used for storing the blocks of the TIN. This table must exist, and must have been created by a statement in the following form: `CREATE TABLE <table-name> AS select * from mdsys.sdo_tin_blk_table;`
Each TIN block table can only be associated with only one `basetable` and `basecol` combination.

ptn_params
Parameters for partitioning the TIN, specified as a quoted string with keywords delimited by commas. For example: '`blk_capacity=1000,work_tablespace=my_work_ts`'. If this parameter is null, the TIN is not partitioned. The following keywords are permitted:

- `blk_capacity=n`, where *n* is the maximum number of rows in each partition. The default value is 5000. If specified, must be a number greater than or equal to 50.
- `work_tablespace=x`, where *x* is the name of the tablespace in which to create temporary tables during the partitioning operations.

tin_extent
SDO_GEOMETRY object representing the spatial extent of the TIN (the minimum bounding object enclosing all objects in the TIN. This parameter must not be null.
For geodetic data, this geometry must have two dimensions; otherwise, it can have up to four dimensions. The dimensionality of this geometry is used as the minimum value permitted for the `tin_tot_dimensions` parameter, as explained in the description of that parameter.

tin_tol
Tolerance value for objects in the TIN. (For information about spatial tolerance, see Section 1.5.5.) If this parameter is null, the default value is 0.0000000000005.

tin_tot_dimensions
A number specifying the *total dimensionality* of the TIN object. For each point in the TIN blocks, `tin_tot_dimensions` ordinates (values) are stored.
The total dimensionality must be greater than or equal to the index dimensionality, which is the number of dimensions in the `tin_extent` geometry. Specifying total dimensionality greater than index dimensionality enables necessary nonspatial attributes to be retrieved in the same fetch operation with spatial data. The maximum total dimensionality value is 8. The default value for this parameter is 2.

tin_domain
(Not currently used.)

tin_break_lines
(Not currently used.)

tin_stop_lines
(Not currently used.)

tin_void_rgns
(Not currently used.)

tin_val_attr_tables
SDO_STRING_ARRAY object specifying the names of any value attribute tables for the TIN. If this parameter is null, the TIN has no associated value attribute tables. Type SDO_STRING_ARRAY is defined as VARRAY(1048576) OF VARCHAR2(32).

tin_other_attrs
XMLTYPE object specifying any other attributes of the TIN. If this parameter is null, the TIN has no other attributes.
This parameter can include metadata on TIN pyramiding, as explained in the Usage Notes.

Usage Notes

After you use this function to initialize an SDO_TIN object, you can create a TIN by specifying this object as input to the SDO_TIN_PKG.CREATE_TIN procedure.

The SDO_TIN data type is described in TIN-Related Object Types.

Modeling Surfaces describes how to use TINs to model surfaces.

The `tin_other_attrs` parameter can be used to specify metadata for TIN pyramiding, for example:

```
xmltype(
 '<opc:sdoTinObjectMetadata
          xmlns:opc="http://xmlns.oracle.com/spatial/vis3d/2011/sdovis3d.xsd"
          xmlns:las="http://liblas.org/schemas/LAS/1.0"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
```

```
            <opc:sdoTinPyramid/>
        </opc:sdoTinObjectMetadata>')
```

TIN pyramiding creates multiple pyramid levels from level 1 (most detailed) to level *n* (least detailed). In contrast to point cloud pyramiding (described in the Usage Notes for SDO_PC_PKG.INIT), there is no option relating to preserving level 1 with TIN pyramiding. A TIN with pyramiding will require more storage space than one without pyramiding, because level 1 is basically equal to the TIN without pyramiding, and all other levels require additional space.

Examples

The following example initializes a TIN by creating an SDO_TIN object. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
declare
  tin sdo_tin;
begin
  -- Initialize the TIN object.
  tin := sdo_tin_pkg.init(
          'BASE', -- Table that has the SDO_TIN column defined
          'TIN',   -- Column name of the SDO_TIN object
          'BLKTAB', -- Table to store blocks of the TIN
           'blk_capacity=1000', -- max # of points per block
           mdsys.sdo_geometry(2003, null, null,
              mdsys.sdo_elem_info_array(1,1003,3),
              mdsys.sdo_ordinate_array(-180, -90, 180, 90)),  -- Extent
              0.0000000005, -- Tolerance for TIN
              3, -- Total number of dimensions
              null);
. . .
```

31.9 SDO_TIN_PKG.LIST_TIN_COLUMNS

Format

```
SDO_TIN_PKG.LIST_TIN_COLUMNS() RETURN TIN_COLUMN_TABLE;
```

Description

Returns a table of type `TIN_COLUMN_TABLE` which contains a list of `TIN_COLUMN_RECORD` objects.

Parameters

Usage Notes

The `SDO_TIN_PKG.LIST_TIN_COLUMNS` function can be used to list the column names of all the `SDO_TIN` objects that may represent either a TIN or a 3D mesh.

This function returns a table of type `TIN_COLUMN_TABLE` which is defined as shown:

```
CREATE OR REPLACE TYPE TIN_COLUMN_TABLE AS TABLE OF TIN_COLUMN_RECORD;
```

The `TIN_COLUMN_RECORD` object is defined as shown:

```
CREATE OR REPLACE TYPE TIN_COLUMN_RECORD AS OBJECT (
  TABLE_NAME VARCHAR2(60),
  COLUMN_NAME VARCHAR2(60));
```

In the preceding code:

- **`TABLE_NAME`:** Name of the table having a column of type `SDO_TIN`.
- **`COLUMN_NAME`:** Name of the column of type `SDO_TIN` in the preceding table.

Examples

The following shows an example using the `SDO_TIN_PKG.LIST_TIN_COLUMNS` function:

```
SQL> SELECT * FROM TABLE (SDO_TIN_PKG.LIST_TIN_COLUMNS());
```

The output obtained is as shown:

```
TABLE_NAME COLUMN_NAME
---------- -----------
TINS       TIN
```

31.10 SDO_TIN_PKG.LIST_TINS

Format

```
SDO_TIN_PKG.LIST_TINS(
     table_name  IN VARCHAR2,
     column_name IN VARCHAR2
   ) RETURN TIN_TABLE;
```

Description

Returns a list of TINs in a table of type `TIN_TABLE`.

Parameters

table_name
Name of the table having a column of type `SDO_TIN`.

column_name
Name of the column of type `SDO_TIN` in the preceding table.

Usage Notes

The `SDO_TIN_PKG.LIST_TINS` function can be used to list all the `SDO_TIN` objects.

This function returns a table of type `TIN_TABLE` which is defined as shown:

```
CREATE OR REPLACE TYPE TIN_TABLE AS TABLE OF TIN_RECORD;
```

The `TIN_RECORD` object is defined as shown:

```
CREATE OR REPLACE TYPE TIN_RECORD AS OBJECT (
  TIN SDO_TIN);
```

In the preceding code, the `TIN` parameter represents an object of type `SDO_TIN`.

Examples

The following shows an example using the `SDO_TIN_PKG.LIST_TINS` function using *`TINS`* and *`TIN`* as the `table_name` and `column_name` parameter respectively:

```
SELECT * FROM TABLE(SDO_TIN_PKG.LIST_TINS('TINS', 'TIN'));
```

The output table lists the `SDO_TIN` object as shown:

```
TIN(BASE_TABLE, BASE_TABLE_COL, TIN_ID, BLK_TABLE, PTN_PARAMS,
TIN_EXTENT(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO,
SDO_ORDINATES),
TIN_TOL, TIN_TOT_DIMENSIONS, TIN_DOMAIN(EXTENT(LOWER_LEFT, UPPER_RIGHT),
SCALE, ORD_CMP_TYPE), TIN_BREAK_LINES(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
Z),
SDO_ELEM_INFO, SDO_ORDINATES), TIN_STOP_LINES(SDO_GTYPE, SDO_SRID,
SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES), TIN_VOID_RGNS(SDO_GTYPE,
SDO_SRID,
SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
---------------------------------------------------------------------------
SDO_TIN('TINS', 'TIN', 9, 'TIN_BLOCKS', 'blk_capacity=100000',
SDO_GEOMETRY(2003, 27700, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(0, 0, 999, 999)), .05, 3, NULL, NULL, NULL, NULL, NULL,
NULL)
```

31.11 SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN

Format

```
SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN(
     ordinates2D SDO_ORDINATE_ARRAY,
     tin         SDO_TIN
     ) RETURN SDO_ORDINATE_ARRAY;
```

Description

Projects two-dimensional points onto a TIN, thereby determining point heights.

Parameters

ordinates2D
SDO_ORDINATE_ARRAY object with the two-dimensional points to be projected. These cannot be oriented points (which are described in Oriented Point).

tin
SDO_TIN object onto which to project the points.

Usage Notes

This function can be thought of as performing height interpolation for the specified two-dimensional input points.

The SDO_TIN data type is described in TIN-Related Object Types.

Modeling Surfaces describes how to use TINs to model surfaces.

Examples

The following example projects two-dimensional points (2.3, 3.4), (4.5, 5.6), (6.7, 7.8) onto a TIN, yielding three-dimensional points (2.3, 3.4, 5.7), (4.5, 5.6, 10.1), (6.7, 7.8, 14.5). In this example, the TIN shape is an inclined surface with `zi=xi+yi`.

```
SELECT
  sdo_tin_pkg.project_ordinates_onto_tin(
    ordinates2d => sdo_ordinate_array(
      2.3,  3.4,
      4.5,  5.6,
      6.7,  7.8),
    tin => (select tin from tins where tin_id = 1))
FROM DUAL;

SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN(ORDINATES2D=>SDO_ORDINATE_ARRAY(2.3,3.4,4
--------------------------------------------------------------------------------
SDO_ORDINATE_ARRAY(2.3, 3.4, 5.7, 4.5, 5.6, 10.1, 6.7, 7.8, 14.5)

1 row selected.
```

31.12 SDO_TIN_PKG.TO_DEM

Format

```
SDO_TIN_PKG.TO_DEM(
     tin                 IN SDO_TIN,
     dem                 IN OUT SDO_GEORASTER,
     blocksize           IN NUMBER,
     crs_units_per_pixel IN NUMBER);
```

Description

Creates a DEM (Digital Elevation Model) GeoRaster object from a TIN.

Parameters

tin
TIN object. (The SDO_TIN data type is described in TIN-Related Object Types.)

dem
DEM GeoRaster object. (The SDO_GEORASTER data type is described in *Oracle Spatial GeoRaster Developer's Guide*.)

blocksize
Pixel block size for the DEM.

crs_units_per_pixel
TIN and DEM coordinate reference system (SRID) units for each pixel. For example, if the SRID unit of measure is decimal degree and if each pixel represents 1/100 of a degree, the `crs_units_per_pixel` value is `0.01`.

Usage Notes

This procedure modifies the specified GeoRaster object (`dem` parameter) based on information in the input TIN.

The TIN and the DEM must have the same coordinate reference system (SRID).

For the `dem` parameter, the input SDO_GEORASTER object can be obtained by inserting a GeoRaster object into a table and returning the GeoRaster object into a variable; for example:

```
INSERT INTO raster_table VALUES (1, sdo_geor.init('raster_data_table'))
   RETURNING raster_image INTO geor;
```

To determine the horizontal extent in pixels of the DEM, divide the horizontal extent in SRID units by the `crs_units_per_pixel` parameter value. For example, assume the following:

- The TIN and DEM SRID is 4326.
- The SRID unit is decimal degrees.
- The input TIN has a horizontal extent of 7 decimal degrees.
- The `crs_units_per_pixel` value is `0.01`.

In this example, the DEM horizontal extent is 700 pixels (7/.01 = 700).

The SDO_TIN data type is described in TIN-Related Object Types.

Modeling Surfaces describes how to use TINs to model surfaces.

Examples

The following example creates a DEM from a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
create table raster_table (id number, raster_image sdo_georaster);

create table raster_data_table of sdo_raster
  (primary key (rasterId, pyramidLevel, bandBlockNumber, rowBlockNumber,
columnBlockNumber))
  lob(rasterblock) store as (nocache nologging);

DECLARE
  inp sdo_tin;
  geor sdo_georaster;
BEGIN
  select tin INTO inp from tins_hawaii_4326 where rownum=1;
  insert into raster_table values (1, sdo_geor.init('raster_data_table')) returning
raster_image into geor;
  sdo_tin_pkg.to_dem(
    tin                 => inp,
    dem                 => geor,
    blocksize           => 128,
    crs_units_per_pixel => 0.01);
  update raster_table set raster_image = geor where id = 1;
```

```
END;
/
```

31.13 SDO_TIN_PKG.TO_GEOMETRY

Format

```
SDO_TIN_PKG.TO_GEOMETRY(
     pts         IN BLOB,
     trs         IN BLOB,
     num_pts     IN NUMBER,
     num_trs     IN NUMBER,
     tin_ind_dim IN NUMBER,
     tin_tot_dim IN NUMBER,
     srid        IN NUMBER DEFAULT NULL,
     blk_domain  IN SDO_ORGSCL_TYPE DEFAULT NULL,
     get_ids     IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry object representing all or part of a TIN.

Parameters

pts
BLOB containing points.

trs
BLOB containing triangles.

num_pts
Maximum number of points to be included in the resulting geometry.

num_pts
Maximum number of triangles to be included in the resulting geometry.

tin_ind_dim
Number of spatial dimensions that are indexed.

tin_tot_dim
Number of spatial dimensions defined for the data.

srid
Spatial reference (coordinate system) ID associated with the data. If this parameter is null, no SRID value is associated with the data.

blk_domain
(Not currently used.)

get_ids
Null or 0 (the default) does not include the block ID and point ID for each point in the returned geometry; 1 includes the block ID and point ID for each point in the returned geometry. If `get_ids` is 1, each point in the returned geometry has its spatial dimensions and two additional dimensions. For example: (x, y, z, blk_id, pt_id).

Usage Notes

This function returns a single collection SDO_GEOMETRY object that represents all point geometries in the `pts` parameter and all triangle geometries in the `trs` parameter. For example, the points and triangles could reflect the result of a clip operation or the contents of an entire block.

Modeling Surfaces describes how to use TINs to model surfaces.

Examples

The following example returns a multipoint collection geometry object representing a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Return points in blk_id of the TIN as a multipoint collection.
select sdo_tin_pkg.to_geometry(
                    a.points,   -- point LOB
                    a.triangles,   -- point LOB
                    a.num_points, -- # of points in the LOB
                    a.num_triangles, -- # of points in the LOB
                    2,  -- index dimensionality (gtype dim in extent in INIT)
                    3,  -- total dimensionality
                    null -- SRID
                    ) from blktab a where blk_id=0;
. . .
```

32

SDO_TRKR Package (Location Tracking)

The MDSYS.SDO_TRKR package contains subprograms for using the location tracking server.

To use these subprograms, you must understand the concepts and techniques described in Location Tracking Server.

- SDO_TRKR.CREATE_TRACKING_SET
- SDO_TRKR.DROP_TRACKING_SET
- SDO_TRKR.GET_NOTIFICATION_MSG
- SDO_TRKR.SEND_LOCATION_MSGS
- SDO_TRKR.SEND_TRACKING_MSG
- SDO_TRKR.START_TRACKING_SET
- SDO_TRKR.STOP_TRACKING_SET

32.1 SDO_TRKR.CREATE_TRACKING_SET

Format

```
SDO_TRKR.CREATE_TRACKING_SET(
  tracking_set_name  IN VARCHAR2,
  num_trkr_queues    IN NUMBER(38) DEFAULT 4,
  num_loc_queues     IN NUMBER(38) DEFAULT 1);
```

Description

Creates a tracking set, specifically the tables and queues required for the location tracking server.

Parameters

tracking_set_name
Name of the tracking set.

num_trkr_queues
Number of queues to create to manage the tracking messages. The default value for this parameter is 4. For large numbers of regions in the tracking regions table, more tracker queues may improve performance. For every tracker queue created a scheduler job is also created, so the number of tracker queues should also be balanced with system resources.

num_loc_queues
Number of queues to create to manage the location messages. The default value for this parameter is 1. If a large number of objects are being tracked, more location queues may improve performance. For every location queue created a scheduler job is also created, so the number of location queues should also be balanced with system resources.

Usage Notes

This procedure creates the necessary tables and queues required for the location tracking server. This is the first step required for enabling the location tracking server

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example creates a tracking network named TRACKING_EXAMPLE with 8 tracking queues and 8 location queues.

```
EXECUTE SDO_TRKR.CREATE_TRACKING_SET('TRACKING_EXAMPLE', 8, 8);
```

32.2 SDO_TRKR.DROP_TRACKING_SET

Format

```
SDO_TRKR.DROP_TRACKING_SET(
   tracking_set_name  IN VARCHAR2);
```

Description

Drops a tracking set. This removes the tables, queues, and jobs required for the location tracking server.

Parameters

tracking_set_name
Name of the tracking set.

Usage Notes

This procedure drops the tracking set that was created by a previous call to the SDO_TRKR.CREATE_TRACKING_SET procedure.

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example drops the previously created tracking set.

```
EXECUTE SDO_TRKR.DROP_TRACKING_SET('TRACKING_EXAMPLE');
```

32.3 SDO_TRKR.GET_NOTIFICATION_MSG

Format

```
SDO_TRKR.GET_NOTIFICATION_MSG(
   tracking_set_name IN VARCHAR2,
   deq_wait          IN NUMBER(38) DEFAULT DBMS_AQ.NO_WAIT,
   message           OUT NOTIFICATION_MSG);
```

Description

Gets the next notification message from the tracking sets notification queue.

Parameters

tracking_set_name
Name of the tracking set. This parameter is used to build the name of the notification queue.

deq_set_wait
Number of seconds to wait for a message to arrive on the notification queue if no message matching the search criteria is not already on the queue. The DEFAULT for this parameter is DBMS_AQ.NO_WAIT, which means that the operation does not wait.

message
Output parameter of type NOTIFICATION_MSG. The next message from the notification queue, or null if the wait time expired.

Usage Notes

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example gets a notification message from the tracking sets notification queue and inserts the contents of the message into the tracking set auxiliary notification table. It will continue to get notification messages until it waits for 30 seconds with no messages arriving.

```
...
 LOOP
   SDO_TRKR.GET_NOTIFICATION_MSG(
     tracking_set_name => 'TRACKING_EXAMPLE',
     message => message,
     deq_wait =>30);
   IF (message IS NULL) THEN
     EXIT;
   END IF;
   INSERT INTO tracking_example_notifications (object_id, region_id,
                                             time, x, y, state)
   VALUES (message.object_id,
           message.region_id,
           message.time,
           message.x,
           message.y,
           message.state);
 END LOOP;
...
```

32.4 SDO_TRKR.SEND_LOCATION_MSGS

Format

```
SDO_TRKR.SEND_LOCATION_MSGS(
   tracking_set_name IN VARCHAR2,
   location_msgs     IN LOCATION_MSG_ARR );
```

Description

Sends an array of new location information for objects that are being tracked in the tracking set.

Parameters

tracking_set_name
Name of the tracking set.

location_msgs
A message of type LOCATION_MSG_ARR.

queue_no
The specific location queue that should be used for this location message. It is recommended that you not specify this parameter, in which case the tracking server determine the best queue for managing this location message.

Usage Notes

This procedure adds a new location message for tracking purposes. Whenever a new location is obtained for an object that is being tracked, this procedure can be used to update the location of that object.

The `location_msgs` parameter is of type LOCATION_MSG_ARR, which is defined in Data Types for the Location Tracking Server.

Each message includes a timestamp value, which is the time of the update and is maintained along with the location information.

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example adds a new location message. The message includes the object id (1), the current time, and the X and Y ordinates (2, 2) of the object's new location

```
EXECUTE SDO_TRKR.SEND_LOCATION_MSGS('TRACKING_EXAMPLE',
LOCATION_MSG_ARR(location_msg(1, CURRENT_TIMESTAMP(), 2,2)));
```

32.5 SDO_TRKR.SEND_TRACKING_MSG

Format

```
SDO_TRKR.SEND_TRACKING_MSG(
   tracking_set_name  IN VARCHAR2,
   tracking_msg  IN TRACKER_MSG );
```

Description

Inserts a tracking message into a tracking queue. One TRACKER_MSG is required for each object that is tracked. If object 1 is being tracked in regions 1, 2, and 3, then three TRACKER_MSGs are required, one for each object ID/region ID pair.

Parameters

tracking_set_name
Name of the tracking set.

tracking_msg
Message of type TRACKER_MSG. This is used to create a relationship between objects that are being tracked and the region or regions in which they are being tracked.

Usage Notes

This procedure creates new row in the tracker table that tells the location tracker server what objects are being tracked within what regions.

The `tracking_ms` parameter is of type TRACKER_MSG, which is defined in Data Types for the Location Tracking Server.

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example inserts a new tracking object with an ID of 4 to be tracked against a region with an ID of 8 in the tracking set named TRACKING_EXAMPLE. Notification messages are sent when the object is **inside** (`I`) the region. If `O` had been specified notifications would have been sent with the object was *outside* the region, and if `T` had been specified, notifications would only be sent when the object *transitions* into or out of the region.

```
EXECUTE SDO_TRKR.SEND_TRACKING_MSG('TRACKING_EXAMPLE', TRACKER_MSG(4, 8, 'I'));
```

32.6 SDO_TRKR.START_TRACKING_SET

Format

```
SDO_TRKR.START_TRACKING_SET(
 tracking_set_name   IN VARCHAR2);
```

Description

Starts the queues for the location tracking server and starts jobs to monitor those queues.

Parameters

tracking_set_name
Name of the tracking set.

Usage Notes

This procedure starts the tracking set that has been previously created by a call to the SDO_TRKR.CREATE_TRACKING_SET procedure.

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example starts the tracking set that was previously created.

```
EXECUTE SDO_TRKR.START_TRACKING_SET('TRACKING_EXAMPLE');
```

32.7 SDO_TRKR.STOP_TRACKING_SET

Format

```
SDO_TRKR.STOP_TRACKING_REGIONS(
 tracking_set_name  IN VARCHAR2 );
```

Description

Stops the queues for the location tracking server and stops the jobs that monitor those queues.

Parameters

traxking_set_name
Name of the tracking set.

Usage Notes

This procedure stops the tracking network that was previously started by a call to the SDO_TRKR.START_TRACKING_SET procedure.

For conceptual and usage information about the location tracking server, see Location Tracking Server.

Examples

The following example stops the tracking set that was previously started.

```
EXECUTE SDO_TRKR.STOP_TRACKING_REGIONS('TRACKING_EXAMPLE');
```

33

SDO_TUNE Package (Tuning)

The MDSYS.SDO_TUNE package contains subprograms for spatial tuning.

- SDO_TUNE.AVERAGE_MBR
- SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE
- SDO_TUNE.EXTENT_OF
- SDO_TUNE.MIX_INFO

33.1 SDO_TUNE.AVERAGE_MBR

Format

```
SDO_TUNE.AVERAGE_MBR(
     table_name  IN VARCHAR2,
     column_name IN VARCHAR2,
     width       OUT NUMBER,
     height      OUT NUMBER);
```

Description

Calculates the average minimum bounding rectangle (MBR) for geometries in a layer.

Parameters

table_name
Spatial geometry table.

column_name
Geometry column for which the average minimum bounding rectangle is to be computed.

width
Width of the average minimum bounding rectangle.

height
Height of the average minimum bounding rectangle.

Usage Notes

This procedure computes and stores the width and height of the average minimum bounding rectangle for all geometries in a spatial geometry table. It calculates the average MBR by keeping track of the maximum and minimum X and Y values for all geometries in a spatial geometry table.

Examples

The following example calculates the minimum bounding rectangle for the SHAPE column of the COLA_MARKETS table.

```
DECLARE
  table_name  VARCHAR2(32) := 'COLA_MARKETS';
  column_name  VARCHAR2(32) := 'SHAPE';
  width  NUMBER;
  height  NUMBER;
BEGIN
SDO_TUNE.AVERAGE_MBR(
  table_name,
  column_name,
  width,
  height);
DBMS_OUTPUT.PUT_LINE('Width = ' || width);
DBMS_OUTPUT.PUT_LINE('Height = ' || height);
END;
/
Width = 3.5
Height = 4.5
```

Related Topics

SDO_AGGR_MBR spatial aggregate function (in Spatial Aggregate Functions)

33.2 SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE

Format

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(
     schemaname IN VARCHAR2,
     tabname    IN VARCHAR2,
     colname    IN VARCHAR2,
     partname   IN VARCHAR2 DEFAULT NULL
     ) RETURN NUMBER;
```

or

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(
     number_of_geoms IN INTEGER,
     db_block_size   IN INTEGER,
     sdo_rtr_pctfree IN INTEGER DEFAULT 10,
     num_dimensions  IN INTEGER DEFAULT 2,
     is_geodetic     IN INTEGER DEFAULT 0
     ) RETURN NUMBER;
```

Description

Estimates the maximum number of megabytes needed for an R-tree spatial index table.

Parameters

schemaname
Schema that owns the spatial geometry table.

tabname
Spatial geometry table name.

colname
Geometry column name.

partname
Name of a partition containing geometries from `colname`. If you specify this parameter, the value returned by the function is the estimated size for an R-tree index table on geometries in

that partition. If you do not specify this parameter, the value is the estimated size for an R-tree index table on all geometries in `colname`.

number_of_geoms
Approximate number of geometries in the spatial geometry table.

db_block_size
Database block size (in bytes).

sdo_rtr_pctfree
Minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. The default value (10) is best for most applications; however, a value of 0 is recommended if no updates will be performed to the geometry column.

num_dimensions
Number of dimensions to be indexed. The default value is 2. If you plan to specify the `sdo_indx_dims` parameter in the CREATE INDEX statement, the `num_dimensions` value should match the `sdo_indx_dims` value.

is_geodetic
A value indicating whether or not the spatial index will be a geodetic index: 1 for a geodetic index, or 0 (the default) for a non-geodetic index.

Usage Notes

The function returns the estimated maximum number of megabytes needed for the spatial index table (described in Spatial Index Table Definition) for an R-tree spatial index to be created. The value returned is the maximum number of megabytes needed after index creation. During index creation, approximately three times this value of megabytes will be needed in the tablespace, to ensure that there is enough space for temporary tables while the index is being created.

This function has two formats:

- Use the format with character string parameters (`schemaname`, `tabname`, `colname`, and optionally `partname`) in most cases when the spatial geometry table already exists, you do not plan to add substantially more geometries to it before creating the index, and you plan to use the default R-tree indexing parameters.
- Use the format with integer parameters (`number_of_geoms`, `db_block_size`, `sdo_rtr_pctfree`, `num_dimensions`, `is_geodetic`) in any of the following cases: the spatial geometry table does not exist; the spatial geometry table exists but you plan to add substantially more geometries to it before creating the index; or the `num_dimensions` value is not 2 for non-geodetic data or 3 for geodetic data, and a nondefault value will be specified using the `sdo_indx_dims` parameter in the CREATE INDEX statement.

Examples

The following example estimates the maximum number of megabytes needed for a spatial index table for an index given the following information: `number_of_geoms = 1000000` (one million), `db_block_size = 2048`, `sdo_rtr_pctfree = 10`, `num_dimensions = 2`, `is_geodetic = 0`.

```
SELECT SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(1000000, 2048, 10, 2, 0) FROM DUAL;

SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(1000000,2048,10,2,0)
```

```
-----------------------------------------------------
                                                   82
```

The following example estimates the maximum number of megabytes needed for a spatial index table for an index on the SHAPE column in the COLA_MARKETS table in the SCOTT schema. The estimate is based on the geometries that are currently in the table.

```
SELECT SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE('SCOTT', 'COLA_MARKETS', 'SHAPE') FROM DUAL;

SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE('SCOTT','COLA_MARKETS','SHAPE')
---------------------------------------------------------------------
                                                                    1
```

33.3 SDO_TUNE.EXTENT_OF

Format

```
SDO_TUNE.EXTENT_OF(
     table_name  IN VARCHAR2,
     column_name IN VARCHAR2,
     use_index   VARCHAR2 default 'TRUE'
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the minimum bounding rectangle (MBR) of all geometries in a layer.

Parameters

table_name
Spatial geometry table, or a view based on a spatial geometry table.

column_name
Geometry column for which the minimum bounding rectangle is to be returned.

use_index
The string `TRUE` (the default) causes the spatial index (if one exists) on the table to be used in the computations. The string `FALSE` causes any spatial index to be ignored. (See the Usage Notes for more information about this parameter.)

Usage Notes

The SDO_AGGR_MBR function, documented in Spatial Aggregate Functions, also returns the MBR of geometries. The SDO_TUNE.EXTENT_OF function has better performance than the SDO_AGGR_MBR function if a spatial index is defined on the geometry column; however, the SDO_TUNE.EXTENT_OF function is limited to two-dimensional geometries, whereas the SDO_AGGR_MBR function is not. In addition, the SDO_TUNE.EXTENT_OF function computes the extent for all geometries in a table; by contrast, the SDO_AGGR_MBR function can operate on subsets of rows.

If an R-tree spatial index is used, this function may return an approximate MBR that encloses the largest extent of data stored in the index, even if data was subsequently deleted.

The default value of `TRUE` for `use_index` is best in most cases, but in some cases you may want to specify `FALSE`. A spatial index can sometimes have the extent as larger than the actual data extent because DML operations might delete data around the edges, resulting in a smaller actual extent, although such deletions do not reduce the index extent. In such cases, if you want the actual data extent, specify `use_index=>'FALSE'`. Note, however, that specifying

`FALSE` will have a significant negative impact on the performance of the function because it will require a full table scan.

Examples

The following example calculates the minimum bounding rectangle for the objects in the SHAPE column of the COLA_MARKETS table.

```
SELECT SDO_TUNE.EXTENT_OF('COLA_MARKETS', 'SHAPE')
  FROM DUAL;

SDO_TUNE.EXTENT_OF('COLA_MARKETS','SHAPE')(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARRAY(1, 1,
10, 11))
```

Related Topics

SDO_AGGR_MBR aggregate function (in Spatial Aggregate Functions)

SDO_TUNE.AVERAGE_MBR procedure

33.4 SDO_TUNE.MIX_INFO

Format

```
SDO_TUNE.MIX_INFO(
     table_name    IN VARCHAR2,
     column_name   IN VARCHAR2
     [, total_geom OUT INTEGER,
     point_geom    OUT INTEGER,
     curve_geom    OUT INTEGER,
     poly_geom     OUT INTEGER,
     complex_geom  OUT INTEGER] );
```

Description

Calculates geometry type information for a spatial layer, such as the percentage of each geometry type.

Parameters

table_name
Spatial geometry table.

column_name
Geometry object column for which the geometry type information is to be calculated.

total_geom
Total number of geometry objects.

point_geom
Number of point geometry objects.

curve_geom
Number of curve string geometry objects.

poly_geom
Number of polygon geometry objects.

complex_geom
Number of complex geometry objects.

Usage Notes

This procedure calculates geometry type information for the table. It calculates the total number of geometries, as well as the number of point, curve string, polygon, and complex geometries.

Examples

The following example displays information about the mix of geometry objects in the SHAPE column of the COLA_MARKETS table.

```
CALL SDO_TUNE.MIX_INFO('COLA_MARKETS',  'SHAPE');
Total number of geometries: 4
Point geometries:        0  (0%)
Curvestring geometries:   0  (0%)
Polygon geometries:      4  (100%)
Complex geometries:      0  (0%)
```

34

SDO_WCS Package (Web Coverage Service)

The MDSYS.SDO_WCS package contains subprograms associated with Oracle Spatial support for Web Coverage Service (WCS).

It assumes that you are familiar with the concepts and techniques described in Web Coverage Service (WCS) Support.

- SDO_WCS.CreateTempTable
- SDO_WCS.DropTempTable
- SDO_WCS.GrantPrivilegesToWCS
- SDO_WCS.Init
- SDO_WCS.PublishCoverage
- SDO_WCS.RevokePrivilegesFromWCS
- SDO_WCS.UnpublishCoverage
- SDO_WCS.ValidateCoverages

34.1 SDO_WCS.CreateTempTable

Format

```
SDO_WCS.CreateTempTable(
     schema_name      IN VARCHAR2 DEFAULT USER,
     tablespace_name  IN VARCHAR2 DEFAULT NULL);
```

Description

Creates temporary tables necessary during GetCoverage processing when reprojection or transformation is involved.

Parameters

schema_name
Name of the schema in which temporary tables will be created. If not specified, the tables are created in invoking user’s schema.

tablespace_name
Name of the tablespace for temporary tables. If not specified, the user's default tablespace is used.

Usage Notes

Each temporary GeoRaster object is stored in the same schema as the original GeoRaster object. When a GetCoverage Operation (WCS) response has been sent to the client, any temporary GeoRaster created during processing of a request is deleted.

This procedure must be invoked for all schemas whose GeoRaster objects will be published as coverages.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example creates WCS temporary tables in the invoker's schema.

```
CALL SDO_WCS.createTempTable();
```

The following example creates WCS temporary tables in the SCOTT schema. The invoking user must have privileges to create tables in the SCOTT schema.

```
CALL SDO_WCS.createTempTable(‘SCOTT’);
```

34.2 SDO_WCS.DropTempTable

Format

```
SDO_WCS.DropTempTable(
     schema_name   IN VARCHAR2 DEFAULT USER);
```

Description

Drops WCS temporary tables from a schema. (WCS Temporary tables are necessary for WCS GeoCoverage processing.)

Parameters

schema_name
Name of the database schema containing WCS temporary tables to be dropped. If not specified, the invoker's schema is used.

Usage Notes

If `schema_name` is not the invoking user, the invoking user must have privileges to drop tables from that schema.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example drop WCS temporary tables from the invoker's schema.

```
BEGIN
SDO_WCS.DropTempTable();
END;
```

The following example drops WCS temporary tables from the SCOTT schema. The invoking user must have privileges to drop tables in the SCOTT schema.

```
BEGIN
SDO_WCS.DropTempTable(‘SCOTT’);
END;
```

34.3 SDO_WCS.GrantPrivilegesToWCS

Format

```
SDO_WCS.GrantPrivilegesToWCS(
     table_name  IN VARCHAR2,
     wcs_schema  IN VARCHAR2,
   updateable  IN VARCHAR2 DEFAULT 'FALSE');
```

Description

Grants select and update privileges on all GeoRaster objects and the raster data tables of the GeoRaster table to the WCS schema when the WCS schema is different from the user schema (that is, the schema with GeoRaster objects).

Parameters

table_name
Name of the table that contains GeoRaster objects that will be published as coverages.

wcs_schema
Name of the schema to be used as the WCS schema.

updateable
The string `TRUE` or `FALSE` (default) indicating if update privilege is to be granted.

Usage Notes

If the user schema (schema with GeoRaster objects published as coverages) and the WCS schema are the same, do **not** use this procedure.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example grant read privileges on all GeoRaster objects and the raster data tables of a table named GEORASTER_TABLE in the current schema to a WCS schema named WCS_1.

```
BEGIN
  SDO_WCS.grantPrivilegesToWCS(‘GEORASTER_TABLE’,’WCS_1’);
END;
/
```

34.4 SDO_WCS.Init

Format

```
SDO_WCS.Init();
```

Description

Creates metadata tables and sequences to store references to GeoRaster objects published as WCS coverages. The calling schema becomes a WCS schema, and is configured in the Java EE container where the Spatial Web Services web application is deployed.

Parameters

(None.)

Usage Notes

This procedure must be called once before publishing any coverages and before configuring a WCS data source in WebLogic Server.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example creates the necessary WCS metadata tables. It then publishes coverages on GeoRaster objects in the GEORASTER_TABLE.RASTER column in the SCOTT schema.

```
BEGIN
  SDO_WCS.Init();
  SDO_WCS.PublishCoverage(‘SCOTT’,’GEORASTER_TABLE’,’RASTER’);
END;
/
```

34.5 SDO_WCS.PublishCoverage

Format

```
SDO_WCS.PublishCoverage(
     georaster   IN SDO_GEORASTER,
     updateable  IN VARCHAR2 DEFAULT 'FALSE');
```

or

```
SDO_WCS.PublishCoverage(
     user_name   IN VARCHAR2,
   table_name  IN VARCHAR2,
     column_name IN VARCHAR2,
     updateable  IN VARCHAR2 DEFAULT 'FALSE');
```

Description

Publishes GeoRaster objects as WCS coverages.

Parameters

georaster
A GeoRaster object to be published as a WCS coverage.

user_name
Name of the user (schema) that owns the table with GeoRaster columns.

table_name
Name of the GeoRaster table whose GeoRaster objects are to be published.

column_name
Name of the GeoRaster column in `table_name`.

updateable
Contains the string `TRUE` if the published coverages are to be editable through a transaction request; contains the string `FALSE` (default) if the published coverages are not to be editable through a transaction request.

Usage Notes

A unique coverage Id is assigned to each GeoRaster published. The GetCapabilities Operation (WCS) response will show the newly generated coverage ID. A GeoRaster object can only be published once.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example publishes a specific GeoRaster object (`where ID=1`) from a table named GEORASTER_TABLE in the SCOTT schema as a coverage.

```
DECLARE
  gr1   SDO_GEORASTER;
BEGIN
  SELECT raster INTO gr1 FROM SCOTT.GEORASTER_TABLE where ID=1;
  SDO_WCS.PublishCoverage(gr1);
END;
/
```

The following example publishes **all** GeoRaster objects in the RASTER column of the IMAGE table in the SCOTT schema.

```
CALL SDO_WCS.publishCoverage('SCOTT','IMAGE','RASTER');
```

34.6 SDO_WCS.RevokePrivilegesFromWCS

Format

```
SDO_WCS.RevokePrivilegesFromWCS(
     table_name  IN VARCHAR2,
     wcs_schema  IN VARCHAR2);
```

Description

Revokes select and update privileges on the specified table in the invoking user’s schema from the specified wcs_schema user.

Parameters

table_name
The name of a GeoRaster table that previously was granted privileges using SDO_WCS.GrantPrivilegesToWCS procedure.

wcs_schema
Name of the WCS schema from which to revoke the privileges. Must not be the same as the user schema containing the GeoRaster objects.

Usage Notes

Do not use this procedure when the WCS schema is the same as the schema for the GeoRaster objects.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example revokes read and update privileges on GEORASTER_TABLE and all raster data tables associated with it from the WCS schema named WCS_1.

```
BEGIN
  SDO_WCS.RevokePrivilegesFromWCS('GEORASTER_TABLE','WCS_1'’);
END;
/
```

34.7 SDO_WCS.UnpublishCoverage

Format

```
SDO_WCS.UnpublishCoverage(
     coverage_id  IN VARCHAR2);
```

Description

Unpublishes a coverage.

Parameters

coverage_id
A string specifying a coverage ID from the list of coverages of a GetCapabilities response.

Usage Notes

A GetCapabilities Operation (WCS) response contains the list of all coverage ID from the given WCS server instance. After this procedure runs, the specified coverage ID will not appear in a GetCapabilities response.

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example unpublishes the coverage with coverage Id C0001.

```
DECLARE
BEGIN
  SDO_WCS.UnpublishCoverage(‘C0001’);
END;
/
```

34.8 SDO_WCS.ValidateCoverages

Format

```
SDO_WCS.ValidateCoverages(
     ) RETURN MDSYS.SDO_WCS_INVALID_COVERAGE;
```

Description

Validates GeoRaster objects in the WCS metadata tables and returns the coverage IDs of all invalid WCS metadata entries.

Parameters

(None.)

Usage Notes

This procedure must be invoked by a WCS user.

When GeoRaster objects are deleted, references to them might remain in WCS metadata tables. Such references are invalid metadata entries.

This function returns an MDSYS.SDO_WCS_INVALID_COVERAGE object, which is defined as: `TABLE OF VARCHAR2(4000)`

Each element of the returned object is a coverage Id from the WCS metadata tables in which the corresponding GeoRaster object was not found. Invalid metadata entries are not handled by the DescribeCoverage Operation (WCS) and GetCoverage Operation (WCS).

For information about support for WCS, see Web Coverage Service (WCS) Support.

Examples

The following example iterates over all invalid coverage IDs and unpublishes them, leaving only valid coverages in the WCS metadata.

```
DECLARE
BEGIN
   FOR i IN (select * from table(SDO_WCS.ValidateCoverages()))
   LOOP
      SDO_WCS.UnpublishCoverage(i.column_value);
   END LOOP;
END;
/
```

35

SDO_UTIL Package (Utility)

The MDSYS.SDO_UTIL package contains spatial utility subprograms.

- SDO_UTIL.AFFINETRANSFORMS
- SDO_UTIL.APPEND
- SDO_UTIL.BEARING_TILT_FOR_POINTS
- SDO_UTIL.CIRCLE_POLYGON
- SDO_UTIL.CONCAT_LINES
- SDO_UTIL.CONVERT_UNIT
- SDO_UTIL.CONVERT3007TO3008
- SDO_UTIL.DELETE_SDO_GEOM_METADATA
- SDO_UTIL.DENSIFY_GEOMETRY
- SDO_UTIL.DISABLE_VECTORTILE_CACHE
- SDO_UTIL.DROP_WORK_TABLES
- SDO_UTIL.ELLIPSE_POLYGON
- SDO_UTIL.ENABLE_VECTORTILE_CACHE
- SDO_UTIL.EXPAND_GEOM
- SDO_UTIL.EXTRACT
- SDO_UTIL.EXTRACT_ALL
- SDO_UTIL.EXTRACT3D
- SDO_UTIL.EXTRUDE
- SDO_UTIL.FROM_GEOJSON
- SDO_UTIL.FROM_GML311GEOMETRY
- SDO_UTIL.FROM_GMLGEOMETRY
- SDO_UTIL.FROM_JSON
- SDO_UTIL.FROM_KMLGEOMETRY
- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.GEO_SEARCH
- SDO_UTIL.GET_2D_FOOTPRINT
- SDO_UTIL.GET_COORDINATE
- SDO_UTIL.GET_TILE_ENVELOPE
- SDO_UTIL.GET_VECTORTILE
- SDO_UTIL.GETFIRSTVERTEX

- SDO_UTIL.GETLASTVERTEX
- SDO_UTIL.GETNUMELEM
- SDO_UTIL.GETNUMVERTICES
- SDO_UTIL.GETNURBSAPPROX
- SDO_UTIL.GETVERTICES
- SDO_UTIL.GRANT_VECTORTILE_CACHE
- SDO_UTIL.H3_BASE_CELL
- SDO_UTIL.H3_BOUNDARY
- SDO_UTIL.H3_CENTER
- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_IS_CLASS3
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_IS_VALID_CELL
- SDO_UTIL.H3_KEY
- SDO_UTIL.H3_MBR
- SDO_UTIL.H3_PARENT
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN
- SDO_UTIL.H3_RESOLUTION
- SDO_UTIL.H3SUM_AS_TABLE
- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION
- SDO_UTIL.H3SUM_GET_CURSOR
- SDO_UTIL.H3SUM_VECTORTILE
- SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS
- SDO_UTIL.INSERT_SDO_GEOM_METADATA
- SDO_UTIL.INTERIOR_POINT
- SDO_UTIL.LINEAR_KEY
- SDO_UTIL.POINT_AT_BEARING
- SDO_UTIL.POLYGONTOLINE
- SDO_UTIL.PURGE_VECTORTILE_CACHE
- SDO_UTIL.RECTIFY_GEOMETRY
- SDO_UTIL.REMOVE_DUPLICATE_VERTICES
- SDO_UTIL.REVERSE_LINESTRING
- SDO_UTIL.REVOKE_VECTORTILE_CACHE
- SDO_UTIL.SIMPLIFY

- SDO_UTIL.SIMPLIFYVW
- SDO_UTIL.THEME3D_GET_BLOCK_TABLE
- SDO_UTIL.THEME3D_HAS_LOD
- SDO_UTIL.THEME3D_HAS_TEXTURE
- SDO_UTIL.TILE_GEOMETRY
- SDO_UTIL.TO_GEOJSON
- SDO_UTIL.TO_GEOJSON_JSON
- SDO_UTIL.TO_GML311GEOMETRY
- SDO_UTIL.TO_GMLGEOMETRY
- SDO_UTIL.TO_JSON
- SDO_UTIL.TO_JSON_JSON
- SDO_UTIL.TO_JSON_VARCHAR
- SDO_UTIL.TO_KMLGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_3DTHEME
- SDO_UTIL.VALIDATE_SCENE
- SDO_UTIL.VALIDATE_VIEWFRAME
- SDO_UTIL.VALIDATE_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.1 SDO_UTIL.AFFINETRANSFORMS

Format

```
SDO_UTIL.AFFINETRANSFORMS(
     geometry    IN SDO_GEOMETRY,
     translation IN VARCHAR2 DEFAULT 'FALSE',
     tx          IN NUMBER DEFAULT 0.0,
     ty          IN NUMBER DEFAULT 0.0,
     tz          IN NUMBER DEFAULT 0.0,
     scaling     IN VARCHAR2 DEFAULT 'FALSE',
     psc1        IN SDO_GEOMETRY DEFAULT NULL,
     sx          IN NUMBER DEFAULT 0.0,
     sy          IN NUMBER DEFAULT 0.0,
     sz          IN NUMBER DEFAULT 0.0,
     rotation    IN VARCHAR2 DEFAULT 'FALSE',
     p1          IN SDO_GEOMETRY DEFAULT NULL,
     line1       IN SDO_GEOMETRY DEFAULT NULL,
     angle       IN NUMBER DEFAULT 0.0,
     dir         IN NUMBER DEFAULT -1,
     shearing    IN VARCHAR2 DEFAULT 'FALSE',
     shxy        IN NUMBER DEFAULT 0.0,
     shyx        IN NUMBER DEFAULT 0.0,
     shxz        IN NUMBER DEFAULT 0.0,
     shzx        IN NUMBER DEFAULT 0.0,
     shyz        IN NUMBER DEFAULT 0.0,
     shzy        IN NUMBER DEFAULT 0.0,
     reflection  IN VARCHAR2 DEFAULT 'FALSE',
     pref        IN SDO_GEOMETRY DEFAULT NULL,
     lineR       IN SDO_GEOMETRY DEFAULT NULL,
     dirR        IN NUMBER DEFAULT -1,
     planeR      IN VARCHAR2 DEFAULT 'FALSE',
     n           IN SDO_NUMBER_ARRAY DEFAULT NULL,
     bigD        IN SDO_NUMBER_ARRAY DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a geometry that reflects an affine transformation of the input geometry.

Parameters

geometry
Input geometry on which to perform the affine transformation.

translation
A string value of `TRUE` causes translation to be performed; a string value of `FALSE` (the default) causes translation not to be performed. If this parameter is `TRUE`, translation is performed about the point at (tx,ty) or (tx,ty,tz).

tx
X-axis value for translation. The default value is 0.0.

ty
Y-axis value for translation. The default value is 0.0.

tz
Z-axis value for translation. The default value is 0.0.

scaling
A string value of `TRUE` causes scaling to be performed; a string value of `FALSE` (the default) causes scaling not to be performed.

psc1
Point on the input geometry about which to perform the scaling. If `scaling` is `TRUE`, this geometry should be either a zero point (point geometry with 0,0 or 0,0,0 ordinates for scaling about the origin) or a nonzero point (point geometry with ordinates for scaling about a point other than the origin). If `scaling` is `FALSE`, `psc1` can be a null value.

sx
X-axis value for scaling (about either the point specified in the `psc1` parameter or the origin). The default value is 0.0.

sy
Y-axis value for scaling (about either the point specified in the `psc1` parameter or the origin). The default value is 0.0.

sz
Z-axis value for scaling (about either the point specified in the `psc1` parameter or the origin). The default value is 0.0.

rotation
A string value of `TRUE` causes rotation to be performed; a string value of `FALSE` (the default) causes rotation not to be performed.

For two-dimensional geometries, rotation uses the `p1` and `angle` values. For three-dimensional geometries, rotation uses either the `angle` and `dir` values or the `line1` and `angle` values.

p1
Point for two-dimensional geometry rotation about a specified point.

line1
Line for rotation about a specified axis.

angle
Angle rotation parameter (in radians) for rotation about a specified axis or about the X, Y, or Z axis. The default value is 0.0.

dir
Rotation parameter for x(0), y(1), or z(2)-axis roll. If the `rotation` parameter value is `TRUE` but the `dir` parameter is not used, use a value of -1 (the default)

shearing
A string value of `TRUE` causes shearing to be performed; a string value of `FALSE` (the default) causes shearing not to be performed.
For two-dimensional geometries, shearing uses the `shxy` and `shyx` parameter values. For three-dimensional geometries, shearing uses the `shxy`, `shyx`, `shxz`, `shzx`, `shyz`, and `shzy` parameter values.

shxy
Value for shearing due to X along the Y direction. The default value is 0.0.

shyx
Value for shearing due to Y along the X direction. The default value is 0.0.

shxz
Value for shearing due to X along the Z direction (three-dimensional geometries only). The default value is 0.0.

shzx
Value for shearing due to Z along the X direction (three-dimensional geometries only).

shyz
Value for shearing due to Y along the Z direction (three-dimensional geometries only).

shzy
Value for shearing due to Z along the Y direction (three-dimensional geometries only).

reflection
A string value of `TRUE` causes reflection to be performed; a string value of `FALSE` (the default) causes reflection not to be performed.
For two-dimensional geometries, reflection uses the `lineR` value for reflection about an axis and the `pref` value for the centroid for self-reflection. For three-dimensional geometries, reflection uses the `lineR` value for reflection about an axis; the `dirR` value for reflection about the yz, xz, and xy planes; the `planeR`, `n`, and `bigD` values for reflection about a specified plane; and the `pref` value for the centroid for self-reflection.

pref
Point through which to perform reflection.

lineR
Line along which to perform reflection.

dirR
Number indicating the plane about (through) which to perform reflection: 0 for the yz plane, 1 for the xz plane, or 2 for the xy plane. If the `reflection` parameter value is `TRUE` but the `dirR` parameter is not used, use a value of -1 (the default).

planeR
A string value of `TRUE` causes reflection about an arbitrary plane to be performed; a string value of `FALSE` (the default) causes reflection about an arbitrary plane not to be performed.

n
Normal vector of the plane.

bigD
Delta value for the plane equation in three-dimensional geometries.
For three-dimensional geometries, `bigD` = delta and `n` = (A,B,C) where `n` is the normal of the plane in three-dimensional space. Thus, the plane equation is:

```
Ax+By+Cz+bigD = 3DDotProd(n,anypointonplane)+bigD = 0
```

Usage Notes

> **Note:**
>
> The SDO_UTIL.AFFINETRANSFORMS function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The order of affine transforms matter because these are matrix and vector multiplications.

You should validate the resulting geometry using the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function.

Examples

The following example performs an affine transformation on a two-dimensional geometry.

```
-- Polygon reflection in 2D about a specified line segment
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry =>   sdo_geometry (2003,8307,null,sdo_elem_info_array (1,1003,1),
                              sdo_ordinate_array (0,2,2,0,5,3,3,5,0,2)),
  translation => 'FALSE',
  tx => 0.0,
  ty => 0.0,
  tz => 0.0,
  scaling => 'FALSE',
  psc1 => NULL,
  sx => 0.0,
  sy => 0.0,
  sz => 0.0,
  rotation => 'TRUE',
  p1 => sdo_geometry (2001,8307,sdo_point_type(0,2,null),null,null),
  line1 => NULL,
  angle => -2.35253274913915,
  dir => -1,
  shearing => 'FALSE',
  shxy => 0.0,
  shyx => 0.0,
  shxz => 0.0,
  shzx => 0.0,
  shyz => 0.0,
  shzy => 0.0,
  reflection => 'FALSE',
  pref => NULL,
  lineR => NULL,
  dirR => 0,
  planeR => 'FALSE',
  n => NULL,
  bigD => NULL
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>SDO_GEOMETRY(2003,8307,NULL,SDO_ELEM_INFO_AR
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(0, 2, -2.8284082, 1.98964306, -2.8128727, -2.2529692, .015535417, -2.2426122,
 0, 2))
```

The following is a simplified version of the preceding example, using the default values for most parameters.

```
-- Simpler form, using most default values
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry =>   sdo_geometry (2003,8307,null,sdo_elem_info_array (1,1003,1),
                            sdo_ordinate_array (0,2,2,0,5,3,3,5,0,2)),
  rotation => 'TRUE',
  p1 => sdo_geometry (2001,8307,sdo_point_type(0,2,null),null,null),
  angle => -2.35253274913915
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>SDO_GEOMETRY(2003,8307,NULL,SDO_ELEM_INFO_AR
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(0, 2, -2.8284082, 1.98964306, -2.8128727, -2.2529692, .015535417, -2.2426122,
 0, 2))
```

The following example performs an affine transformation on a three-dimensional geometry.

```
-- Polygon reflection in 3D about a specified plane (z=1 plane in this example)
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry => MDSYS.SDO_GEOMETRY(3003, 0, NULL,
     MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1),
     MDSYS.SDO_ORDINATE_ARRAY(
     1.5,0,0,
     2.5,1,0,
     1.5,2,0,
     0.5,2,0,
     0.5,0,0,
     1.5,0,0)),
  translation => 'FALSE',
  tx => 0.0,
  ty => 0.0,
  tz => 0.0,
  scaling => 'FALSE',
  psc1 => NULL,
  sx => 0.0,
  sy => 0.0,
  sz => 0.0,
  rotation => 'FALSE',
  p1 => NULL,
  line1 => NULL,
  angle => 0.0,
  dir => 0,
  shearing => 'FALSE',
  shxy => 0.0,
  shyx => 0.0,
  shxz => 0.0,
  shzx => 0.0,
  shyz => 0.0,
  shzy => 0.0,
  reflection => 'TRUE',
  pref => NULL,
  lineR => NULL,
  dirR => -1,
  planeR => 'TRUE',
  n => SDO_NUMBER_ARRAY(0.0, 0.0, 1.0),
  bigD => SDO_NUMBER_ARRAY(-1.0)
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>MDSYS.SDO_GEOMETRY(3003,0,NULL,MDSYS.SDO_ELE
--------------------------------------------------------------------------------
SDO_GEOMETRY(3003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1.5, 0, 2, 2.5, 1, 2, 1.5, 2, 2, .5, 2, 2, .5, 0, 2, 1.5, 0, 2))
```

Related Topics

- SDO_UTIL.CONVERT_UNIT
- SDO_UTIL.POINT_AT_BEARING

35.2 SDO_UTIL.APPEND

Format

```
SDO_UTIL.APPEND(
     geometry1  IN SDO_GEOMETRY,
     geometry2  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Appends one geometry to another geometry to create a new geometry.

Parameters

geometry1
Geometry object to which `geometry2` is to be appended.

geometry2
Geometry object to append to `geometry1`.

Usage Notes

This function should be used only on geometries that do not have any spatial interaction (that is, on disjoint objects). If the input geometries are not disjoint, the resulting geometry might be invalid.

This function does not perform a union operation or any other computational geometry operation. To perform a union operation, use the SDO_GEOM.SDO_UNION function, which is described in SDO_GEOM Package (Geometry). The APPEND function executes faster than the SDO_GEOM.SDO_UNION function.

The geometry type (SDO_GTYPE value) of the resulting geometry reflects the types of the input geometries and the append operation. For example, if the input geometries are two-dimensional polygons (SDO_GTYPE = 2003), the resulting geometry is a two-dimensional multipolygon (SDO_GTYPE = 2007).

An exception is raised if `geometry1` and `geometry2` are based on different coordinate systems.

Examples

The following example appends the `cola_a` and `cola_c` geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.APPEND(c_a.shape, c_c.shape)
  FROM cola_markets c_a, cola_markets c_c
  WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_UTIL.APPEND(C_A.SHAPE,C_C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3, 5, 1003, 1), SDO_
ORDINATE_ARRAY(1, 1, 5, 7, 3, 3, 6, 3, 6, 5, 4, 5, 3, 3))
```

Related Topics

- SDO_GEOM.SDO_UNION (in SDO_GEOM Package (Geometry))

35.3 SDO_UTIL.BEARING_TILT_FOR_POINTS

Format

```
SDO_UTIL.BEARING_TILT_FOR_POINTS(
     start_point IN SDO_GEOMETRY,
     end_point   IN SDO_GEOMETRY,
     tol         IN NUMBER,
     bearing     OUT NUMBER,
     tilt        OUT NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Computes the bearing and tilt from a start point to an end point.

Parameters

start_point
Starting point geometry object from which to compute the bearing and tilt. The point geometry must be based on a geodetic coordinate system.

end_point
Ending point geometry object to use in computing the bearing and tilt. The point geometry must be based on the same geodetic coordinate system as `start_point`.

tol
Tolerance value (see Tolerance).

bearing
Number of radians, measured clockwise from North.

tilt
Number of radians, measured from the normal.

Usage Notes

The input point geometries must be based on the same geodetic coordinate system. If they are based on a non-geodetic coordinate system, the output bearing is a null value.

The tilt is computed as the arctangent of the difference between the height values divided by the distance between the points (with height excluded from the distance calculation). That is: `tilt = atan(height_difference/distance)`

To convert radians to decimal degrees or decimal degrees to radians, you can use the SDO_UTIL.CONVERT_UNIT function. To return a point geometry that is at a specified distance and bearing from a start point, you can use the SDO_UTIL.POINT_AT_BEARING function.

Examples

The following example computes the bearing and tilt for two longitude/latitude points, where the elevation of the start point is 0 (zero) and the elevation of the end point is 5000 meters. This example displays the bearing and tilt values in radians.

```
DECLARE
  bearing NUMBER;
  tilt    NUMBER;
BEGIN
  SDO_UTIL.BEARING_TILT_FOR_POINTS(
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71.5, 43, 0), NULL, NULL), -- start_point
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71, 43.5, 5000), NULL, NULL), -- end_point
    0.05,  --tolerance
    bearing,
    tilt);
  DBMS_OUTPUT.PUT_LINE('Bearing = ' || bearing);
  DBMS_OUTPUT.PUT_LINE('Tilt = ' || tilt);
END;
/
Bearing = .628239101930666
Tilt = .0725397288678286910476298724869396973718
```

The following example is the same as the preceding one, except that it displays the bearing and tilt in decimal degrees instead of radians.

```
DECLARE
  bearing NUMBER;
  tilt    NUMBER;
BEGIN
  SDO_UTIL.BEARING_TILT_FOR_POINTS(
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71.5, 43, 0), NULL, NULL), -- start_point
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71, 43.5, 5000), NULL, NULL), -- end_point
    0.05,  --tolerance
    bearing,
    tilt);
  DBMS_OUTPUT.PUT_LINE('Bearing in degrees = '
    || bearing * 180 / 3.1415926535897932384626433832795);
  DBMS_OUTPUT.PUT_LINE('Tilt in degrees = '
    || tilt * 180 / 3.1415926535897932384626433832795);
END;
/
```

```
Bearing in degrees = 35.99544906571628894295547577999851892359
Tilt in degrees = 4.15622031114988533540349823511872120415
```

Related Topics

- SDO_UTIL.CONVERT_UNIT
- SDO_UTIL.POINT_AT_BEARING

35.4 SDO_UTIL.CIRCLE_POLYGON

Format

```
SDO_UTIL.CIRCLE_POLYGON(
     point         IN SDO_GEOMETRY,
     radius        IN NUMBER,
     arc_tolerance IN NUMBER,
     start_azimuth IN NUMBER DEFAULT NULL,
     end_azimuth   IN NUMBER DEFAULT NULL,
     orientation   IN NUMBER DEFAULT NULL,
     arc           IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.CIRCLE_POLYGON(
     center_longitude IN NUMBER,
     center_latitude  IN NUMBER,
     radius           IN NUMBER,
     arc_tolerance    IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.CIRCLE_POLYGON(
     center_longitude IN NUMBER,
     center_latitude  IN NUMBER,
     radius           IN NUMBER,
     start_azimuth    IN NUMBER,
     end_azimuth      IN NUMBER,
     arc_tolerance    IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Creates polygon or polyline approximations of circles and arcs in geodetic coordinate systems.

- The first format allows full control of the output.
- The second format returns the polygon geometry that approximates and is covered by a specified circle.
- The third format returns a line geometry that approximates the boundary of the circle from the start to the end azimuth (an arc).

Parameters

point
The center of the circle. Must be a point geometry in a geodetic coordinate system. The returned geometry will be in the same coordinate system.

center_longitude
Center longitude (in degrees) of the circle to be used to create the returned geometry.

center_latitude
Center latitude (in degrees) of the circle to be used to create the returned geometry.

radius
Length (in meters) of the radius of the circle to be used to create the returned geometry.

arc_tolerance
A numeric value to be used to construct the polygon geometry. The `arc_tolerance` parameter value has the same meaning and usage guidelines as the `arc_tolerance` keyword value in the `params` parameter string for the SDO_GEOM.SDO_ARC_DENSIFY function. The unit of measurement associated with the geometry is associated with the `arc_tolerance` parameter value. (For more information, see the Usage Notes for the SDO_GEOM.SDO_ARC_DENSIFY function in SDO_GEOM Package (Geometry).)

start_azimuth
Start angle (in degrees) of the arc, measured counterclockwise from due south.
If `start_azimuth` and `end_azimuth` are null, the behavior is comparable to the second format, which returns the polygon geometry that approximates and is covered by a specified circle.

end_azimuth
End angle (in degrees) of the arc, measured counterclockwise from due south. If `orientation` is not explicitly specified, then the arc will be the counterclockwise section of the circle from `start_azimuth` if `end_azimuth` is greater than `start_azimuth`, and the arc will be the clockwise section if `end_azimuth` is less than `start_azimuth`.
If `start_azimuth` and `end_azimuth` are null, the behavior is comparable to the second format, which returns the polygon geometry that approximates and is covered by a specified circle.

orientation
Controls which portion of the circle from `start_azimuth` to `end_azimuth` is used. This controls the shape of the returned output, not the orientation of the output: a returned polygon is always oriented counterclockwise, and a returned arc is always from `start_azimuth` to `end_azimuth`. The value can be one of the following:

- 0 or null (default): Automatic (see the `end_azimuth` parameter description).
- 1 or +1: Arc is drawn counterclockwise from `start_azimuth` to `end_azimuth`.
- -1: Arc is drawn clockwise from `start_azimuth` to `end_azimuth`.

arc
If set to 1, the result will be a line; if 0 or null (the default), the result is a polygon. If `start_azimuth` and `end_azimuth` specify a subset of the circle with a polygon result, the returned polygon will include the center of the circle (that is, will be a sector of the circle).

Usage Notes

The first format of this function is useful for creating a circle-like polygon around a specified center point when a true circle cannot be used (a circle is not valid for geodetic data with Oracle Spatial). The returned geometry has an SDO_SRID value of 8307 (for `Longitude / Latitude (WGS 84)`).

The second and third formats of this function are useful for creating a polyline approximation to a circular arc or a polygon that represents a sector of the circle.

If the start and end azimuth values are specified, they must not be equal to each other, and must cover no more than a 360 degree rotation. Angles must be in the range -720 to +720.

Circles will always be created with at least four distinct vertices (a square).

Examples

The following example returns a circle-like polygon around a point near the center of Concord, Massachusetts. A `radius` value of 100 meters and an `arc_tolerance` value of 5 meters are used in computing the polygon vertices.

```
SELECT SDO_UTIL.CIRCLE_POLYGON(-71.34937, 42.46101, 100, 5)
   FROM DUAL;

SDO_UTIL.CIRCLE_POLYGON(-71.34937,42.46101,100,5)(SDO_GTYPE, SDO_SRID, SDO_POINT
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(-71.34937, 42.4601107, -71.348653, 42.4602824, -71.348211, 42.4607321, -71.34
8211, 42.4612879, -71.348653, 42.4617376, -71.34937, 42.4619093, -71.350087, 42.
4617376, -71.350529, 42.4612879, -71.350529, 42.4607321, -71.350087, 42.4602824,
 -71.34937, 42.4601107))
```

Related Topics

- SDO_UTIL.ELLIPSE_POLYGON

35.5 SDO_UTIL.CONCAT_LINES

Format

```
SDO_UTIL.CONCAT_LINES(
     geometry1  IN SDO_GEOMETRY,
     geometry2  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Concatenates two line or multiline two-dimensional geometries to create a new geometry.

Parameters

geometry1
First geometry object for the concatenation operation.

geometry2
Second geometry object for the concatenation operation.

Usage Notes

Each input geometry must be a two-dimensional line or multiline geometry (that is, the SDO_GTYPE value must be 2002 or 2006). This function is not supported for LRS geometries. To concatenate LRS geometric segments, use the SDO_LRS.CONCATENATE_GEOM_SEGMENTS function (described in SDO_LRS Package (Linear Referencing System)).

The input geometries must be line strings whose vertices are connected by straight line segments. Circular arcs and compound line strings are not supported.

If an input geometry is a multiline geometry, the elements of the geometry must be disjoint. If they are not disjoint, this function may return incorrect results.

The topological relationship between `geometry1` and `geometry2` must be DISJOINT or TOUCH; and if the relationship is TOUCH, the geometries must intersect only at two end points.

You can use the SDO_AGGR_CONCAT_LINES spatial aggregate function (described in Spatial Aggregate Functions) to concatenate multiple two-dimensional line or multiline geometries.

An exception is raised if `geometry1` and `geometry2` are based on different coordinate systems.

Examples

The following example concatenates two simple line string geometries.

```
-- Concatenate two touching lines: one from (1,1) to (5,1) and the
-- other from (5,1) to (8,1).
SELECT SDO_UTIL.CONCAT_LINES(
  SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
     SDO_ORDINATE_ARRAY(1,1, 5,1)),
  SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
     SDO_ORDINATE_ARRAY(5,1, 8,1))
  ) FROM DUAL;

SDO_UTIL.CONCAT_LINES(SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,2,1),SDO
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
1, 1, 5, 1, 8, 1))
```

Related Topics

- SDO_AGGR_CONCAT_LINES (in Spatial Aggregate Functions)
- SDO_LRS.CONCATENATE_GEOM_SEGMENTS (in SDO_LRS Package (Linear Referencing System))

35.6 SDO_UTIL.CONVERT_UNIT

Format

```
SDO_UTIL.CONVERT_UNIT(
     ivalue    IN NUMBER,
     in_unit   IN VARCHAR2,
     out_unit  IN VARCHAR2
     ) RETURN NUMBER;
```

Description

Converts values from one angle, area, or distance unit of measure to another.

Parameters

value
Number of units to be converted. For example, to convert 10 decimal degrees to radians, specify `10`.

in_unit
The unit of measure from which to convert the input value. Must be a value from the SDO_UNIT column of the MDSYS.SDO_ANGLE_UNITS table (described in MDSYS.SDO_ANGLE_UNITS View), the MDSYS.SDO_AREA_UNITS table (described in Unit of Measurement Support), or the MDSYS.SDO_DIST_UNITS table (described in Unit of Measurement Support). For example, to convert decimal degrees to radians, specify `Degree`.

out_unit
The unit of measure into which to convert the input value. Must be a value from the SDO_UNIT column of the same table used for `in_unit`. For example, to convert decimal degrees to radians, specify `Radian`.

Usage Notes

The value returned by this function might not be correct at an extremely high degree of precision because of the way internal mathematical operations are performed, especially if they involve small numbers or irrational numbers (such as *pi*). For example, converting 1 decimal degree into decimal minutes results in the value 60.0000017.

Examples

The following example converts 1 radian into decimal degrees.

```
SQL> SELECT SDO_UTIL.CONVERT_UNIT(1, 'Radian', 'Degree') FROM DUAL;

SDO_UTIL.CONVERT_UNIT(1,'RADIAN','DEGREE')
------------------------------------------
                                57.2957796
```

Related Topics

None.

35.7 SDO_UTIL.CONVERT3007TO3008

Format

```
SDO_UTIL.CONVERT3007TO3008(
     geometry  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Converts an input three-dimensional multisurface geometry (SDO_GTYPE 3007) to a simple solid geometry (SDO_GTYPE 3008).

Parameters

geometry
Geometry object with SDO_GTYPE 3007 (multisurface). The surfaces are simple polygons without interiors.

Usage Notes

> **Note:**
>
> The SDO_UTIL.CONVERT3007TO3008 function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

For information about SDO_GEOMETRY attributes for 3D geometries, see Three-Dimensional Spatial Objects.

This function does not check the validity of the returned simple solid geometry. To check the validity of a geometry object, use the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function.

Examples

The following example converts an input three-dimensional multisurface geometry (SDO_GTYPE 3007) to a simple solid geometry (SDO_GTYPE 3008). It assumes that a table named GEOMS3D exists with at least a numeric ID column and a column named GEOM of type SDO_GEOMETRY containing three-dimensional multisurface geometries.

```
SELECT sdo_util.convert3007to3008(g.geom) FROM geoms3d g WHERE g.id=1;
```

35.8 SDO_UTIL.DELETE_SDO_GEOM_METADATA

Format

```
SDO_UTIL.DELETE_SDO_GEOM_METADATA(
  owner       IN   VARCHAR2,
  table_name  IN VARCHAR2,
  column_name IN VARCHAR2);
```

Description

Deletes metadata for a spatial table from the geometry metadata views USER_SDO_GEOMETRY_METADATA and ALL_SDO_GEOMETRY_METADATA.

Parameters

owner
Name of the schema that owns the spatial table. Must be uppercase.

table_name
Name of the spatial table (a feature table that has a column of type SDO_GEOMETRY). Must be uppercase.

column_name
Name of the column of type SDO_GEOMETRY. Must be uppercase.

Usage Notes

Deleting the metadata for a spatial table from the geometry metadata views also effectively disables any spatial index based on that metadata (`owner`, `table_name`, and `column_name`).

If you want to restore the metadata after deleting it, you can use the SDO_UTIL.INSERT_SDO_GEOM_METADATA procedure.

To execute this procedure, you must be the owner of the metadata, have DBA privileges, or have the SELECT or INDEX privilege on the table.

To use this procedure on a spatial table in another user’s schema, you must have DBA privileges or the SELECT privilege on that other user’s table. For example, if USER1 wants to insert geometry metadata for the USER2.COLA_MARKETS table, then USER1 must have DBA privileges or the SELECT privilege on the USER2.COLA_MARKETS table.

Examples

The following example deletes metadata for a spatial table named COLA_MARKETS with the geometry column named SHAPE in the USER2 schema, and it thereby disables any spatial index defined on that metadata. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
EXECUTE SDO_UTIL.DELETE_SDO_GEOM_METADATA ('USER2', 'COLA_MARKETS', 'SHAPE');
```

Related Topics

- Geometry Metadata Views for an explanation of the USER_SDO_GEOM_METADATA and ALL_SDO_GEOM_METADATA views
- SDO_UTIL.INSERT_SDO_GEOM_METADATA procedure

35.9 SDO_UTIL.DENSIFY_GEOMETRY

Format

```
SDO_UTIL.DENSIFY_GEOMETRY(
     geometry  IN SDO_GEOMETRY,
     interval  IN NUMBER DEFAULT 5000
     ) RETURN SDO_GEOMETRY;
```

Description

Densifies the input geometry, based on an interval value.

Parameters

geometry
Geometry object to be densified.

interval
Interval value to be used for the geometry densification. Should be a positive number. (Zero or a negative number causes the input geometry to be returned.) The default is 5000. For a geodetic geometry, the default is 5000 meters.

Usage Notes

This function densifies the input geometry by adding more points so that no line segment is longer than the given `interval`.

This function is useful when a geodetic long line is to be shown on a planar map by showing the curvature of the great circle interpolation. When displaying geodetic geometries on a flat or planar map, the function helps you see the geodesic path between vertices along a line string or polygon, instead of connecting those vertices with straight lines. The densification is performed along the geodesic path.

Examples

The following example densifies an input geometry. (Descriptive comments are added in the output.)

```
SELECT SDO_UTIL.DENSIFY_GEOMETRY(
  SDO_GEOMETRY(2004, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 5, 1, 1),
  SDO_ORDINATE_ARRAY(-78.24299, 31.50939, -31.99998, 31.51001, -64.6683, 32.38425)),
1000000)
FROM DUAL;

SDO_UTIL.DENSIFY_GEOMETRY(SDO_GEOMETRY(2004,8307,NULL,SDO_ELEM_INFO_ARRAY(1,2,1,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2004, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 13, 1, 1),
SDO_ORDINATE_ARRAY(-78.24299, 31.50939, -67.77851, 33.0389493, -57.05549, 33.6714211,
-46.2911, 33.3720604, -35.71139, 32.1574866, -31.99998, 31.51001,  /* 4 points are added
inside the long line */
-64.6683, 32.38425)) /* single point is still the same as before */
```

Related Topics

- SDO_GEOM.SDO_ARC_DENSIFY

35.10 SDO_UTIL.DISABLE_VECTORTILE_CACHE

Format

```
SDO_UTIL.DISABLE_VECTORTILE_CACHE(
  table_name     IN VARCHAR2,
  geom_col_name  IN VARCHAR2
);
```

Description

Disables a vector tile cache.

Parameters

table_name
Name of the table or view containing the information used to build the vector tiles (a geometry column and zero or more attribute columns).

geom_col_name
Name of the SDO_GEOMETRY type column in `table_name` which is used to build vector tiles.

Usage Notes

Note the following when calling `SDO_UTIL.DISABLE_VECTORTILE_CACHE`:

- Only the schema that enabled the cache is allowed to disable that cache.
- The `table_name` and `geom_col_name` parameters are used to remove caches' information from `SDO_VECTOR_TILE_CACHE$INFO` and all of the caches' data from `SDO_VECTOR_TILE_CACHE$TABLE`.
- When the last tile cache is disabled, both the `SDO_VECTOR_TILE_CACHE$INFO` and `SDO_VECTOR_TILE_CACHE$TABLE` tables will be empty. Note that the empty tables are not dropped but left intact to be used by future caches. However, you may drop these tables if desired after you ensure that they are empty.
- Once the cache is disabled, all calls to `SDO_UTIL.GET_VECTORTILE` will build the vector tiles from scratch and these are returned without caching the result.

Examples

The following example calls `SDO_UTIL.DISABLE_VECTORTILE_CACHE` to disable cache on the `counties` table.

```
-- Disable the cache on the COUNTIES table
EXEC SDO_UTIL.DISABLE_VECTORTILE_CACHE('counties', 'geom');
```

35.11 SDO_UTIL.DROP_WORK_TABLES

Format

```
SDO_UTIL.DROP_WORK_TABLES(
     oidstr IN VARCHAR2);
```

Description

Drops any transient ("scratch") tables and views in the current schema that were created during the creation of a point cloud or TIN.

Parameters

oidstr
Object ID string representing a hexadecimal number. Use the string given in the error message that indicated that scratch tables need to be dropped.

Usage Notes

If scratch tables still exist from a previous SDO_PC_PKG.CREATE_PC or SDO_TIN_PKG.CREATE_TIN operation when you try to create a point cloud or TIN, an error message is displayed indicating that you must first drop the scratch tables. Use the SDO_UTIL.DROP_WORK_TABLES procedure to drop these scratch tables.

This procedure drops all tables and views that match `'M%_<oidstr>$$%'`.

Examples

The following example drops the scratch tables from a previous SDO_PC_PKG.CREATE_PC or SDO_TIN_PKG.CREATE_TIN operation, using an OID string specified in a previous error message.

```
EXECXUTE SDO_UTIL.DROP_WORK_TABLES('A1B2C3');
```

Related Topics

- SDO_PC_PKG.CREATE_PC
- SDO_TIN_PKG.CREATE_TIN

35.12 SDO_UTIL.ELLIPSE_POLYGON

Format

```
SDO_UTIL.ELLIPSE_POLYGON(
     center_longitude IN NUMBER,
     center_latitude  IN NUMBER,
     semi_major_axis  IN NUMBER,
     semi_minor_axis  IN NUMBER,
     azimuth          IN NUMBER,
     arc_tolerance    IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the polygon geometry that approximates and is covered by a specified ellipse.

Parameters

center_longitude
Center longitude (in degrees) of the ellipse to be used to create the returned geometry.

center_latitude
Center latitude (in degrees) of the ellipse to be used to create the returned geometry.

semi_major_axis
Length (in meters) of the semi-major axis of the ellipse to be used to create the returned geometry.

semi_minor_axis
Length (in meters) of the semi-minor axis of the ellipse to be used to create the returned geometry.

azimuth
Number of degrees of the azimuth (clockwise rotation of the major axis from north) of the ellipse to be used to create the returned geometry. Must be from 0 to 180. The returned geometry is rotated by the specified number of degrees.

arc_tolerance
A numeric value to be used to construct the polygon geometry. The `arc_tolerance` parameter value has the same meaning and usage guidelines as the `arc_tolerance` keyword value in the `params` parameter string for the SDO_GEOM.SDO_ARC_DENSIFY function. The unit of measurement associated with the geometry is associated with the `arc_tolerance` parameter value. (For more information, see the Usage Notes for the SDO_GEOM.SDO_ARC_DENSIFY function in SDO_GEOM Package (Geometry).)

Usage Notes

This function is useful for creating an ellipse-like polygon around a specified center point when a true ellipse cannot be used (an ellipse is not valid for geodetic data with Oracle Spatial). The returned geometry has an SDO_SRID value of 8307 (for `Longitude / Latitude (WGS 84)`).

Examples

The following example returns an ellipse-like polygon, oriented east-west (`azimuth` = 90), around a point near the center of Concord, Massachusetts. An `arc_tolerance` value of 5 meters is used in computing the polygon vertices.

```
SELECT SDO_UTIL.ELLIPSE_POLYGON(-71.34937, 42.46101, 100, 50, 90, 5)
   FROM DUAL;

SDO_UTIL.ELLIPSE_POLYGON(-71.34937,42.46101,100,50,90,5)(SDO_GTYPE, SDO_SRID, SD
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(-71.350589, 42.46101, -71.350168, 42.4606701, -71.349708, 42.460578, -71.3493
7, 42.4605603, -71.349032, 42.460578, -71.348572, 42.4606701, -71.348151, 42.461
01, -71.348572, 42.4613499, -71.349032, 42.461442, -71.34937, 42.4614597, -71.34
9708, 42.461442, -71.350168, 42.4613499, -71.350589, 42.46101))
```

Related Topics

- SDO_UTIL.CIRCLE_POLYGON

35.13 SDO_UTIL.ENABLE_VECTORTILE_CACHE

Format

```
SDO_UTIL.ENABLE_VECTORTILE_CACHE(
  table_name     IN VARCHAR2,
  geom_col_name  IN VARCHAR2,
  ts_name        IN VARCHAR2 default NULL,
  min_zoom       IN NUMBER DEFAULT 0,
  max_zoom       IN NUMBER DEFAULT 23
);
```

Description

Enables cache for vector tiles built from a table using the geometry column.

Parameters

table_name
Name of the table or view containing the information used to build the vector tiles (a geometry column and zero or more attribute columns).

geom_col_name
Name of the SDO_GEOMETRY type column in `table_name` which is used to build the vector tiles.

ts_name
Name of the table space.
This is an optional parameter. If specified, the tables (`SDO_VECTOR_TILE_CACHE$INFO` and `SDO_VECTOR_TILE_CACHE$TABLE`) that are created for tile caching are created in the specified table space. Otherwise, the cache tables are created in the schema's default table space.

min_zoom
Minimum zoom level stored in the cache.
This is an optional parameter with a default value of zero. If a `min_zoom` of eight is specified, then only tiles with a zoom of eight or higher are cached. If a tile at `min_zoom` of six is requested, then the tile is computed and returned to the caller, but it is not cached.

max_zoom
Maximum zoom level stored in the cache.
This is an optional parameter with a default value of 23. If a `max_zoom` of 16 is specified, then only tiles with a zoom of 16 or less are cached. If a tile at zoom 20 is requested, then the tile is computed and returned to the caller, but it is not cached.

Usage Notes

Vector tile caching is not enabled by default. To enable a vector tile cache, you can call this `SDO_UTIL.ENABLE_VECTORTILE_CACHE` procedure.

Tile caching creates and maintains two tables in the schema that enabled the cache:

- **`SDO_VECTOR_TILE_CACHE$INFO`**: This table contains the metadata. Every tile cache has one row in this table describing the `table_name`, `geom_col_name`, `min_zoom`, and `max_zoom` of the cache.
  This table is small and is stored in the same table space as `SDO_VECTOR_TILE_CACHE$TABLE`.

- **`SDO_VECTOR_TILE_CACHE$TABLE`**: This table contains vector tiles for all vector tile caches enabled in the schema. This table can get very large, and is owned by the schema that enabled the cache.
  It is stored in the same table space as `SDO_VECTOR_TILE_CACHE$INFO`. It is because of the potential size of `SDO_VECTOR_TILE_CACHE$TABLE` that the `ts_name` parameter is required. It allows the user to place this table and the `SDO_VECTOR_TILE_CACHE$INFO` table in a table space large enough to handle the load.

Both `SDO_VECTOR_TILE_CACHE$INFO` and `SDO_VECTOR_TILE_CACHE$TABLE` are owned by the schema that enabled the cache. As such, the schema may query and manipulate the data within these tables. However, it is important to note that these tables are only to be manipulated through the vector cache API.

A call to `SDO_UTIL.ENABLE_VECTORTILE_CACHE` creates an entry in `SDO_VECTOR_TILE_CACHE$INFO`. Once enabled, the cache is populated when you use the `SDO_UTIL.GET_VECTORTILE` API. Over time, performance improves as more tiles are available in the cache and fewer need to be computed.

If the caching tables `SDO_VECTOR_TILE_CACHE$INFO` and `SDO_VECTOR_TILE_CACHE$TABLE` do not already exist, then they are created when `SDO_UTIL.ENABLE_VECTORTILE_CACHE` is called the first time.

Calling `SDO_UTIL.ENABLE_VECTORTILE_CACHE` on an already enabled cache with different `min_zoom`, `max_zoom`, or both adjusts those values for the cache. Any tiles already in the cache that violate the new `min_zoom` or `max_zoom` will remain in the cache but the newly computed tiles will follow the new configurations.

Changing a tile caches' tablespace requires you to disable all the caches. The `SDO_VECTOR_TILE_CACHE$INFO` and `SDO_VECTOR_TILE_CACHE$TABLE` cache tables must be dropped. You can then call `SDO_UTIL.ENABLE_VECTORTILE_CACHE` again with the desired tablespace as a parameter. Note that this is a disruptive process that eliminates all currently cached tiles.

Examples

The following example calls `SDO_UTIL.ENABLE_VECTORTILE_CACHE` to enable cache on the `counties` table.

```
-- Enable a cache on the Counties table using the Geometry column
EXEC SDO_UTIL.ENABLE_VECTORTILE_CACHE('counties', 'geom');

-- Compute a vector tile
SELECT SDO_UTIL.GET_VECTORTILE(TABLE_NAME=>'COUNTIES', GEOM_COL_NAME=>'GEOM',
                                 TILE_ZOOM=>8, TILE_X=>73, TILE_Y=>97,
                                 ATT_COL_NAMES=>sdo_string_array('COUNTY','LANDSQMI'))
FROM dual;

-- Confirm that the cache now contains a copy of the computed tile.
-- If the same tile is requested again, then this cached version is returned.
SELECT COUNT(*) FROM SDO_VECTOR_TILE_CACHE$TABLE WHERE table_name='counties';
```

35.14 SDO_UTIL.EXPAND_GEOM

Format

```
SDO_UTIL.EXPAND_GEOM(
     geometry  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

For a geometry with an exterior ring and/or one or more interior rings, where one or more of the rings are polygons specified in optimized form (optimized rectangles), returns the geometry in a form where all optimized polygon rings are specified as simple polygons (all vertices specified).

Parameters

geometry
Geometry with exterior and/or interior polygon rings specified in optimized form.

Usage Notes

If none of the rings in the input geometry are specified in optimized form (optimized rectangles), the function returns the input geometry.

Simple polygons and optimized rectangles have SDO_ETYPE values of 1003 or 2003 but different SDO_INTERPRETATION values, as explained in SDO_ELEM_INFO.

This function is supported with both 2D and 3D geometries.

This function can be useful if you use any applications that do not work with optimized rectangles, or if you prefer to use simple polygons instead of optimized rectangles.

Examples

The following example uses an input geometry whose exterior and interior polygon rings are optimized rectangles (and in this case, squares): the exterior ring is 8x8, and the interior ring is 2x2. It returns a geometry whose exterior and interior rings are specified as simple polygons.

```
SELECT sdo_util.expand_geom(sdo_geometry(2003, null, null, -
     sdo_elem_info_array(1,1003,3, 5,2003,3), -
     sdo_ordinate_array(0,0, 8,8, 3,3, 5,5))) FROM DUAL;

SDO_UTIL.EXPAND_GEOM(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,3,5,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1, 11, 2003, 1), SDO
_ORDINATE_ARRAY(0, 8, 0, 0, 8, 0, 8, 8, 0, 8, 3, 3, 3, 5, 5, 5, 5, 3, 3, 3))
```

35.15 SDO_UTIL.EXTRACT

Format

```
SDO_UTIL.EXTRACT(
     geometry IN SDO_GEOMETRY,
     element  IN NUMBER,
     ring     IN NUMBER DEFAULT 0
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the two-dimensional geometry that represents a specified element (and optionally a ring) of the input two-dimensional geometry.

Parameters

geometry
Geometry from which to extract the geometry to be returned. Must be a two-dimensional geometry.

element
Number of the element in the geometry: 1 for the first element, 2 for the second element, and so on. Geometries with SDO_GTYPE values (explained in SDO_GTYPE) ending in 1, 2, or 3 have one element; geometries with SDO_GTYPE values ending in 4, 5, 6, or 7 can have more than one element. For example, a multipolygon with an SDO_GTYPE of 2007 might contain three elements (polygons).

ring
Number of the subelement (ring) within `element`: 1 for the first subelement, 2 for the second subelement, and so on. This parameter is valid only for specifying a subelement of a polygon with one or more holes or of a point cluster:

- For a polygon with holes, its first subelement is its exterior ring, its second subelement is its first interior ring, its third subelement is its second interior ring, and so on. For example, in the polygon with a hole shown inPolygon with a Hole, the exterior ring is subelement 1 and the interior ring (the hole) is subelement 2.
- For a point cluster, its first subelement is the first point in the point cluster, its second subelement is the second point in the point cluster, and so on.

The default is 0, which causes the entire element to be extracted.

Usage Notes

This function applies to two-dimensional geometries only. For three-dimensional geometries, use the SDO_UTIL.EXTRACT3D function.

This function is useful for extracting a specific element or subelement from a complex geometry. For example, if you have identified a geometry as invalid by using the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function or the SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT procedure (both of which are documented in SDO_GEOM Package (Geometry)), you can use the EXTRACT function to extract the invalid geometry in order to examine it.

For a polygon with one or more holes, the returned geometry representing an extracted interior ring is reoriented so that its vertices are presented in counterclockwise order (as opposed to the clockwise order within an interior ring).

If `geometry` is null or has an SDO_GTYPE value ending in 0, this function returns a null geometry.

`geometry` cannot contain a type 0 (zero) element. Type 0 elements are described in Type 0 (Zero) Element.

This function is not intended for use with geometries that have any null ordinate values. Any null ordinate values in the returned geometry are replaced by 0 (zero).

An exception is raised if `element` or `ring` is an invalid number for `geometry`.

Examples

The following example extracts the first (and only) element in the `cola_c` geometry. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.name, SDO_UTIL.EXTRACT(c.shape, 1)
   FROM cola_markets c WHERE c.name = 'cola_c';

NAME
--------------------------------
SDO_UTIL.EXTRACT(C.SHAPE,1)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_IN
--------------------------------------------------------------------------------
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3, 3, 6, 3, 6, 5, 4, 5, 3, 3))
```

The following example inserts a polygon with a hole (using the same INSERT statement as in Example 2-9 in Polygon with a Hole), and extracts the geometry representing the hole (the second subelement). Notice that in the geometry returned by the EXTRACT function, the vertices are in counterclockwise order, as opposed to the clockwise order in the hole (second subelement) in the input geometry.

```
-- Insert polygon with hole.
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  SDO_GEOMETRY(
    2003,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
    SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
        7,5, 7,10, 10,10, 10,5, 7,5)
  )
);

1 row created.

-- Extract the hole geometry (second subelement).
SELECT SDO_UTIL.EXTRACT(c.shape, 1, 2)
   FROM cola_markets c WHERE c.name = 'polygon_with_hole';

SDO_UTIL.EXTRACT(C.SHAPE,1,2)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(7, 5, 10, 5, 10, 10, 7, 10, 7, 5))
```

Related Topics

- SDO_UTIL.EXTRACT3D
- SDO_UTIL.GETVERTICES
- SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
- SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT

35.16 SDO_UTIL.EXTRACT_ALL

Format

```
SDO_UTIL.EXTRACT_ALL(
     geometry IN SDO_GEOMETRY,
     flatten  IN NUMBER DEFAULT 1
     ) RETURN SDO_GEOMETRY_ARRAY;
```

Description

Returns all elements and subelements of the input two-dimensional geometry, as an array of one or more geometries. Returns an object of type SDO_GEOMETRY_ARRAY, which is defined as `VARRAY OF SDO_GEOMETRY`.

Parameters

geometry
Geometry from which to extract all elements and subelements. Must be a two-dimensional geometry.

flatten
A flag indicating whether to "flatten" rings into individual geometries for geometries that contain an exterior ring and one or more interior rings:

- `0` (zero) returns one geometry for each element, but does not flatten rings into individual geometries. (A geometry will still be returned for each element of the input geometry.)
- `1` (the default) or any other nonzero value flattens rings into individual geometries.

For example, if a polygon contains an outer ring and an inner ring, a value of `0` returns a single geometry containing both rings, and a value of `1` returns two geometries, each containing a ring as a geometry.
This parameter is ignored for geometries that do not contain an exterior ring and one or more interior rings.

Usage Notes

This function applies to two-dimensional geometries only. For three-dimensional geometries, use the SDO_UTIL.EXTRACT3D function.

This function enables you to extract all elements and subelements from a geometry, regardless of how many elements and subelements the geometry has. Geometries with SDO_GTYPE values (explained in SDO_GTYPE) ending in 1, 2, or 3 have one element; geometries with SDO_GTYPE values ending in 4, 5, 6, or 7 can have more than one element. For example, a multipolygon with an SDO_GTYPE of 2007 might contain three elements (polygons). To extract individual elements, use the SDO_UTIL.EXTRACT function instead.

For a polygon with one or more holes, with the default value for the `flatten` parameter, the returned geometry representing an extracted interior ring is reoriented so that its vertices are presented in counterclockwise order (as opposed to the clockwise order within an interior ring). However, if the `flatten` parameter value is 0, no reorientation is performed.

If `geometry` is null or has an SDO_GTYPE value ending in 0, this function returns a null geometry.

`geometry` cannot contain a type 0 (zero) element. Type 0 elements are described in Type 0 (Zero) Element.

This function is not intended for use with geometries that have any null ordinate values. Any null ordinate values in the returned geometry are replaced by 0 (zero).

Examples

The following example extracts all elements from the `cola_b` geometry. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT * FROM TABLE(
  SELECT SDO_UTIL.EXTRACT_ALL(c.shape)
    FROM cola_markets c WHERE c.name = 'cola_b');

 SDO_GTYPE   SDO_SRID
---------- ----------
SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
SDO_ELEM_INFO
--------------------------------------------------------------------------------
SDO_ORDINATES
--------------------------------------------------------------------------------
      2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1)
SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1)
```

The following example inserts a polygon with a hole (using the same INSERT statement as in Example 2-9 in Polygon with a Hole), and extracts all elements and subelements from the `polygon_with_hole` geometry. Notice that because the `flatten` parameter is not specified, in the second geometry returned by the EXTRACT_ALL function the vertices are in counterclockwise order, as opposed to the clockwise order in the hole (second subelement) in the input geometry.

```
-- Insert polygon with hole.
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  SDO_GEOMETRY(
    2003,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
    SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
        7,5, 7,10, 10,10, 10,5, 7,5)
  )
);

1 row created.

-- Extract all, with default for flatten.
SELECT * FROM TABLE(
  SELECT SDO_UTIL.EXTRACT_ALL(c.shape)
  FROM cola_markets c WHERE c.name = 'polygon_with_hole');

 SDO_GTYPE   SDO_SRID
---------- ----------
SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
SDO_ELEM_INFO
--------------------------------------------------------------------------------
SDO_ORDINATES
--------------------------------------------------------------------------------
      2003
```

```
SDO_ELEM_INFO_ARRAY(1, 1003, 1)
SDO_ORDINATE_ARRAY(2, 4, 4, 3, 10, 3, 13, 5, 13, 9, 11, 13, 5, 13, 2, 11, 2, 4)


 SDO_GTYPE   SDO_SRID
---------- ----------
SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
SDO_ELEM_INFO
--------------------------------------------------------------------------------
SDO_ORDINATES
--------------------------------------------------------------------------------
      2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1)
SDO_ORDINATE_ARRAY(7, 5, 10, 5, 10, 10, 7, 10, 7, 5)
```

The following example extracts all elements and subelements from the `polygon_with_hole` geometry (inserted in the preceding example), and it specifies the `flatten` parameter value as 0 (zero). This causes the returned array to contain a single geometry that is the same as the input geometry; thus, in the geometry returned by the EXTRACT_ALL function, the vertices are in same clockwise order in the hole (second subelement) as in the input geometry.

```
-- Extract all, with flatten = 0.
SELECT * FROM TABLE(
  SELECT SDO_UTIL.EXTRACT_ALL(c.shape, 0)
    FROM cola_markets c WHERE c.name = 'polygon_with_hole');

 SDO_GTYPE   SDO_SRID
---------- ----------
SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
SDO_ELEM_INFO
--------------------------------------------------------------------------------
SDO_ORDINATES
--------------------------------------------------------------------------------
      2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1, 19, 2003, 1)
SDO_ORDINATE_ARRAY(2, 4, 4, 3, 10, 3, 13, 5, 13, 9, 11, 13, 5, 13, 2, 11, 2, 4,
7, 5, 7, 10, 10, 10, 10, 5, 7, 5)

 SDO_GTYPE   SDO_SRID
---------- ----------
SDO_POINT(X, Y, Z)
--------------------------------------------------------------------------------
SDO_ELEM_INFO
--------------------------------------------------------------------------------
SDO_ORDINATES
--------------------------------------------------------------------------------
```

Related Topics

- SDO_UTIL.EXTRACT

35.17 SDO_UTIL.EXTRACT3D

Format

```
SDO_UTIL.EXTRACT3D(
     geometry IN SDO_GEOMETRY,
     label    IN VARCHAR2
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the three-dimensional geometry that represents a specified subset of the input three-dimensional geometry.

Parameters

geometry
Geometry from which to extract the geometry to be returned. Must be a three-dimensional geometry

label
A comma-delimited string of numbers that identify the subset geometry to be returned. Each number identifies the relative position of a geometry item within the input geometry. The items and their positions within the `label` string are:

- `pointID`: Point number
- `edgeID`: Edge number
- `ringID`: Ring number
- `polygonID`: Polygon number
- `csurfID`: Composite surface number
- `solidID`: Solid number
- `multiID`: Multisolid number

A value of 0 (zero) means that the item does not apply, and you can omit trailing items that do not apply. For example, `'0,2,1,4,1'` means that point number does not apply, and it specifies the second edge of the first ring of the fourth polygon of the first composite surface.

Usage Notes

> **Note:**
>
> The SDO_UTIL.EXTRACT3D function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function applies to three-dimensional geometries only. For two-dimensional geometries, use the SDO_UTIL.EXTRACT function.

This function uses the `getElementByLabel` method of the `oracle.spatial.geometry.ElementExtractor` Java class, which is described in *Oracle Spatial Java API Reference*.

Examples

The following example extracts, from a specified three-dimensional geometry, the subset geometry consisting of the following: edge 2 of ring 1 of polygon 4 of composite surface 1 of the input geometry.

```
SELECT SDO_UTIL.EXTRACT3D(
  SDO_GEOMETRY (3008,NULL,NULL ,
    SDO_ELEM_INFO_ARRAY(
      1,1007,1,
      1,1006,6,
      1,1003,1,
      16,1003,1,
      31,1003,1,
      46,1003,1,
      61,1003,1,
      76,1003,1),
    SDO_ORDINATE_ARRAY(
      1.0,0.0,-1.0,
      1.0,1.0,-1.0,
      1.0,1.0,1.0,
      1.0,0.0,1.0,
      1.0,0.0,-1.0,
      1.0,0.0,1.0,
      0.0,0.0,1.0,
      0.0,0.0,-1.0,
      1.0,0.0,-1.0,
      1.0,0.0,1.0,
      0.0,1.0,1.0,
      0.0,1.0,-1.0,
      0.0,0.0,-1.0,
      0.0,0.0,1.0,
      0.0,1.0,1.0,
      1.0,1.0,-1.0,
      0.0,1.0,-1.0,
      0.0,1.0,1.0,
      1.0,1.0,1.0,
      1.0,1.0,-1.0,
      1.0,1.0,1.0,
      0.0,1.0,1.0,
      0.0,0.0,1.0,
      1.0,0.0,1.0,
      1.0,1.0,1.0,
      1.0,1.0,-1.0,
      1.0,0.0,-1.0,
      0.0,0.0,-1.0,
      0.0,1.0,-1.0,
      1.0,1.0,-1.0
      )
    ),
  '0,2,1,4,1')
FROM DUAL;

SDO_UTIL.EXTRACT3D(SDO_GEOMETRY(3008,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1007,1,1,10
--------------------------------------------------------------------------------
SDO_GEOMETRY(3002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
0, 1, -1, 0, 1, 1))
```

Related Topics

- SDO_UTIL.EXTRACT

35.18 SDO_UTIL.EXTRUDE

Format

```
SDO_UTIL.EXTRUDE(
     geometry  IN SDO_GEOMETRY,
     grdheight IN SDO_NUMBER_ARRAY,
     height    IN SDO_NUMBER_ARRAY,
     tol       IN NUMBER,
     optional3dSrid IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Returns the three-dimensional extrusion solid geometry from an input two-dimensional polygon or multipolygon geometry.

Parameters

geometry
Two-dimensional polygon geometry from which to return the extrusion geometry. This geometry forms the "base" of the returned geometry.

grdheight
Ground heights as a set of Z (height) values at the base of the solid. The numbers in this array should be the Z (height) values at the base of each vertex in the input geometry.

height
Height values for the extrusion geometry. The numbers in this array should be the Z (height) values at the "top" of each corresponding point in the grdheight array. For example, if the ground height at the base of the first vertex is 0 and the height at that vertex is 10, the solid at that point along the base extends 10 units high.

tol
Tolerance value (see Tolerance).

optional3dSrid
Three-dimensional coordinate system (SRID) to be assigned to the returned geometry. If you do not specify this parameter, Spatial automatically assigns a three-dimensional SRID value based on the SRID value of the input geometry.

Usage Notes

> **Note:**
>
> The SDO_UTIL.EXTRUDE is function supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry must be a two-dimensional polygon or multipolygon geometry.

If the input geometry is a polygon with multiple inner rings, this function internally combines these inner rings to make them one inner ring, producing a new geometry that approximately represents the original appearance; the function then performs the extrusion process on this new geometry, and returns the result.

Examples

The following example returns the three-dimensional solid geometry representing an extrusion from a two-dimensional polygon geometry.

```
SELECT SDO_UTIL.EXTRUDE(
  SDO_GEOMETRY(
    2003,
    null,
    null,
    SDO_ELEM_INFO_ARRAY(1,1003,1),
    SDO_ORDINATE_ARRAY(5, 1,8,1,8,6,5,7,5,1)),
  SDO_NUMBER_ARRAY(0,0,0,0,0),
  SDO_NUMBER_ARRAY(5,10,10,5,5),
  0.005) from dual;

SDO_UTIL.EXTRUDE(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SDO_O
--------------------------------------------------------------------------------
SDO_GEOMETRY(3008, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1007, 1, 1, 1006, 6, 1, 10
03, 1, 16, 1003, 1, 31, 1003, 1, 46, 1003, 1, 61, 1003, 1, 76, 1003, 1), SDO_ORD
INATE_ARRAY(5, 1, 0, 5, 7, 0, 8, 6, 0, 8, 1, 0, 5, 1, 0, 5, 1, 5, 8, 1, 10, 8, 6
, 10, 5, 7, 5, 5, 1, 5, 5, 1, 0, 8, 1, 0, 8, 1, 10, 5, 1, 5, 5, 1, 0, 8, 1, 0, 8
, 6, 0, 8, 6, 10, 8, 1, 10, 8, 1, 0, 8, 6, 0, 5, 7, 0, 5, 7, 5, 8, 6, 10, 8, 6,
0, 5, 7, 0, 5, 1, 0, 5, 1, 5, 5, 7, 5, 5, 7, 0))
```

The following example returns the three-dimensional composite solid geometry representing an extrusion from a two-dimensional polygon geometry with inner rings.

```
SELECT SDO_UTIL.EXTRUDE(
  SDO_GEOMETRY(
    2003,
    null,
    null,
    SDO_ELEM_INFO_ARRAY(1, 1003, 1, 11, 2003, 1,
      21, 2003,1, 31,2003,1, 41, 2003, 1),
    SDO_ORDINATE_ARRAY(0,0, 8,0, 8,8, 0,8, 0,0,
      1,3, 1,4, 2,4, 2,3, 1,3, 1,1, 1,2, 2,2, 2,1, 1,1,
      1,6, 1,7, 2,7, 2,6, 1,6, 3,2, 3,4, 4,4, 4,2, 3,2)),
  SDO_NUMBER_ARRAY(-1.0),
  SDO_NUMBER_ARRAY(1.0),
  0.0001) from dual;

SDO_UTIL.EXTRUDE(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1,11,200
--------------------------------------------------------------------------------
SDO_GEOMETRY(3008, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1008, 4, 1, 1007, 1, 1, 10
06, 16, 1, 1003, 1, 46, 1003, 1, 91, 1003, 1, 106, 1003, 1, 121, 1003, 1, 136, 1
003, 1, 151, 1003, 1, 166, 1003, 1, 181, 1003, 1, 196, 1003, 1, 211, 1003, 1, 22
6, 1003, 1, 241, 1003, 1, 256, 1003, 1, 271, 1003, 1, 286, 1003, 1, 301, 1007, 1
, 301, 1006, 10, 301, 1003, 1, 328, 1003, 1, 355, 1003, 1, 370, 1003, 1, 385, 10
03, 1, 400, 1003, 1, 415, 1003, 1, 430, 1003, 1, 445, 1003, 1, 460, 1003, 1, 475
, 1007, 1, 475, 1006, 6, 475, 1003, 1, 490, 1003, 1, 505, 1003, 1, 520, 1003, 1,
 535, 1003, 1, 550, 1003, 1, 565, 1007, 1, 565, 1006, 10, 565, 1003, 1, 592, 100
3, 1, 619, 1003, 1, 634, 1003, 1, 649, 1003, 1, 664, 1003, 1, 679, 1003, 1, 694,
 1003, 1, 709, 1003, 1, 724, 1003, 1), SDO_ORDINATE_ARRAY(4, 0, -1, 4, 2, -1, 4,
 4, -1, 3, 4, -1, 2, 4, -1, 2, 7, -1, 1, 7, -1, 1, 6, -1, 1, 4, -1, 1, 3, -1, 0,
 3, -1, 0, 8, -1, 8, 8, -1, 8, 0, -1, 4, 0, -1, 4, 0, 1, 8, 0, 1, 8, 8, 1, 0, 8,
 1, 0, 3, 1, 1, 3, 1, 1, 4, 1, 1, 6, 1, 1, 7, 1, 2, 7, 1, 2, 4, 1, 3, 4, 1, 4, 4
, 1, 4, 2, 1, 4, 0, 1, 4, 0, -1, 8, 0, -1, 8, 0, 1, 4, 0, 1, 4, 0, -1, 8, 0, -1,
 8, 8, -1, 8, 8, 1, 8, 0, 1, 8, 0, -1, 8, 8, -1, 0, 8, -1, 0, 8, 1, 8, 8, 1, 8,
8, -1, 0, 8, -1, 0, 3, -1, 0, 3, 1, 0, 8, 1, 0, 8, -1, 0, 3, -1, 1, 3, -1, 1, 3,
 1, 0, 3, 1, 0, 3, -1, 1, 3, -1, 1, 4, -1, 1, 4, 1, 1, 3, 1, 1, 3, -1, 1, 4, -1,
 1, 6, -1, 1, 6, 1, 1, 4, 1, 1, 4, -1, 1, 6, -1, 1, 7, -1, 1, 7, 1, 1, 6, 1, 1,
6, -1, 1, 7, -1, 2, 7, -1, 2, 7, 1, 1, 7, 1, 1, 7, -1, 2, 7, -1, 2, 4, -1, 2, 4,
 1, 2, 7, 1, 2, 7, -1, 2, 4, -1, 3, 4, -1, 3, 4, 1, 2, 4, 1, 2, 4, -1, 3, 4, -1,
 4, 4, -1, 4, 4, 1, 3, 4, 1, 3, 4, -1, 4, 4, -1, 4, 2, -1, 4, 2, 1, 4, 4, 1, 4,
4, -1, 4, 2, -1, 4, 0, -1, 4, 0, 1, 4, 2, 1, 4, 2, -1, 0, 3, -1, 1, 3, -1, 1, 1,
 -1, 2, 1, -1, 3, 2, -1, 4, 2, -1, 4, 0, -1, 0, 0, -1, 0, 3, -1, 0, 3, 1, 0, 0,
1, 4, 0, 1, 4, 2, 1, 3, 2, 1, 2, 1, 1, 1, 1, 1, 1, 3, 1, 0, 3, 1, 0, 3, -1, 0, 0
, -1, 0, 0, 1, 0, 3, 1, 0, 3, -1, 0, 0, -1, 4, 0, -1, 4, 0, 1, 0, 0, 1, 0, 0, -1
, 4, 0, -1, 4, 2, -1, 4, 2, 1, 4, 0, 1, 4, 0, -1, 4, 2, -1, 3, 2, -1, 3, 2, 1, 4
, 2, 1, 4, 2, -1, 3, 2, -1, 2, 1, -1, 2, 1, 1, 3, 2, 1, 3, 2, -1, 2, 1, -1, 1, 1
, -1, 1, 1, 1, 2, 1, 1, 2, 1, -1, 1, 1, -1, 1, 3, -1, 1, 3, 1, 1, 1, 1, 1, 1, -1
, 1, 3, -1, 0, 3, -1, 0, 3, 1, 1, 3, 1, 1, 3, -1, 1, 6, -1, 2, 6, -1, 2, 4, -1,
1, 4, -1, 1, 6, -1, 1, 6, 1, 1, 4, 1, 2, 4, 1, 2, 6, 1, 1, 6, 1, 1, 6, -1, 1, 4,
 -1, 1, 4, 1, 1, 6, 1, 1, 6, -1, 1, 4, -1, 2, 4, -1, 2, 4, 1, 1, 4, 1, 1, 4, -1,
 2, 4, -1, 2, 6, -1, 2, 6, 1, 2, 4, 1, 2, 4, -1, 2, 6, -1, 1, 6, -1, 1, 6, 1, 2,
 6, 1, 2, 6, -1, 1, 3, -1, 2, 3, -1, 2, 4, -1, 3, 4, -1, 3, 2, -1, 2, 1, -1, 2,
2, -1, 1, 2, -1, 1, 3, -1, 1, 3, 1, 1, 2, 1, 2, 2, 1, 2, 1, 1, 3, 2, 1, 3, 4, 1,
 2, 4, 1, 2, 3, 1, 1, 3, 1, 1, 3, -1, 1, 2, -1, 1, 2, 1, 1, 3, 1, 1, 3, -1, 1, 2
, -1, 2, 2, -1, 2, 2, 1, 1, 2, 1, 1, 2, -1, 2, 2, -1, 2, 1, -1, 2, 1, 1, 2, 2, 1
, 2, 2, -1, 2, 1, -1, 3, 2, -1, 3, 2, 1, 2, 1, 1, 2, 1, -1, 3, 2, -1, 3, 4, -1,
3, 4, 1, 3, 2, 1, 3, 2, -1, 3, 4, -1, 2, 4, -1, 2, 4, 1, 3, 4, 1, 3, 4, -1, 2, 4
, -1, 2, 3, -1, 2, 3, 1, 2, 4, 1, 2, 4, -1, 2, 3, -1, 1, 3, -1, 1, 3, 1, 2, 3, 1
, 2, 3, -1))
```

Related Topics

None.

35.19 SDO_UTIL.FROM_GEOJSON

Format

```
SDO_UTIL.FROM_GEOJSON(
     geometry  IN VARCHAR2,
     crs       IN VARCHAR2 DEFAULT NULL,
     srid      IN VARCHAR2 DEFAULT 4326
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GEOJSON(
     geometry  IN CLOB,
     crs       IN VARCHAR2 DEFAULT NULL,
     srid      IN VARCHAR2 DEFAULT 4326
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GEOJSON(
     geometry  IN JSON,
     crs       IN VARCHAR2 DEFAULT NULL,
     srid      IN VARCHAR2 DEFAULT 4326
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a GeoJSON object (or more specifically a geometry object in GeoJSON format) to a Spatial geometry object.

Parameters

geometry
Geometry in GeoJSON format to be converted to SDO_GEOMETRY format. The JSON object data type can be VARCHAR2, CLOB, or JSON.

crs
(Reserved for future use. The default is null.)

srid
SDO_SRID value to be used in the returned geometry. The default is 4326, which is the EPSG SRID value for the WGS 84 (longitude/latitude) coordinate system.

Usage Notes

The input geometry must be in GeoJSON format. For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

To convert an SDO_GEOMETRY object to GeoJSON format, use the SDO_UTIL.TO_GEOJSON function.

Examples

The following example shows conversion to and from GeoJSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.) In this example, specifying `srid => NULL` causes the returned SDO_GEOMETRY object to have an SDO_SRID value of NULL, as opposed to the default of 4326 if the parameter is not specified.

```
DECLARE
  cola_b_geom SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json CLOB;

BEGIN

-- Populate geometry variable with cola market cols_b shape.
SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';

-- From geometry to JSON
returned_json := SDO_UTIL.TO_GEOJSON(cola_b_geom);

-- From JSON to geometry
returned_geom := SDO_UTIL.FROM_GEOJSON(returned_json, srid => NULL);

END;
/
```

Related Topics

- SDO_UTIL.TO_GEOJSON

35.20 SDO_UTIL.FROM_GML311GEOMETRY

Format

```
SDO_UTIL.FROM_GML311GEOMETRY(
     geometry     IN CLOB,
     srsNamespace IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(
     geometry     IN CLOB,
     srsNamespace IN VARCHAR2,
     coordOrder   IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(
     geometry  IN VARCHAR2,
     srsNamespace  IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(
     geometry  IN VARCHAR2,
     coordOrder  IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(
     geometry  IN VARCHAR2,
     srsNamespace  IN VARCHAR2,
     coordOrder  IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a geography markup language (GML 3.1.1) fragment to a Spatial geometry object.

Parameters

geometry
Geometry in GML version 3.1.1 format to be converted to SDO_GEOMETRY format.

srsNamespace
(Reserved for Oracle use.)

coordOrder
If the data in GML format is in latitude/longitude format instead of the longitude/latitude format used by Oracle Spatial, specify 1 for this parameter. Otherwise, do not specify this parameter. (See the Usage Notes for more information.)

Usage Notes

> **Note:**
>
> The SDO_UTIL.FROM_GML311GEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry must be a valid GML fragment describing a GML version 3.1.1 geometry type defined in the Open GIS Implementation Specification.

Some EPSG geodetic coordinate systems have the axis order reversed in their definition. For such SRIDs, the data in the GML format might come in as latitude/longitude instead of longitude/latitude. If such GML is to be converted to the SDO_GEOMETRY type, the `coordOrder` parameter should be specified as 1 so that the latitude/longitude values are converted to longitude/latitude, because longitude/latitude is the order used in the SDO_GEOMETRY type.

Examples

The following example shows conversion to and from GML version 3.1.1 format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  gmlgeom CLOB;
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To GML 3.1.1 geometry
gmlgeom := SDO_UTIL.TO_GML311GEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To GML 3.1.1 geometry result = ' || TO_CHAR(gmlgeom));

-- From GML 3.1.3 geometry
geom_result := SDO_UTIL.FROM_GML311GEOMETRY(gmlgeom);

END;
/
To GML 3.1.1 geometry result = <gml:Polygon srsName="SDO:"
xmlns:gml="http://www.opengis.net/gml"><gml:exterior><gml:LinearRing><gml:posLis
t srsDimension="2">5.0 1.0 8.0 1.0 8.0 6.0 5.0 7.0 5.0 1.0
</gml:posList></gml:LinearRing></gml:exterior></gml:Polygon>

PL/SQL procedure successfully completed.
```

Related Topics

- SDO_UTIL.FROM_GMLGEOMETRY
- SDO_UTIL.TO_GML311GEOMETRY
- SDO_UTIL.TO_GMLGEOMETRY

35.21 SDO_UTIL.FROM_GMLGEOMETRY

Format

```
SDO_UTIL.FROM_GMLGEOMETRY(
     geometry     IN CLOB,
     srsNamespace IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GMLGEOMETRY(
     geometry     IN VARCHAR2,
     srsNamespace IN VARCHAR2 DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a geography markup language (GML 2.0) fragment to a Spatial geometry object.

Parameters

geometry
Geometry in GML version 2.0 format to be converted to SDO_GEOMETRY format.

srsNamespace
(Reserved for Oracle use.)

Usage Notes

> **Note:**
>
> The SDO_UTIL.FROM_GMLGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry must be a valid GML fragment describing a GML version 2.0 geometry type defined in the Open GIS Implementation Specification.

Examples

The following example shows conversion to and from GML version 2.0 format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  gmlgeom CLOB;
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To GML geometry
gmlgeom := SDO_UTIL.TO_GMLGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To GML geometry result = ' || TO_CHAR(gmlgeom));
```

```
-- From GML geometry
geom_result := SDO_UTIL.FROM_GMLGEOMETRY(gmlgeom);

END;
/
To GML geometry result = <gml:Polygon srsName="SDO:"
xmlns:gml="http://www.opengis.net/gml"><gml:outerBoundaryIs><gml:LinearRing><gml
:coordinates decimal="." cs="," ts=" ">5.0,1.0 8.0,1.0 8.0,6.0 5.0,7.0 5.0,1.0
</gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon>

PL/SQL procedure successfully completed.
```

Related Topics

- SDO_UTIL.FROM_GML311GEOMETRY
- SDO_UTIL.TO_GML311GEOMETRY
- SDO_UTIL.TO_GMLGEOMETRY

35.22 SDO_UTIL.FROM_JSON

Format

```
SDO_UTIL.FROM_JSON(
     geometry  IN JSON,
     crs       IN VARCHAR2 DEFAULT NULL,
     srid      IN VARCHAR2 DEFAULT -1
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_JSON(
     geometry  IN CLOB,
     crs       IN VARCHAR2 DEFAULT NULL,
     srid      IN VARCHAR2 DEFAULT -1
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a JSON object (or more specifically a geometry object in JSON format) to a Spatial geometry object.

Parameters

geometry
Geometry in JSON format to be converted to SDO_GEOMETRY format. The JSON object data type can be JSON or CLOB.

crs
(Reserved for future use. The default is null.)

srid
(Reserved for future use. The default is -1.)

Usage Notes

> **Note:**
>
> The SDO_UTIL.FROM_JSON function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry must be in JSON format. For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

For information about Spatial support for JSON, see JSON and GeoJSON Support in Oracle Spatial.

To convert an SDO_GEOMETRY object to JSON format, use the SDO_UTIL.TO_JSON or SDO_UTIL.TO_JSON_VARCHAR function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom   SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json CLOB;
BEGIN
  -- Populate geometry variable with cola market cols_b shape.
  SELECT c.shape into cola_b_geom
  FROM cola_markets c
  WHERE c.name = 'cola_b';

  -- From geometry to JSON
  returned_json := SDO_UTIL.TO_JSON(cola_b_geom);

  -- From JSON to geometry
  returned_geom := SDO_UTIL.FROM_JSON(returned_json);

END;
/
```

The following example shows a JSON object that represents a specified geometry being converted back into SDO_GEOMETRY. (In this case the JSON reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.FROM_JSON(
  '{"polygon": {"boundary": [{"line": {"datapoints": [[5.0, 1.0],
       [8.0, 1.0], [8.0, 6.0], [5.0, 7.0], [5.0, 1.0]]}}]}}') GEOM
FROM DUAL;

GEOM
------
SDO_GEOMETRY(2003, NULL, NULL,
  SDO_ELEM_INFO_ARRAY(1, 1003, 1),
  SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

Related Topics

- SDO_UTIL.TO_JSON
- SDO_UTIL.TO_JSON_JSON
- SDO_UTIL.TO_JSON_VARCHAR

35.23 SDO_UTIL.FROM_KMLGEOMETRY

Format

```
SDO_UTIL.FROM_KMLGEOMETRY(
     geometry  IN CLOB
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_KMLGEOMETRY(
     geometry  IN VARCHAR2
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a KML (Keyhole Markup Language) document to a Spatial geometry object.

Parameters

geometry
Geometry in KML format of type CLOB or VARCHAR2 to be converted to SDO_GEOMETRY format.

Usage Notes

> **Note:**
>
> The SDO_UTIL.FROM_KMLGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry must be a valid document conforming to the KML 2.1 specification.

This function does not process the whole KML document; it only processes the KML geometry tags.

Examples

The following example shows conversion to and from KML format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_c` geometry from the COLA_MARKETS table.)

```
-- Convert cola_c geometry to a KML document; convert that result to
-- a spatial geometry.
DECLARE
  kmlgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_c';

-- To KML geometry
kmlgeom := SDO_UTIL.TO_KMLGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To KML geometry result = ' || TO_CHAR(kmlgeom));

-- From KML geometry
geom_result := SDO_UTIL.FROM_KMLGEOMETRY(kmlgeom);
-- Validate the returned geometry
val_result := SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(geom_result, 0.005);
DBMS_OUTPUT.PUT_LINE('Validation result = ' || val_result);

END;
/
To KML geometry result =
<Polygon><extrude>0</extrude><tessellate>0</tessellate><altitudeMode>relativeToG
round</altitudeMode><outerBoundaryIs><LinearRing><coordinates>3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </coordinates></LinearRing></outerBoundaryIs></Polygon>
Validation result = TRUE
```

Related Topics

- SDO_UTIL.TO_KMLGEOMETRY

35.24 SDO_UTIL.FROM_WKBGEOMETRY

Format

```
SDO_UTIL.FROM_WKBGEOMETRY(
     geometry  IN BLOB,
     srid      IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_WKBGEOMETRY(
     geometry  IN CLOB,
     srid      IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_WKBGEOMETRY(
     geometry  IN VARCHAR2,
     srid      IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a geometry in the well-known binary (WKB) or extended well-known binary formats to a Spatial geometry object.

Parameters

geometry
Geometry in WKB format to be converted to SDO_GEOMETRY format.

srid
An optional SRID describing the input geometry. The value specified overrides any SRID specification in the input geometry.

Usage Notes

> **Note:**
>
> The SDO_UTIL.FROM_WKBGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry may be in the well-known binary (WKB) format, or in the extended well-known binary format. The input may optionally be hex-encoded as ASCII as a CLOB or VARCHAR2. The result will be the most suitable minimal SDO_GEOMETRY type required to represent the input geometry.

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert an SDO_GEOMETRY object to WKB format, use the SDO_UTIL.TO_WKBGEOMETRY function.

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/
```

```
To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.25 SDO_UTIL.FROM_WKTGEOMETRY

Format

```
SDO_UTIL.FROM_WKTGEOMETRY(
     geometry  IN CLOB,
     srid      IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_WKTGEOMETRY(
     geometry  IN VARCHAR2,
     srid      IN NUMBER DEFAULT NULL
     ) RETURN SDO_GEOMETRY;
```

Description

Converts a geometry in the well-known text (WKT) or extended well-known text (EWKT) formats to a Spatial geometry object.

Parameters

geometry
Geometry in WKT format to be converted to SDO_GEOMETRY format.

srid
An optional SRID describing the input geometry. The value specified overrides any SRID specification in the input geometry.

Usage Notes

> **Note:**
>
> - The SDO_UTIL.FROM_WKTGEOMETRY function automatically validates and fixes any incorrect ring rotation in the input geometry (in WKT format). The validation process will also update the SDO_GTYPE attribute of the resulting SDO_GEOMETRY object to accurately reflect the corrected orientation, if necessary.
> - SDO_UTIL.FROM_WKTGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

The input geometry may be in the well-known text (WKT) format, or in the EWKT format. The result will be the most suitable minimal SDO_GEOMETRY type required to represent the input geometry.

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert an SDO_GEOMETRY object to a CLOB in WKT format, use the SDO_UTIL.TO_WKTGEOMETRY function. (You can use the SQL function TO_CHAR to convert the resulting CLOB to VARCHAR2 type.)

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
```

```
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.26 SDO_UTIL.GEO_SEARCH

Format

```
SDO_UTIL.GEO_SEARCH(
     name  IN VARCHAR2,
     fuzzy IN NUMBER DEFAULT NULL
    ) RETURN SDO_GEO_SEARCH_TABLE;
```

Description

Queries the table with the geographic name hierarchy (ELOC_ADMIN_AREA_SEARCH).

Parameters

name
One or more names from the table with the geographic name hierarchy. Use commas to separate multiple name values.
This table is described in ELOC_ADMIN_AREA_SEARCH Table.

fuzzy
Determines whether Oracle Text fuzzy matching will be used in finding matches for the `name` value or values. `0` (zero, the default) does not use fuzzy matching; `1` uses fuzzy matching. However, see the Usage Notes for further explanation and examples.

Usage Notes

To use this function, you must understand the concepts in Location Data Enrichment, which also describes the necessary setup actions.

For the `fuzzy` parameter, if the value is 0 (the default), the values in name must match in spelling the values in the data set for the location, although for a location the data set may permit many variations in spelling and case. If the value is 1, minor errors in name values (like spelling mistakes) will also be considered as matching the location. For example:

- `fuzzy=>0` will match `‘nashua, nh, usa’` and `‘nashua, new hampshire, usa’` to the same standard name.
- `fuzzy=>1`, in addition to matching values included for 0, will match `‘nashuaa,NH,usa’` (where the city name is misspelled) to that same standard name.

Examples

The following example searches for information about San Francisco. It does not use fuzzy matching.

```
SELECT * from TABLE(sdo_util.geo_search('San Francisco,Ca,UNITED STATES'));
```

The following example uses fuzzy matching (`fuzzy` value of `1`), and therefore will find matches for San Francisco, California, despite the misspelling of the city name in the `name` parameter (San**f** Fr**ac**isco).

```
SELECT * from TABLE(sdo_util.geo_search('Sanf Fracisco,Ca,UNITED STATES', 1));
```

35.27 SDO_UTIL.GET_2D_FOOTPRINT

Format

```
SDO_UTIL.GET_2D_FOOTPRINT(
     geometry  IN SDO_GEOMETRY,
     tolerance IN NUMBER  DEFAULT 0.0000005
    ) RETURN SDO_GEOMETRY;
```

Description

Returns a two-dimensional geometry that reflects the footprint of the input three-dimensional geometry.

Parameters

geometry
Three-dimensional geometry object.

tolerance
Tolerance value (see Tolerance).

Usage Notes

> **Note:**
>
> The SDO_UTIL.GET_2D_FOOTPRINT function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

You can use this function to return the 2D (on an x-y plane where z=0) footprint of 3D geometries such as buildings.

Examples

The following example returns the 2D footprint of a 3D geometry. It assumes that a table named FTPTS exists with at least a numeric ID column and a column named GEOMETRY of type SDO_GEOMETRY containing three-dimensional geometries.

```
SELECT sdo_util.get_2d_footprint(geometry, 0.05) FROM ftpts WHERE id =1;
```

35.28 SDO_UTIL.GET_COORDINATE

Format

```
SDO_UTIL.GET_COORDINATE(
     geometry    IN SDO_GEOMETRY,
     coord_index IN NUMBER
     ) RETURN MDSYS.SDO_GEOMETRY DETERMINISTIC PARALLEL_ENABLE;
```

Description

Returns the coordinate of a geometry.

Parameters

geometry
Input geometry.

coord_index
Index number for the geometry coordinate to be returned.

Usage Notes

If there is no corresponding coordinate for the given `coord_index` value (for example, such as `0`, `-1`, or any large value), then the SDO_UTIL.GET_COORDINATE function returns the last coordinate of the geometry.

Examples

The following example returns the second coordinate of a geometry object, `cola_b` . (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SQL> SELECT SDO_UTIL.get_coordinate(c.shape,2) FROM cola_markets c WHERE
c.name='cola_b';

SDO_UTIL.GET_COORDINATE(C.SHAPE,2)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
SDO_
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(8, 1, NULL), NULL, NULL)
```

The following example returns the last coordinate of a geometry object, `cola_b`, as the given index number is `0`. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SQL> SELECT SDO_UTIL.get_coordinate(c.shape,0) FROM cola_markets c WHERE
c.name='cola_b';

SDO_UTIL.GET_COORDINATE(C.SHAPE,0)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
SDO_
------------------------------------------------------------------------------
```

```
--
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(5, 1, NULL), NULL, NULL)
```

35.29 SDO_UTIL.GET_TILE_ENVELOPE

Format

```
SDO_UTIL.GET_TILE_ENVELOPE(
    tile_x     IN NUMBER,
    tile_y     IN NUMBER,
    tile_zoom  IN NUMBER,
    google_ts  IN BOOLEAN DEFAULT TRUE
) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Converts a tile address into a tile envelope (an SDO geometry describing a square).

Parameters

tile_x
The X ordinate of the origin point of the tile being fetched.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(X) = (2^tile_zoom) - 1`. Note that specifying a X ordinate outside the valid range raises an exception.

tile_y
The Y ordinate (in `NUMBER` format) of the origin point of the tile being fetched.
The minimum valid value for this paramter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(Y) = (2^tile_zoom) - 1`. Note that specifying a Y ordinate outside the valid range raises an exception.

tile_zoom
Determines the number of tiles required to divide a map. These segments can then be joined at a higher resolution without having to read in the entire map.
For instance, a `tile_zoom` of zero is a single tile of the entire map without a lot of details. A `tile_zoom` of `n` breaks the map into `2^n x 2^n` tiles (that is, the number of tiles along the X axis times the number of tiles along the Y axis). For example, at a `tile_zoom` of `8` there would be `65,536` tiles. This implies that higher the value of `n`, the more details there are in a tile. Note that the parameter values outside the valid range raise an exception.

google_ts
Boolean value that indicates if the Google tiling scheme is used.
The following two tiling schemes are supported when reading the tile addresses:

- **GOOGLE:** In this tiling scheme, the origin point (X,Y) of a tile is in the northwest corner. The X ordinates increase as tiles are read from west to east. The Y ordinates increase as tiles are read north to south.
- **TMS:** In this tiling scheme, the origin point (X,Y) of a tile is in the southwest corner. The X ordinates still increase as tiles are read from west to east, but the Y ordinates increase as tiles are read from south to north.

Usage Notes

None.

Example

The following example converts the tile coordinates into an SDO_GEOMETRY using the default Google tiling scheme.

```
SELECT SDO_UTIL.GET_TILE_ENVELOPE(131, 84, 8) FROM DUAL;

SDO_UTIL.GET_TILE_ENVELOPE(131,84,8)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
SDO_ELEM_INFO, SDO_ORDINATES)
-----------------------------------------------------------------------------------------
------------------
SDO_GEOMETRY(2003, 3857, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(465715.526, 6727436.88, 630085.712, 6891807.07))
```

The following example converts the tile coordinates into an SDO_GEOMETRY using the TMS tiling scheme.

```
SELECT SDO_UTIL.GET_TILE_ENVELOPE(131, 171, 8) FROM DUAL;

SDO_UTIL.GET_TILE_ENVELOPE(131,171,8,FALSE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
SDO_ELEM_INFO, SDO_ORDINATES)
-----------------------------------------------------------------------------------------
-------------------------
SDO_GEOMETRY(2003, 3857, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(465715.526, -6891807.1, 630085.712, -6727436.9))
```

35.30 SDO_UTIL.GET_VECTORTILE

Format

```
SDO_UTIL.GET_VECTORTILE(
    TABLE_NAME       IN VARCHAR2,
    GEOM_COL_NAME    IN VARCHAR2,
    TILE_X           IN NUMBER,
    TILE_Y           IN NUMBER,
    TILE_ZOOM        IN NUMBER,
    ATT_COL_NAMES    IN MDSYS.SDO_STRING_ARRAY DEFAULT NULL,
    SIMPLE_PREDICATE IN MDSYS.SDO_STRING_ARRAY DEFAULT NULL,
    LAYER_NAME       IN VARCHAR2 DEFAULT 'LAYER',
    TILE_EXTENT      IN NUMBER DEFAULT 4096,
    GOOGLE_TS        IN BOOLEAN DEFAULT TRUE,
    MAX_FEATURES     IN NUMBER DEFAULT 20000,
    ROWID_FLG        IN BOOLEAN DEFAULT FALSE
    ) RETURN BLOB;
```

or

```
SDO_UTIL.GET_VECTORTILE(
    TABLE_NAME       IN VARCHAR2,
    GEOM_COL_NAME    IN VARCHAR2,
    TILE_X           IN NUMBER,
    TILE_Y_PBF       IN VARCHAR2,
    TILE_ZOOM        IN NUMBER,
    ATT_COL_NAMES    IN MDSYS.SDO_STRING_ARRAY DEFAULT NULL,
    SIMPLE_PREDICATE IN MDSYS.SDO_STRING_ARRAY DEFAULT NULL,
    LAYER_NAME       IN VARCHAR2 DEFAULT 'LAYER',
    TILE_EXTENT      IN NUMBER DEFAULT 4096,
    GOOGLE_TS        IN BOOLEAN DEFAULT TRUE,
    MAX_FEATURES     IN NUMBER DEFAULT 20000,
    ROWID_FLG         IN BOOLEAN DEFAULT FALSE
    ) RETURN BLOB;
```

or

```
FUNCTION GET_VECTORTILE(
  CUR               IN SYS_REFCURSOR,
  TILE_X            IN NUMBER,
  TILE_Y            IN NUMBER,
  TILE_ZOOM         IN NUMBER,
  LAYER_NAME        IN VARCHAR2 DEFAULT 'LAYER',
  TILE_EXTENT       IN NUMBER DEFAULT 4096,
  GOOGLE_TS         IN BOOLEAN DEFAULT TRUE,
  MAX_FEATURES      IN NUMBER DEFAULT 20000
) RETURN BLOB;
```

Description

Generates a BLOB that represents a Mapbox Vector Tile (MVT).

Parameters

table_name
Name of a valid table or view containing the named geometry column and all of the columns named in the attribute column list.
Ensure that you have `READ` access to the table (or view). If you do not have the necessary privilege, or if the table does not exist, then an exception is raised.

geom_col_name
Name of the SDO_GEOMETRY type column in `table_name` or a function-based spatial index. If the column does not exist in `table_name`, or if it is not of SDO_GEOMETRY type, then an exception is raised.

cur
`CURSOR` for the SQL query used in the APEX application.
The format is `CURSOR(<`*`user_SQL_query`*`>)`.
Also, note the following for the SQL query:

- The first column in the `SELECT` clause must be a geometry column.
- The `WHERE` clause must contain a call to SDO_RELATE with the following parameters - `mask=anyinteract`, `min_resolution=' || res || '`, and `bypass_point=true`. Optionally, other predicates from the SQL query may also be included in the `WHERE` clause.

  The value for the `min_resolution` parameter can be calculated using the following formula: `((40075016.0/(2`$^{<tile\_zoom>}$`)) * .001)`, where `40075016` is the default value that indicates the number of meters along the `X` and `Y` axis of a tile at zoom level `0`, `tile_zoom` is the zoom of the tile being requested, and `.001` is a constant that should not be changed.

  Even if the call to the SDO_RELATE method is not specified in the `WHERE` clause, the resulting tile will still remain the same. However, the cost to compute the tile is far more expensive as all the geometries get processed instead of just the geometries of interest.
- Optionally, depending on how much distribution information is required in the vector tile, you can include the `ORDER BY` and `FETCH FIRST ROWS ONLY` clauses in the SQL query.

If the `CURSOR` is `NULL` or the query provided is invalid, then an exception is raised.

tile_x
The X ordinate of the origin point of the tile being fetched.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(X) = (2^tile_zoom) - 1`. Note that specifying a X ordinate outside the valid range raises an exception.

tile_y
The Y ordinate (in `NUMBER` format) of the origin point of the tile being fetched.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(Y) = (2^tile_zoom) - 1`. Note that specifying a Y ordinate outside the valid range raises an exception.

tile_y_pbf
The Y ordinate (in `VARCHAR2` format) of the origin point of the tile being fetched.
The `tile_y_pbf` value is a `VARCHAR2` string that specifies a number followed by any file extension. The Y ordinate value is extracted after stripping the file extension in the string. For example, consider the string value `‘23.pbf’` or `‘23.XYZ’`. Then `23` will be extracted as the Y ordinate value and everything after the ‘`.`’ will be stripped and ignored.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(Y) = (2^tile_zoom) - 1`. Note that specifying a Y ordinate outside the valid range raises an exception.

tile_zoom
Determines the number of tiles required to divide a map. These segments can be joined at a higher resolution without having to read in the entire map.
For instance, a `tile_zoom` of zero is a single tile of the entire map without a lot of details. A `tile_zoom` of `n` breaks the map into `2^n x 2^n` tiles (that is, the number of tiles along the X axis times the number of tiles along the Y axis). For example, at a `tile_zoom` of `8` there would be `65,536` tiles. A higher value of `n` implies more details in a tile. Note that the parameter values outside the valid range raise an exception.

att_col_names
Attribute column names that contain non-spatial data for a feature.
This is an optional parameter. For example, when querying county polygons, you may also be interested in the county name, state where it resides, and the total population of that county. These columns are specified as an `SDO_STRING_ARRAY` as in `ATT_COL_NAMES => sdo_string_array('COUNTY','STATE','TOTPOP')`.
Each item in the array must be a unique and a valid column name in the table (`table_name`). However, violating these restrictions is not fatal because:

- If an item name is not found to be a column in the table, then it is simply ignored.
- If multiple columns of the same item name are specified, then only the last item value is used.

Also, note that the item values listed in the array follow standard Oracle casing rules where `'COUNTY'`, `'County'`, and `'county'` are considered duplicates, and these all resolve to `'COUNTY'`. However, `'"COUNTY"'`, `'"County"'`, and `'"county"'` are not considered duplicates, and therefore all these three can be columns names in a table without conflict.
The following table lists the data types, both ANSI and Oracle built-ins, that are supported for the columns specified in the `att_col_names` list.

Category	Data Type

Character Data Types	`CHAR`
	`CHARACTER`
	`CHAR VARYING`
	`CHARACTER VARYING`
	`NATIONAL CHAR`
	`NATIONAL CHARACTER`
	`NATIONAL CHAR VARYING`
	`NATIONAL CHARACTER VARYING`
	`NCHAR`
	`NCHAR VARYING`
	`NVARCHAR2`
	`VARCHAR`
	`VARCHAR2`

Numeric Data Types	`DEC`
	`DECIMAL`
	`DOUBLE PRECISION`
	`FLOAT`
	`INT`
	`INTEGER`
	`NUMBER`
	`NUMERIC`
	`REAL`
	`SMALLINT`

Date and Time	`DATE` `TIMESTAMP`

> **See Also:**
>
> Data Types in *Oracle Database SQL Language Reference* for more information on Oracle SQL data types.

The following lists the unsupported data types for the columns specified in the `att_col_names` list.

- `BINARY FLOAT`
- `BINARY DOUBLE`
- `LONG`
- `LONG RAW`
- `RAW`
- `INTERVAL YEAR TO MONTH`
- `INTERVAL DAY TO SECOND`

- `BLOB`
- `CLOB`
- `NCLOB`
- `BFILE`
- `ROWID`
- `UROWID`
- User defined datatypes including `SDO_GEOMETRY`, `SDO_TOPO_GEOMETRY` and `SDO_GEORASTER`

> **Note:**
>
> - `SDO_GEOMETRY` is still a valid, in fact, required data type for the `geom_col_name` specified in the vector tile request.
> - If one or more columns with an unsupported data type are specified in the `att_col_names` list, the columns are ignored and the tile is returned as if the columns were not requested.

simple_predicate
A formatted `SDO_STRING` array of triplets (*operand*, *operator*, *value*) which form a predicate.
Note the following regarding the elements that form the triplet:

- The *operand*, first element in the triplet, must be a valid column name in the table (`table_name`). If the column name is not valid, an exception is raised.
- The *operator* is the second element in the triplet, and only the following operators are supported:
  - =, !=, <, >, <=, >=
  - `IS [NOT] NULL`
  - `AND`
  - `[NOT] LIKE`
- The *value*, third element in the triplet, must be a string or a number. For example, *'answer'* is treated as a string. However, both *'42'* and *42* are treated as numbers.
- Multiple triplets form multiple predicates joined by the `AND` operator. For example, consider the following `SIMPLE_PREDICATE` array:

  ```
  SIMPLE_PREDICATE => sdo_string_array('STATE', '=', 'WI', 'COUNTY', 'LIKE',
  'B*', 'TOTPOP', '>', '50000')
  ```

  This forms the predicate where `"STATE"='WI' AND "COUNTY" LIKE 'B*' AND "TOTPOP" > 50000`.

layer_name
Name of the layer in the vector tile.
This is an optional parameter. Only a single layer having a default `'LAYER'` value is supported in the vector tile.

tile_extent
Integer coordinates that describe the width and height of the tile.

This is an optional parameter. The default value of `4096` indicates that the vector tile is `4096` units high and `4096` units wide. The actual size of these units varies based on the tiles zoom level. The distance between two coordinates within a tile will be much greater at zoom level zero than it would be at zoom level 12. It is recommended that you change the default parameter value only if using a non-standard tiling scheme.

google_ts
Boolean value that indicates if the Google tiling scheme is used.
This is an optional parameter. The default value is `TRUE` which indicates a GOOGLE tiling scheme.
The following two tiling schemes are supported when reading tile addresses:

- **GOOGLE (default):** In this tiling scheme, the origin point (X,Y) of a tile is in the northwest corner. The X ordinates increase as tiles are read from west to east. The Y ordinates increase as tiles are read north to south.
- **TMS:** In this tiling scheme, the origin point (X,Y) of a tile is in the southwest corner. The X ordinates still increase as tiles are read west to east, but the Y ordinates increase as tiles are read south to north

max_features
Maximum number of features included in a layer.
This is an optional parameter with a default value 20000.
A vector tile is made up of layers. A layer is made up of features. A feature is a geometry that interacts with the tile envelope and any of its attribute columns. For large tile envelopes covering an entire state or an entire country, the number of buildings and their attributes can be very large. Processing overly large numbers of features can be resource intensive both on the CPU and memory.
Therefore, using this parameter allows you to control the maximum number of features to be included in a layer.

rowid_flg
Boolean value that indicates if `ROWID`s should be retrieved as an attribute column.
This is an optional parameter and the default value is `FALSE`.
If `FALSE`, then the `ROWID` is not included as a column attribute in the tiles features.
If `TRUE`, then the `ROWID` is included as a column attribute in the tiles features.
See the Usage Notes for more information.

Usage Notes

The SDO_UTIL.GET_VECTORTILE function supports three formats (as described at the beginning of the section):

- The first format takes as input the X and Y ordinates (both in `NUMBER` format) at a specific zoom level and returns a BLOB containing all the features that interact with the tile envelope defined by the given tile address.
- The second format takes as input the X ordinate (in `NUMBER` format) and the Y ordinate with a `.PBF` suffix (in `VARCHAR2` format) at a specific zoom level and returns a BLOB vector tile data.
- The third format applies for generating vector tiles using SQL queries. It take a cursor input to fetch the rows needed for building the vector tiles. The output vector tile data is returned as a BLOB.

Note that each feature in the BLOB comprises a geometry that interacts with the tile envelope and any requested attribute columns associated with the geometry.

A tile is a polygon (a square) that describes a piece of a map. A tile envelope is also a square that covers the tile with an extra 2.5% added to each end of both the X and Y axis. From the user perspective, both tile and tile envelope are the same. The tile envelope is used as the filter in a call to SDO_RELATE with `MASK=ANYINTERACT` set.

Note that in the SDO_UTIL.GET_VECTORTILE function, the X, Y origin, zoom level, and tile scheme are passed instead of the tile envelope. The function internally calls SDO_UTIL.GET_TILE_ENVELOPE which forms the tile envelope.

If you are calling the SDO_UTIL.GET_VECTORTILE function inside a SQL query, then you must consider the following:

- Ensure that the tile address (`tile_x`, `tile_y`, and `tile_zoom`) and the tiling scheme (`google_ts`) used to create the tile envelope are the same as those passed to the vector tile function. Otherwise, the function may not return any data as different addresses or schemes may provide different tile envelopes.
- Similarly, if you include `max_features` in the SQL query to determine the number of rows to be fetched, then ensure that the maximum features value in the query is the same as that is passed to the vector tile function. Also, note the following:
  - If the `max_features` value specified in the query is greater than the value specified in the vector tile API, then the query will still try to read larger number of rows but processing of the feature will be limited to the `max_features` value as passed to the API.
  - If the `max_features` value specified in the query is lesser than the value specified in the vector tile API, then the query fetches the specified number of rows and exits.
- The `rowid_flg` parameter is not included in the SDO_UTIL.GET_VECTORTILE function format that supports cursor input. In this case, you can retrieve the ROWID column attribute by adding , ROWIDTOCHAR(<table_alias>.rowid) "ROWID" in the SELECT clause. This attribute column can be present anywhere in the list of columns to be retrieved. It can also be the only column in the list to be retrieved.
  - The `“ROWID”` psuedo-column name is only a suggestion. You can choose any name of your choice.
  - The `ROWIDTOCHAR` function call requires the `ROWID` to be prefixed with the table alias from where the rowids are generated. Since there are two tables in the query, the data table and the tile envelope table, this alias is needed to clarify from which table the rowids are to be generated.
  - If you wish to limit the number of rows returned from the query, then you must use `WHERE NUMROW <= :x` where `:x` is the value of the `max_features` parameter.

Examples

The following example obtains the vector tile data using both X and Y ordinates in `NUMBER` format at a specific zoom level. The example also maintains a size limit of 10000 records for each vector tile.

```
SQL> SELECT SDO_UTIL.GET_VECTORTILE(
       TABLE_NAME=>'states',
       GEOM_COL_NAME=>'geom',
       ATT_COL_NAMES=>sdo_string_array('totpop', 'name', 'state_abbrv'),
       SIMPLE_PREDICATE=>sdo_string_array('totpop','>', '50000'),
       TILE_X=>1192,
       TILE_Y=>1579,
       TILE_ZOOM=>12,
       MAX_FEATURES=>10000);
```

```
SDO_UTIL.GET_VECTORTILE(TABLE_NAME=>'US_STATE',GEOM_COL_NAME=>'GEOM',ATT_COL_NAMES=>SDO_S
TRING_ARRAY('TOTPOP','NAME','STATE_ABBRV'),SIMPLE_PREDICATE=>SDO_STRING
-----------------------------------------------------------------------------------------
-----------------------------------------------------------------------
1A150A0E084E59414E205350415449414C0828802078021ABE010A054C41594552122C080012060000101020
21803221E09CB01AE233AA80919AE2845B2010CFC06FD0B94098912009F069743000F12
```

The following example describes the steps to obtain the vector tile data using a SQL query.

```
SELECT SDO_UTIL.GET_VECTORTILE(
       CURSOR(
         WITH tet(tec) AS
             (SELECT SDO_UTIL.GET_TILE_ENVELOPE(tile_zoom=>12, tile_x=>1192,
tile_y=>1579))
         SELECT geom, totpop, state, state_abrv
             FROM states, tet
             WHERE totpop > 200 and ROWNUM <= 10000 and
              SDO_RELATE(geom, tet.tec,
                 'mask=anyinteract min_resolution=9.7839 bypass_point=true') = 'TRUE'),
         tile_zoom=>12, tile_x=>1192, tile_y=>1579) FROM DUAL;

SDO_UTIL.GET_VECTORTILE(CURSOR(WITHTET(TEC)AS(SELECTSDO_UTIL.GET_TILE_ENVELOPE(T
--------------------------------------------------------------------------------
1A150A0E084E59414E205350415449414C0828802078021A620A054C41594552121C080012060000
010102021803220E09CB01B81B128E10851D8D10000F1A06544F54504F501A0553544154451A0A53
544154455F414252562209190000000000673D5241220A0A084D6172796C616E6422040A024D442880
207802
```

In the preceding example, the `min_resolution` value is computed as shown:

```
SQL> SELECT ((40075016.0/POWER(2, 12)) * .001) FROM DUAL;

((40075016.0/POWER(2,12))*.001)
-------------------------------
                     9.78393945
```

The following example returns the ROWIDs as a column attribute in the tiles features. The vector tiles are generated using a SQL query (having a `cursor` input) as shown.

```
SELECT SDO_UTIL.GET_VECTORTILE(
       cursor(
         WITH tet(tec) AS
             (SELECT SDO_UTIL.GET_TILE_ENVELOPE(tile_zoom=>12, tile_x=>1192,
tile_y=>1579))
         SELECT geom, totpop, state, state_abrv, ROWIDTOCHAR(vtt.rowid) "ROWID"
             FROM states, tet
             WHERE totpop > 200 and ROWNUM <= 10000 and
                   SDO_RELATE(geom, tet.tec,
                     'mask=anyinteract min_resolution=9.7839 bypass_point=true') =
'TRUE'),
       tile_zoom=>12, tile_x=>1192, tile_y=>1579) FROM DUAL;
```

In the following example the `ROWID_FLG` parameter is set to `TRUE` and therefore the procedure returns the ROWIDs as a column attribute in the tiles features.

```
SELECT SDO_UTIL.GET_VECTORTILE(
       TABLE_NAME=>'states',
       GEOM_COL_NAME=>'geom',
       ATT_COL_NAMES=>sdo_string_array('totpop', 'state', 'state_abbrv'),
       SIMPLE_PREDICATE=>sdo_string_array('totpop','>', '200'),
       TILE_X=>1192,
       TILE_Y=>1579,
       TILE_ZOOM=>12,
       ROWID_FLG=>TRUE,
       MAX_FEATURES=>10000);
```

35.31 SDO_UTIL.GETFIRSTVERTEX

Format

```
SDO_UTIL.GETFIRSTVERTEX(
     geometry  IN SDO_GEOMETRY
     ) RETURN MDSYS.VERTEX_TYPE;
```

Description

Returns the first coordinate of the vertices of the input geometry.

Parameters

geometry
Input geometry.

Usage Notes

This function returns an object of type MDSYS.VERTEX_TYPE, which is defined as follows:

```
CREATE TYPE vertex_type AS OBJECT
 (x   NUMBER,
  y   NUMBER,
  z   NUMBER,
  w   NUMBER,
  v5  NUMBER,
  v6  NUMBER,
  v7  NUMBER,
  v8  NUMBER,
  v9  NUMBER,
  v10 NUMBER,
  v11 NUMBER,
  id  NUMBER);
```

The MYSYS.VERTEX_TYPE type is intended for Oracle use only. Do **not** use this type in column definitions or in functions that you create.

Examples

This example assumes a table named DATA_2D that has been created and populated as follows:

```
CREATE TABLE data_2d (geom_name varchar2(12), shape sdo_geometry);

INSERT INTO data_2d VALUES ( 'LINE1',
   sdo_geometry(2002, NULL, NULL,
   sdo_elem_info_array(1,2,1),
   sdo_ordinate_array(12,13, 14,15, 16,17, 18,19, 20,21)));
```

The following SELECT statement calls both the SDO_UTIL.Get**First**Vertex and SDO_UTIL.Get**Last**Vertex functions. The result shows that the first vertex is at (12,13) and the last vertex is at (20,21). (The output is reformatted for readability.)

```
SELECT geom_name,
       sdo_util.GetFirstVertex(a.shape).X,
       sdo_util.GetFirstVertex(a.shape).Y
FROM data_2d a;

GEOM_NAME    SDO_UTIL.GETFIRSTVERTEX(A.SHAPE).X
SDO_UTIL.GETFIRSTVERTEX(A.SHAPE).Y
------------ ----------------------------------
----------------------------------
LINE1
12                                 13


SELECT geom_name,
       sdo_util.GetLastVertex(a.shape).X,
       sdo_util.GetLastVertex(a.shape).Y
FROM data_2d a;

GEOM_NAME    SDO_UTIL.GETLASTVERTEX(A.SHAPE).X
SDO_UTIL.GETLASTVERTEX(A.SHAPE).Y
------------ ----------------------------------
----------------------------------
LINE1                                        20
21
```

Related Topics

- SDO_UTIL.GETLASTVERTEX

35.32 SDO_UTIL.GETLASTVERTEX

Format

```
SDO_UTIL.GETLASTVERTEX(
     geometry  IN SDO_GEOMETRY
     ) RETURN MDSYS.VERTEX_TYPE;
```

Description

Returns the last coordinate of the vertices of the input geometry.

Parameters

geometry
Input geometry.

Usage Notes

This function returns an object of type MDSYS.VERTEX_TYPE, which is defined as follows:

```
CREATE TYPE vertex_type AS OBJECT
 (x   NUMBER,
  y   NUMBER,
  z   NUMBER,
  w   NUMBER,
  v5  NUMBER,
  v6  NUMBER,
  v7  NUMBER,
  v8  NUMBER,
  v9  NUMBER,
  v10 NUMBER,
  v11 NUMBER,
  id  NUMBER);
```

The MYSYS.VERTEX_TYPE type is intended for Oracle use only. Do **not** use this type in column definitions or in functions that you create.

Examples

This example assumes a table named DATA_2D that has been created and populated as follows:

```
CREATE TABLE data_2d (geom_name varchar2(12), shape sdo_geometry);

INSERT INTO data_2d VALUES ( 'LINE1',
   sdo_geometry(2002, NULL, NULL,
   sdo_elem_info_array(1,2,1),
   sdo_ordinate_array(12,13, 14,15, 16,17, 18,19, 20,21)));
```

The following SELECT statement calls both the SDO_UTIL.Get**First**Vertex and SDO_UTIL.Get**Last**Vertex functions. The result shows that the first vertex is at (12,13) and the last vertex is at (20,21). (The output is reformatted for readability.)

```
SELECT geom_name,
       sdo_util.GetFirstVertex(a.shape).X,
       sdo_util.GetFirstVertex(a.shape).Y
FROM data_2d a;

GEOM_NAME    SDO_UTIL.GETFIRSTVERTEX(A.SHAPE).X
SDO_UTIL.GETFIRSTVERTEX(A.SHAPE).Y
------------ ----------------------------------
----------------------------------
LINE1
12                                 13


SELECT geom_name,
       sdo_util.GetLastVertex(a.shape).X,
       sdo_util.GetLastVertex(a.shape).Y
FROM data_2d a;

GEOM_NAME    SDO_UTIL.GETLASTVERTEX(A.SHAPE).X
SDO_UTIL.GETLASTVERTEX(A.SHAPE).Y
------------ ----------------------------------
----------------------------------
LINE1                                        20
21
```

Related Topics

- SDO_UTIL.GETFIRSTVERTEX

35.33 SDO_UTIL.GETNUMELEM

Format

```
SDO_UTIL.GETNUMELEM(
     geometry  IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

Description

Returns the number of elements in the input geometry.

Parameters

geometry
Geometry for which to return the number of elements.

Usage Notes

None.

Examples

The following example returns the number of elements for each geometry in the SHAPE column of the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.name, SDO_UTIL.GETNUMELEM(c.shape)
  FROM cola_markets c;

NAME                             SDO_UTIL.GETNUMELEM(C.SHAPE)
-------------------------------- ----------------------------
cola_a                                                      1
cola_b                                                      1
cola_c                                                      1
cola_d                                                      1
```

Related Topics

- SDO_UTIL.GETNUMVERTICES

35.34 SDO_UTIL.GETNUMVERTICES

Format

```
SDO_UTIL.GETNUMVERTICES(
     geometry  IN SDO_GEOMETRY
     ) RETURN NUMBER;
```

Description

Returns the number of vertices in the input geometry.

Parameters

geometry
Geometry for which to return the number of vertices.

Usage Notes

None.

Examples

The following example returns the number of vertices for each geometry in the SHAPE column of the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.name, SDO_UTIL.GETNUMVERTICES(c.shape)
  FROM cola_markets c;

NAME                             SDO_UTIL.GETNUMVERTICES(C.SHAPE)
-------------------------------- --------------------------------
cola_a                                                          2
cola_b                                                          5
cola_c                                                          5
cola_d                                                          3
```

Related Topics

- SDO_UTIL.GETVERTICES
- SDO_UTIL.GETNUMELEM

35.35 SDO_UTIL.GETNURBSAPPROX

Format

```
SDO_UTIL.GETNURBSAPPROX(
     geometry  IN SDO_GEOMETRY,
     tolerance IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a line string geometry that is an approximation of the input NURBS curve geometry.

Parameters

geometry
NURBS curve geometry object.

tolerance
Tolerance value (see Tolerance). As long as the tolerance value is valid, it does not affect the operation and output of the function, as explained in the Usage Notes.

Usage Notes

> **Note:**
>
> The SDO_UTIL.GETNURBSAPPROX function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function is useful for returning a polyline approximation of the input geometry for further processing by subprograms that cannot directly process NURBS curve geometries. The function is called internally by several Oracle Spatial functions, and it can also be called directly by users.

The input geometry must be a NURBS curve in projected (not geodetic) coordinate system.

If the input geometry does not contain at least one NURBS curve element, the function returns the input geometry.

A tolerance value is required as input because of Oracle Spatial's internal usage of the function. However, for direct calls to the function by users, the specified tolerance value does not affect the returned polyline, which can have up to approximately 200 points.

The end points of the returned line string geometry are the first and last control points, because a NURBS curve is clamped at its end points.

For information about support for NURBS (non-uniform rational B-spline) geometries, see NURBS Curve Support in Oracle Spatial.

Examples

The following example creates a spatial table and inserts a NURBS curve geometry, then uses the SDO_UTIL.GETNURBSAPPROX function (with a tolerance value of 0.05) to return a line string geometry that is an approximation of the NURBS curve geometry.

```
-- Create Table
create table test (gid  INTEGER,
                   geom mdsys.sdo_geometry);

-- Insert metadata
Insert into user_sdo_geom_metadata VALUES('TEST', 'GEOM',
  sdo_dim_array( sdo_dim_element('X', -10, 10, 0.05),
                 sdo_dim_element('Y', -10, 10, 0.05)),
                 NULL);

-- Two-dimensional NURBS curve with degree 3, 7 control points, and 11 knots
insert into test values(1, SDO_GEOMETRY(2002, NULL, NULL,
                                        SDO_ELEM_INFO_ARRAY(1, 2, 3),
                           SDO_ORDINATE_ARRAY(3, 7, 0, 0, 1, -0.5, 1, 1, 0.2, 2,
                                              1, 0.5, 3.5, 1, 0.8, 2, 1, 0.9, 1,
                                              1, 0.3, 0, 1, 11, 0, 0, 0, 0.25,
                                              0.5, 0.75, 1.0, 1.0, 1.0, 1.0)));

-- sdo_util.getNurbsApprox gives an approximate polyline for the NURBS curve.
Select gid, sdo_util.getNurbsApprox(a.geom, 0.05) from test a where gid = 1;

       GID
----------
SDO_UTIL.GETNURBSAPPROX(A.GEOM,0.05)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SD
--------------------------------------------------------------------------------
         1
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
0, 0, -.02912839, .059699523, -.05624374, .118211319, -.08139356, .175559751, -.
10462535, .231769184, -.12598662, .286863981, -.14552488, .340868505, -.16328764
, .39380712, -.17932241, .445704191, -.1936767, .496584079, -.20639802, .5464711
5, -.21753387, .595389767, -.22713177, .643364292, -.23523922, .690419091, -.241
90374, .736578527, -.24717284, .781866962, -.25109401, .826308762, -.25371477, .
869928288, -.25508264, .912749906, -.25524512, .954797979, -.25424971, .99609687
, -.25214393, 1.03667094, -.24897529, 1.07654456, -.24479129, 1.11574209, -.2396
3945, 1.15428789, -.23356727, 1.19220633, -.22662227, 1.22952177, -.21885194, 1.
26625857, -.21030381, 1.3024411, -.20102538, 1.33809372, -.19106416, 1.37324079,
 -.18046765, 1.40790668, -.16928338, 1.44211576, -.15755884, 1.47589238, -.14534
154, 1.50926091, -.132679, 1.54224571, -.11961872, 1.57487115, -.10620822, 1.607
16159, -.092495, 1.63914139, -.07852657, 1.67083492, -.06435044, 1.70226654, -.0
5001412, 1.73346062, -.03556511, 1.76444151, -.02105094, 1.79523359, -.0065191,
1.82586121, .007982896, 1.85634874, .022407535, 1.88672054, .036707311, 1.917000
98, .050834714, 1.94721442, .064742236, 1.97738522, .078382506, 2.00753762, .091
725045, 2.03768051, .104772175, 2.06779294, .117529987, 2.09785056, .130004572,
2.12782899, .14220202, 2.15770388, .154128423, 2.18745085, .165789872, 2.2170455
6, .177192457, 2.24646363, .188342269, 2.27568069, .1992454, 2.3046724, .2099079
4, 2.33341438, .22033598, 2.36188226, .23053561, 2.3900517, .240512923, 2.417898
31, .250274008, 2.44539774, .259824957, 2.47252563, .269171861, 2.49925761, .278
32081, 2.52556931, .287277896, 2.55143638, .296049209, 2.57683445, .30464084, 2.
60173916, .31305888, 2.62612614, .321309421, 2.64997102, .329398552, 2.67324946,
 .337332365, 2.69593707, .345116951, 2.71800951, .352758401, 2.7394424, .3602628
05, 2.76021137, .367636255, 2.78029208, .374884841, 2.79966015, .382014654, 2.81
829122, .389031786, 2.83616093, .395942326, 2.85324491, .402752367, 2.8695188, .
409467999, 2.88495824, .416095312, 2.89953885, .422640398, 2.91323629, .42910934
8, 2.92602618, .435508253, 2.93788416, .441843203, 2.94878587, .448120289, 2.958
70695, .454345602, 2.96762302, .460525234, 2.97550973, .466665275, 2.98234271, .
472771816, 2.98809761, .478850948, 2.99275004, .484908761, 2.99627566, .49095134
8, 2.9986501, .496984798, 2.999849, .50301505, 2.999849, .509044541, 2.9986501,
.515072205, 2.99627566, .521096823, 2.99275004, .527117177, 2.98809761, .5331320
5, 2.98234271, .539140223, 2.97550973, .545140477, 2.96762302, .551131595, 2.958
70695, .557112359, 2.94878587, .56308155, 2.93788416, .56903795, 2.92602618, .57
4980341, 2.91323629, .580907505, 2.89953885, .586818223, 2.88495824, .592711277,
 2.8695188, .59858545, 2.85324491, .604439523, 2.83616093, .610272278, 2.8182912
2, .616082496, 2.79966015, .621868959, 2.78029208, .62763045, 2.76021137, .63336
575, 2.7394424, .639073641, 2.71800951, .644752905, 2.69593707, .650402323, 2.67
324946, .656020678, 2.64997102, .661606751, 2.62612614, .667159324, 2.60173916,
.672677178, 2.57683445, .678159097, 2.55143638, .683603861, 2.52556931, .6890102
52, 2.49925761, .694377052, 2.47252563, .699703043, 2.44539774, .704987007, 2.41
789831, .710227725, 2.3900517, .71542398, 2.36188226, .720574553, 2.33341438, .7
25678226, 2.3046724, .730733781, 2.27568069, .735739999, 2.24646363, .740695663,
 2.21704556, .745599554, 2.18745085, .750450454, 2.15770388, .755247146, 2.12782
899, .75998841, 2.09785056, .764673028, 2.06779294, .769299783, 2.03768051, .773
867456, 2.00753762, .778372773, 1.97738522, .782794569, 1.94721442, .787102465,
1.91700098, .791266007, 1.88672054, .795254739, 1.85634874, .799038208, 1.825861
21, .802585958, 1.79523359, .805867536, 1.76444151, .808852487, 1.73346062, .811
510356, 1.70226654, .813810689, 1.67083492, .815723031, 1.63914139, .817216927,
1.60716159, .818261924, 1.57487115, .818827566, 1.54224571, .8188834, 1.50926091
, .818398969, 1.47589238, .817343821, 1.44211576, .8156875, 1.40790668, .8133995
52, 1.37324079, .810449523, 1.33809372, .806806957, 1.3024411, .802441401, 1.266
25857, .797322399, 1.22952177, .791419497, 1.19220633, .784702242, 1.15428789, .
777140177, 1.11574209, .768702849, 1.07654456, .759359802, 1.03667094, .74908058
4, .99609687, .737834738, .954797979, .725591811, .912749906, .712321348, .86992
8288, .697992894, .826308762, .682575995, .781866962, .666040196, .736578527, .6
48355043, .690419091, .629490081, .643364292, .609414855, .595389767, .588098912
, .54647115, .565511797, .496584079, .541623054, .445704191, .51640223, .3938071
2, .48981887, .340868505, .46184252, .286863981, .432442724, .231769184, .401589
029, .175559751, .36925098, .118211319, .335398121, .059699523, .3, 0))

1 row selected.
```

35.36 SDO_UTIL.GETVERTICES

Format

```
SDO_UTIL.GETVERTICES(
     geometry             IN SDO_GEOMETRY,
     include_oriented_pt  IN NUMBER DEFAULT NULL
     ) RETURN VERTEX_SET_TYPE;
```

Description

Returns the coordinates of the vertices of the input geometry.

Parameters

geometry
Geometry for which to return the coordinates of the vertices.

include_oriented_pt
It controls the return of both the point coordinates and the orientation vector as two vertices for an oriented point.

> **Note:**
>
> This is only effective when the input is an oriented point geometry. See Oriented Point for more information about oriented points.

The valid value can be one of the following:

- `0`: Returns only the coordinates of the vertices
- `1`: Returns both the coordinates and the orientation vector

Usage Notes

This function returns an object of MDSYS.VERTEX_SET_TYPE, which consists of a table of objects of MDSYS.VERTEX_TYPE. Oracle Spatial defines the type VERTEX_SET_TYPE as:

```
CREATE TYPE vertex_set_type as TABLE OF vertex_type;
```

Oracle Spatial defines the object type VERTEX_TYPE as:

```
CREATE TYPE vertex_type AS OBJECT
   (x   NUMBER,
    y   NUMBER,
    z   NUMBER,
    w   NUMBER,
    v5  NUMBER,
    v6  NUMBER,
    v7  NUMBER,
    v8  NUMBER,
    v9  NUMBER,
    v10 NUMBER,
    v11 NUMBER,
    id  NUMBER);
```

> **Note:**
>
> The VERTEX_SET_TYPE and VERTEX_TYPE types are intended for use by Oracle only. Do not use these types in column definitions or functions that you create.

This function can be useful in finding a vertex that is causing a geometry to be invalid. For example, if you have identified a geometry as invalid by using the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function or the

SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT procedure (both of which are documented in SDO_GEOM Package (Geometry)), you can use the GETVERTICES function to view the vertices in tabular format.

This function only returns the point coordinates and does not return the orientation vectors when the input is an oriented point geometry. In order to have the orientation vectors also to be returned, you must pass the parameter `INCLUDE_ORIENTED_PT` set to `1`. See the last example in Examples section.

Examples

The following example returns the X and Y coordinates and `ID` values of the vertices of the geometries in the SHAPE column of the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT c.mkt_id, c.name, t.X, t.Y, t.id
   FROM cola_markets c,
   TABLE(SDO_UTIL.GETVERTICES(c.shape)) t
   ORDER BY c.mkt_id, t.id;

    MKT_ID NAME                                X          Y         ID
---------- -------------------------------- ---------- ---------- ----------
         1 cola_a                                    1          1          1
         1 cola_a                                    5          7          2
         2 cola_b                                    5          1          1
         2 cola_b                                    8          1          2
         2 cola_b                                    8          6          3
         2 cola_b                                    5          7          4
         2 cola_b                                    5          1          5
         3 cola_c                                    3          3          1
         3 cola_c                                    6          3          2
         3 cola_c                                    6          5          3
         3 cola_c                                    4          5          4
         3 cola_c                                    3          3          5
         4 cola_d                                    8          7          1
         4 cola_d                                   10          9          2
         4 cola_d                                    8         11          3

15 rows selected.
```

The following example returns both, the coordinates and the orientation vector, as two vertices for an oriented point geometry. (This example uses the point geometry created in Example 2-14).

```
select sdo_util.getvertices(c.shape, 1) from cola_markets c;

SDO_UTIL.GETVERTICES(C.SHAPE,1)(X, Y, Z, W, V5, V6, V7, V8, V9, V10, V11, ID)
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
----------------
VERTEX_SET_TYPE(VERTEX_TYPE(12, 14, NULL, NULL, NULL, NULL, NULL, NULL, NULL,
NULL, NULL, 1), VERTEX_TYPE(.3, .2, NULL, NULL, NULL, NULL, NULL, NULL, NULL,
NULL, NULL, 2))
```

Related Topics

- SDO_UTIL.EXTRACT
- SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT

- SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
- SDO_UTIL.GETNUMVERTICES

35.37 SDO_UTIL.GRANT_VECTORTILE_CACHE

Format

```
SDO_UTIL.GRANT_VECTORTILE_CACHE(
  schema_name     IN VARCHAR2,
  read_only       IN BOOLEAN DEFAULT FALSE
);
```

Description

Grants read or write priviliges on vector tile caches to another schema.

Parameters

schema_name
Name of the schema being granted access to a vector tile cache.

read_only
Controls the vector tile cache privileges.
Supported values are:

- **FALSE**(default): This allows another schema user to:
  - Read existing copies of vector tiles from the cache.
  - Compute and write a tile that is not in the cache.
- **TRUE**: Grants read only privilige on vector tile cache to another schema. In this case, the new schema can read tiles from the cache. In case the tile they need is not in the cache, it gets computed and returned, but not saved to the cache.

Usage Notes

Although `SDO_UTIL.GRANT_VECTORTILE_CACHE` allows another schema to read and insert tiles, only the owning schema is allowed to enable, disable, or purge a vector tile cache.

Examples

The following example calls `SDO_UTIL.GRANT_VECTORTILE_CACHE` to grant `user_b` read and write privileges on the vector tile cache owned by `user_a`. As a prerequisite, to allow `user_b` to build vector tiles on `user_a.counties` table, `READ` privilege is granted on the `counties` table to `user_b`.

```
-- Grant user_b read access to the source table
GRANT READ on counties TO user_b;

-- Grant user_b full access to the cache
SDO_UTIL.GRANT_VECTORTILE_CACHE('user_b');

-- user_b can then access:
SELECT SDO_UTIL.GET_VECTORTILE(TABLE_NAME=>'USER_A.COUNTIES',
                               GEOM_COL_NAME=>'GEOM',
                               TILE_ZOOM=>8, TILE_X=>73, TILE_Y=>97,
                               ATT_COL_NAMES=>sdo_string_array('COUNTY','LANDSQMI'))
FROM dual;
```

Also note that there may be multiple vector tile caches in the `user_a` schema. But since `user_b` is granted `READ` privilege only on the `COUNTIES` table, those are the only tiles `user_b` will be able to read from the cache.

35.38 SDO_UTIL.H3_BASE_CELL

Format

```
SDO_UTIL.H3_BASE_CELL(
  h3_key IN RAW
) RETURN NUMBER;
```

Description

Returns the H3 base cell (64-bit, 8 byte RAW) corresponding to the given H3 cell.

Parameters

h3_key
The given H3 cell.

Usage Notes

Note that a hexagon cannot be subdivided exactly into smaller hexagons. As a result, some cells are not entirely contained in their base cell.

Examples

The following example shows the base cell containing Paris:

```
SELECT SDO_UTIL.H3_BASE_CELL('0877AA5145FFFFFF') FROM DUAL;
SDO_UTIL.H3_BASE_CELL('0877AA5145FFFFFF')
-----------------------------------------
                                       61
```

The following example shows the base cell containing the North Pole:

```
SELECT SDO_UTIL.H3_BASE_CELL('08F0326233AB0399') FROM DUAL;
SDO_UTIL.H3_BASE_CELL('08F0326233AB0399')
-----------------------------------------
                                        1
```

Related Topics

- SDO_UTIL.H3_KEY
- SDO_UTIL.H3_PARENT
- SDO_UTIL.H3_RESOLUTION

35.39 SDO_UTIL.H3_BOUNDARY

Format

```
SDO_UTIL.H3_BOUNDARY(
  h3_key IN RAW,
  srid IN NUMBER DEFAULT NULL
) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Computes a polygon representing the given cell.

Parameters

h3_key
The H3 cell.

srid
Optional srid for the returned geometry. Must be a geodetic (longitude/latitude) coordinate system.

Usage Notes

Edges which cross faces of the H3 icsohedron model may have extra vertices along some edges to improve accuracy.

Examples

The following example computes the polygon for the given H3 cell:

```
SELECT SDO_UTIL.H3_BOUNDARY('0877AA5145FFFFFF') FROM DUAL;
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(48.8614522, 2.3465296,
48.8610871, 2.35865517, 48.8505953, 2.36541433, 48.8404669, 2.36004832,
48.840831, 2.34792133, 48.8513246,
2.34116178, 48.8614522, 2.3465296))
```

Related Topics

- SDO_UTIL.H3_CENTER
- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_MBR
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN

35.40 SDO_UTIL.H3_CENTER

Format

```
SDO_UTIL.H3_CENTER(
  h3_key IN RAW,
  srid   IN NUMBER DEFAULT NULL
) RETURN MDSYS.SDO_GEOMETRY;

SDO_UTIL.H3_CENTER(
  h3_key IN RAW,
  x      OUT NUMBER,
  y      OUT NUMBER);
```

Description

Computes the center of the given H3 cell.

Parameters

h3_key
The H3 cell.

srid
Optional srid for the returned geometry. Must be a geodetic (longitude/latitude) coordinate system.

x
The longitude of the center of the given H3 cell.

y
The latitude of the center of the given H3 cell.

Usage Notes

None.

Examples

The following example computes the center of the coarsest (largest) cell containing the North Pole:

```
SELECT SDO_UTIL.H3_CENTER('08001FFFFFFFFFFF') FROM DUAL;
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(38.023407, 79.2423985, NULL), NULL,
NULL)
```

Related Topics

- SDO_UTIL.H3_BOUNDARY

35.41 SDO_UTIL.H3_HEX_AREA

Format

```
SDO_UTIL.H3_HEX_AREA(
  resolution IN NUMBER,
  unit       IN VARCHAR2 DEFAULT 'SQ_KM',
  measure    IN VARCHAR2 DEFAULT 'AVERAGE'
) RETURN NUMBER;
```

Description

Returns the minimum (‘MIN’), maximum (‘MAX’), or average (‘AVG’) area of hexes for the given H3 level.

Parameters

resolution
The H3 level to query.

unit
The unit of area measurement to use (see Table 6-26).

measure
One of the following supported values: MIN, MAX, AVG, or AVERAGE.

Usage Notes

Note that the pentagons have their own statistics. If you want the area of a specific cell, rather than values for the entire level, use `SDO_GEOM.SDO_AREA(SDO_UTIL.H3_BOUNDARY(h3_key),0.00001)`.

Examples

The following example shows the area of the largest H3 cell (largest level-0 cell):

```
SELECT SDO_UTIL.H3_HEX_AREA(0, 'SQ_MILE', 'MAX') FROM DUAL;
1937932.68
```

Related Topics

- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN

35.42 SDO_UTIL.H3_HEX_EDGELEN

Format

```
SDO_UTIL.H3_HEX_EDGELEN(
  resolution IN NUMBER,
  unit       IN VARCHAR2 DEFAULT 'KM',
  measure    IN VARCHAR2 DEFAULT 'AVERAGE'
) RETURN NUMBER;
```

Description

Returns the minimum (‘MIN’), maximum (‘MAX’) or average (‘AVG’) edgelen of hexes at the given resolution.

Parameters

resolution
The H3 level to query.

unit
The unit of length measurement to use (see Table 6-26).

measure
One of the following supported values: MIN, MAX, AVG, or AVERAGE.

Usage Notes

The `SDO_UTIL.H3_HEX_EDGELEN` procedure returns the requested constant statistic for the given H3 level. Note that the 12 pentagons at each level have their own statistics. For hexagons (but not pentagons) the edgelen is also the distance from the hex's center to a vertex.

If you want the area of a specific cell, rather than values for the entire level, use SDO_GEOM.SDO_AREA`(`SDO_UTIL.H3_BOUNDARY`(h3_key),0.00001)`.

Examples

The following example shows the edgelen of the smallest H3 cell (smallest level-15 cell):

```
SELECT SDO_UTIL.H3_HEX_EDGELEN(15, 'M', 'MAX') FROM DUAL;
64482
```

Related Topics

- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN

35.43 SDO_UTIL.H3_NUM_CELLS

Format

```
SDO_UTIL.H3_NUM_CELLS(
  resolution IN NUMBER
) RETURN NUMBER;
```

Description

Returns the number of H3 cells covering the Earth at the specified resolution.

Parameters

resolution
The H3 level to query.

Usage Notes

Includes pentagons and hexagons. At each resolution 12 cells are pentagons and the rest are hexagons.

Examples

The following example computes the number of base cells:

```
SELECT SDO_UTIL.H3_NUM_CELLS(0) FROM DUAL;
122
```

Related Topics

- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN

35.44 SDO_UTIL.H3_IS_CLASS3

Format

```
SDO_UTIL.H3_IS_CLASS3(
  resolution IN NUMBER
) RETURN BOOLEAN;

SDO_UTIL.H3_IS_CLASS3(
  h3_key IN RAW
) RETURN BOOLEAN;
```

Description

Returns a boolean value that determines if the given cells at the given resolution are “Class 3” in Uber’s H3 system.

Parameters

resolution
The H3 level to query.

h3_key
An H3 cell to query.

Usage Notes

The orientation of hexes are rotated by 30 degrees with respect to the layer one level coarser or finer, so all the even-numbered levels have their hexes oriented the same way, and all the odd-numbered levels have their hexes oriented the same way. “Class 3” is Uber’s name for the orientation of the odd-numbered levels.

Examples

The following example shows that the cells at level 7 are oriented to Class 3:

```
SELECT SDO_UTIL.H3_IS_CLASS3(7) FROM DUAL;
TRUE
```

Related Topics

- SDO_UTIL.H3_PENTAGON_AREA

35.45 SDO_UTIL.H3_IS_PENTAGON

Format

```
SDO_UTIL.H3_IS_PENTAGON(
  h3_key IN RAW
) RETURN BOOLEAN;
```

Description

Returns a boolean value that determines whether a given cell is a pentagon (instead of a hexagon) or not.

Parameters

h3_key
An H3 cell to query.

Usage Notes

At each H3 resolution, there are exactly 12 pentagons (centered at the vertices of the icosahedron used for the H3 projection) and all other cells are hexagons. All 12 pentagons at any given H3 resolution are identical in size. The centers of the 12 pentagons are the same at all resolutions, and all the pentagon centers are in the ocean.

Examples

The following examples call `SDO_UTIL.H3_IS_PENTAGON` to determine if the given cell is a pentagon or not.

```
SQL> SELECT SDO_UTIL.H3_IS_PENTAGON('08928342E20FFFFF') pentagon;

PENTAGON
-----------
FALSE

SQL> SELECT SDO_UTIL.H3_IS_PENTAGON('08FD600000000000') pentagon;

PENTAGON
-----------
TRUE
```

35.46 SDO_UTIL.H3_IS_VALID_CELL

Format

```
SDO_UTIL.H3_IS_VALID_CELL(
  h3_key IN RAW
) RETURN BOOLEAN;
```

Description

Returns `TRUE` if the given H3 key is correctly formed and identifies an H3 cell; otherwise, the procedure returns `FALSE`.

Parameters

h3_key
The H3 key to be validated.

Usage Notes

None.

Examples

The following example queries use the `SDO_UTIL.H3_IS_VALID_CELL` procedure to determine the validity of the input H3 key:

```
SELECT SDO_UTIL.H3_IS_VALID_CELL('0877AA5145FFFFFF') FROM DUAL;

SDO_UTIL.H3
-----------
TRUE


SELECT SDO_UTIL.H3_IS_VALID_CELL('0000000000000000') FROM DUAL;

SDO_UTIL.H3
-----------
FALSE
```

Related Topics

- SDO_UTIL.H3_KEY
- SDO_UTIL.H3_BOUNDARY
- SDO_UTIL.H3_CENTER

35.47 SDO_UTIL.H3_KEY

Format

```
SDO_UTIL.H3_KEY(
 longitude  IN NUMBER,
 latitude   IN NUMBER,
 resolution IN NUMBER DEFAULT 15) RETURN RAW;

SDO_UTIL.H3_KEY(
 geometry   IN mdsys.sdo_geometry,
 resolution IN NUMBER DEFAULT 15) RETURN RAW;
```

Description

Returns the H3 cell for the given geodetic point and resolution.

Parameters

longitude
The longitude of the input point.

latitude
The latitude of the input point.

geometry
A geometry consisting of a single point in a geodetic coordinate system. SRID must be non-null. If it is not SRID 4326, then the point will be transformed to SRID 4326.

resolution
The resolution of the H3 cell to return, from zero (coarsest) to 15 (finest).

Usage Notes

The `SDO_UTIL.H3_KEY` function converts point locations to the hexagonal hierarchical spatial indexing system designed by Uber. This indexing system divides the world into 122 resolution 0 cells of 4.4 million km^2 each at the top level (level 0). Cells are mapped onto an icoshedron (regular 20-sided polyhedron). Each increase in resolution subdivides into smaller cells until level 15 which has 569,707,381,193,162 cells of about 1 m^2 each. The cells are hexagons except for 12 pentagons at each level (a sphere cannot be tiled with just hexagons). Note that a hexagon cannot be subdivided exactly with hexagons. As a result, cells near the border of their parent cell are not perfectly contained in their parent cell.

H3 is always computed in SRID 4326 coordinate system.

Examples

The following example shows an H3 cell in Paris:

```
SELECT SDO_UTIL.H3_KEY(48.85755957774311, 2.344920508484808, 7) FROM DUAL;
0877AA5145FFFFFF
```

The following example shows the smallest H3 cell (level 15) containing the North Pole:

```
SELECT SDO_UTIL.H3_KEY(SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(0, 90, NULL),
NULL, NULL), 15);
08F0326233AB0399
```

Related Topics

- SDO_UTIL.H3_BASE_CELL
- SDO_UTIL.H3_BOUNDARY
- SDO_UTIL.H3_CENTER
- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_IS_CLASS3
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_MBR
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_PARENT
- SDO_UTIL.H3_PENTAGON_AREA
- SDO_UTIL.H3_PENTAGON_EDGELEN
- SDO_UTIL.H3_RESOLUTION

- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.LINEAR_KEY

35.48 SDO_UTIL.H3_MBR

Format

```
SDO_UTIL.H3_MBR(
  h3_key IN RAW,
  exact  IN BOOLEAN DEFAULT TRUE
) RETURN SDO_GEOMETRY;
```

Description

Returns the MBR of the given H3 cell.

Parameters

h3_key
Identifies the H3 cell.

exact

- If `TRUE` (default), the MBR is exact.
- If `FALSE`, the returned MBR is a rectangle based on the center of the H3 cell and the largest cell size at that resolution.

Usage Notes

The approximate MBR is quicker to compute. You need to verify that the time and accuracy tradeoff is appropriate to your application.

Examples

The following example computes the exact MBR value.

```
SELECT SDO_UTIL.H3_MBR('0877AA5145FFFFFF', TRUE) FROM DUAL;

SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(48.8614522, 2.3465296, 48.8610871, 2.35865517, 48.8505953,
2.36541433,
48.8404669, 2.36004832, 48.840831, 2.34792133, 48.8513246, 2.34116178,
48.8614522,
2.3465296))
```

The following example converts the exact MBR to a bounding box.

```
SELECT SDO_GEOM.SDO_MBR(SDO_UTIL.H3_MBR('0877AA5145FFFFFF', TRUE)) FROM DUAL;

SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(48.8404669, 2.34116178, 48.8614522, 2.36541433))
```

The following example computes the approximate H3_MBR of the same cell:

```
SELECT SDO_UTIL.H3_MBR('0877AA5145FFFFFF', FALSE) FROM DUAL;

SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(48.8383005, 2.34064005, 48.8636193, 2.36593751))
```

Related Topics

- SDO_UTIL.H3_BOUNDARY
- SDO_UTIL.H3_CENTER
- SDO_UTIL.H3_HEX_EDGELEN

35.49 SDO_UTIL.H3_PARENT

Format

```
SDO_UTIL.H3_PARENT(
  h3_key     IN RAW,
  resolution IN NUMBER DEFAULT NULL
) RETURN RAW;
```

Description

Computes the containing H3 cell (64-bit (8 byte RAW)) for the given cell, based on the H3 hierarchy.

Parameters

h3_key
The H3 cell to query.

resolution
Specifies the level for which you want the containing cell.
H3_RESOLUTION`(h3_key)` must be a number. If NULL, then the immediate parent (one level coarser) is returned.

Usage Notes

Cells in the H3 hierarchy are not always strictly contained in their parent cells, and in some extreme cases, may not even touch the “containing” cell three or more levels coarser.

If you want the cell at several levels coarser resolution that most overlaps a given cell, an alternative approach would be to compute the H3 cell of the center. For example, SDO_UTIL.H3_KEY`(`SDO_UTIL.H3_CENTER`(h3_key), resolution)`.

Examples

The following example shows that the parent of a level-7 cell is a level-6 cell:

```
SELECT SDO_UTIL.H3_RESOLUTION('0877AA5145FFFFFF') FROM DUAL;
7

SELECT SDO_UTIL.H3_PARENT('0877AA5145FFFFFF') FROM DUAL;
0867AA5147FFFFFF
```

```
SELECT SDO_UTIL.H3_RESOLUTION('0867AA5147FFFFFF') FROM DUAL;
6
```

Related Topics

- SDO_UTIL.H3_RESOLUTION

35.50 SDO_UTIL.H3_PENTAGON_AREA

Format

```
SDO_UTIL.H3_PENTAGON_AREA(
  resolution IN NUMBER,
  unit       IN VARCHAR2 DEFAULT 'SQ_KM'
 ) RETURN NUMBER;
```

Description

Returns the size of a pentagon at the given resolution.

Parameters

resolution
The H3 level to query.

unit
The unit of area measurement to use (see Table 6-26).

Usage Notes

All pentagons at a given level are the same size in the H3 coordinate system (SRID 4326).

Examples

The following example shows the area of the smallest H3 pentagon (level 15):

```
SELECT SDO_UTIL.H3_PENTAGON_AREA(15, 'SQ_M') FROM DUAL;
.452
```

Related Topics

- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_PENTAGON_EDGELEN

35.51 SDO_UTIL.H3_PENTAGON_EDGELEN

Format

```
SDO_UTIL.H3_PENTAGON_EDGELEN(
  resolution IN NUMBER,
  unit       IN VARCHAR2 DEFAULT 'KM'
 ) RETURN NUMBER;
```

Description

Returns the length of an edge of a pentagon at the given resolution.

Parameters

resolution
The H3 level to query.

unit
The unit of area measurement to use (see Table 6-26).

Usage Notes

All pentagons at a given level are the same size in the H3 coordinate system (SRID 4326).

Examples

The following example shows the length of one side of the largest H3 pentagons:

```
SELECT SDO_UTIL.H3_PENTAGON_EDGELEN(0, 'KM') FROM DUAL;
1215.4
```

Related Topics

- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_HEX_EDGELEN
- SDO_UTIL.H3_IS_PENTAGON
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_PENTAGON_AREA

35.52 SDO_UTIL.H3_RESOLUTION

Format

```
SDO_UTIL.H3_RESOLUTION(
  h3_key     IN RAW
) RETURN NUMBER;
```

Description

Returns the resolution of an H3 cell from 0 (coarsest) to 15 (finest).

Parameters

h3_key
The H3 cell to query.

Usage Notes

None.

Examples

The following example shows the resolution of an H3 cell:

```
SELECT SDO_UTIL.H3_RESOLUTION('0877AA5145FFFFFF');
7
```

Related Topics

- SDO_UTIL.H3_PARENT

35.53 SDO_UTIL.H3SUM_AS_TABLE

Format

```
SDO_UTIL.H3SUM_AS_TABLE(
  h3table_in       VARCHAR2,
  levelnum         NUMBER,
  mbr              SDO_GEOMETRY
)RETURN H3SUM_TAB_T PIPELINED;
```

Description

Returns rows from an H3 summary table as a table of type `H3SUM_TAB_T` .

Parameters

h3table_in
The name of the H3 summary table to query.

levelnum
The H3 level to query within the H3 summary table.

mbr
The search query.

Usage Notes

The returned table has a fixed structure, with all the numeric columns returned as a single array. The information for these columns is implicit in the names of the columns in the H3 summary table, returned in the same order.

```
TYPE h3sum_row_t IS RECORD(
  hex            sdo_geometry,     -- The geometry of the hex
  levelnum       number(2),        -- The H3 level number
  h3             raw(8),           -- The h3 code of this cell
  cols           sdo_number_array  -- The payload data
);

TYPE h3sum_tab_t IS TABLE OF h3sum_row_t;
```

Examples

The following H3 summary table is created with three data fields: `ID_CNT`, `ID_MIN`, and `ID_MAX`. Every summary table automatically includes the `LEVELNUM` and `KEY` columns.

```
SQL> CREATE TABLE PARIS AS (SELECT *
    FROM SDO_UTIL.H3SUM_AS_TABLE('WORLD_H3', 2, SDO_GEOMETRY(2003, 4326, 
NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
         SDO_ORDINATE_ARRAY(48.8383005, 2.34064005, 48.8636193, 
2.36593751))));

Table created.

SQL> DESCRIBE PARIS;
 Name                                      Null?    Type
 ----------------------------------------- -------- 
----------------------------
 HEX                                                MDSYS.SDO_GEOMETRY
 LEVELNUM                                           NUMBER(2)
 H3                                                 RAW(8)
 COLS                                               MDSYS.SDO_NUMBER_ARRAY

SQL> SELECT * FROM PARIS WHERE ROWNUM < 2;

HEX(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
------------------------------------------------------------------------------
--
  LEVELNUM H3
---------- ----------------
COLS
------------------------------------------------------------------------------
--
SDO_GEOMETRY(2003, 4326, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), 
SDO_ORDINATE_ARRAY(48.4824473, .425072204, 48.9470689, 1.89827044, 
47.8984915, 3.15671027, 46.3634494, 2.96578105, 45.8697755, 1.48783745, 
46.9399386, .205091826, 48.4824473, .425072204))
         2 0827A17FFFFFFFFF
SDO_NUMBER_ARRAY(6, 40725, 40906)
```

The values `(6, 40725, 40906)` in the preceding query output correspond to the three user-data columns, `ID_CNT`, `ID_MIN`, and `ID_MAX` in the same order as they occur in the H3 summary table.

```
SQL> DESCRIBE WORLD_H3;
 Name                                      Null?    Type
 ----------------------------------------- -------- 
----------------------------
 LEVELNUM                                           NUMBER(2)
 KEY                                                RAW(8)
 ID_CNT                                             NUMBER
 ID_MIN                                             NUMBER
 ID_MAX                                             NUMBER
```

Related Topics

- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_GET_CURSOR
- SDO_UTIL.H3SUM_VECTORTILE

35.54 SDO_UTIL.H3SUM_CREATE_TABLE

Format

```
SDO_UTIL.H3SUM_CREATE_TABLE(
  table_out     IN VARCHAR2,
  table_in      IN VARCHAR2,
  geomcol_spec  IN VARCHAR2,
  col_spec      IN VARCHAR2,
  max_H3_level  IN NUMBER DEFAULT 15
);
```

Description

Creates an H3 summary table for geodetic point data.

Parameters

table_out
The name of the table to create.

table_in
The name of the input table, which contains point geometry information in a geodetic (longitude, latitude) coordinate system.

geomcol_spec
A description of the columns containing the point geometry. This is either the name of a column that contains the point geometries (for example, `'LOCATION'`), or the names of two NUMBER columns that form a (longitude, latitude) pair, separated by a comma (for example, `'X, Y'`).

col_spec
A list of numeric columns in the input table to summarize in the result table, along with the rule for summarizing the data. Each field is a column name and a summarizing math operation separated by a comma, and each field is separated by a semi-colon. The legal math operations are MIN, MAX, AVG, SUM, CNT. If no math operation is specified, CNT is assumed. The values are computed using the SQL functions MIN, MAX, AVG, SUM, and COUNT respectively. The value ‘1’ can be used as a column name and works as a column of values which are all 1. The values are computed using the SQL functions MIN, MAX, AVG, SUM, and COUNT respectively.
For example, `'Name,CNT; Vehicles,AVG; col2; col3,MAX'` would create columns `NAME_CNT` (counting the non-null Name values), `VEHICLES_AVG`, `COL2_CNT`, `COL3_MAX`.

max_H3_level
Specifies the maximum level (smallest cells) to create in the summary table.

Usage Notes

Creates a new table which summarizes the point data from a specified input table into one data row per H3 hex, per H3 resolution level. Only geometries which are single points are included;

non-point and multipoint data is ignored. H3 values are computed from the specified geometry columns. H3 key columns in the source table (if any) are ignored.

All points which are in the same hex have their data values combined. The `col_spec` specifies which numeric columns you want in the resulting output (H3 summary) table, and how you want the values combined. Only numeric data values can be in the H3 summary output table (including a simple count of the number of points, indicated using `“1,CNT”` as a data column).

The table is indexed for fast access by the SDO_UTIL.H3SUM_GET_CURSOR and SDO_UTIL.H3SUM_VECTORTILE functions.

Examples

Consider, the following WORLD table as an example:

```
SQL> describe WORLD
 Name                                      Null?    Type
 ----------------------------------------- -------- --------------------
 X                                                  NUMBER
 Y                                                  NUMBER
 ID                                                 NUMBER
 PT                                                 PUBLIC.SDO_GEOMETRY
 INFO                                               VARCHAR2(20)
```

The following code uses the `SDO_UTIL.H3SUM_CREATE_TABLE` procedure to create an H3 summary table which simply counts the number of points that are combined into each hex:

```
begin
sdo_util.h3sum_create_table('WORLD_H3', 'WORLD', 'pt', '1,CNT');
end;
/
```

On running the following SQL query on the H3 summary table, it is observed that although the number of points are the same at each level, the hexes are larger and fewer at the coarser levels (lower level numbers). Therefore, each row of the table represents more points:

```
SQL> select levelnum, count(1), sum(id_cnt) from WORLD_H3 group by levelnum
order by levelnum;

  LEVELNUM   COUNT(1) SUM(ID_CNT)
---------- ---------- -----------
         0        122       64621
         1        842       64621
         2       5882       64621
         3      38781       64621
         4      57074       64621
         5      61857       64621
         6      63650       64621
         7      64329       64621
         8      64442       64621
         9      64442       64621
        10      64442       64621

  LEVELNUM   COUNT(1) SUM(ID_CNT)
---------- ---------- -----------
```

```
         11       64442         64621
         12       64442         64621
         13       64442         64621
         14       64442         64621
         15       64442         64621

16 rows selected.
```

Related Topics

- SDO_UTIL.H3_KEY
- SDO_UTIL.H3SUM_VECTORTILE
- SDO_UTIL.H3SUM_AS_TABLE
- SDO_UTIL.H3SUM_GET_CURSOR

35.55 SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION

Format

```
SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION(
  h3_table     IN VARCHAR2 DEFAULT NULL,
  tile_zoom    IN NUMBER,
  hexes        IN NUMBER DEFAULT NULL
) RETURN NUMBER;
```

Description

Provides an H3 resolution which will result in approximately the requested number of hexes in the given tile.

Parameters

h3_table
The H3 table used to get the extent of the data. If `NULL`, then it is assumed that the data extent is global.

tile_zoom
The zoom value. This value is mandatory.

hexes
The number of hexes required in the given tile. If NULL, then a default value of 300 is used.

Usage Notes

The `SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION` procedure returns a number between 0 and 15 inclusive.

Increasing or decreasing the resolution by 1 changes the number of hexes by approximately a factor of 7. Also, note that the tiles near the equator represent areas as much as 130x larger than tiles at the poles. Therefore, the actual number of hexes in a tile will vary considerably from the goal value.

Examples

The following example queries use the `SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION` procedure to determine the estimated H3 resolution:

```
SELECT SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION(tile_zoom=>7) FROM DUAL;

SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION(TILE_ZOOM=>7)
------------------------------------------------
                                               5


SELECT SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION(tile_zoom=>7, hexes=>500) FROM DUAL;

SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION(500,TILE_ZOOM=>7)
----------------------------------------------------
                                                   6


SELECT SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION('QUTTINIRPAAQ_H3', tile_zoom=>7,
hexes=>500);


SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION('QUTTINIRPAAQ_H3',TILE_ZOOM=>7,HEXES=>500)
-----------------------------------------------------------------------------
                                                                            7
```

Related Topics

- SDO_UTIL.H3_BOUNDARY
- SDO_UTIL.H3_HEX_AREA
- SDO_UTIL.H3_NUM_CELLS
- SDO_UTIL.H3_RESOLUTION
- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_VECTORTILE

35.56 SDO_UTIL.H3SUM_GET_CURSOR

Format

```
SDO_UTIL.H3SUM_GET_CURSOR(
  h3_table          IN VARCHAR2,
  levelnum          IN NUMBER,
  mbr               SDO_GEOMETRY
)RETURN SYS_REFCURSOR;
```

Description

Creates a cursor for the results of searching an H3 summary table with the specified `levelnum` and search `mbr`.

Parameters

h3_table
The name of the H3 summary table to query.

levelnum
The H3 level to query within the H3 summary table.

mbr
The search query.

Usage Notes

None.

Related Topics

- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_VECTORTILE
- SDO_UTIL.H3SUM_GET_CURSOR

35.57 SDO_UTIL.H3SUM_VECTORTILE

Format

```
SDO_UTIL.H3SUM_VECTORTILE(
  h3_table          IN VARCHAR2,
  levelnum          IN NUMBER DEFAULT NULL,
  tile_x            IN NUMBER,
  tile_y            IN NUMBER,
  tile_zoom         IN NUMBER,
  layer_name        IN VARCHAR2 DEFAULT 'LAYER',
  tile_extent       IN NUMBER DEFAULT 4096,
  google_ts         IN BOOLEAN DEFAULT TRUE,
  max_features      IN NUMBER DEFAULT 20000
) RETURN BLOB;
```

or

```
FUNCTION H3SUM_VECTORTILE(
  h3_table          IN VARCHAR2,
  levelnum          IN NUMBER DEFAULT NULL,
  tile_x            IN NUMBER,
  tile_y_pbf        IN VARCHAR2,
  tile_zoom         IN NUMBER,
  layer_name        IN VARCHAR2 DEFAULT 'LAYER',
  tile_extent       IN NUMBER DEFAULT 4096,
  google_ts         IN BOOLEAN DEFAULT TRUE,
  max_features      IN NUMBER DEFAULT 20000
) RETURN BLOB;
```

Description

Creates and returns the specified MVT vector tile from an H3 summary table created with SDO_UTIL.H3SUM_CREATE_TABLE.

Parameters

h3_table
The H3 summary table to query.

levelnum
The H3 level to return. If `levelnum` is larger than the `max_H3_level` specified when the H3 summary table was created, no data will be returned. If not specified, a default value based on the `tile_zoom` value will be used.

tile_x
The X ordinate of the origin point of the tile being fetched.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(X) = (2^tile_zoom) - 1`. Note that specifying a X ordinate outside the valid range raises an exception.

tile_y
The Y ordinate (in `NUMBER` format) of the origin point of the tile being fetched.
The minimum valid value for this parameter is zero. The maximum valid value is dependent on the zoom specified and can be computed as `max(Y) = (2^tile_zoom) - 1`. Note that specifying a Y ordinate outside the valid range raises an exception.

tile_y_pbf
The `tile_y_pbf` value is a `VARCHAR2` string that specifies a number followed by any file extension. The Y ordinate value is extracted after stripping the file extension in the string. For example, consider the string value `‘23.pbf’` or `‘23.XYZ’`. Then `23` will be extracted as the Y ordinate value and everything after the ‘`.`’ will be stripped and ignored.

tile_zoom
Determines the number of tiles required to divide a map. These segments can be joined at a higher resolution without having to read in the entire map.
For instance, a `tile_zoom` of zero is a single tile of the entire map without a lot of details. A `tile_zoom` of `n` breaks the map into `2^n x 2^n` tiles (that is, the number of tiles along the X axis times the number of tiles along the Y axis). For example, at a `tile_zoom` of `8` there would be `65,536` tiles. A higher value of `n` implies more details in a tile. Note that the parameter values outside the valid range raise an exception.

layer_name
Name of the layer in the vector tile.
This is an optional parameter. Only a single layer having a default `'LAYER'` value is supported in the vector tile.

tile_extent
Integer coordinates that describe the width and height of the tile.
This is an optional parameter. The default value of `4096` indicates that the vector tile is `4096` units high and `4096` units wide. The actual size of these units varies based on the tiles zoom level. The distance between two coordinates within a tile will be much greater at zoom level zero than it would be at zoom level 12. It is recommended that you change the default parameter value only if using a non-standard tiling scheme.

google_ts
Boolean value that indicates if the Google tiling scheme is used.
This is an optional parameter. The default value is `TRUE` which indicates a GOOGLE tiling scheme.
The following two tiling schemes are supported when reading tile addresses:

- **GOOGLE (default):** In this tiling scheme, the origin point (X,Y) of a tile is in the northwest corner. The X ordinates increase as tiles are read from west to east. The Y ordinates increase as tiles are read north to south.
- **TMS:** In this tiling scheme, the origin point (X,Y) of a tile is in the southwest corner. The X ordinates still increase as tiles are read west to east, but the Y ordinates increase as tiles are read south to north

max_features
Maximum number of features included in a layer.
This is an optional parameter with a default value 20000.
A vector tile is made up of layers. A layer is made up of features. A feature is a geometry that interacts with the tile envelope and any of its attribute columns. For large tile envelopes covering an entire state or an entire country, the number of buildings and their attributes can be very large. Processing overly large numbers of features can be resource intensive both on the CPU and memory.
Therefore, using this parameter allows you to control the maximum number of features to be included in a layer.

Usage Notes

The `SDO_UTIL.H3SUM_VECTORTILE` function can accept both the X and Y ordinates in `NUMBER` format or the X ordinate in `NUMBER` format and the Y ordinate with a `.PBF` suffix in `VARCHAR2` format at a specific zoom level.

In both cases, the data in the H3 summary table is returned as a set of polygons for the boundaries of the H3 cells (hexes and pentagons) that are visible on the specified tile, along with the associated column values. If the H3 summary table was limited to less than level 15, then there is no data in the summary table to return for values above that specified level, and an empty tile will be returned. Tile parameter values and rendering limits are the same as in SDO_UTIL.GET_VECTORTILE.

Examples

The following example describes the usage of `SDO_UTIL.H3SUM_VECTORTILE` function by visualization software to render maps.

```
SQL> SELECT
dbms_lob.getlength(SDO_UTIL.H3SUM_VECTORTILE(H3_TABLE=>'WORLD_H3',LEVELNUM=>1,
        TILE_X=>2,TILE_Y=>2,TILE_ZOOM=>2)) "BLOBSIZE" FROM DUAL;

  BLOBSIZE
----------
     14304
```

Related Topics

- SDO_UTIL.H3_KEY
- SDO_UTIL.H3SUM_CREATE_TABLE
- SDO_UTIL.H3SUM_ESTIMATE_RESOLUTION

35.58 SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS

Format

```
SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
```

Description

Initializes all spatial indexes in a tablespace that was transported to another database.

Parameters

None.

Usage Notes

This procedure is part of the support for using the Oracle transportable tablespace feature with tablespaces that contain any spatial indexes. Use this procedure only either (A) the import operation of pre-Release 11.2 dump files is completed, or (B) after the import operation from different endian platform in Release 11.2 or later is completed. Each user that has a spatial index in the tablespace must call the procedure.

For pre-Release 11.2 dump files, after calling the SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS procedure, you must execute a statement in the following format for each index that is in the imported transportable tablespace:

```
ALTER INDEX spatial-index-from-imported-tts PARAMETERS ('CLEAR_TTS=TRUE');
```

For detailed information about transportable tablespaces and transporting tablespaces to other databases, see *Oracle Database Administrator's Guide*.

Examples

The following example for an import of pre-Release 11.2 dump files initializes all spatial indexes in a tablespace that was transported to another database. It also includes the required ALTER INDEX statement for two hypothetical spatial indexes.

```
CALL SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
ALTER INDEX xyz1_spatial_idx PARAMETERS ('CLEAR_TTS=TRUE');
ALTER INDEX xyz2_spatial_idx PARAMETERS ('CLEAR_TTS=TRUE');
```

In the following example, the owner of the spatial index must call the SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS procedure only if the SELECT statement returns the string `Y`, to reflect the fact that the spatial indexes are imported from different endian platforms in Release 11.2.

```
SELECT DECODE(BITAND(sdo_index_version, 1024), 1024, 'Y', 'N') ENDIAN_FLAG
  FROM user_sdo_index_metadata
  WHERE sdo_index_name = :index_name;
-- If the result is 'Y', perform the next statement.
CALL SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
-- No ALTER INDEX statements are needed.
```

In this example, if you call the SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS procedure when the SELECT statement returns the string `N`, the procedure does nothing because there is no need to perform endian conversion.

Related Topics

None.

35.59 SDO_UTIL.INSERT_SDO_GEOM_METADATA

Format

```
SDO_UTIL.INSERT_SDO_GEOM_METADATA(
  owner       IN   VARCHAR2,
  table_name  IN VARCHAR2,
  column_name IN VARCHAR2,
  diminfo     IN SDO_DIM_ARRAY,
  srid        IN NUMBER);
```

Description

Adds metadata for a spatial table to the geometry metadata views USER_SDO_GEOMETRY_METADATA and ALL_SDO_GEOMETRY_METADATA.

Parameters

owner
Name of the schema that owns the spatial table. Must be uppercase.

table_name
Name of the spatial table (a feature table that has a column of type SDO_GEOMETRY). Must be uppercase.

column_name
Name of the column of type SDO_GEOMETRY. Must be uppercase.

diminfo
Varying length array of an object type, ordered by dimension, and has one entry for each dimension. (The SDO_DIM_ARRAY type is explained in DIMINFO.)

srid
Either of the following: the SDO_SRID value for the coordinate system for all geometries in the column, or NULL if no specific coordinate system should be associated with the geometries.

Usage Notes

This procedure is an alternative to using the SQL INSERT statement to add metadata for a spatial table to the geometry metadata views. (The use of an INSERT statement to update the USER_SDO_GEOMETRY_METADATA view is shown in Simple Example: Inserting, Indexing, and Querying Spatial Data.)

To use this procedure on a spatial table in another user’s schema, you must have DBA privileges or the SELECT privilege on that other user’s table. For example, if USER1 wants to insert geometry metadata for the USER2.COLA_MARKETS table, then USER1 must have DBA privileges or the SELECT privilege on the USER2.COLA_MARKETS table.

Examples

The following example adds metadata for a spatial table named COLA_MARKETS with the geometry column named SHAPE in the USER2 schema. It also creates the spatial index. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
---------------------------------------------------------------------------
-- UPDATE METADATA VIEWS --
---------------------------------------------------------------------------
```

```
-- Add information to the USER_SDO_GEOM_METADATA and USER_SDO_GEOM_METADATA views. This
-- is required before the spatial index can be created. Do this only once for each layer
-- (that is, table-column combination; here: cola_markets and shape).

EXECUTE SDO_UTIL.INSERT_SDO_GEOM_METADATA ('USER2', 'COLA_MARKETS', 'SHAPE', -
  SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, 0.005), -
                SDO_DIM_ELEMENT('Y', 0, 20, 0.005)), -
  NULL);

-------------------------------------------------------------------
-- CREATE THE SPATIAL INDEX --
-------------------------------------------------------------------

CREATE INDEX cola_spatial_idx
ON cola_markets(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX_V2;
```

Related Topics

- Geometry Metadata Views for an explanation of the USER_SDO_GEOM_METADATA and ALL_SDO_GEOM_METADATA views
- SRID attribute of the SDO_GEOMETRY type
- Coordinate Systems (Spatial Reference Systems) for detailed information about support for coordinate systems
- SDO_UTIL.DELETE_SDO_GEOM_METADATA

35.60 SDO_UTIL.INTERIOR_POINT

Format

```
SDO_UTIL.INTERIOR_POINT(
     geom IN SDO_GEOMETRY,
     tol  IN NUMBER  DEFAULT 0.00000000005
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a point that is guaranteed to be an interior point (not on the boundary or edge) on the surface of a polygon geometry object.

Parameters

geom
Polygon geometry object. The SDO_GTYPE value of the geometry must be 2003 or 2007. (SDO_GTYPE values are explained in SDO_GTYPE.)

tol
Tolerance value (see Tolerance).

Usage Notes

This function returns a point geometry object representing a point that is guaranteed to be an interior point on the surface, but not on the boundary or edge, of `geom`. The returned point can be any interior point on the surface; however, if you call the function multiple times with the same `geom` and `tol` parameter values, the returned point will be the same.

The relationship between the returned point and the original geometry is INSIDE, which you can check using the SDO_RELATE operator with`'mask=inside'`.

In most cases this function is more useful than the SDO_GEOM.SDO_POINTONSURFACE function, which returns a point that is not guaranteed to be an interior point.

Examples

The following example returns a geometry object that is an interior point on the surface of `cola_a`. (The example uses the definitions and data from Simple Example: Inserting, Indexing, and Querying Spatial Data.)

```
-- Return an interior point on the surface of a geometry.
SELECT SDO_UTIL.INTERIOR_POINT(c.shape, 0.005)
  FROM cola_markets c
  WHERE c.name = 'cola_a';

SDO_UTIL.INTERIOR_POINT(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(2.75, 2.875, NULL), NULL, NULL)
```

Related Topics

None.

35.61 SDO_UTIL.LINEAR_KEY

Format

```
SDO_UTIL.LINEAR_KEY(
     geometry  IN SDO_GEOMETRY,
     min_x     IN NUMBER DEFAULT 0.0,
     min_y     IN NUMBER DEFAULT 0.0,
     max_x     IN NUMBER DEFAULT 0.0,
     max_y     IN VARCHAR2 DEFAULT 'FALSE',
     lvl       IN NUMBER DEFAULT 8
     ) RETURN RAW;
```

Description

Returns a linear (Hilbert) key for a geometry at the specified level. (If the geometry is not a point, it uses some points on the geometry to generate the key.)

Parameters

geometry
Input geometry for which to generate a linear (Hilbert) key.

min_x
Minimum value along the x-axis to consider in generating the key. (See the Usage Notes for more information.)

min_y
Minimum value along the y-axis to consider in generating the key. (See the Usage Notes for more information.)

max_x
Maximum value along the x-axis to consider in generating the key. (See the Usage Notes for more information.)

max_y
Maximum value along the y-axis to consider in generating the key. (See the Usage Notes for more information.)

lvl
A value greater than or equal to 1, where 1 is the size of 1/4 of the coordinate system bounds. The default value is 8. (See the Usage Notes for more information.)

Usage Notes

The main use case for this function is to be able to cluster data using this linear key so that the goemetries that are close to each other are also close to each other on the disk. Another use case is to be able to generate clusters for data using this linear key.

Linear key clustering is an efficient technique for boosting performance for large point data sets. This function is parallel enabled, and can cluster millions of rows in seconds. You can imagine the world as covered by a piece of graph paper, with each cell of the paper having a unique ID. Oracle Spatial does not actually create such cells, but when you pass a point into the SDO_UTIL.LINEAR_KEY function, it returns a "cell" ID. Many points can map to the same cell ID (thus the "clustering"). You can use the `lvl` parameter to affect the cell size: larger cell sizes (`lvl` values) will result in more points mapping to the same cell, resulting in fewer cluster groups.

For `min_x`, `min_y`, `max_x`, `max_y`, with longitude/latitude data (geodetic SRS) the values are -180, -180, 180, 180 for square cells, although you can specify -180, -90, 180, 90 if you want rectangular cells. With projected coordinate systems, the bounds values vary; for example, with World Mercator the recommended values are -20037508, -20037508, 20037508, 20037508.

The clustering results can be persisted in a table or generated "on the fly". See the Examples for an example of each approach.

Before using this function, you should validate the input geometry using the SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT function.

Examples

The following example persists the results in a table. This approach is especially recommended when clustering large data sets. The example uses a lvl value of 17, and specifies substantial degree of parallel execution through the optimizer hint (`/*+ append parallel(16) */`).

```
ALTER SESSION ENABLE PARALLEL DML;
DROP TABLE results;
CREATE TABLE results (cnt NUMBER, cell_center SDO_GEOMETRY);
INSERT /*+ append parallel(16) */ INTO results NOLOGGING
SELECT  count(*) cnt
              ,sdo_geom.sdo_centroid(sdo_util.hhcell_boundary
(cell_id,-180,-180,180,180), .05) cell_center
FROM (SELECT sdo_util.linear_key (geom, -180,-180,180,180,17) as cell_id
             FROM lon_lat_geoms)
GROUP BY cell_id;
```

The following performs "on the fly" clustering of point data. This example uses a `lvl` value of 13. A low degree of parallel execution may be sufficient for this approach, although you can specify higher values.

```
SELECT /*+ parallel(2) */  count(*) cnt
         ,sdo_geom.sdo_centroid(set_srid (sdo_util.hhcell_boundary
(cell_id,-180,-180,180,180), 4326), .05) cell_center
FROM (SELECT sdo_util.linear_key (geom, -180,-180,180,180,13) as cell_id
         FROM lon_lat_geoms
         WHERE sdo_filter(geom,sdo_geometry(2003,4326,null,sdo_elem_info_array(1,1003,3),
                                       sdo_ordinate_array(-72,41,-71,42))) = 'TRUE')
GROUP BY cell_id;
```

Related Topics

- SDO_UTIL.H3_KEY

35.62 SDO_UTIL.POINT_AT_BEARING

Format

```
SDO_UTIL.POINT_AT_BEARING(
     start_point IN SDO_GEOMETRY,
     bearing     IN NUMBER,
     distance    IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a point geometry that is at the specified distance and bearing from the start point.

Parameters

start_point
Point geometry object from which to compute the distance at the specified bearing, to locate the desired point. The point geometry must be based on a geodetic coordinate system.

bearing
Number of radians, measured clockwise from North. Must be in the range of either -*pi* to *pi* or 0 to 2**pi*. (Either convention on ranges will work).

distance
Number of meters from `start_point` and along the initial bearing direction to the computed destination point. Must be less than one-half the circumference of the Earth.

Usage Notes

The input point geometry must be based on a geodetic coordinate system. If it is based on a non-geodetic coordinate system, this function returns a null value.

To convert decimal degrees to radians or nonmetric distances to meters, you can use the SDO_UTIL.CONVERT_UNIT function. To compute the bearing and tilt from a start point to an end point, you can use the SDO_UTIL.BEARING_TILT_FOR_POINTS procedure.

Examples

The following example returns the point 100 kilometers at a bearing of 1 radian from the point with the longitude and latitude coordinates (-72, 43).

```
SELECT SDO_UTIL.POINT_AT_BEARING(
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-72, 43, NULL), NULL, NULL),
  1,  -- 1 radian (57.296 degrees clockwise from North)
  100000 -- 100 kilometers
) FROM DUAL;

SDO_UTIL.POINT_AT_BEARING(SDO_GEOMETRY(2001,8307,SDO_POINT_TYPE(-72,43,NULL),NUL
--------------------------------------------------------------------------------
SDO_GEOMETRY(2001, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
-70.957053, 43.4811935))
```

Related Topics

- SDO_UTIL.BEARING_TILT_FOR_POINTS
- SDO_UTIL.CONVERT_UNIT

35.63 SDO_UTIL.POLYGONTOLINE

Format

```
SDO_UTIL.POLYGONTOLINE(
     geometry  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Converts all polygon-type elements in a geometry to line-type elements, and sets the SDO_GTYPE value accordingly.

Parameters

geometry
Geometry to convert.

Usage Notes

The order of the vertices of each resulting line-type element is the same as in the associated polygon-type element, and the start and end points of each line-type segment are the same point.

If the input geometry is a line, it is returned.

Examples

The following example converts the input polygon geometry, which is the same geometry as cola_b (see Simple Example: Inserting_ Indexing_ and Querying Spatial Data), to a line string geometry. In the returned geometry, the SDO_GTYPE value (2002) indicates a two-dimensional LINE geometry, and the SDO_ETYPE value (2) and SDO_INTERPRETATION value (1) in the SDO_ELEM_INFO array indicate a line string whose vertices are connected by straight line segments.

```
SELECT SDO_UTIL.POLYGONTOLINE(
  SDO_GEOMETRY(
    2003,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
  )
) FROM DUAL;

SDO_UTIL.POLYGONTOLINE(SDO_GEOMETRY(2003,--TWO-DIMENSIONALPOLYGONNULL,NULL,SDO_E
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

Related Topics

None.

35.64 SDO_UTIL.PURGE_VECTORTILE_CACHE

Format

```
SDO_UTIL.PURGE_VECTORTILE_CACHE(
  table_name     IN VARCHAR2
);
```

Description

Purges all vector tiles generated from data contained in the specified table.

Parameters

table_name
Name of the table or view whose containing vector tiles are purged from the cache.

Usage Notes

Generally there is only a single tile cache associated with a table. However, if a table has multiple geometry columns, then it can also have multiple tile caches. In such a case, calling `SDO_UTIL.PURGE_VECTORTILE_CACHE` will remove all vector tiles from all caches associated with the table, but the caches will remain enabled.

Examples

The following example calls `SDO_UTIL.PURGE_VECTORTILE_CACHE` to purge cache on the `counties` table.

```
-- Enable a cache on the Counties table using the geometry column
EXEC SDO_UTIL.ENABLE_VECTORTILE_CACHE('counties', 'geom');

-- Compute a vector tile
SELECT SDO_UTIL.GET_VECTORTILE(TABLE_NAME=>'COUNTIES', GEOM_COL_NAME=>'GEOM',
                                 TILE_ZOOM=>8, TILE_X=>73, TILE_Y=>97,
                                 ATT_COL_NAMES=>sdo_string_array('COUNTY','LANDSQMI'))
  FROM dual;

-- Show the cache now contains a vector tile
SELECT COUNT(*) FROM SDO_VECTOR_TILE_CACHE$TABLE WHERE table_name='counties';

-- Purge the tile cache for COUNTIES
EXEC SDO_UTIL.PURGE_VECTORTILE_CACHE('counties');

-- Show that the cache is still enabled
SELECT * FROM SDO_VECTOR_TILE_CACHE$INFO WHERE table_name='counties';
```

```
-- Verify that the cached tiles are purged from the cache
SELECT COUNT(*) FROM SDO_VECTOR_TILE_CACHE$TABLE WHERE table_name='counties';
```

35.65 SDO_UTIL.RECTIFY_GEOMETRY

Format

```
SDO_UTIL.RECTIFY_GEOMETRY(
     geometry  IN SDO_GEOMETRY,
     tolerance IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Fixes certain problems with the input geometry, and returns a valid geometry.

Parameters

geometry
Geometry to be checked for problems that can be fixed.

tolerance
Tolerance value (see Tolerance).

Usage Notes

This function checks for the following problems that can make a geometry invalid, and fixes the problems in the returned geometry:

- Duplicate vertices
- Polygon boundary intersecting itself
- Incorrect orientation of exterior or interior rings (or both) of a polygon

If the input geometry has any other problem that makes it invalid, the function raises an exception.

If the input geometry is valid, the function returns a geometry that is identical to the input geometry.

For information about using this function as part of the recommended procedure for loading and validating spatial data, see Recommendations for Loading and Validating Spatial Data.

This function is used internally by the SDO_UTIL.SIMPLIFY function as part of the geometry simplification process.

This function internally calls the SDO_GEOM.SDO_SELF_UNION function if necessary.

Examples

The following example checks the `cola_b` geometry to see if it has problems that can be fixed. (In this case, the geometry is valid, so the input geometry is returned. The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.RECTIFY_GEOMETRY(shape, 0.005)
  FROM COLA_MARKETS c WHERE c.name = 'cola_b';

SDO_UTIL.RECTIFY_GEOMETRY(SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

Related Topics

SDO_UTIL.RECTIFY_GEOMETRY

SDO_GEOM.SDO_SELF_UNION

35.66 SDO_UTIL.REMOVE_DUPLICATE_VERTICES

Format

```
SDO_UTIL.REMOVE_DUPLICATE_VERTICES(
     geometry  IN SDO_GEOMETRY,
     tolerance IN NUMBER
     ) RETURN SDO_GEOMETRY;
```

Description

Removes duplicate (redundant) vertices from a geometry.

Parameters

geometry
Geometry from which to remove duplicate vertices.

tolerance
Tolerance value (see Tolerance).

Usage Notes

When two consecutive vertices in a geometry are the same or within the tolerance value associated with the geometry, Spatial considers the geometry to be invalid. The Spatial geometry validation functions return the error ORA-13356 in these cases. You can use the REMOVE_DUPLICATE_VERTICES function to change such invalid geometries into valid geometries.

This function also closes polygons so that the first vertex of the ring is the same as the last vertex of the ring.

This function is not supported for any point geometries (including oriented points).

If the input geometry does not contain any duplicate vertices, it is returned.

Examples

The following example removes a duplicate vertex from the input geometry, which is the same geometry as cola_b (see Simple Example: Inserting_ Indexing_ and Querying Spatial Data) except that it has been deliberately made invalid by adding a third vertex that is the same point as the second vertex (8,1).

```
SELECT SDO_UTIL.REMOVE_DUPLICATE_VERTICES(
  SDO_GEOMETRY(
    2003,  -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,1, 8,6, 5,7, 5,1) -- 2nd and 3rd points
                                                 -- are duplicates.
  ),
  0.005 -- tolerance value
```

```
) FROM DUAL;

SDO_UTIL.REMOVE_DUPLICATE_VERTICES(SDO_GEOMETRY(2003,--TWO-DIMENSIONALPOLYGONNUL
--------------------------------------------------------------------------------
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

Related Topics

None.

35.67 SDO_UTIL.REVERSE_LINESTRING

Format

```
SDO_UTIL.REVERSE_LINESTRING(
     geometry  IN SDO_GEOMETRY
     ) RETURN SDO_GEOMETRY;
```

Description

Returns a line string geometry with the vertices of the input geometry in reverse order.

Parameters

geometry
Line string geometry whose vertices are to be reversed in the output geometry. The SDO_GTYPE value of the input geometry must be 2002. (SDO_GTYPE explains SDO_GTYPE values.)

Usage Notes

Because the SDO_GTYPE value of the input geometry must be 2002, this function cannot be used to reverse LRS geometries. To reverse an LRS geometry, use the SDO_LRS.REVERSE_GEOMETRY function, which is described in SDO_LRS Package (Linear Referencing System) .

Examples

The following example returns a line string geometry that reverses the vertices of the input geometry.

```
SELECT SDO_UTIL.REVERSE_LINESTRING(
  SDO_GEOMETRY(2002, 8307, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
    SDO_ORDINATE_ARRAY(-72,43, -71.5,43.5, -71,42, -70,40))
) FROM DUAL;

SDO_UTIL.REVERSE_LINESTRING(SDO_GEOMETRY(2002,8307,NULL,SDO_ELEM_INFO_ARRAY(1,2,
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
-70, 40, -71, 42, -71.5, 43.5, -72, 43))
```

Related Topics

- SDO_LRS.REVERSE_GEOMETRY (in SDO_LRS Package (Linear Referencing System))

35.68 SDO_UTIL.REVOKE_VECTORTILE_CACHE

Format

```
SDO_UTIL.REVOKE_VECTORTILE_CACHE(
  schema_name     IN VARCHAR2
);
```

Description

Revokes privileges on vector tile caches for the specified schema.

Parameters

schema_name
Name of the schema whose privileges on a vector tile cache is revoked.

Usage Notes

You can revoke a vector tile cache access for a schema by calling `SDO_UTIL.REVOKE_VECTORTILE_CACHE`. Note that if the schema user attempts to call `SDO_UTIL.GET_VECTORTILE` after the cache access privilege is revoked, a vector tile is still returned. However, this vector tile is a computed one and not from the cache. Only when the owning schema user revokes access on the source table (that contains the source data to build the vector tiles) as well, then a call to SDO_UTIL.GET_VECTORTILE does not return a tile.

Examples

The following example calls `SDO_UTIL.REVOKE_VECTORTILE_CACHE` to revoke `user_b` privileges on the vector tile cache owned by `user_a`.

```
-- user_a revokes user_b access to the cache
SDO_UTL.REVOKE_VECTORTILE_CACHE('user_b');
```

Although cache access is revoked, if `user_b` attempts to call `SDO_UTIL.GET_VECTORTILE`, then the vector tile is computed and returned.

```
-- user_b attempts to access the cache
SELECT SDO_UTIL.GET_VECTORTILE(TABLE_NAME=>'USER_A.COUNTIES',
                                   GEOM_COL_NAME=>'GEOM',
                                   TILE_ZOOM=>8, TILE_X=>73, TILE_Y=>97,
                                   ATT_COL_NAMES=>sdo_string_array('COUNTY','LANDSQMI'))
FROM dual;
```

In case `user_a` revokes access to the `counties` table (`REVOKE READ ON counties FROM user_b;`) as well, then no tile is returned when user_b attempts to run the preceding code. Only an error message stating that `USER_A.COUNTIES` does not exist is displayed.

35.69 SDO_UTIL.SIMPLIFY

Format

```
SDO_UTIL.SIMPLIFY(
     geometry     IN SDO_GEOMETRY,
     threshold    IN NUMBER
     tolerance    IN NUMBER DEFAULT 0.0000005,
     remove_loops IN NUMBER DEFAULT 0
     ) RETURN SDO_GEOMETRY;
```

Description

Simplifies the input geometry, based on a threshold value, using the Douglas-Peucker algorithm.

Parameters

geometry
Geometry to be simplified.

threshold
Threshold value to be used for the geometry simplification. Should be a positive number. (Zero causes the input geometry to be returned.) If the input geometry is geodetic, the value is the number of meters; if the input geometry is non-geodetic, the value is the number of units associated with the data.
As the threshold value is decreased, the returned geometry is likely to be closer to the input geometry; as the threshold value is increased, fewer points are likely to be in the returned geometry. See the Usage Notes for more information.

tolerance
Tolerance value (see Tolerance). Must not be greater than `threshold`; and for better performance, should not be the same as `threshold`. If you do not specify a value, the default value is 0.0000005.

remove_loops
For some line geometries, when the line is simplified, it might end up with self-crossing loops in the middle. While this is a valid geometry (for lines), in some cases it is not desirable to have these loops in the result of the simplify operation. A value of `0` (the default) does not remove such loops; a value of `1` (or any other nonzero positive number) removes any such loops and always returns simple line segments.

Usage Notes

This function also converts arcs to line stings, eliminates duplicate vertices, and corrects many overlapping edge polygon problems. The reason this function sometimes fixes problems is that it internally calls the SDO_UTIL.RECTIFY_GEOMETRY function at the end of the simplification process to ensure that a valid geometry is returned. However, note that if two perfectly aligned geometries are simplified independently, the geometries might not be aligned after simplification.

This function is useful when you want a geometry with less fine resolution than the original geometry. For example, if the display resolution cannot show the hundreds or thousands of turns in the course of a river or in a political boundary, better performance might result if the geometry were simplified to show only the major turns.

If you use this function with geometries that have more than two dimensions, only the first two dimensions are used in processing the query, and only the first two dimensions in the returned geometry are to be considered valid and meaningful.

This function uses the Douglas-Peucker algorithm, which is explained in several cartography textbooks and reference documents. (In some explanations, the term *tolerance* is used instead of *threshold*; however, this is different from the Oracle Spatial meaning of tolerance.)

Compare this function with SDO_UTIL.SIMPLIFYVW, which uses the Visvalingham-Whyatt algorithm.

The returned geometry can be a polygon, line, or point, depending on the geometry definition and the threshold value. The following considerations apply:

- A polygon can simplify to a line or a point and a line can simplify to a point, if the threshold value associated with the geometry is sufficiently large. For example, a thin rectangle will simplify to a line if the distance between the two parallel long sides is less than the threshold value, and a line will simplify to a point if the distance between the start and end points is less than the threshold value.
- In a polygon with a hole, if the exterior ring or the interior ring (the hole) simplifies to a line or a point, the interior ring disappears from (is not included in) the resulting geometry.
- Topological characteristics of the input geometry might not be maintained after simplification. For a collection geometry, the number of elements might increase, to prevent overlapping of individual elements. In all cases, this function will not return an invalid geometry.

This function is not supported for Linear referencing system (LRS) geometries (which are described in Linear Referencing System).

Examples

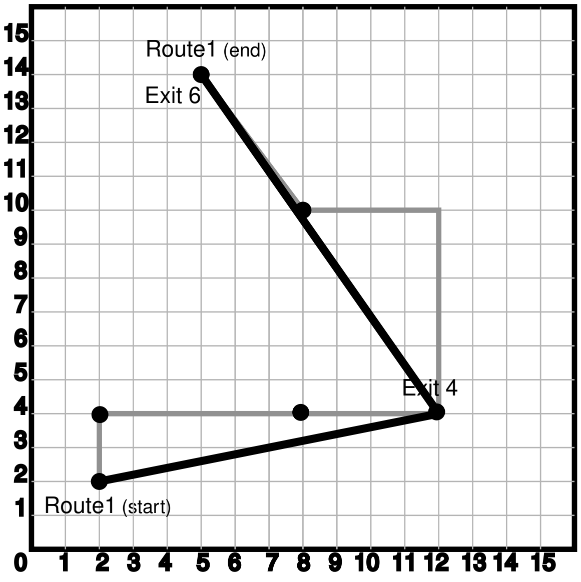
The following example simplifies a line string geometry that reflects the vertices of the road shown in Figure 7-20 in Example of LRS Functions, although the geometry in this example is not an LRS geometry. With the threshold value as 6, the resulting line string has only three points: the start and end points, and (12, 4,12).

```
SELECT SDO_UTIL.SIMPLIFY(
  SDO_GEOMETRY(
    2002,  -- line string, 2 dimensions (X,Y)
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    SDO_ORDINATE_ARRAY(
      2,2,   -- Starting point
      2,4,
      8,4,
      12,4,
      12,10,
      8,10,
      5,14)  -- Ending point
  ),
  6, -- threshold value for geometry simplification
  0.5  -- tolerance
) FROM DUAL;

SDO_UTIL.SIMPLIFY(SDO_GEOMETRY(2002,--LINESTRING,2DIMENSIONS(X,Y)NULL,NULL,SDO_E
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 12, 4, 5, 14))
```

Figure 35-1 shows the result of this example. In Figure 35-1, the thick solid black line is the resulting geometry, and the thin solid light line between the start and end points is the input geometry.

Figure 35-1 Simplification of a Geometry



Related Topics

SDO_UTIL.SIMPLIFYVW

SDO_UTIL.RECTIFY_GEOMETRY

35.70 SDO_UTIL.SIMPLIFYVW

Format

```
SDO_UTIL.SIMPLIFYVW(
     geometry         IN SDO_GEOMETRY,
     vertex_threshold IN NUMBER,
     tolerance        IN NUMBER DEFAULT 0.0000005,
     remove_loops     IN NUMBER DEFAULT 0
     ) RETURN SDO_GEOMETRY;
```

Description

Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.

Parameters

geometry
Geometry to be simplified.

vertex_threshold
Threshold value to be used for the geometry simplification, expressed as a percentage value between 0 and 100. As the value is decreased, the returned geometry is likely to be closer to the input geometry; as the value is increased, fewer points are likely to be in the returned geometry.
You may want to experiment with different values to get the desired level of simplification.

tolerance
Tolerance value (see Tolerance). If you do not specify a value, the default value is 0.0000005.

remove_loops
For some line geometries, when the line is simplified, it might end up with self-crossing loops in the middle. While this is a valid geometry (for lines), in some cases it is not desirable to have these loops in the result of the simplify operation. A value of `0` (the default) does not remove such loops; a value of `1` (or any other nonzero positive number) removes any such loops and always returns simple line segments.

Usage Notes

> **Note:**
>
> The SDO_UTIL.SIMPLIFYVW function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

See the Usage Notes for the SDO_UTIL.SIMPLIFY function, which also simplifies an input geometry but uses a different algorithm (Douglas-Peucker).

Examples

The following example simplifies the same line string geometry used in the example for SDO_UTIL.SIMPLIFY.

```
SELECT SDO_UTIL.SIMPLIFYVW(
  SDO_GEOMETRY(
    2002,  -- line string, 2 dimensions (X,Y)
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    SDO_ORDINATE_ARRAY(
      2,2,   -- Starting point
      2,4,
      8,4,
      12,4,
      12,10,
      8,10,
      5,14)  -- Ending point
  ),
  80, -- threshold "percentage" value for geometry simplification
  0.5  -- tolerance
) FROM DUAL;

SDO_UTIL.SIMPLIFYVW(SDO_GEOMETRY(2002,--LINESTRING,2DIMENSIONS(X,Y)NULL,NULL,SDO
--------------------------------------------------------------------------------
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 12, 4, 5, 14))
```

Note that the resulting geometry in this case, using 80 as the `vertex_threshold` value, has the same points as the example for SDO_UTIL.SIMPLIFY, but without any measure dimension information (that is, the vertices are 2,2, 12,4, and 5,14). A significantly lower `vertex_threshold` value would probably result in a geometry with more vertices.

Related Topics

SDO_UTIL.SIMPLIFY

SDO_UTIL.RECTIFY_GEOMETRY

35.71 SDO_UTIL.THEME3D_GET_BLOCK_TABLE

Format

```
SDO_UTIL.THEME3D_GET_BLOCK_TABLE(
     theme_name   IN VARCHAR2
     ) RETURN NUMBER;
```

Description

Returns the block table (if any) for a 3D theme (DEM, PC, and TIN themes).

Parameters

theme_name
Name of the 3D theme. Must be a value from the USER_SDO_3DTHEMES or ALL_SDO_3DTHEMES view (described in xxx_SDO_3DTHEMES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.THEME3D_GET_BLOCK_TABLE function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function returns the name of the block table for the theme, if the theme has an associated block table. If there is no associated block table, the function returns a null value.

Examples

This example does the following for each theme in the USER_SDO_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER_SDO_3DTHEMES table.)

```
SELECT
  name,
  sdo_util.theme3d_has_lod(name) "Has LOD",
  sdo_util.theme3d_has_texture(name) "Has Texture",
  sdo_util.theme3d_get_block_table(name) "Block Table"
FROM user_sdo_3dthemes
ORDER BY name;

NAME                                Has LOD Has Texture Block Table
-------------------------------- ---------- ----------- -------------------------
DEM Hawaii Theme 4326                     1           0 DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles             1           1 DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme                        1           0 DEM_SPLITTED_HAWAII_4326
Geom Theme                                0           0
```

```
GeomForDEM Theme                          0            0
GeomForTIN Theme                          0            0
PC Category Theme                         1            0 PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326                      1            0 PC_BLOCKS_HAWAII_4326
PC Intensity Theme                        1            0 PC_BLOCKS_INTENSITY
PC LAS File Theme                         1            0 PC_BLOCKS_LAS
PC RGB Theme                              1            0 PC_BLOCKS_RGB
PC Split Theme                            1            0 PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme                    1            0 PC_SUBSET_BLOCKS_4326
PC Theme                                  0            0 PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326                     1            0 TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles             1            1 TIN_BLOCKS_HAWAII_4326
TIN Split Theme                           1            0 TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme                   1            0 TIN_SUBSET_BLOCKS_4326

18 rows selected.
```

Related Topics

- SDO_UTIL.THEME3D_HAS_LOD
- SDO_UTIL.THEME3D_HAS_TEXTURE

35.72 SDO_UTIL.THEME3D_HAS_LOD

Format

```
SDO_UTIL.THEME3D_HAS_LOD(
     theme_name  IN VARCHAR2
     ) RETURN NUMBER;
```

Description

Checks if a 3D theme has multiple levels of detail (LODs) (for DEM, PC, and TIN themes with pyramiding), or if a theme is involved in a chain of themes at multiple LODs (for SDO_GEOMETRY themes).

Parameters

theme_name
Name of the 3D theme. Must be a value from the USER_SDO_3DTHEMES or ALL_SDO_3DTHEMES view (described in xxx_SDO_3DTHEMES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.THEME3D_HAS_LOD function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function returns 0 (zero) if the theme does not have multiple LODs or link to a theme with multiple LODs; otherwise, it returns 1.

Examples

This example does the following for each theme in the USER_SDO_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER_SDO_3DTHEMES table.)

```
SELECT
  name,
  sdo_util.theme3d_has_lod(name) "Has LOD",
  sdo_util.theme3d_has_texture(name) "Has Texture",
  sdo_util.theme3d_get_block_table(name) "Block Table"
FROM user_sdo_3dthemes
ORDER BY name;

NAME                                Has LOD Has Texture Block Table
-------------------------------- ---------- ----------- ------------------------
DEM Hawaii Theme 4326                     1           0 DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles             1           1 DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme                        1           0 DEM_SPLITTED_HAWAII_4326
Geom Theme                                0           0
GeomForDEM Theme                          0           0
GeomForTIN Theme                          0           0
PC Category Theme                         1           0 PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326                      1           0 PC_BLOCKS_HAWAII_4326
PC Intensity Theme                        1           0 PC_BLOCKS_INTENSITY
PC LAS File Theme                         1           0 PC_BLOCKS_LAS
PC RGB Theme                              1           0 PC_BLOCKS_RGB
PC Split Theme                            1           0 PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme                    1           0 PC_SUBSET_BLOCKS_4326
PC Theme                                  0           0 PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326                     1           0 TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles             1           1 TIN_BLOCKS_HAWAII_4326
TIN Split Theme                           1           0 TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme                   1           0 TIN_SUBSET_BLOCKS_4326

18 rows selected.
```

Related Topics

- SDO_UTIL.THEME3D_GET_BLOCK_TABLE
- SDO_UTIL.THEME3D_HAS_TEXTURE

35.73 SDO_UTIL.THEME3D_HAS_TEXTURE

Format

```
SDO_UTIL.THEME3D_HAS_TEXTURE(
     theme_name  IN VARCHAR2
     ) RETURN NUMBER;
```

Description

Checks if a 3D theme has textures (for DEM, TIN, map tile server, and SDO_GEOMETRY themes).

Parameters

theme_name
Name of the 3D theme. Must be a value from the USER_SDO_3DTHEMES or ALL_SDO_3DTHEMES view (described in xxx_SDO_3DTHEMES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.THEME3D_HAS_TEXTURE function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function returns 0 (zero) if the theme does not have textures; otherwise, it returns 1.

Examples

This example does the following for each theme in the USER_SDO_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER_SDO_3DTHEMES table.)

```
SELECT
  name,
  sdo_util.theme3d_has_lod(name) "Has LOD",
  sdo_util.theme3d_has_texture(name) "Has Texture",
  sdo_util.theme3d_get_block_table(name) "Block Table"
FROM user_sdo_3dthemes
ORDER BY name;

NAME                                Has LOD Has Texture Block Table
-------------------------------- ---------- ----------- -------------------------
DEM Hawaii Theme 4326                     1           0 DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles             1           1 DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme                        1           0 DEM_SPLITTED_HAWAII_4326
Geom Theme                                0           0
GeomForDEM Theme                          0           0
GeomForTIN Theme                          0           0
PC Category Theme                         1           0 PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326                      1           0 PC_BLOCKS_HAWAII_4326
PC Intensity Theme                        1           0 PC_BLOCKS_INTENSITY
PC LAS File Theme                         1           0 PC_BLOCKS_LAS
PC RGB Theme                              1           0 PC_BLOCKS_RGB
PC Split Theme                            1           0 PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme                    1           0 PC_SUBSET_BLOCKS_4326
PC Theme                                  0           0 PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326                     1           0 TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles             1           1 TIN_BLOCKS_HAWAII_4326
TIN Split Theme                           1           0 TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme                   1           0 TIN_SUBSET_BLOCKS_4326

18 rows selected.
```

Related Topics

- SDO_UTIL.THEME3D_GET_BLOCK_TABLE

- SDO_UTIL.THEME3D_HAS_LOD

35.74 SDO_UTIL.TILE_GEOMETRY

Format

```
SDO_UTIL.TILE_GEOMETRY(
  geom                   IN SDO_GEOMETRY,
  x_axis_min             IN NUMBER,
  x_axis_max             IN NUMBER,
  y_axis_min             IN NUMBER,
  y_axis_max             IN NUMBER,
  tile_resolution        IN NUMBER,
  resolution_factor      IN NUMBER   := 0,
  perform_intersection   IN VARCHAR2 := 'TRUE',
  compute_percent        IN VARCHAR2 := 'FALSE',
  geodetic_tolerance     IN NUMBER   := .05)
  RETURN mdsys.tile_geom_table_type DETERMINISTIC
         PIPELINED PARALLEL_ENABLE;
```

Description

Tiles a geometry based on the specified tile resolution and resolution factor. Returns `MDSYS.TILE_GEOM_TABLE_TYPE`, which is a table of `MDSYS.TILE_GEOM_TYPE` objects.

Parameters

geom
Geometry to tile.

x_axis_min
Minimum value along the x-axis for tiling domain. (See the Usage Notes for more information.)

x_axis_max
Maximum value along the x-axis for tiling domain. (See the Usage Notes for more information.)

y_axis_min
Minimum value along the y-axis for tiling domain. (See the Usage Notes for more information.)

y_axis_max
Maximum value along the y-axis for tiling domain. (See the Usage Notes for more information.)

tile_resolution
Tile size value. (See the Usage Notes for more information.)

resolution_factor
A value factor applied to the `tile_resolution` parameter.
Default value is 0. (See the Usage Notes for more information.)

perform_intersection
A string value of `TRUE` (the default) clips boundary tiles to the geometry boundary.
A string value of `FALSE` returns full tiles along the geometry boundary.

compute_percent
The default string value is `FALSE`.

A string value of `TRUE` computes the value between 0 and 1. To compute this value `perform_intersection` must also be set to `TRUE`.

geodetic_tolerance
Default is `0.05`.
This parameter is only used if the geometry to tile is longitude/latitude. The default value can be overridden with a value smaller than 0.05.

Usage Notes

The `SDO_UTIL.TILE_GEOMETRY` function can be used to:

- Tile geometries, for example, farm plots or land parcels
- Tile geometries with the tiles that coincide with the cells of a raster.
  For raster cell sized tiles, use the extent of the raster as the tiling domain, and set the `tile_resolution` to the raster resolution.

This function returns a table of type `MDSYS.TILE_GEOM_TABLE_TYPE`, which is defined as follows:

```
CREATE OR REPLACE TYPE mdsys.tile_geom_table_type AS TABLE OF tile_geom_type;
```

The object type `MDSYS.TILE_GEOM_TYPE`, used in the preceding code, is defined as follows:

```
CREATE OR REPLACE TYPE mdsys.tile_geom_type AS OBJECT (
  tile_id      NUMBER,
  status       CHAR,
  percent      NUMBER,
  tile_center  SDO_GEOMETRY,
  geom         SDO_GEOMETRY);
```

The parameters used to define the object type, `MDSYS.TILE_GEOM_TYPE` are:

- **`tile_id`**: A unique number assigned to each tile, beginning with 1.
- **`status`**: The value can be either:
  - `'I'`: for interior tile
  - `'B'`: for boundary tile on the geometry
- **`percent`**: Percent of tile area coincident with geometry area. Value between 0 and 1. Interior tiles will always return 1.
- **`tile_center`**: Center point of the tile.
- **`geom`**: A geometry tile. If the parameter `perform_intersection` is `TRUE`, boundary tiles are clipped to the geometry boundary.

The parameters, `x_axis_min`, `x_axis_max`, `y_axis_min` and `y_axis_max` used in the `SDO_UTIL.TILE_GEOMETRY` function, represent the tiling domain. The tiling domain is an extent that contains all the geometries that are required to tile. For example, for longitude/latitude geometries, a tiling domain can be specified using the following parameter values:

`x_axis_min`: `-180`
`x_axis_max`: `180`
`y_axis_min`: `-90`
`y_axis_max`: `90`

Also note, if the same tiling domain is specified when tiling more than one geometry, common tiles are generated when geometries overlap.

The `tile_resolution` and `resolution_factor` parameters influence the tile size as highlighted in the following:

- The desired tile size value is determined by the `tile_resolution` parameter. For example, for a value 5, tiles will be 5x5 or a factor of 5x5 if the parameter `resolution_factor` is not 0.
- `resolution_factor`, when specified, applies a factor to the `tile_resolution` parameter, to tile a geometry with either smaller or larger tiles than `tile_resolution`.
  The following table describes the tile size as determined by the `resolution_factor` values:

Resolution Factor Value	Tile Size
0 (the default)	No factor is applied. Tiles size are driven by the `tile_resolution` parameter. See Example-1 for more information.
> 0	Tiles generated will be a factor smaller relative to the `tile_resolution` parameter. For example, for the following `resolution_factor` values: – 1: tile size is 1/4 smaller than `tile_resolution` – 2: tile size is 1/16 smaller than `tile_resolution` – 3: tile size is 1/64 smaller than `tile_resolution` See Example-2 for more information.
< 0	Tiles generated will be a factor larger relative to the `tile_resolution` parameter. For example, for the following `resolution_factor` values: – -1: tile size is 4 times larger than `tile_resolution` – -2: tile size is 16 times larger than `tile_resolution` – -3: tile size is 64 times larger than `tile_resolution` See Example-3 for more information.

However, when generating tiles, smaller tiles will be fully contained by larger tiles. Also, tiles generated with different resolutions, larger or smaller, will always be aligned.

Examples

The following examples tile geometries with the tiles that coincide with the cells of a raster. Also, the raster extent is projected (not longitude, latitude), so the domain extent is set to the extent of the raster. The parameter, `perform_intersection => 'TRUE'` in the examples, causes clipping of the boundary tiles to the boundary of the farm.

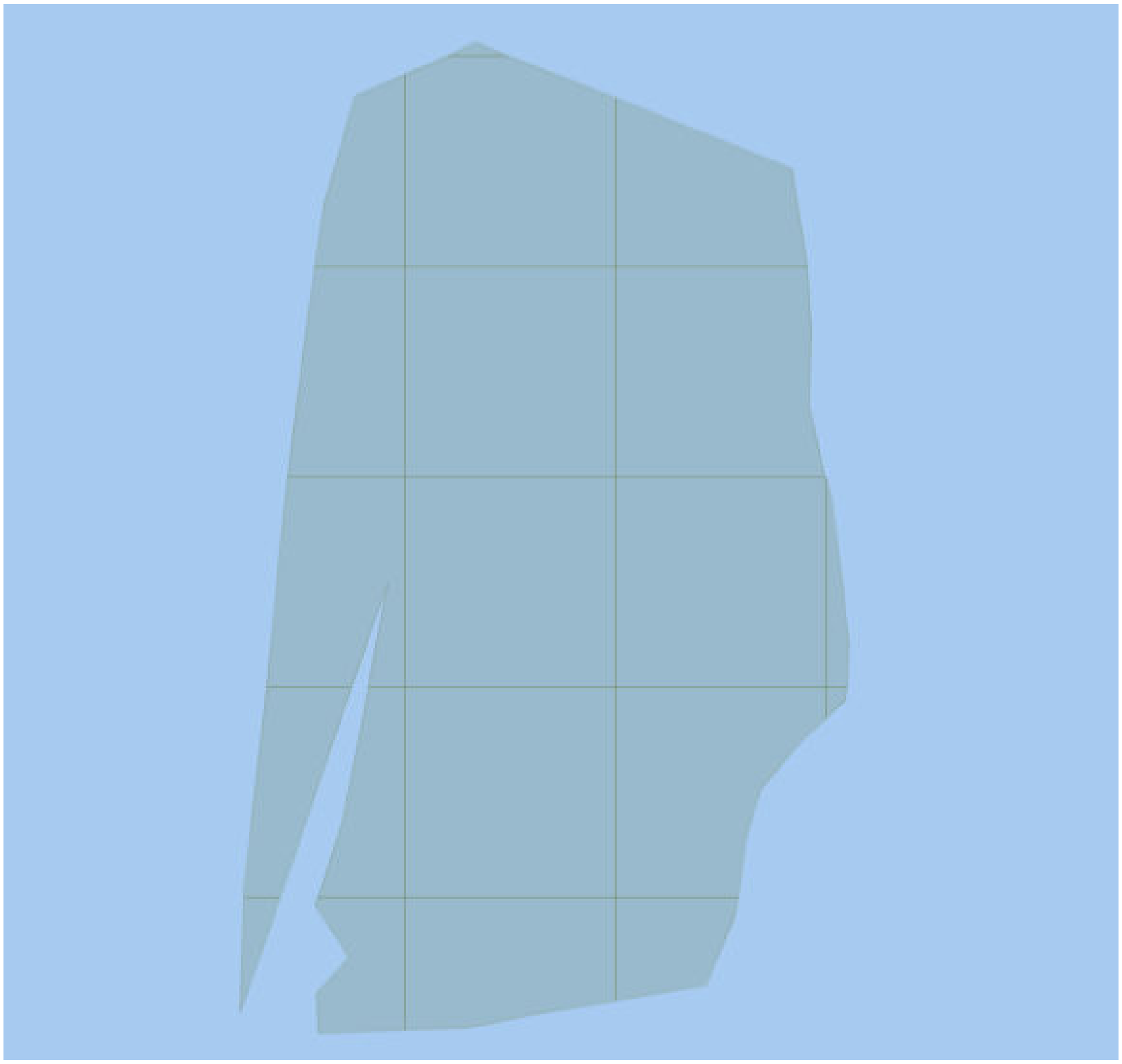
Example 1

This example tiles a farm geometry with tiles that are equal to the size of a raster cell. The resolution of the raster is 1000, so tiles will be 1000x1000

```
WITH
  part0 AS (SELECT b.tile_id,
                   b.status,
                   b.percent,
                   b.tile_center,
                   b.geom
            FROM farm_plots a,
            TABLE (sdo_util.tile_geometry(geom                 => a.geom,
                                          x_axis_min          => 272039.5,
                                          x_axis_max          => 275188.5,
                                          y_axis_min          => 370575.5,
                                          y_axis_max          => 380165.5,
                                          tile_resolution     => 1000,
                                          resolution_factor   => 0,
                                          perform_intersection => 'TRUE',
                                          compute_percent     => 'TRUE',
                                          geodetic_tolerance  => NULL)) b
            WHERE a.id = -1)
 SELECT tile_id, geom FROM part0 ORDER BY tile_id;
```

The following figure depicts the resulting output:

Figure 35-2 Tile size same as `tile_resolution`



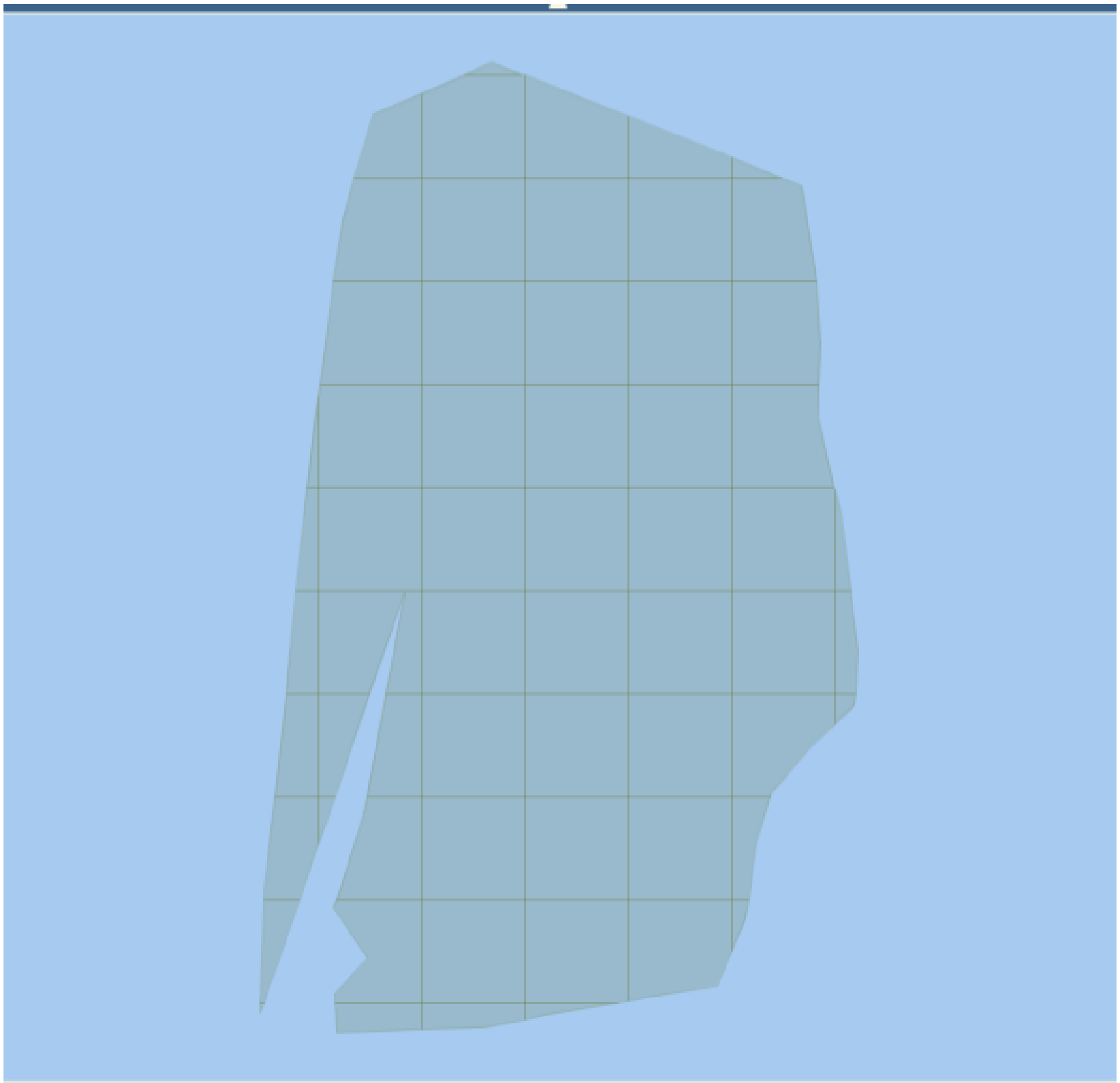
Example 2

The following example tiles a farm geometry with tiles that are 1/4 times smaller than 1000 x 1000, because `resolution_factor => 1` is specified.

```
WITH
  part0 AS (SELECT b.tile_id,
                   b.status,
                   b.percent,
                   b.tile_center,
                   b.geom
            FROM farm_plots a,
            TABLE (sdo_util.tile_geometry(geom                  => a.geom,
                                          x_axis_min            => 272039.5,
                                          x_axis_max            => 275188.5,
                                          y_axis_min            => 370575.5,
                                          y_axis_max            => 380165.5,
                                          tile_resolution       => 1000,
                                          resolution_factor     => 1,
                                          perform_intersection => 'TRUE',
                                          compute_percent       => 'TRUE',
                                          geodetic_tolerance    => NULL)) b
            WHERE a.id = -1)
 SELECT tile_id, geom FROM part0 ORDER BY tile_id;
```

The following figure depicts the resulting output:

Figure 35-3 Tile size smaller than `tile_resolution`



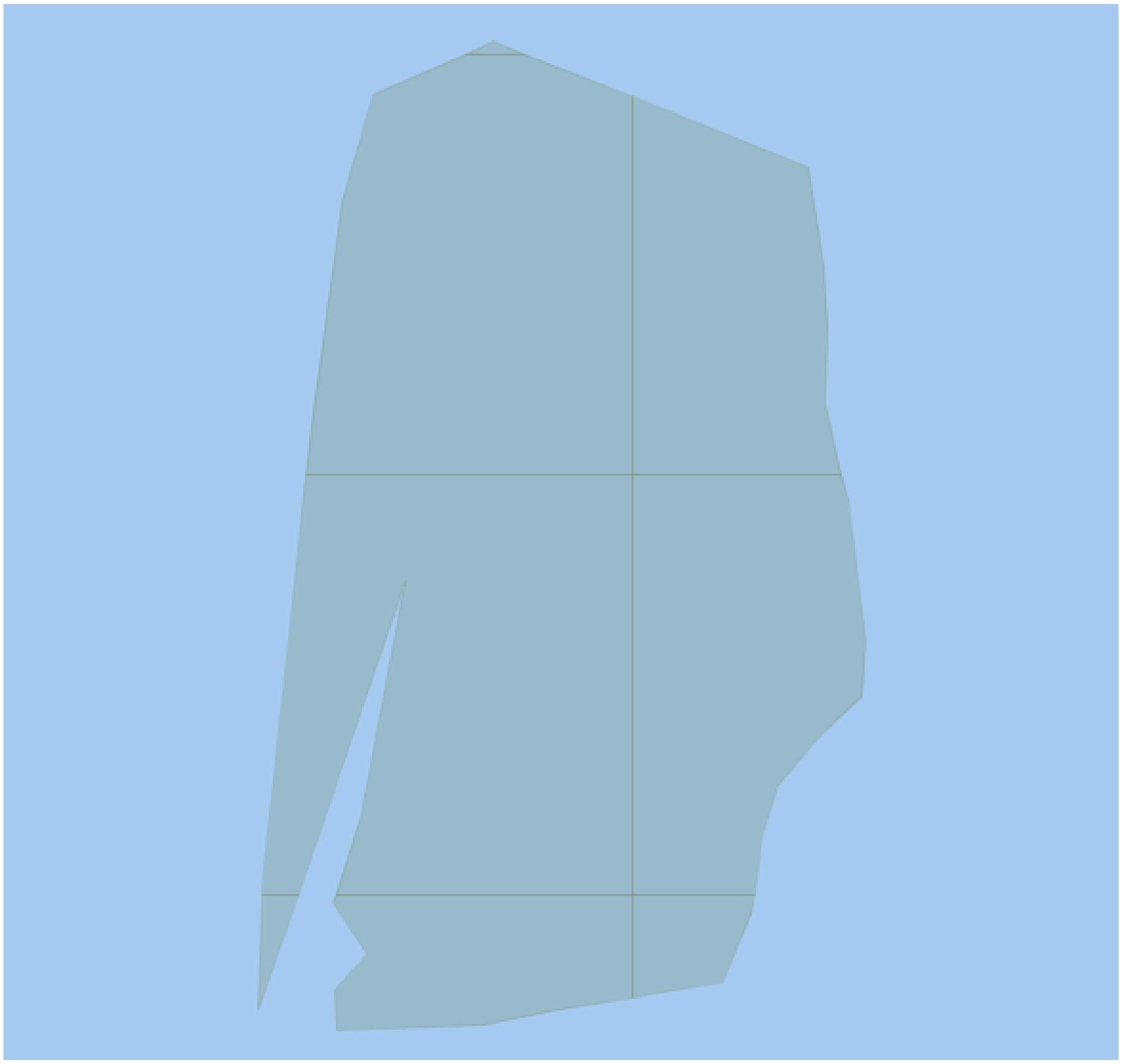
Example 3

The following example tiles a farm geometry with tiles that are 4 times greater than 1000 x 1000, because `resolution_factor => -1` is specified.

```
WITH
  part0 AS (SELECT b.tile_id,
                   b.status,
                   b.percent,
                   b.tile_center,
                   b.geom
            FROM farm_plots a,
            TABLE (sdo_util.tile_geometry(geom                 => a.geom,
                                          x_axis_min           => 272039.5,
                                          x_axis_max           => 275188.5,
                                          y_axis_min           => 370575.5,
                                          y_axis_max           => 380165.5,
                                          tile_resolution      => 1000,
                                          resolution_factor    => -1,
                                          perform_intersection => 'TRUE',
                                          compute_percent      => 'TRUE',
                                          geodetic_tolerance   => NULL)) b
            WHERE a.id = -1)
 SELECT tile_id, geom FROM part0 ORDER BY tile_id;
```

The following figure depicts the resulting output:

Figure 35-4 Tile size greater than `tile_resolution`



35.75 SDO_UTIL.TO_GEOJSON

Format

```
SDO_UTIL.TO_GEOJSON(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

Description

Converts an SDO_GEOMETRY object to a geometry of type CLOB in GeoJSON format.

Parameters

geometry
Geometry in SDO_GEOMETRY format to be converted to a GeoJSON object.

Usage Notes

For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

To convert a geometry in GeoJSON format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_GEOJSON function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json CLOB;

BEGIN

-- Populate geometry variable with cola market cola_b shape.
SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';

-- From geometry to JSON
returned_json := SDO_UTIL.TO_GEOJSON(cola_b_geom);

-- From JSON to geometry
returned_geom := SDO_UTIL.FROM_GEOJSON(returned_json);

END;
/
```

The following example shows the GeoJSON object that represents a specified geometry. (In this case the geometry definition reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.TO_GEOJSON(SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003,
1), SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))) from DUAL;

SDO_UTIL.TO_GEOJSON(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SD
--------------------------------------------------------------------------------
{ "type": "Polygon", "coordinates": [ [ [5, 1], [8, 1], [8, 6], [5, 7], [5, 1] ]
```

Related Topics

- SDO_UTIL.TO_GEOJSON_JSON
- SDO_UTIL.FROM_GEOJSON

35.76 SDO_UTIL.TO_GEOJSON_JSON

Format

```
SDO_UTIL.TO_GEOJSON_JSON(
     geometry  IN SDO_GEOMETRY
     ) RETURN JSON;
```

Description

Converts an SDO_GEOMETRY object to a geometry of type JSON in GeoJSON format.

Parameters

geometry
Geometry in SDO_GEOMETRY format to be converted to a JSON object in GeoJSON format.

Usage Notes

For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

To convert a geometry in GeoJSON format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_GEOJSON function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json JSON;

BEGIN

-- Populate geometry variable with cola market cola_b shape.
SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';

-- From geometry to JSON
returned_json := SDO_UTIL.TO_GEOJSON_JSON(cola_b_geom);

-- From JSON to geometry
returned_geom := SDO_UTIL.FROM_GEOJSON_JSON(returned_json);

END;
/
```

The following example shows the GeoJSON object that represents a specified geometry. (In this case the geometry definition reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.TO_GEOJSON(SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003,
1), SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))) from DUAL;

SDO_UTIL.TO_GEOJSON(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SD
--------------------------------------------------------------------------------
{ "type": "Polygon", "coordinates": [ [ [5, 1], [8, 1], [8, 6], [5, 7], [5, 1] ]
```

Related Topics

- SDO_UTIL.TO_GEOJSON
- SDO_UTIL.FROM_GEOJSON

35.77 SDO_UTIL.TO_GML311GEOMETRY

Format

```
SDO_UTIL.TO_GML311GEOMETRY(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

Description

Converts a Spatial geometry object to a geography markup language (GML version 3.1.1) fragment based on the geometry types defined in the Open GIS `geometry.xsd` schema document.

Parameters

geometry
Geometry for which to return the GML version 3.1.1 fragment.

Usage Notes

> **Note:**
>
> The SDO_UTIL.TO_GML311GEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

This function converts the input geometry to a GML version 3.1.1 fragment based on some GML geometry types defined in the Open GIS Implementation Specification.

Polygons must be defined using the conventions for Oracle9*i* and later releases of Spatial. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the SDO_LRS.CONVERT_TO_STD_GEOM or SDO_LRS.CONVERT_TO_STD_LAYER function) before being passed to the TO_GMLGEOMETRY function. (See the Examples section for an example that uses CONVERT_TO_STD_GEOM with the TO_GMLGEOMETRY function.)

Any circular arcs or circles must be densified (using the SDO_GEOM.SDO_ARC_DENSIFY function) or represented as polygons (using the SDO_GEOM.SDO_BUFFER function) before being passed to the TO_GMLGEOMETRY function. (See the Examples section for an example that uses SDO_ARC_DENSIFY with the TO_GMLGEOMETRY function.)

Label points are discarded. That is, if a geometry has a value for the SDO_POINT field and values in SDO_ELEM_INFO and SDO_ORDINATES, the SDO_POINT is not output in the GML fragment.

The SDO_SRID value is output in the form `srsName="SDO:<srid>"`. For example, `"SDO:8307"` indicates SDO_SRID 8307, and `"SDO:"` indicates a null SDO_SRID value. No checks are made for the validity or consistency of the SDO_SRID value. For example, the value is not checked to see if it exists in the MDSYS.CS_SRS table or if it conflicts with the SRID value for the layer in the USER_SDO_GEOM_METADATA view.

Coordinates are always output using the `<coordinates>` tag and `decimal='.'`, `cs=','` (that is, with the comma as the coordinate separator), and `ts=' '` (that is, with a space as the tuple separator), even if the NLS_NUMERIC_CHARACTERS setting has `','` (comma) as the decimal character.

The GML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL*Plus, use the TO_CHAR() function or set the SQL*Plus parameter LONG to a suitable value (for example, `SET LONG 40000`). To get formatted GML output or to use the return value of TO_GMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

Examples

The following example returns the GML version 3.1.1 fragment for the `cola_b` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Convert cola_b geometry to GML 3.1.1 fragment.
SELECT TO_CHAR(SDO_UTIL.TO_GML311GEOMETRY(shape)) AS Gml311Geometry
  FROM COLA_MARKETS c WHERE c.name = 'cola_b';

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:exterior
><gml:LinearRing><gml:posList srsDimension="2">5.0 1.0 8.0 1.0 8.0 6.0 5.0 7.0 5
.0 1.0 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon>
```

The following example returns the GML version 3.1.1 fragment for the arc densification of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SET LONG 40000
SELECT XMLTYPE(SDO_UTIL.TO_GML311GEOMETRY(
  SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo, 'arc_tolerance=0.05')))
    AS Gml311Geometry FROM cola_markets c, user_sdo_geom_metadata m
    WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
    AND c.name = 'cola_d';

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:exterior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">8.0 7.0 8.76536686473018 7.15224093497743 9.
4142135623731 7.58578643762691 9.84775906502257 8.23463313526982 10.0 9.0 9.8477
5906502257 9.76536686473018 9.4142135623731 10.4142135623731 8.76536686473018 10
.8477590650226 8.0 11.0 7.23463313526982 10.8477590650226 6.58578643762691 10.41
42135623731 6.15224093497743 9.76536686473018 6.0 9.0 6.15224093497743 8.2346331
3526982 6.58578643762691 7.5857864376269 7.23463313526982 7.15224093497743 8.0 7
.0 </gml:posList>
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>
```

The following example converts an LRS geometry to a standard geometry and returns the GML version 3.1.1 fragment for the geometry. (The example uses the definitions and data from Example of LRS Functions.)

```
SET LONG 40000
-- Convert LRS grometry to standard geometry before using TO_GML311GEOMETRY.
SELECT XMLTYPE(SDO_UTIL.TO_GML311GEOMETRY(
  SDO_LRS.CONVERT_TO_STD_GEOM(route_geometry)))
  AS Gml311Geometry FROM lrs_routes a WHERE a.route_id = 1;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Curve srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:segments>
    <gml:LineStringSegment>
      <gml:posList srsDimension="2">2.0 2.0 2.0 4.0 8.0 4.0 12.0 4.0 12.0 10.0 8
.0 10.0 5.0 14.0 </gml:posList>
    </gml:LineStringSegment>
  </gml:segments>
</gml:Curve>
```

The following examples return GML version 3.1.1 fragments for a variety of geometry types.

```
-- Point geometry with coordinates in SDO_ORDINATES. Note the
--    coordinates in the GML are (10.0 10.0) and the values in the
--    SDO_POINT field are discarded.
SELECT TO_CHAR(
  SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2001, 8307,
    sdo_point_type(-80, 70, null),
    sdo_elem_info_array(1,1,1), sdo_ordinate_array(10, 10)))
)
AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Point srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:posLis
t srsDimension="2">10.0 10.0 </gml:posList></gml:Point>


-- Multipolygon
SET LONG 40000
SELECT SDO_UTIL.TO_GML311GEOMETRY(
  sdo_geometry(2007, 8307, null,
   sdo_elem_info_array(1,1003,1, 13,1003,1, 23,1003,3),
   sdo_ordinate_array(10.10,10.20, 20.50,20.10, 30.30,30.30, 40.10,40.10,
     30.50, 30.20, 10.10, 10.20,
     5,5, 5,6, 6,6, 6,5, 5,5, 7,7, 8,8 ))
)
AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:MultiSurface srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml
:surfaceMember><gml:Polygon><gml:exterior><gml:LinearRing><gml:posList srsDimens
ion="2">10.1 10.2 20.5 20.1 30.3 30.3 40.1 40.1 30.5 30.2 10.1 10.2 </gml:posLis
t></gml:LinearRing></gml:exterior></gml:Polygon></gml:surfaceMember><gml:surface
Member><gml:Polygon><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">
5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gml:posList></gml:LinearRing></gml:ext
erior></gml:Polygon></gml:surfaceMember><gml:surfaceMember><gml:Polygon><gml:ext
erior><gml:LinearRing><gml:posList srsDimension="2">7.0 7.0 8.0 7.0 8.0 8.0 7.0
8.0 7.0 7.0 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon></gml:su
rfaceMember></gml:MultiSurface>
```

```
SET LONG 80
-- Rectangle (geodetic)
SELECT TO_CHAR(
  SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 8307, null,
   sdo_elem_info_array(1,1003,3),
    sdo_ordinate_array(10.10,10.10, 20.10,20.10 )))
)
AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:exte
rior><gml:LinearRing><gml:posList srsDimension="2">10.1 10.1 20.1 10.1 20.1 20.1
 10.1 20.1 10.1 10.1 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon
>

-- Polygon with holes
SELECT TO_CHAR(
  SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 262152, null,
   sdo_elem_info_array(1,1003,3, 5, 2003, 1, 13, 2003, 1),
   sdo_ordinate_array(10.10,10.20, 40.50, 41.10, 30.30, 30.30, 30.30,
     40.10, 40.10, 40.10, 30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
)
AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:ex
terior><gml:LinearRing><gml:posList srsDimension="2">10.1 10.2 40.5 10.2 40.5 41
.1 10.1 41.1 10.1 10.2 </gml:posList></gml:LinearRing></gml:exterior><gml:interi
or><gml:LinearRing><gml:posList srsDimension="2">30.3 30.3 30.3 40.1 40.1 40.1 3
0.3 30.3 </gml:posList></gml:LinearRing></gml:interior><gml:interior><gml:Linear
Ring><gml:posList srsDimension="2">5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gml
:posList></gml:LinearRing></gml:interior></gml:Polygon>


-- Creating an XMLTYPE from the GML fragment. Also useful for "pretty
--  printing" the GML output.
SET LONG 40000
SELECT XMLTYPE(
  SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 262152, null,
   sdo_elem_info_array(1,1003,1, 11, 2003, 1, 21, 2003, 1),
   sdo_ordinate_array(10.10,10.20, 40.50,10.2, 40.5,41.10, 10.1,41.1,
     10.10, 10.20, 30.30,30.30, 30.30, 40.10, 40.10, 40.10, 40.10, 30.30,
     30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
)
AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml">
  <gml:exterior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">10.1 10.2 40.5 10.2 40.5 41.1 10.1 41.1 10.1
 10.2 </gml:posList>
    </gml:LinearRing>
  </gml:exterior>
  <gml:interior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">30.3 30.3 30.3 40.1 40.1 40.1 40.1 30.3 30.3
 30.3 </gml:posList>
```

```
GML311GEOMETRY
--------------------------------------------------------------------------------
    </gml:LinearRing>
  </gml:interior>
  <gml:interior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gm
l:posList>
    </gml:LinearRing>
  </gml:interior>
</gml:Polygon>
```

Related Topics

SDO_UTIL.TO_GMLGEOMETRY

35.78 SDO_UTIL.TO_GMLGEOMETRY

Format

```
SDO_UTIL.TO_GMLGEOMETRY(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

or

```
SDO_UTIL.TO_GML311GEOMETRY(
     geometry   IN SDO_GEOMETRY,
     coordOrder IN NUMBER
     ) RETURN CLOB;
```

Description

Converts a Spatial geometry object to a geography markup language (GML 2.0) fragment based on the geometry types defined in the Open GIS `geometry.xsd` schema document.

Parameters

geometry
Geometry for which to return the GML fragment.

coordOrder
(Reserved for Oracle use.)

Usage Notes

> **Note:**
>
> The SDO_UTIL.TO_GMLGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

This function converts the input geometry to a GML fragment based on some GML geometry types defined in the Open GIS Implementation Specification.

Polygons must be defined using the conventions for Oracle9*i* and later releases of Spatial. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the SDO_LRS.CONVERT_TO_STD_GEOM or SDO_LRS.CONVERT_TO_STD_LAYER function) before being passed to the TO_GMLGEOMETRY function. (See the Examples section for an example that uses CONVERT_TO_STD_GEOM with the TO_GMLGEOMETRY function.)

Any circular arcs or circles must be densified (using the SDO_GEOM.SDO_ARC_DENSIFY function) or represented as polygons (using the SDO_GEOM.SDO_BUFFER function) before being passed to the TO_GMLGEOMETRY function. (See the Examples section for an example that uses SDO_ARC_DENSIFY with the TO_GMLGEOMETRY function.)

Label points are discarded. That is, if a geometry has a value for the SDO_POINT field and values in SDO_ELEM_INFO and SDO_ORDINATES, the SDO_POINT is not output in the GML fragment.

The SDO_SRID value is output in the form `srsName="SDO:<srid>"`. For example, `"SDO:8307"` indicates SDO_SRID 8307, and `"SDO:"` indicates a null SDO_SRID value. No checks are made for the validity or consistency of the SDO_SRID value. For example, the value is not checked to see if it exists in the MDSYS.CS_SRS table or if it conflicts with the SRID value for the layer in the USER_SDO_GEOM_METADATA view.

Coordinates are always output using the `<coordinates>` tag and `decimal='.'`, `cs=','` (that is, with the comma as the coordinate separator), and `ts=' '` (that is, with a space as the tuple separator), even if the NLS_NUMERIC_CHARACTERS setting has `','` (comma) as the decimal character.

The GML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL*Plus, use the TO_CHAR() function or set the SQL*Plus parameter LONG to a suitable value (for example, `SET LONG 40000`). To get formatted GML output or to use the return value of TO_GMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

Examples

The following example returns the GML fragment for the `cola_b` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
-- Convert cola_b geometry to GML fragment.
SELECT TO_CHAR(SDO_UTIL.TO_GMLGEOMETRY(shape)) AS GmlGeometry
  FROM COLA_MARKETS c WHERE c.name = 'cola_b';

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:outerBou
ndaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">5,1 8,1 8,6 5
,7 5,1 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon>
```

The following example returns the GML fragment for the arc densification of the `cola_d` geometry in the COLA_MARKETS table. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SET LONG 40000
SELECT XMLTYPE(SDO_UTIL.TO_GMLGEOMETRY(
  SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo, 'arc_tolerance=0.05')))
    AS GmlGeometry FROM cola_markets c, user_sdo_geom_metadata m
    WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
    AND c.name = 'cola_d';

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:outerBou
ndaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">8,7 8.7653668
6473018,7.15224093497743 9.4142135623731,7.58578643762691 9.84775906502257,8.234
63313526982 10,9 9.84775906502257,9.76536686473018 9.4142135623731,10.4142135623
731 8.76536686473018,10.8477590650226 8,11 7.23463313526982,10.8477590650226 6.5
8578643762691,10.4142135623731 6.15224093497743,9.76536686473018 6,9 6.152240934
97743,8.23463313526982 6.58578643762691,7.5857864376269 7.23463313526982,7.15224
093497743 8,7 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Pol
ygon>
```

The following example converts an LRS geometry to a standard geometry and returns the GML fragment for the geometry. (The example uses the definitions and data from Example of LRS Functions.)

```
SET LONG 40000
-- Convert LRS geometry to standard geometry before using TO_GMLGEOMETRY.
SELECT XMLTYPE(SDO_UTIL.TO_GMLGEOMETRY(
  SDO_LRS.CONVERT_TO_STD_GEOM(route_geometry)))
  AS GmlGeometry FROM lrs_routes a WHERE a.route_id = 1;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:LineString srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:coordinates decimal="." cs="," ts=" ">2,2 2,4 8,4 12,4 12,10 8,10 5,14 </
gml:coordinates>
</gml:LineString>
```

The following examples return GML fragments for a variety of geometry types.

```
-- Point geometry with coordinates in SDO_ORDINATES. Note the
-- coordinates in the GML are (10,10) and the values in the
-- SDO_POINT field are discarded.
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2001, 8307,
    sdo_point_type(-80, 70, null),
    sdo_elem_info_array(1,1,1), sdo_ordinate_array(10, 10)))
)
AS GmlGeometry FROM DUAL;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Point srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:coordi
nates decimal="." cs="," ts=" ">10,10 </gml:coordinates></gml:Point>


-- Multipolygon
SET LONG 40000
SELECT SDO_UTIL.TO_GMLGEOMETRY(
  sdo_geometry(2007, 8307, null,
    sdo_elem_info_array(1,1003,1, 13,1003,1, 23,1003,3),
    sdo_ordinate_array(10.10,10.20, 20.50,20.10, 30.30,30.30, 40.10,40.10,
      30.50, 30.20, 10.10, 10.20,
      5,5, 5,6, 6,6, 6,5, 5,5, 7,7, 8,8 ))
```

```
 )
 AS GmlGeometry FROM DUAL;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:MultiPolygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml
:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:LinearRing><gml:coordinate
s decimal="." cs="," ts=" ">10.1,10.2 20.5,20.1 30.3,30.3 40.1,40.1 30.5,30.2 10
.1,10.2 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon><
/gml:polygonMember><gml:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:Lin
earRing><gml:coordinates decimal="." cs="," ts=" ">5.0,5.0 5.0,6.0 6.0,6.0 6.0,5
.0 5.0,5.0 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygo
n></gml:polygonMember><gml:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:
LinearRing><gml:coordinates decimal="." cs="," ts=" ">7.0,7.0 8.0,7.0 8.0,8.0 7.
0,8.0 7.0,7.0 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Pol
ygon></gml:polygonMember></gml:MultiPolygon>

SQL> SET LONG 80

-- Rectangle (geodetic)
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 8307, null,
    sdo_elem_info_array(1,1003,3),
    sdo_ordinate_array(10.10,10.10, 20.10,20.10 )))
)
AS GmlGeometry FROM DUAL;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Box srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:coordina
tes decimal="." cs="," ts=" ">10.1,10.1 20.1,20.1 </gml:coordinates></gml:Box>


-- Polygon with holes
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 262152, null,
    sdo_elem_info_array(1,1003,3, 5, 2003, 1, 13, 2003, 1),
    sdo_ordinate_array(10.10,10.20, 40.50, 41.10, 30.30, 30.30, 30.30,
      40.10, 40.10, 40.10, 30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
)
AS GmlGeometry FROM DUAL;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:ou
terBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">10.1,10
.2, 40.5,10.2, 40.5,41.1, 10.1,41.1, 10.1,10.2 </gml:coordinates></gml:LinearRin
g></gml:outerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><gml:coordinates de
cimal="." cs="," ts=" ">30.3,30.3 30.3,40.1 40.1,40.1 30.3,30.3 </gml:coordinate
s></gml:LinearRing></gml:innerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><g
ml:coordinates decimal="." cs="," ts=" ">5,5 5,6 6,6 6,5 5,5 </gml:coordinates><
/gml:LinearRing></gml:innerBoundaryIs></gml:Polygon>


-- Creating an XMLTYPE from the GML fragment. Also useful for "pretty
-- printing" the GML output.
SET LONG 40000
SELECT XMLTYPE(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 262152, null,
    sdo_elem_info_array(1,1003,1, 11, 2003, 1, 21, 2003, 1),
    sdo_ordinate_array(10.10,10.20, 40.50,10.2, 40.5,41.10, 10.1,41.1,
      10.10, 10.20, 30.30,30.30, 30.30, 40.10, 40.10, 40.10, 40.10, 30.30,
      30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
)
AS GmlGeometry FROM DUAL;

GMLGEOMETRY
--------------------------------------------------------------------------------
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:ou
terBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">10.1,10
.2 40.5,10.2 40.5,41.1 10.1,41.1 10.1,10.2 </gml:coordinates></gml:LinearRing></
gml:outerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><gml:coordinates decima
l="." cs="," ts=" ">30.3,30.3 30.3,40.1 40.1,40.1 40.1,30.3 30.3,30.3 </gml:coor
dinates></gml:LinearRing></gml:innerBoundaryIs><gml:innerBoundaryIs><gml:LinearR
ing><gml:coordinates decimal="." cs="," ts=" ">5,5 5,6 6,6 6,5 5,5 </gml:coordin
ates></gml:LinearRing></gml:innerBoundaryIs></gml:Polygon>
```

The following example uses the TO_GMLGEOMETRY function with the Oracle XML DB XMLTYPE data type and the XMLELEMENT and XMLFOREST functions.

```
SELECT xmlelement("State", xmlattributes(
  'http://www.opengis.net/gml' as "xmlns:gml"),
  xmlforest(state as "Name", totpop as "Population",
  xmltype(sdo_util.to_gmlgeometry(geom)) as "gml:geometryProperty"))
  AS theXMLElements FROM states WHERE state_abrv in ('DE', 'UT');

THEXMLELEMENTS
--------------------------------------------------------------------------------
<State xmlns:gml="http://www.opengis.net/gml">
  <Name>Delaware</Name>
  <Population>666168</Population>
  <gml:geometryProperty>
    <gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
      <gml:outerBoundaryIs>
        <gml:LinearRing>
          <gml:coordinates decimal="." cs="," ts=" ">-75.788704,39.721699 -75.78
8704,39.6479 -75.767014,39.377106 -75.76033,39.296497 -75.756294,39.24585 -75.74
8016,39.143196 -75.722961,38.829895 -75.707695,38.635166 -75.701912,38.560619 -7
5.693871,38.460011 -75.500336,38.454002 -75.341614,38.451855 -75.049339,38.45165
3 -75.053841,38.538429 -75.06015,38.605465 -75.063263,38.611275 -75.065308,38.62
949 -75.065887,38.660919 -75.078697,38.732403 -75.082527,38.772045 -75.091667,38
.801208 -75.094185,38.803699 -75.097572,38.802986 -75.094116,38.793579 -75.09926
6,38.78756 -75.123619,38.781784 -75.137962,38.782703 -75.18692,38.803772 -75.215
019,38.831547 -75.23735,38.849014 -75.260498,38.875 -75.305908,38.914673 -75.316
399,38.930309 -75.317284,38.93676 -75.312851,38.945576 -75.312859,38.945618 -75.
31205,38.967804 -75.31778,38.986012 -75.341431,39.021233 -75.369606,39.041359 -7
5.389229,39.051422 -75.40181,39.06702 -75.401306,39.097713 -75.411369,39.148029
-75.407845,39.175201 -75.396271,39.187778 -75.39225,39.203377 -75.40181,39.23104
9 -75.402817,39.253189 -75.409355,39.264759 -75.434006,39.290424 -75.439041,39.3
13065 -75.453125,39.317093 -75.457657,39.326653 -75.469231,39.330677 -75.486336,
39.341743 -75.494888,39.354324 -75.504448,39.357346 -75.51284,39.366291 -75.5129
24,39.366482 -75.523773,39.392052 -75.538651,39.415707 -75.56749,39.436436 -75.5
9137,39.463696 -75.592941,39.471806 -75.590019,39.488026 -75.587311,39.496136 -7
5.5774,39.508076 -75.554192,39.506947 -75.528442,39.498005 -75.530373,39.510303
-75.527145,39.531326 -75.52803,39.535168 -75.53437,39.540592 -75.519386,39.55528
6 -75.512291,39.567505 -75.515587,39.580639 -75.528046,39.584 -75.538269,39.5935
67 -75.554016,39.601727 -75.560143,39.622578 -75.556602,39.6348 -75.549599,39.63
7699 -75.542397,39.645901 -75.535507,39.647099 -75.514999,39.668499 -75.507523,3
9.69685 -75.496597,39.701302 -75.488914,39.714722 -75.477997,39.714901 -75.47550
2,39.733501 -75.467972,39.746975 -75.463707,39.761101 -75.448494,39.773857 -75.4
38301,39.783298 -75.405701,39.796101 -75.415405,39.801678 -75.454102,39.820202 -
75.499199,39.833199 -75.539703,39.8381 -75.5802,39.838417 -75.594017,39.837345 -
75.596107,39.837044 -75.639488,39.82893 -75.680145,39.813839 -75.71096,39.796352
 -75.739716,39.772881 -75.760689,39.74712 -75.774101,39.721699 -75.788704,39.721
```

```
699 </gml:coordinates>
        </gml:LinearRing>
      </gml:outerBoundaryIs>
    </gml:Polygon>
  </gml:geometryProperty>
</State>

<State xmlns:gml="http://www.opengis.net/gml">
  <Name>Utah</Name>
  <Population>1722850</Population>
  <gml:geometryProperty>
    <gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
      <gml:outerBoundaryIs>
        <gml:LinearRing>
          <gml:coordinates decimal="." cs="," ts=" ">-114.040871,41.993805 -114.
038803,41.884899 -114.041306,41 -114.04586,40.116997 -114.046295,39.906101 -114.
046898,39.542801 -114.049026,38.67741 -114.049339,38.572968 -114.049095,38.14864
 -114.0476,37.80946 -114.05098,37.746284 -114.051666,37.604805 -114.052025,37.10
3989 -114.049797,37.000423 -113.484375,37 -112.898598,37.000401 -112.539604,37.0
00683 -112,37.000977 -111.412048,37.001514 -111.133018,37.00079 -110.75,37.00320
1 -110.5,37.004265 -110.469505,36.998001 -110,36.997967 -109.044571,36.999088 -1
09.045143,37.375 -109.042824,37.484692 -109.040848,37.881176 -109.041405,38.1530
27 -109.041107,38.1647 -109.059402,38.275501 -109.059296,38.5 -109.058868,38.719
906 -109.051765,39 -109.050095,39.366699 -109.050697,39.4977 -109.050499,39.6605
 -109.050156,40.222694 -109.047577,40.653641 -109.0494,41.000702 -109.2313,41.00
2102 -109.534233,40.998184 -110,40.997398 -110.047768,40.997696 -110.5,40.994801
 -111.045982,40.998013 -111.045815,41.251774 -111.045097,41.579899 -111.045944,4
2.001633 -111.506493,41.999588 -112.108742,41.997677 -112.16317,41.996784 -112.1
72562,41.996643 -112.192184,42.001244 -113,41.998314 -113.875,41.988091 -114.040
871,41.993805 </gml:coordinates>
        </gml:LinearRing>
      </gml:outerBoundaryIs>
    </gml:Polygon>
  </gml:geometryProperty>
</State>
```

Related Topics

SDO_UTIL.TO_GML311GEOMETRY

35.79 SDO_UTIL.TO_JSON

Format

```
SDO_UTIL.TO_JSON(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

Description

Converts an SDO_GEOMETRY object to a JSON object in **CLOB** format.

Parameters

geometry
Geometry in SDO_GEOMETRY format to be converted to a JSON object.

Usage Notes

For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

For information about Spatial support for JSON, see JSON and GeoJSON Support in Oracle Spatial.

The SDO_UTIL.TO_JSON_VARCHAR function (which returns a VARCHAR2 result) runs faster that this function. However, because that function returns a VARCHAR2 result, it can be used only on very small geometries. Any geometry that generates more that 4000 bytes of JSON (or 32767 bytes if the database parameter MAX_STRING_SIZE is set to EXTENDED) results in a truncated and invalid JSON object.

To convert a geometry in JSON format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_JSON function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom   SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json CLOB;
BEGIN
  -- Populate geometry variable with cola market cola_b shape.
  SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';
  -- From geometry to JSON
  returned_json := SDO_UTIL.TO_JSON(cola_b_geom);

  -- From JSON to geometry
  returned_geom := SDO_UTIL.FROM_JSON(returned_json);
END;
/
```

The following example shows the JSON object that represents a specified geometry. (In this case the geometry definition reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.TO_JSON(
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 1),
    SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))) JSON
FROM DUAL;
JSON
------
{"polygon": {"boundary": [{"line": {"datapoints": [[5.0, 1.0], [8.0, 1.0], [8.0, 6.0],
[5.0, 7.0], [5.0, 1.0]]}}]}}
```

Related Topics

- SDO_UTIL.TO_JSON_JSON
- SDO_UTIL.TO_JSON_VARCHAR
- SDO_UTIL.FROM_JSON

35.80 SDO_UTIL.TO_JSON_JSON

Format

```
SDO_UTIL.TO_JSON_JSON(
     geometry  IN SDO_GEOMETRY
     ) RETURN JSON;
```

Description

Converts an SDO_GEOMETRY object to a JSON object.

Parameters

geometry
Geometry in SDO_GEOMETRY format to be converted to a JSON object.

Usage Notes

For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

For information about Spatial support for JSON, see JSON and GeoJSON Support in Oracle Spatial.

To convert a geometry in JSON format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_JSON function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom   SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json JSON;
BEGIN
  -- Populate geometry variable with cola market cola_b shape.
  SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';
  -- From geometry to JSON
  returned_json := SDO_UTIL.TO_JSON_JSON(cola_b_geom);

  -- From JSON to geometry
  returned_geom := SDO_UTIL.FROM_JSON(returned_json);
END;
/
```

The following example shows the GeoJSON object that represents a specified geometry. (In this case the geometry definition reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.TO_JSON_JSON(
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 1),
    SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))) JSON
FROM DUAL;
```

```
JSON
------
{"polygon": {"boundary": [{"line": {"datapoints": [[5.0, 1.0], [8.0, 1.0], [8.0, 6.0],
[5.0, 7.0], [5.0, 1.0]]}}]}}
```

Related Topics

- SDO_UTIL.TO_JSON
- SDO_UTIL.TO_JSON_VARCHAR
- SDO_UTIL.FROM_JSON

35.81 SDO_UTIL.TO_JSON_VARCHAR

Format

```
SDO_UTIL.TO_JSON_VARCHAR(
     geometry  IN SDO_GEOMETRY
     ) RETURN VARCHAR2;
```

Description

Converts an SDO_GEOMETRY object to a JSON object in **VARCHAR2** format.

Parameters

geometry
Geometry in SDO_GEOMETRY format to be converted to a JSON object.

Usage Notes

For information about using JSON data that is stored in Oracle Database, see *Oracle Database JSON Developer's Guide*.

For information about Spatial support for JSON, see JSON and GeoJSON Support in Oracle Spatial.

This function (which returns a VARCHAR2 result) runs faster than the SDO_UTIL.TO_JSON (which returns a CLOB result). However, this function can be used only on very small geometries. Any geometry that generates more that 4000 bytes of JSON (or 32767 bytes if the database parameter MAX_STRING_SIZE is set to EXTENDED) results in a truncated and invalid JSON object.

To convert a geometry in JSON format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_JSON function.

Examples

The following example shows conversion to and from JSON format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  cola_b_geom   SDO_GEOMETRY;
  returned_geom SDO_GEOMETRY;
  returned_json VARCHAR2(4000);
BEGIN
  -- Populate geometry variable with cola market cola_b shape.
  SELECT c.shape into cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';
  -- From geometry to JSON
  returned_json := SDO_UTIL.TO_JSON_VARCHAR(cola_b_geom);

  -- From JSON to geometry
  returned_geom := SDO_UTIL.FROM_JSON(returned_json);
END;
/
```

The following example shows the GeoJSON object that represents a specified geometry. (In this case the geometry definition reflects the `cola_b` geometry from the COLA_MARKETS table, defined in Simple Example: Inserting_ Indexing_ and Querying Spatial Data.)

```
SELECT SDO_UTIL.TO_JSON_VARCHAR(
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 1003, 1),
    SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))) JSON
FROM DUAL;
JSON
------
{"polygon": {"boundary": [{"line": {"datapoints": [[5.0, 1.0], [8.0, 1.0], [8.0, 6.0],
[5.0, 7.0], [5.0, 1.0]]}}]}}
```

Related Topics

- SDO_UTIL.TO_JSON
- SDO_UTIL.TO_JSON_JSON
- SDO_UTIL.FROM_JSON

35.82 SDO_UTIL.TO_KMLGEOMETRY

Format

```
SDO_UTIL.TO_KMLGEOMETRY(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

Description

Converts a Spatial geometry object to a KML (Keyhole Markup Language) document.

Parameters

geometry
Geometry for which to return the KML document.

Usage Notes

> **Note:**
>
> The SDO_UTIL.TO_KMLGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

Polygons must be defined using the conventions for Oracle9*i* and later releases of Spatial. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the SDO_LRS.CONVERT_TO_STD_GEOM or SDO_LRS.CONVERT_TO_STD_LAYER function) before being passed to the TO_KMLGEOMETRY function.

Any circular arcs or circles must be densified (using the SDO_GEOM.SDO_ARC_DENSIFY function) or represented as polygons (using the SDO_GEOM.SDO_BUFFER function) before being passed to the TO_KMLGEOMETRY function.

Label points are discarded. That is, if a geometry has a value for the SDO_POINT field and values in SDO_ELEM_INFO and SDO_ORDINATES, the SDO_POINT is not output in the KML document.

Solid geometries are converted to KML MultiGeometry objects, because KML 2.1 does not support solids. If you then use the SDO_UTIL.FROM_KMLGEOMETRY function on the MultiGeometry, the result is not an Oracle Spatial solid geometry (that is, its SDO_GTYPE value does not reflect a geometry type of SOLID or MULTISOLID).

The KML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL*Plus, use the TO_CHAR() function or set the SQL*Plus parameter LONG to a suitable value (for example, `SET LONG 2000`). To get formatted GML output or to use the return value of TO_KMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

Examples

The following example shows conversion to and from KML format. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_c` geometry from the COLA_MARKETS table.)

```
-- Convert cola_c geometry to a KML document; convert that result to
-- a spatial geometry.
set long 2000;
DECLARE
  kmlgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_c';

-- To KML geometry
kmlgeom := SDO_UTIL.TO_KMLGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To KML geometry result = ' || TO_CHAR(kmlgeom));

-- From KML geometry
geom_result := SDO_UTIL.FROM_KMLGEOMETRY(kmlgeom);
-- Validate the returned geometry.
val_result := SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(geom_result, 0.005);
DBMS_OUTPUT.PUT_LINE('Validation result = ' || val_result);

END;
```

```
/
To KML geometry result =
<Polygon><extrude>0</extrude><tessellate>0</tessellate><altitudeMode>relativeToG
round</altitudeMode><outerBoundaryIs><LinearRing><coordinates>3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </coordinates></LinearRing></outerBoundaryIs></Polygon>
Validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_KMLGEOMETRY

35.83 SDO_UTIL.TO_WKBGEOMETRY

Format

```
SDO_UTIL.TO_WKBGEOMETRY(
     geometry  IN SDO_GEOMETRY
     ) RETURN BLOB;
```

Description

Converts a Spatial geometry object to the well-known binary (WKB) format.

Parameters

geometry
SDO_GEOMETRY object to be converted to WKB format.

Usage Notes

The input geometry is converted to the well-known binary (WKB) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert a geometry in WKB format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_WKBGEOMETRY function.

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));
```

```
-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.84 SDO_UTIL.TO_WKTGEOMETRY

Format

```
SDO_UTIL.TO_WKTGEOMETRY(
     geometry  IN SDO_GEOMETRY
     ) RETURN CLOB;
```

Description

Converts a Spatial geometry object to the well-known text (WKT) format.

Parameters

geometry
SDO_GEOMETRY object to be converted to WKT format.

Usage Notes

The input geometry is converted to the well-known text (WKT) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert a geometry in WKT format to an SDO_GEOMETRY object, use the SDO_UTIL.FROM_WKTGEOMETRY function.

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example:

Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKBGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.85 SDO_UTIL.VALIDATE_3DTHEME

Format

```
SDO_UTIL.VALIDATE_3DTHEME(
     theme_name  IN VARCHAR2
     ) RETURN VARCHAR2;
```

Description

Validates a 3D theme.

Parameters

theme_name
Name of the 3D theme. Must be a value from the USER_SDO_3DTHEMES or ALL_SDO_3DTHEMES view (described in xxx_SDO_3DTHEMES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.VALIDATE_3DTHEME function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function performs several validity checks appropriate to the type of theme. For each check it returns the string `TRUE` if there are no issues, or a brief description of the issue.

If the specified theme has not been defined, the output indicates that there is no theme with that name.

Examples

The following example validates the themes in the USER_SDO_3DTHEMES table. (It assumes that the themes were previously inserted into the USER_SDO_3DTHEMES table.)

```
SELECT
    name || ': ' ||
    sdo_util.validate_3dtheme(name) "Theme validity"
  FROM user_sdo_3dthemes
  ORDER BY name;

Theme validity
-----------------------------------------------------------------------------------
Test PC Hawaii Theme 4326: TRUE
Test PC Hawaii Theme 4326 A: No Theme-related Metadata
Test PC Hawaii Theme 4326 A2: XML metadata for "Test PC Hawaii Theme 4326 A2" not well-
formed
Test PC Hawaii Theme 4326 C1: SRID 0 not found
Test PC Hawaii Theme 4326 C2: No VERTICAL SRID 5758 allowed
Test PC Hawaii Theme 4326 D: THEME_COLUMN column and xml metadata do not match,
regarding feature table column
Test PC Hawaii Theme 4326 D2: User "MDMETT"'s table "PCS_HAWAII_4326" has no column
"PC3", according to USER_TAB_COLUMNS
.

Test PC Hawaii Theme 4326 D3: User "MDMETT" has no table "PCS_HAWAII_4326A", according
to USER_TABLES.
Test PC Hawaii Theme 4326 D4: THEME_TYPE column and xml metadata do not match, regarding
geometric feature type
Test PC Hawaii Theme 4326 D5: User "MDMETT"'s table "PCS_HAWAII_4326" has a column "PC"
of type "SDO_PC", not "SDO_PC3",
 according to USER_TAB_COLUMNS.

Test PC Hawaii Theme 4326 E: Elevation not strictly monotonously rising from position 1
to 2 (value 123.2 >= 123.1)
Test PC Hawaii Theme 4326 E2: No elevation @color specified at position 2
Test PC Hawaii Theme 4326 E3: No @elevation specified at position 2
Test PC Hawaii Theme 4326 E4: Elevation @color at position 2 does not have hex format
RRGGBB
Test PC Hawaii Theme 4326 E5: Elevation @color at position 2 does not have hex format
RRGGBB (character 6)

15 rows selected.
```

Related Topics

- SDO_UTIL.THEME3D_GET_BLOCK_TABLE
- SDO_UTIL.THEME3D_HAS_LOD
- SDO_UTIL.THEME3D_HAS_TEXTURE
- SDO_UTIL.VALIDATE_SCENE
- SDO_UTIL.VALIDATE_VIEWFRAME

35.86 SDO_UTIL.VALIDATE_SCENE

Format

```
SDO_UTIL.VALIDATE_SCENE(
     scene_name  IN VARCHAR2
     ) RETURN VARCHAR2;
```

Description

Validates a 3D scene.

Parameters

scene_name
Name of the 3D scene. Must be a value from the USER_SDO_SCENES or ALL_SDO_SCENES view (described in xxx_SDO_SCENES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.VALIDATE_SCENE function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function performs several validity checks. For each check it returns the string `TRUE` if there are no issues, or a brief description of the issue.

If the specified scene has not been defined, the output indicates that there is no scene with that name.

Examples

The following example validates the scenes in the USER_SDO_SCENES table. (It assumes that the scenes were previously inserted into the USER_SDO_SCENES table.)

```
SELECT
    name || ': ' ||
    sdo_util.validate_scene(name) "Scene validity"
  FROM user_sdo_scenes
  ORDER BY name;

Scene validity
--------------------------------------------------------------------------------
Test PC Hawaii Scene 4326: TRUE
Test PC Hawaii Scene 4326 A: No Scene-related Metadata
Test PC Hawaii Scene 4326 A2: XML metadata for "Test PC Hawaii Scene 4326 A2" not well-
formed
Test PC Hawaii Scene 4326 B: Referenced theme "Test PC Hawaii Theme 4326 A": No Theme-
related Metadata
Test PC Hawaii Scene 4326 C1: SRID 0 not found
Test PC Hawaii Scene 4326 C2: No VERTICAL SRID 5758 allowed

6 rows selected.
```

Related Topics

- SDO_UTIL.VALIDATE_3DTHEME
- SDO_UTIL.VALIDATE_VIEWFRAME

35.87 SDO_UTIL.VALIDATE_VIEWFRAME

Format

```
SDO_UTIL.VALIDATE_VIEWFRAME(
     viewframe_name  IN VARCHAR2
     ) RETURN VARCHAR2;
```

Description

Validates a 3D viewframe.

Parameters

viewframe_name
Name of the 3D theme. Must be a value from the USER_SDO_VIEWFRAMES or ALL_SDO_VIEWFRAMES view (described in xxx_SDO_VIEWFRAMES Views.

Usage Notes

> **Note:**
>
> The SDO_UTIL.VALIDATE_VIEWFRAME function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

This function performs several validity checks. For each check it returns the string `TRUE` if there are no issues, or a brief description of the issue.

If the specified viewframe has not been defined, the output indicates that there is no viewframe with that name.

Examples

The following example validates the themes in the USER_SDO_3DTHEMES table. (It assumes that the themes were previously inserted into the USER_SDO_3DTHEMES table.)

```
SELECT
    name || ': ' ||
    sdo_util.validate_viewframe(name) "Viewframe validity"
  FROM user_sdo_viewframes
  ORDER BY name;

Viewframe validity
---------------------------------------------------------------------------------
Test PC Hawaii Viewpoint 4326: TRUE
Test PC Hawaii Viewpoint 4326 A: No Viewframe-related Metadata
Test PC Hawaii Viewpoint 4326 A2: XML metadata for "Test PC Hawaii Viewpoint 4326 A2"
not well-formed
Test PC Hawaii Viewpoint 4326 B1: Referenced scene "Made up": No scene with name "Made
up"
Test PC Hawaii Viewpoint 4326 B2: Referenced scene "Test PC Hawaii Scene 4326 B":
Referenced theme "Test PC Hawaii Theme
 4326 A": No Theme-related Metadata

Test PC Hawaii Viewpoint 4326 B3: SCENE_NAME column and xml metadata do not match,
regarding scene name
Test PC Hawaii Viewpoint 4326 C1: SRID 0 not found
Test PC Hawaii Viewpoint 4326 C2: No VERTICAL SRID 5758 allowed

8 rows selected.
```

Related Topics

- SDO_UTIL.VALIDATE_3DTHEME
- SDO_UTIL.VALIDATE_SCENE

35.88 SDO_UTIL.VALIDATE_WKBGEOMETRY

Format

```
SDO_UTIL.VALIDATE_WKBGEOMETRY(
     geometry  IN BLOB
     ) RETURN VARCHAR2;
```

Description

Validates the input geometry, which is in the standard well-known binary (WKB or EWKB) format; returns the string `TRUE` if the input is valid, or `FALSE` if the input is not valid WKB or EWKB.

Parameters

geometry
Geometry in WKB or EWKB format to be checked for validity.

Usage Notes

> **Note:**
>
> The SDO_UTIL.VALIDATE_WKBGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

To be valid, the input geometry may be in the well-known binary (WKB) format, or in the EWKB format.

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To validate a geometry in the well-known text (WKT) format, use the SDO_UTIL.VALIDATE_WKTGEOMETRY function.

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_WKTGEOMETRY

35.89 SDO_UTIL.VALIDATE_WKTGEOMETRY

Format

```
SDO_UTIL.VALIDATE_WKTGEOMETRY(
     geometry  IN CLOB
     ) RETURN VARCHAR2;
```

or

```
SDO_UTIL.VALIDATE_WKTGEOMETRY(
     geometry  IN VARCHAR2
     ) RETURN VARCHAR2;
```

Description

Validates the input geometry, which is of type CLOB or VARCHAR2 and in the standard well-known text (WKT or EWKT) format; returns the string `TRUE` if the input is valid, or `FALSE` if the input is not valid WKT or EWKT.

Parameters

geometry
Geometry in WKT or EWKT format to be checked for validity.

Usage Notes

> **Note:**
>
> The SDO_UTIL.VALIDATE_WKTGEOMETRY function is supported only if Oracle JVM is enabled on your Oracle Autonomous Database Serverless deployments. To enable Oracle JVM, see Use Oracle Java in *Using Oracle Autonomous Database Serverless* for more information.

To be valid, the input geometry may be in the well-known text (WKT) format, or in the EWKT format.

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To validate a geometry in the well-known binary (WKB) format, use the SDO_UTIL.VALIDATE_WKBGEOMETRY function.

Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from Simple Example: Inserting_ Indexing_ and Querying Spatial Data, specifically the `cola_b` geometry from the COLA_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

Related Topics

- SDO_UTIL.FROM_WKBGEOMETRY
- SDO_UTIL.FROM_WKTGEOMETRY
- SDO_UTIL.TO_WKBGEOMETRY
- SDO_UTIL.TO_WKTGEOMETRY
- SDO_UTIL.VALIDATE_WKBGEOMETRY

36

SDO_WFS_LOCK Package (WFS)

The MDSYS.SDO_WFS_LOCK package contains subprograms for WFS support for registering and unregistering feature tables.

Registering a feature table enables the table for WFS transaction locking; unregistering a feature table disables the table for WFS transaction locking.

To use the subprograms in this chapter, you must understand the conceptual and usage information about Web Feature Services (WFS) in Web Feature Service (WFS) Support.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_WFS_LOCK.EnableDBTxns
- SDO_WFS_LOCK.RegisterFeatureTable
- SDO_WFS_LOCK.UnRegisterFeatureTable

36.1 SDO_WFS_LOCK.EnableDBTxns

Format

```
SDO_WFS_LOCK.EnableDBTxns();
```

Description

Enables database transactions on WFS tables.

Parameters

None.

Usage Notes

This procedure overrides, through the end of the session, the WFS-T standard restriction against database transactions on WFS tables, so that any transaction with the current session ID can perform update and delete operations on WFS tables. Oracle Database triggers still check the WFS locks before the current transaction is allowed to modify a row; and so if a WFS transaction has a lock on a row, the triggers will not allow the operation to be performed. However, if there is no WFS lock on the current row, the triggers will allow the current transaction to modify the row.

You must call this procedure to perform certain operations when using Oracle Workspace Manager to version-enable a WFS table, as explained in Using WFS with Oracle Workspace Manager. However, you can also use this procedure even if you do not use Workspace Manager with WFS tables.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example enables database transactions on WFS tables for the remainder of the current session.

```
BEGIN
  SDO_WFS_LOCK.enableDBTxns;
END;
/
```

36.2 SDO_WFS_LOCK.RegisterFeatureTable

Format

```
SDO_WFS_LOCK.RegisterFeatureTable(
     username  IN VARCHAR2,
     tablename IN VARCHAR2);
```

Description

Registers a feature table; that is, enables the feature table for WFS transaction locking.

Parameters

username
Name of the database user that owns the feature table to be registered.

tablename
Name of the feature table to be registered.

Usage Notes

This procedure ensures that the necessary constraints for implementing WFS transaction semantics are associated with the feature table.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

To unregister a table that has not been version-enabled, use the SDO_WFS_LOCK.UnRegisterFeatureTable procedure.

Examples

The following example registers the feature table named COLA_MARKETS_CS, which is owned by user WFS_REL_USER.

```
BEGIN
  SDO_WFS_LOCK.registerFeatureTable('wfs_rel_user', 'cola_markets_cs');
END;
/
```

36.3 SDO_WFS_LOCK.UnRegisterFeatureTable

Format

```
SDO_WFS_LOCK.UnRegisterFeatureTable(
     username  IN VARCHAR2,
     tablename IN VARCHAR2);
```

Description

Unregisters a feature table; that is, disables the feature table for WFS transaction locking.

Parameters

username
Name of the database user that owns the feature table to be unregistered.

tablename
Name of the feature table to be unregistered.

Usage Notes

This procedure disables, for the feature table, the constraints for implementing WFS transaction semantics.

The feature table must have been previously registered in a call to the SDO_WFS_LOCK.RegisterFeatureTable procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example unregisters the feature table named COLA_MARKETS_CS, which is owned by user WFS_REL_USER.

```
BEGIN
  SDO_WFS_LOCK.unRegisterFeatureTable('wfs_rel_user', 'cola_markets_cs');
END;
/
```

37

SDO_WFS_PROCESS Package (WFS Processing)

The MDSYS.SDO_WFS_PROCESS package contains subprograms for various processing operations related to support for Web Feature Services.

To use the subprograms in this chapter, you must understand the conceptual and usage information about Web Feature Services in Web Feature Service (WFS) Support.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

- SDO_WFS_PROCESS.DropFeatureType
- SDO_WFS_PROCESS.DropFeatureTypes
- SDO_WFS_PROCESS.GenCollectionProcs
- SDO_WFS_PROCESS.GetFeatureTypeId
- SDO_WFS_PROCESS.GrantFeatureTypeToUser
- SDO_WFS_PROCESS.GrantMDAccessToUser
- SDO_WFS_PROCESS.InsertCapabilitiesInfo
- SDO_WFS_PROCESS.InsertFtDataUpdated
- SDO_WFS_PROCESS.InsertFtMDUpdated
- SDO_WFS_PROCESS.PopulateFeatureTypeXMLInfo
- SDO_WFS_PROCESS.PublishFeatureType
- SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema
- SDO_WFS_PROCESS.RegisterMTableView
- SDO_WFS_PROCESS.RevokeFeatureTypeFromUser
- SDO_WFS_PROCESS.RevokeMDAccessFromUser
- SDO_WFS_PROCESS.UnRegisterMTableView

37.1 SDO_WFS_PROCESS.DropFeatureType

Format

```
SDO_WFS_PROCESS.DropFeatureType(
     ftnsUrl  IN VARCHAR2,
     ftName   IN VARCHAR2);
```

Description

Deletes a specified feature type.

Parameters

ftnsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

Usage Notes

If you want to drop a feature type whose content comes from a multitable view, you must call the SDO_WFS_PROCESS.UnRegisterMTableView procedure before you call the SDO_WFS_PROCESS.DropFeatureType procedure.

If you want to drop all feature types in the namespace, you can use the SDO_WFS_PROCESS.DropFeatureTypes procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example deletes the feature type named `COLA` in a specified namespace.

```
BEGIN
    SDO_WFS_PROCESS.dropFeatureType('http://www.example.com/myns','COLA');
END;
/
```

37.2 SDO_WFS_PROCESS.DropFeatureTypes

Format

```
SDO_WFS_PROCESS.DropFeatureTypes(
     ftnsUrl   IN VARCHAR2);
```

Description

Deletes all feature types in a specified namespace.

Parameters

ftnsUrl
Uniform resource locator (URL) of the namespace.

Usage Notes

To drop a single feature type in a namespace, use the SDO_WFS_PROCESS.DropFeatureType procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example deletes all feature types in a specified namespace.

```
BEGIN
    SDO_WFS_PROCESS.dropFeatureTypes('http://www.example.com/myns');
```

```
END;
/
```

37.3 SDO_WFS_PROCESS.GenCollectionProcs

Format

```
SDO_WFS_PROCESS.GenCollectionProcs();
```

Description

Generates helper procedures for relational feature types that have collection-based columns (for example, VARRAYs or nested tables).

Parameters

None.

Usage Notes

Use this procedure if any feature tables have features that are defined in collection-based columns (for example, VARRAYs or nested tables).

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example generates helper procedures for relational feature types that have collection-based columns.

```
BEGIN
  SDO_WFS_PROCESS.GenCollectionProcs;
END;
/
```

37.4 SDO_WFS_PROCESS.GetFeatureTypeId

Format

```
SDO_WFS_PROCESS.GetFeatureTypeId(
     ftnsUrl  IN VARCHAR2,
     ftName   IN VARCHAR2) RETURN NUMBER;
```

Description

Gets the feature type ID of a specified feature type.

Parameters

ftnsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

Usage Notes

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example gets the feature type ID of a feature type named `COLA`.

```
DECLARE
  ftid number;
BEGIN
  ftId := SDO_WFS_PROCESS.GetFeatureTypeId('http://www.example.com/myns','COLA');
END;
/
```

37.5 SDO_WFS_PROCESS.GrantFeatureTypeToUser

Format

```
SDO_WFS_PROCESS.GrantFeatureTypeToUser(
     ftnsUrl   IN VARCHAR2,
     ftName    IN VARCHAR2,
     userName  IN VARCHAR2);
```

Description

Grants access to a feature type to a database user.

Parameters

ftnsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

userName
Name of the database user.

Usage Notes

To revoke access to a feature type from a database user, use the SDO_WFS_PROCESS.RevokeFeatureTypeFromUser procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example grants access to the `COLA` feature type to user `SMITH`.

```
BEGIN
  SDO_WFS_PROCESS.GrantFeatureTypeToUser('http://www.example.com/myns','COLA',
    'SMITH');
END;
/
```

37.6 SDO_WFS_PROCESS.GrantMDAccessToUser

Format

```
SDO_WFS_PROCESS.GrantMDAccessToUser(
     userName  IN VARCHAR2);
```

Description

Grants access to Web Feature Service metadata tables to a database user.

Parameters

userName
Name of the database user.

Usage Notes

To call this procedure, you should be connected to the database as a user with the DBA role.

To revoke access to Web Feature Service metadata tables from a database user, use the SDO_WFS_PROCESS.RevokeMDAccessFromUser procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example grants access to Web Feature Service metadata tables to the database user named `WFS_REL_USER`.

```
BEGIN
  SDO_WFS_PROCESS.GrantMDAccessToUser('WFS_REL_USER');
END;
/
```

37.7 SDO_WFS_PROCESS.InsertCapabilitiesInfo

Format

```
SDO_WFS_PROCESS.InsertCapabilitiesInfo(
     capabilitiesInfo IN XMLTYPE);
```

Description

Inserts the capabilities template information.

Parameters

capabilitiesInfo
XML document for the capabilities template, which is used at runtime to generate capabilities documents.

Usage Notes

At runtime, the capabilities document is dynamically generated by binding feature type information from the WFS metadata with the capabilities template. For information about capabilities documents, see Capabilities Documents.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example inserts the capabilities template information.

```
BEGIN
  SDO_WFS_PROCESS.insertCapabilitiesInfo(
    xmltype(bfilename('WFSUSERDIR', 'capabilitiesTemplate.xml'),
       nls_charset_id('AL32UTF8')));
END
/
```

37.8 SDO_WFS_PROCESS.InsertFtDataUpdated

Format

```
SDO_WFS_PROCESS.InsertFtDataUpdated(
     ns             IN VARCHAR2,
     name           IN VARCHAR2,
     updatedRowList IN ROWPOINTERLIST,
     updateTs       IN TIMESTAMP);
```

Description

Inserts a notification that the data for one or more feature instances was updated in the database.

Parameters

ns
Namespace of the feature type.

name
Name of the feature type.

updatedRowList
Rowids of feature instances that have been updated.

updateTS
Date and time when the data was updated.

Usage Notes

This procedure is used for WFS cache data synchronization.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example inserts a notification that the data for the feature instances associated with specific rowids in the COLA_MARKETS_CS table was updated in the database.

```
. . .
begin
updatedRowIdList:= . . . -- list of rowIds of the
--          WFS_REL_USER.COLA_MARKETS_CS table
--          that have been updated.
```

```
. . .
SDO_WFS_PROCESS.InsertFtDataUpdated(
    'http://www.example.com/myns','COLA', updatedRowIdList, sysdate);
. . .
end;
/
```

37.9 SDO_WFS_PROCESS.InsertFtMDUpdated

Format

```
SDO_WFS_PROCESS.InsertFtMDUpdated(
     ns        IN VARCHAR2,
     name      IN VARCHAR2,
     updateTs  IN TIMESTAMP);
```

Description

Inserts a notification that the metadata for a feature type was updated in the database.

Parameters

ns
Namespace of the feature type.

name
Name of the feature type.

updateTS
Date and time when the metadata was updated.

Usage Notes

This procedure is used for WFS cache metadata synchronization.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example inserts a notification that the metadata for the `COLA` feature type was updated in the database.

```
begin
SDO_WFS_PROCESS.InsertFtMDUpdated(
    'http://www.example.com/myns','COLA', sysdate);
end;
/
```

37.10 SDO_WFS_PROCESS.PopulateFeatureTypeXMLInfo

Format

```
SDO_WFS_PROCESS.PopulateFeatureTypeXMLInfo(
     xmlColTypeXsd  IN XMLTYPE,
     fTypeId        IN NUMBER,
     columnName     IN VARCHAR2,
     objPathInfo    IN MDSYS.STRINGLIST);
```

Description

Populates metadata for a relational feature type that has an XMLType column.

Parameters

xmlColTypeXsd
Schema definition of the relational feature type that has an XMLType column.

fTypeId
ID of the relational feature type that has an XMLType column.

columnName
Name of the XMLType column in the feature table

objPathInfo
Path information. `The MDSYS.STRINGLIST type is defined as VARRAY(1000000) OF VARCHAR2(4000).`

Usage Notes

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example populates the metadata for the relational feature type described by the XML schema definition in `ROADS.xsd` and stored in an XMLType column named DATACOL

```
BEGIN
  SDO_WFS_PROCESS.populateFeatureTypeXMLInfo(
    xmltype(bfilename('WFSUSERDIR', 'ROADS.xsd'), nls_charset_id('AL32UTF8')),
    1,
    'DATACOL',
    mdsys.StringList('METADATA'));
END;
/
```

37.11 SDO_WFS_PROCESS.PublishFeatureType

Format

```
SDO_WFS_PROCESS.PublishFeatureType(
     dataSrc           IN VARCHAR2,
     ftNsUrl           IN VARCHAR2,
     ftName            IN VARCHAR2,
     ftNsAlias         IN VARCHAR2,
     featureDesc       IN XMLTYPE,
     schemaLocation    IN VARCHAR2,
     pkeyCol           IN VARCHAR2,
     columnInfo        IN MDSYS.STRINGLIST,
     pSpatialCol       IN VARCHAR2,
     featureMemberNs   IN VARCHAR2,
     featureMemberName IN VARCHAR2,
     srsNs             IN VARCHAR2,
     srsNsAlias        IN VARCHAR2,
     mandatoryColumnInfo IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.PublishFeatureType(
     dataSrc             IN VARCHAR2,
     ftNsUrl             IN VARCHAR2,
     ftName              IN VARCHAR2,
     ftNsAlias           IN VARCHAR2,
     featureDesc         IN XMLTYPE,
     schemaLocation      IN VARCHAR2,
     pkeyCol             IN VARCHAR2,
     columnInfo          IN MDSYS.STRINGLIST,
     pSpatialCol         IN VARCHAR2,
     featureMemberNs     IN VARCHAR2,
     featureMemberName   IN VARCHAR2,
     srsNs               IN VARCHAR2,
     srsNsAlias          IN VARCHAR2,
     viewTableName       IN VARCHAR2,
     viewTablepkeyCol    IN VARCHAR2,
     mandatoryColumnInfo IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.PublishFeatureType(
     dataSrc               IN VARCHAR2,
     ftNsUrl               IN VARCHAR2,
     ftName                IN VARCHAR2,
     ftNsAlias             IN VARCHAR2,
     featureDesc           IN XMLTYPE,
     schemaLocation        IN VARCHAR2,
     pkeyCol               IN VARCHAR2,
     columnInfo            IN MDSYS.STRINGLIST,
     pSpatialCol           IN VARCHAR2,
     featureMemberNs       IN VARCHAR2,
     featureMemberName     IN VARCHAR2,
     srsNs                 IN VARCHAR2,
     srsNsAlias            IN VARCHAR2,
     featureCollectionNs   IN VARCHAR2,
     featureCollectionName IN VARCHAR2,
     isGML3                IN VARCHAR2,
     formattedKeyCols      IN MDSYS.STRINGLIST,
     viewTableName         IN VARCHAR2,
     viewTablepkeyCol      IN VARCHAR2,
     viewTableFmtKeyCols   IN VARCHAR2,
     mandatoryColumnInfo   IN MDSYS.STRINGLIST);
```

Description

Publishes a feature type; that is, registers metadata related to the feature type.

Parameters

dataSrc
Name of the feature table or view containing the spatial features. It must be in the format *schema-name.table-name* or *schema-name.view-name*; that is, the name of the database user that owns the table must be included.

ftNsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

ftNsAlias
Alias of the namespace for the feature type.

featureDesc
Feature type description to be reported in the capabilities document, as a document of type XMLTYPE.

schemaLocation
String to be used to populate the `xsi:schemaLocation` attribute in the feature type XSD. If this parameter is null, a string is automatically generated.

pkeyCol
Primary key column in the feature table or view identified in `dataSrc`. If a feature type table or view has a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example: `'COL1;COL2'`

columnInfo
Type string associated with each spatial column (SDO_GEOMETRY type) in the feature table identified in `dataSrc`., as an object of type MDSYS.STRINGLIST (for example, for WFS 1.1.*n*, `MDSYS.STRINGLIST('PolygonPropertyType', 'PointPropertyType').`
See the Usage Notes for information about any spatial columns specified in the `columnInfo` parameter.

pSpatialCol
Spatial column of type SDO_GEOMETRY in the feature table.

featureMemberNs
Namespace of the feature member element that will contain feature instances in a feature collection. If this parameter is null, the default is: `http://www.opengis.net/gml`

featureMemberName
Name of the feature member element that will contain feature instances in a feature collection. If this parameter is null, the default is `featureMember`.

srsNs
User-defined namespace of the spatial reference system (coordinate system) associated with the spatial data for the feature type. This namespace (if specified) is also used to generate the `srsName` attribute in the `<boundedBy>` element of the FeatureCollection result generated for the GetFeature request.

srsNsAlias
Namespace alias of the namespace of the spatial reference system (coordinate system) associated with the spatial data for the feature type.

featureCollectionNs
Namespace of the WFS feature collection within which this feature type instances can occur.

featureCollectionName
Name of the WFS feature collection within which this feature type instances can occur.

isGML3
A string value: `Y` means that the geometries inside instances of this feature type are GML3.1.1 compliant; `N` means that the geometries inside instances of this feature type are GML 2.1.2 compliant.

formattedKeyCols
String formatted representation of the content of the primary key column or (for a multicolumn primary key) columns. For example, if ROAD_ID is the primary key column of type NUMBER, specify `MDSYS.STRINGLIST('to_char(ROAD_ID)')`. To specify multiple strings in the MDSYS.STRINGLIST type constructor, separate each with a comma. The list of string formatted primary key columns should be specified in the same order as the primary key columns specified in the `pkeyCol` parameter.

viewTableName
Name of the underlying table if the feature type will by defined on a view based on a single underlying table. The published feature type will be based on the view, specified in the `dataSrc` parameter (*user-name.view-name)*. Do not enter a value for the `viewTableName` parameter if the feature type is based on a table or on a multitable view.

viewTablepkeyCol
Primary key column of the table specified in the `viewTableName` parameter, if the feature type will by defined on a view based on a single underlying table.

viewTableFmtKeyCols
If the feature type is based on a view defined on a single table, and if the view has one or more formatted primary key columns, this parameter represents a list of string formatted primary key columns in the underlying table that correspond to the string formatted primary key columns in the view (specified by `formattedkeyCols` parameter). For example, if ROAD_ID is the primary key column of type NUMBER, specify `MDSYS.STRINGLIST('to_char(ROAD_ID)')`. To specify multiple strings in the MDSYS.STRINGLIST type constructor, separate each with a comma.
If feature type is not based on a single table view, or if the feature type is based on a single table view but the feature type does not have formatted primary key columns, this parameter should be null.

mandatoryColumnInfo
List of columns that must be returned in the GetFeature request, irrespective of the columns requested. (The requested columns will be returned in all cases.) If this parameter is omitted, all columns are mandatory (that is, all columns will be returned). However, if this parameter is specified as NULL, no columns are mandatory (that is, only the requested columns will be returned). To specify column names, use the MDSYS.STRINGLIST type constructor as in the following example: `MDSYS.STRINGLIST('COL1', 'COL2', 'COL5')`

Usage Notes

In the `columnInfo` parameter, each column of type SDO_GEOMETRY in the feature type instances table must have the correct associated string value specified in the `columnInfo` parameter, with the string values in the same order as the order of the spatial columns in the table definition.

For WFS 1.0.*n*, for example, if the single SDO_GEOMETRY column named SHAPE in the feature type instances table contains polygon geometries, the `columnInfo` value must be `SHAPE_GEOMETRYTYPE>PolygonMemberType`. Table 37-1 lists the geometry types and their required associated `columnInfo` parameter values for WFS version 1.0.*n*. (Replace <*column-name*> with the name of the column.)

Table 37-1 Geometry Types and columnInfo Parameter Values (WFS 1.0.n)

Geometry Type	columnInfo Parameter Value
Polygon or Surface	<*column-name*>_GEOMETRYTYPE>PolygonMemberType

Table 37-1 (Cont.) Geometry Types and columnInfo Parameter Values (WFS 1.0.n)

Geometry Type	columnInfo Parameter Value
Multipolygon or Multisurface	<*column-name*>_GEOMETRYTYPE>MultiPolygonMemberType
Point	<*column-name*>_GEOMETRYTYPE>PointMemberType
Multipoint	<*column-name*>_GEOMETRYTYPE>MultiPointMemberType
Line or Curve	<*column-name*>_GEOMETRYTYPE>CurveMemberType
Multiline or multicurve	<*column-name*>_GEOMETRYTYPE>MultiCurveMemberType
Solid	<*column-name*>_GEOMETRYTYPE>SolidMemberType
Multisolid	<*column-name*>_GEOMETRYTYPE>MultiSolidMemberType
Collection	<*column-name*>_GEOMETRYTYPE>GeometryMemberType

For WFS 1.1.*n*, for example, if the single SDO_GEOMETRY column in the feature type instances table contains polygon geometries, the `columnInfo` value must be `PolygonPropertyType`. Table 37-2 lists the geometry types and their required associated `columnInfo` parameter values for WFS version 1.1.*n*.

Table 37-2 Geometry Types and columnInfo Parameter Values (WFS 1.1.n)

Geometry Type	columnInfo Parameter Value
Polygon or Surface	PolygonPropertyType
Multipolygon or Multisurface	MultiPolygonPropertyType
Point	PointPropertyType
Multipoint	MultiPointPropertyType
Line or Curve	CurvePropertyType
Multiline or multicurve	MultiCurvePropertyType
Solid	SolidPropertyType
Multisolid	MultiSolidPropertyType
Collection	GeometryPropertyType

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example registers metadata for a feature type named `COLA` with the polygon geometries stored in the column named `SHAPE`. (It assumes the use of WFS 1.1.*n*.)

```
DECLARE
columnInfo MDSYS.StringList := MDSYS.StringList('PolygonPropertyType');
BEGIN
SDO_WFS_PROCESS.publishFeatureType(
 'WFS_USER.COLA_MARKETS_VIEW',
 'http://www.example.com/myns',
 'COLA',
 'myns',
 xmltype(bfilename('WFSUSERDIR', 'featuredesct.xml'), nls_charset_id('AL32UTF8')),
 null, 'MKT_ID', columnInfo, 'SHAPE', null, null, null, null);
END;
/
```

37.12 SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema

Format

```
SDO_WFS_PROCESS.Publish_FeatureTypes_In_Schema(
     p_owner              IN VARCHAR2,
     p_namespace_url      IN VARCHAR2,
     p_namespace_alias    IN VARCHAR2,
     p_wls_postxml_url    IN VARCHAR2,
     p_tablename_pattern  IN VARCHAR2 DEFAULT NULL,
     p_wfs_version        IN VARCHAR2 DEFAULT NULL,
     p_write_xsd          IN VARCHAR2 DEFAULT NULL);
```

Description

Publishes the feature types in a schema; that is, registers metadata related to the feature types (using “camel case”).

Parameters

p_owner
Name of the database user that owns the table containing the spatial features (which can have spatial and non-spatial properties).

p_namespace_url
Uniform resource locator (URL) of the namespace for the feature type. (Corresponds to the `ftNsUrl` parameter of the SDO_WFS_PROCESS.PublishFeatureType procedure.)

p_namespace_alias
Alias of the namespace for the feature type. (Corresponds to the `ftNsAlias` parameter of the SDO_WFS_PROCESS.PublishFeatureType procedure)

p_wls_postxml_url
The HTTP URL in the format to execute POST XML requests to the WFS Server:

- `http://hostname:listening_port/SpatialWS-SpatialWS-context-root/SpatialWSXmlServlet` [old notation]
- `http://hostname:listening_port/oraclespatial/wfs` [new notation]

This URL is used for any cache reload for the WFS engine.

p_tablename_pattern
The table name pattern to identify tables that need to be newly published or republished if they are already published. The default it is "%", which means all feature types in the schema.

p_wfs_version
The WFS version needed for the POST XML request. The default value is 1.1.0, the latest WFS version supported for Release 12.2.

p_write_xsd
If `Y`, then an XSD file is written to WFSUSERDIR. The file naming convention matches *owner_tablename_columnname*.xsd.

Usage Notes

This procedure publishes all feature types in a schema with each feature type XSD derived from the corresponding `DescribeFeatureType` response without using the WFS administration console.

This procedure assumes that each feature type table has a single spatial column, even though WFS can handle multiple spatial columns.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example performs all metadata registry operations . It assumes the use of WFS 1.1.0 (the default).

```
EXECUTE  SDO_WFS_PROCESS.publish_featureTypes_in_schema(
   p_owner=> 'WFS_REL_USER',
   p_namespace_url => 'http://cite.opengeospatial.org/gmlsf',
   p_namespace_alias=> 'sf',
   p_wls_postxml_url=> 'http://localhost:7003/oraclespatial/wfs');
```

The following example publishes the GEOD_STATES table in the STUDENT schema.

```
EXECUTE sdo_wfs_process.publish_featureTypes_in_schema (
   'STUDENT',
   'http://www.myserver.com/student_data',
   'sdns',
   'http://localhost:7001/oraclespatial/wfs',
   p_tablename_pattern=>'GEOD_STATES');
```

37.13 SDO_WFS_PROCESS.RegisterMTableView

Format

```
SDO_WFS_PROCESS.RegisterMTableView(
     ftNsUrl              IN VARCHAR2,
     ftName               IN VARCHAR2,
     viewTableList        IN MDSYS.STRINGLIST,
     viewTablePkeyColList IN MDSYS.STRINGLIST,
     tablePkeyColList     IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.RegisterMTableView(
     ftNsUrl                   IN VARCHAR2,
     ftName                    IN VARCHAR2,
     viewTableList             IN MDSYS.STRINGLIST,
     viewTablePkeyColList      IN MDSYS.STRINGLIST,
     formattedViewTableColList IN MDSYS.STRINGLISTLIST,
     tablePkeyColList          IN MDSYS.STRINGLIST);
```

Description

Enables the publishing of content from a multitable view as a feature instance.

Parameters

ftNsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

viewTableList
List of tables in the view. To specify table names, use the MDSYS.STRINGLIST type constructor as in the following example: `MDSYS.STRINGLIST('MYUSER.ROADS', 'MYUSER.ROADS_DESC')`

viewTablePkeyColList
List of view columns that correspond to the primary key columns in the tables in the view, in the order that corresponds to the order of the tables in `viewTableList`. To specify column names, use the MDSYS.STRINGLIST type constructor as in the following example: `MDSYS.STRINGLIST('ROAD_ID', 'ROAD_ID')`, where both the ROADS and ROAD_DESC table have ROAD_ID as primary key.
If the view has columns that correspond to table columns in a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example: `'COL1;COL2'`

formattedViewTableColList
A list of string formatted table primary key columns that correspond to the string formatted primary key columns in the view, in the order that corresponds to the order of the tables in `viewTableList`. To specify column names, use the MDSYS.STRINGLISTLIST type constructor as in the following example:
`MDSYS.STRINGLISTLIST(MDSYS.STRINGLIST('to_char(ROAD_ID)'), MDSYS.STRINGLIST('to_char(ROAD_ID)'))`
The list of string formatted primary key columns for each table should be specified in the same order as the primary key columns for each table specified in `tablePkeyColList` parameter.

tablePkeyColList
List of the primary key columns in the tables, in the order that corresponds to the order of the tables in `viewTableList`. For each table the primary key columns should be specified in the order that correspond to the key columns in the view as specified in `viewTablePkeyColList` parameter. To specify column names, use the MDSYS.STRINGLIST type constructor as in the following example: `MDSYS.STRINGLIST('ROAD_ID', 'ROAD_ID')`
If a table has a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example : `'COL1;COL2'`

Usage Notes

If you need to publish content from a multitable view as a feature instance, you must call this procedure after calling the SDO_WFS_PROCESS.PublishFeatureType procedure.

To disable the publishing of content from a multitable view as a feature instance, use the SDO_WFS_PROCESS.UnRegisterMTableView procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example creates two feature tables, creates a view based on these tables. publishes a feature type, and registers the multitable view to enable the publishing of content from the view.

```
CREATE TABLE cola_markets_cs (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape MDSYS.SDO_GEOMETRY);

CREATE TABLE cola_markets_cs_details (
  mkt_id NUMBER PRIMARY KEY,
  description VARCHAR2(400));

create view cola_markets_view as select t1.mkt_id, t1.name, t1.shape,
  t2.description from
  cola_markets_cs t1, cola_markets_cs_details t2
  where t1.mkt_id = t2.mkt_id;

DECLARE
cm MDSYS.StringList := MDSYS.StringList('PolygonMemberType');
BEGIN
SDO_WFS_PROCESS.publishFeatureType(
 'WFS_USER.COLA_MARKETS_VIEW',
 'http://www.example.com/myns',
 'COLA',
 'myns',
 xmltype(bfilename('WFSUSERDIR', 'featuredesct.xml'), nls_charset_id('AL32UTF8')),
 null, 'MKT_ID', cm, 'SHAPE', null, null, null, null);
END;
/

BEGIN
SDO_WFS_PROCESS.registerMTableView('http://www.example.com/myns',
        'COLA', mdsys.StringList('WFS_USER.COLA_MARKETS_CS',
        'WFS_USER.COLA_MARKETS_CS_DETAILS'),
        mdsys.StringList('MKT_ID', 'MKT_ID'), -- view keys per table
        mdsys.StringList('MKT_ID', 'MKT_ID'));-- corresponding table keys
END;
/
```

37.14 SDO_WFS_PROCESS.RevokeFeatureTypeFromUser

Format

```
SDO_WFS_PROCESS.RevokeFeatureTypeFromUser(
     ftnsUrl   IN VARCHAR2,
     ftName    IN VARCHAR2,
     userName IN VARCHAR2);
```

Description

Revokes access to a feature type from a database user.

Parameters

ftnsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

userName
Name of the database user.

Usage Notes

To grant access to a feature type to a database user, use the SDO_WFS_PROCESS.GrantFeatureTypeToUser procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example revokes access to the `COLA` feature type from user `SMITH`.

```
BEGIN
  SDO_WFS_PROCESS.RevokeFeatureTypeFromUser('http://www.example.com/myns','COLA',
    'SMITH');
END;
/
```

37.15 SDO_WFS_PROCESS.RevokeMDAccessFromUser

Format

```
SDO_WFS_PROCESS.RevokeMDAccessFromUser(
     userName   IN VARCHAR2);
```

Description

Revokes access to Web Feature Service metadata tables from a database user.

Parameters

userName
Name of the database user.

Usage Notes

To call this procedure, you should be connected to the database as a user with the DBA role.

To grant access to Web Feature Service metadata tables to a database user, use the SDO_WFS_PROCESS.GrantMDAccessToUser procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example revokes access to Web Feature Service metadata tables from the database user named `WFS_REL_USER`.

```
BEGIN
  SDO_WFS_PROCESS.RevokeMDAccessToUser('WFS_REL_USER');
END;
/
```

37.16 SDO_WFS_PROCESS.UnRegisterMTableView

Format

```
SDO_WFS_PROCESS.UnRegisterMTableView(
     ftNsUrl  IN VARCHAR2,
     ftName   IN VARCHAR2);
```

Description

Disables the publishing of content from a multitable view as a feature instance.

Parameters

ftNsUrl
Uniform resource locator (URL) of the namespace for the feature type.

ftName
Name of the feature type.

Usage Notes

The SDO_WFS_PROCESS.RegisterMTableView procedure must have been called previously to enable the publishing of content from the multitable view as a feature instance.

If you want to drop a feature type whose content comes from a multitable view, you must call this procedure before you call the SDO_WFS_PROCESS.DropFeatureType procedure.

For information about support for Web Feature Services, see Web Feature Service (WFS) Support.

Examples

The following example unregisters a multitable view to disable the publishing of content from the view.

```
DECLARE
BEGIN
  SDO_WFS_PROCESS.unRegisterMTableView('http://www.example.com/myns', 'COLA');
END;
/
```

Part IV

Supplementary Information

This document has the following parts:

- Conceptual and Usage Information provides conceptual and usage information about Oracle Spatial.
- Spatial Web Services provides conceptual and usage information about Oracle Spatial web services.
- Reference Information provides reference information about Oracle Spatial operators, functions, and procedures.
- Part IV provides supplementary information (appendixes and a glossary).
- Installation, Migration, Compatibility, and Upgrade
  This appendix provides information about installation, migration, compatibility, and upgrade relating to Oracle Spatial.
- Complex Spatial Queries: Examples
  This appendix provides examples, with explanations, of queries that are more complex than the examples in the reference chapters.
- Loading ESRI Shapefiles into Spatial
  The Java shapefile converter transforms an ESRI shapefile into an Oracle Database table for use with Oracle Spatial.
- Routing Engine Administration
  This appendix is for advanced users who need to administer the routing engine. It is not intended for most routing users.

A

Installation, Migration, Compatibility, and Upgrade

This appendix provides information about installation, migration, compatibility, and upgrade relating to Oracle Spatial.

If you are upgrading to the current Oracle Database release, Oracle Spatial is automatically upgraded as part of the operation. For information about the upgrade procedure, see *Oracle Database Upgrade Guide*.

If you need to downgrade Spatial to the previous Oracle Database release, follow the instructions for downgrading a database back to the previous Oracle Database release in *Oracle Database Upgrade Guide*.

If you need to migrate spatial data from one database to another, see Migrating Spatial Data from One Database to Another.

If you use Oracle Spatial GeoRaster, see Ensuring That GeoRaster Works Properly After an Installation or Upgrade.

If you are using Spatial Web Feature Service (WFS) or Catalog Services for the Web (CSW) support, and if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, see Index Maintenance Before and After an Upgrade (WFS and CSW).

If you need to support geometries with more than 1,048,576 ordinates, see Increasing the Size of Ordinate Arrays to Support Very Large Geometries.

- Manually Installing Spatial
- Migrating Spatial Data from One Database to Another
- Ensuring That GeoRaster Works Properly After an Installation or Upgrade
- Index Maintenance Before and After an Upgrade (WFS and CSW)
- Increasing the Size of Ordinate Arrays to Support Very Large Geometries

A.1 Manually Installing Spatial

This section applies if you do not have Oracle Spatial installed by default at the time of Oracle Database installation and you want to install Spatial later.

To install Spatial manually, you must execute the following steps using a SQL based interface such as SQL Developer or SQLPLUS:

1. Connect to Oracle Database as `SYSDBA`:

   ```
   CONNECT / AS SYSDBA
   ```

2. Execute the `mdinst.sql` script as shown:

   ```
   @$ORACLE_HOME/md/admin/mdinst.sql
   ```

Multitenant Installations

To install Spatial in CDB$ROOT and all the PDBs in a multitenant environment, run the `catcon.pl` script to execute `mdinst.sql` as shown:

```
cd $ORACLE_HOME/perl/bin/
perl $ORACLE_HOME/rdbms/admin/catcon.pl -u sys/knl_test7 -s -e -b mdinst.log
mdinst.sql > mdinst_catcon.log >> mdinst_catcon.err
```

> **Note:**
>
> Spatial must always be installed in CDB$ROOT before it is installed in any other PDBs.

If you want to install Spatial only in some specific PDBs, see Running Oracle-Supplied SQL Scripts in a CDB for more information.

A.2 Migrating Spatial Data from One Database to Another

Migrating spatial data refers to moving or copying Oracle Spatial geometry objects from one Oracle database to another. (The databases can have the same or different Oracle Database release numbers.)

If you are migrating spatial data using database links, export/import, Oracle Data Pump, or transportable tablespaces, the MDSYS schema must already exist in the destination database.

In limited situations you might also need to use the SDO_MIGRATE.TO_CURRENT subprogram (described in SDO_MIGRATE Package (Upgrading)). See the Usage Notes for that subprogram.

A.3 Ensuring That GeoRaster Works Properly After an Installation or Upgrade

To use the GeoRaster feature of Oracle Spatial, you must enable it.

Before or after an upgrade, if there are any 4-band JPEG compressed GeoRaster objects, decompress them or convert them into 1-band or 3-band JPEG compressed objects. After an upgrade, verify that GeoRaster objects and data are valid and that GeoRaster is enabled for all schemas that use the feature, as explained in Maintaining GeoRaster Objects and System Data in the Database in *Oracle Spatial GeoRaster Developer's Guide*.

- Enabling GeoRaster at the Schema Level
- Converting 4-band JPEG Compressed GeoRaster Objects

A.3.1 Enabling GeoRaster at the Schema Level

GeoRaster must be enabled for each database schema that will use the GeoRaster feature.

By default, the GeoRaster feature is disabled after the Oracle Spatial is initially installed. GeoRaster can be enabled only within the scope of a schema (that is, not for the entire database), and it must be enabled for each schema that will use the GeoRaster feature.

To enable GeoRaster, follow these steps *for each schema* for which GeoRaster will be enabled:

1. Ensure that the user for this schema has the `CREATE TRIGGER` privilege (which is required for GeoRaster to work properly). If the user does not have the `CREATE TRIGGER` privilege (or if you do not know), connect as a user with DBA privilege and execute the following code:

   ```
   GRANT CREATE TRIGGER TO scott;
   ```

2. Connect to the database as the user for that schema. For example:

   ```
   CONNECT scott/<password-for-scott>
   ```

3. Enter the following statement:

   ```
   EXECUTE SDO_GEOR_ADMIN.enableGeoRaster;
   ```

4. Verify that GeoRaster is now enabled by checking that the following statement returns `TRUE`:

   ```
   SELECT SDO_GEOR_ADMIN.isGeoRasterEnabled FROM DUAL;
   ```

For each database schema, SDO_GEOR_ADMIN.enableGeoRaster only needs to be called once. In any case, you can call SDO_GEOR_ADMIN.isGeoRasterEnabled function to check if GeoRaster feature is enabled. You can use SDO_GEOS_ADMIN.disableGeoRaster procedure to disable GeoRaster feature for the database schema.

If a GeoRaster table has been created and populated with data, then after a database upgrade, GeoRaster is automatically enabled for that table's schema, and you do ***not*** need to re-enable GeoRaster for the schema. (Just ensure that the CREATE TRIGGER privilege is granted to the user.)

A.3.2 Converting 4-band JPEG Compressed GeoRaster Objects

Oracle Spatial GeoRaster Release 23ai only supports 1-band and 3-band JPEG compression in the GeoRaster objects. Therefore, before upgrading or migrating to Oracle Database Release 23ai, any 4-band JPEG compressed GeoRaster objects from the previous releases need to be decompressed or converted to 1-band JPEG compressed GeoRaster objects. See My Oracle Support Doc ID 2960620.1 for detailed instructions.

In case if those 4-band JPEG compressed GeoRaster objects were not decompressed or converted prior to database upgrade or migration, then they can be converted outside the database using JDK 8. See My Oracle Support Doc ID 2992512.1 for detailed instructions.

A.4 Index Maintenance Before and After an Upgrade (WFS and CSW)

Effective with Release 11.2, the SYS.XMLTABLEINDEX index type is deprecated, and therefore the Spatial WFS and CSW `createXMLTableIndex` methods create indexes of type XDB.XMLINDEX instead of type SYS.XMLTABLEINDEX as in previous releases. However, if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes before the upgrade and re-create the indexes after the upgrade, as follows:

1. Using Oracle Database Release 11.1, call the `dropXMLTableIndex` method (in `oracle.spatial.csw.CSWAdmin` or `oracle.spatial.wfs.WFSAdmin`, as appropriate depending on the application) to drop associated indexes.
2. Upgrade the database from Release 11.1 to Release 11.2.
3. Using Oracle Database Release 11.2, call the `createXMLTableIndex` (in `oracle.spatial.csw.CSWAdmin` or `oracle.spatial.wfs.WFSAdmin`, as appropriate depending on the application) to create indexes that were dropped in step 1.

For information about Spatial Web Feature Service (WFS) support, see Web Feature Service (WFS) Support.

For information about Spatial Catalog Services for the Web (CSW) support, see Catalog Services for the Web (CSW) Support.

A.5 Increasing the Size of Ordinate Arrays to Support Very Large Geometries

If you need to support geometries with more than 1,048,576 ordinates, you must follow the instructions in this section. However, doing so involves significant extra work (running a script, migrating existing spatial data), some database downtime, and some considerations and restrictions. Therefore, you should not perform the actions in this section unless you need to.

To increase the size of ordinate arrays to support geometries with up to 10M ordinates, follow these steps:

1. Ensure that no users are using any spatial tables or Oracle Spatial features.
2. Connect to the database as the SYS user with SYSDBA privileges (SYS AS SYSDBA, and enter the SYS account password when prompted).
3. If any materialized views exist on tables containing SDO_GEOMETRY columns, drop all such materialized views *before* performing the next step (running `sdoupggeom.sql`).

   You can re-create these materialized views after the upgrade operation is completed.
4. Enter the following statement:
   - Linux: `@$ORACLE_HOME/md/admin/sdoupggeom.sql`
   - Windows: `@%ORACLE_HOME%\md\admin\sdoupggeom.sql`

   One of the actions of the `sdoupggeom.sql` script is to automatically migrate all spatial data to accommodate the new SDO_ORDINATE_ARRAY definition. This script may take a long time to complete, and the amount of time will depend on the amount of spatial data that exists in the database.

After you perform these steps, the following considerations and restrictions apply:

- Any existing transportable tablespaces that were created with the old SDO_ORDINATE_ARRAY definition will not work.
- If an export file was created using the Original Export utility on a database with the old SDO_ORDINATE_ARRAY definition, and if that file needs to be imported into a database that is using the new SDO_ORDINATE_ARRAY definition, you must specify the `TOID_NOVALIDATE` flag with the Original Import utility, as in the following example:

```
imp scott/<password> file=states.dmp tables=states
TOID_NOVALIDATE=MDSYS.SDO_GEOMETRY,MDSYS.SDO_ORDINATE_ARRAY,MDSYS.SDO_ELEM_INFO_ARRAY
```

- If you plan to use Oracle Data Pump to import data after `sdoupggeom.sql` has been executed on a source database, you must also run `sdoupggeom.sql` on the target (destination) database after the import operation.

B

Complex Spatial Queries: Examples

This appendix provides examples, with explanations, of queries that are more complex than the examples in the reference chapters.

This appendix focuses on operators that are frequently used in Spatial applications, such as SDO_WITHIN_DISTANCE and SDO_NN.

This appendix is based on input from Oracle personnel who provide support and training to Spatial users. The Oracle Spatial training course covers many of these examples, and provides additional examples and explanations.

Before you use any of the examples in this appendix, be sure you understand the usage and reference information for the relevant operator or function in Conceptual and Usage Information and Reference Information .

- Tables Used in the Examples
- SDO_WITHIN_DISTANCE Examples
- SDO_NN Examples

B.1 Tables Used in the Examples

The examples in this appendix refer to tables named GEOD_CITIES, GEOD_COUNTIES, and GEOD_INTERSTATES, which are defined as follows:

```
CREATE TABLE GEOD_CITIES(
  LOCATION      SDO_GEOMETRY,
  CITY          VARCHAR2(42),
  STATE_ABRV    VARCHAR2(2),
  POP90         NUMBER,
  RANK90        NUMBER);

CREATE TABLE GEOD_COUNTIES(
  COUNTY_NAME    VARCHAR2(40),
  STATE_ABRV     VARCHAR2(2),
  GEOM           SDO_GEOMETRY);

CREATE TABLE GEOD_INTERSTATES(
  HIGHWAY    VARCHAR2(35),
  GEOM       SDO_GEOMETRY);
```

B.2 SDO_WITHIN_DISTANCE Examples

The SDO_WITHIN_DISTANCE operator identifies the set of spatial objects that are within some specified distance of a given object. You can indicate that the distance is approximate or exact. If you specify `querytype=FILTER`, the distance is approximate because only a primary filter operation is performed; otherwise, the distance is exact because both primary and secondary filtering operations are performed.

Example B-1   Finding All Cities Within a Distance of a Highway

Example B-1 finds all cities within 15 miles of the interstate highway I170.

```
SELECT /*+ ORDERED */ c.city
FROM geod_interstates i, geod_cities c
WHERE i.highway = 'I170'
   AND sdo_within_distance (
        c.location, i.geom,
       'distance=15 unit=mile') = 'TRUE';
```

Example B-1 finds all cities within 15 miles (`'distance=15 unit=mile'`) of the specified highway (`i.highway = 'I170'`), and by default the result is exact (because the `querytype` parameter was not used to limit the query to a primary filter operation). In the `WHERE` clause of this example:

- `i.highway` refers to the HIGHWAY column of the INTERSTATES table, and `I170` is a value from the HIGHWAY column.
- `c.location` specifies the search column (`geometry1`). This is the LOCATION column of the GEOD_CITIES table.
- `i.geom` specifies the query window (`aGeom`). This is the spatial geometry in the GEOM column of the GEOD_INTERSTATES table, in the row whose HIGHWAY column contains the value `I170`.

Example B-2   Finding All Highways Within a Distance of a City

Example B-2 finds all interstate highways within 15 miles of the city of Tampa.

```
SELECT /*+ ORDERED */ i.highway
FROM geod_cities c, geod_interstates i
WHERE c.city = 'Tampa'
   AND sdo_within_distance (
        i.geom, c.location,
        'distance=15 unit=mile') = 'TRUE';
```

Example B-2 finds all highways within 15 miles (`'distance=15 unit=mile'`) of the specified city (`c.city = 'Tampa'`), and by default the result is exact (because the `querytype` parameter was not used to limit the query to a primary filter operation). In the `WHERE` clause of this example:

- `c.city` refers to the CITY column of the GEOD_CITIES table, and `Tampa` is a value from the CITY column.
- `i.geom` specifies the search column (`geometry1`). This is the GEOM column of the GEOD_INTERSTATES table.
- `c.location` specifies the query window (`aGeom`). This is the spatial geometry in the LOCATION column of the GEOD_CITIES table, in the row whose CITY column contains the value `Tampa`.

B.3 SDO_NN Examples

The SDO_NN operator determines the nearest neighbor geometries to a geometry. No assumptions should be made about the order of the returned results, unless you specify the SDO_NN_DISTANCE ancillary operator in the ORDER BY clause to have the results returned in distance order. If you specify no optional parameters, one nearest neighbor geometry is returned.

If you specify the optional `sdo_num_res` keyword, you can request how many nearest neighbors you want, but no other conditions in the WHERE clause are evaluated. For example, assume that you want the five closest banks from an intersection, but only where the bank name is `CHASE`. If the five closest banks are not named `CHASE`, SDO_NN with `sdo_num_res=5` will return no rows because the `sdo_num_res` keyword only takes proximity into account, and not any other conditions in the WHERE clause.

If you specify the optional `sdo_batch_size` keyword, any `sdo_num_res` specification is ignored, and SDO_NN keeps returning neighbor geometries in distance order to the WHERE clause. If the WHERE clause specifies `bank_name = 'CHASE' AND rownum < 6`, you can return the five closest banks with `bank_name = 'CHASE'`.

SDO_NN_DISTANCE is an ancillary operator to the SDO_NN operator. It returns the distance of an object returned by the SDO_NN operator and is valid only within a call to the SDO_NN operator.

See also Example 5-1in Using Partitioned Spatial Indexes.

Example B-3 Finding the Cities Nearest to a Highway

Example B-3 finds the five cities nearest to the interstate highway I170 and the distance in miles from the highway for each city, ordered by distance in miles.

```
SELECT /*+ ORDERED */
       c.city,
       sdo_nn_distance (1) distance_in_miles
FROM geod_interstates i,
     geod_cities c
WHERE i.highway = 'I170'
  AND sdo_nn(c.location, i.geom,
           'sdo_num_res=5 unit=mile', 1) = 'TRUE'
ORDER BY distance_in_miles;
```

In Example B-3, because the `/*+ ORDERED*/` optimizer hint is used, it is important to have an index on the GEOD_INTERSTATES.HIGHWAY column. In this example, the hint forces the query to locate highway I170 before it tries to find nearest neighbor geometries. In the `WHERE` clause of this example:

- `i.highway` refers to the HIGHWAY column of the GEOD_INTERSTATES table, and `I170` is a value from the HIGHWAY column.
- `c.location` specifies the search column (`geometry1`). This is the LOCATION column of the GEOD_CITIES table.
- `i.geom` specifies the query window (`geometry2`). This is the spatial geometry in the GEOM column of the GEOD_INTERSTATES table, in the row whose HIGHWAY column contains the value `I170`.
- `sdo_num_res=5` specifies how many nearest neighbor geometries to find.
- `unit=mile` specifies the unit of measurement to associate with distances returned by the SDO_NN_DISTANCE ancillary operator.
- `1` (in `sdo_nn_distance (1)` and `'sdo_num_res=5 unit=mile', 1`) is the `number` parameter value that associates the call to SDO_NN with the call to SDO_NN_DISTANCE.

In Example B-3, `ORDER BY distance_in_miles` orders the results from the WHERE clause by distance in miles.

The statement in Example B-3 produces the following output (slightly reformatted for readability):

```
CITY                    DISTANCE_IN_MILES
----------------------  ------------------------------
St Louis                  5.36297295
Springfield              78.7997464
Peoria                  141.478022
```

```
Evansville              158.22422
Springfield             188.508631
```

Example B-4 Finding the Cities Above a Specified Population Nearest to a Highway

Example B-4 extends Example B-3 by limiting the results to cities with a 1990 population over a certain number. It finds the five cities nearest to the interstate highway I170 that have a population greater than 300,000, the 1990 population for each city, and the distance in miles from the highway for each city, ordered by distance in miles.

```
SELECT /*+ ORDERED  NO_INDEX(c pop90_idx) */
       c.city, pop90,
       sdo_nn_distance (1) distance_in_miles
FROM geod_interstates i,
     geod_cities c
WHERE i.highway = 'I170'
  AND sdo_nn(c.location, i.geom,
            'sdo_batch_size=10 unit=mile', 1) = 'TRUE'
  AND c.pop90 > 300000
  AND rownum < 6
ORDER BY distance_in_miles;
```

In Example B-4, because the `ORDERED` optimizer hint is used, it is important to have an index on the GEOD_INTERSTATES.HIGHWAY column. In this example, the hint forces the query to locate highway I170 before it tries to find nearest neighbor geometries.

To ensure correct results, disable all nonspatial indexes on columns that come from the same table as the SDO_NN search column (`geometry1`). In this example, the `NO_INDEX(c pop90_idx)` optimizer hint disables the nonspatial index on the POP90 column.

In the `WHERE` clause of this example:

- `sdo_batch_size=10` causes geometries to be returned continually (in distance order, in batches of 10 geometries), to be checked to see if they satisfy the other conditions in the WHERE clause.
- `c.pop90 > 300000` restricts the results to rows where the POP90 column value is greater than 300000.
- `rownum < 6` limits the number of results returned to five.

In Example B-4, `ORDER BY distance_in_miles` orders the results from the WHERE clause by distance in miles.

The statement in Example B-4 produces the following output (slightly reformatted for readability):

```
CITY                POP90    DISTANCE_IN_MILES
-----------------  -------  ---------------------
St Louis             396685     5.36297295
Kansas City          435146   227.404883
Indianapolis         741952   234.708666
Memphis              610337   244.202072
Chicago             2783726   253.547961
```

C

Loading ESRI Shapefiles into Spatial

The Java shapefile converter transforms an ESRI shapefile into an Oracle Database table for use with Oracle Spatial.

The shapefile converter uses the Oracle Spatial Java-based shapefile `AdapterShapefileJGeom` and `SampleShapefileToJGeomFeature` classes to load a shapefile directly into a database table, with the Oracle-equivalent `.dbf` data types for the attribute columns and the SDO_GEOMETRY data type for the geometry column.

To load a shapefile into the database, use the converter as described in this appendix. (You can also use the `Adapter` class to create your own applications and interfaces that transform shapefiles to SDO_GEOMETRY or JGeometry data types; however, doing this is beyond the scope of this manual. For information about shapefile-related classes, see *Oracle Spatial Java API Reference*).

To use the shapefile converter, you must have the following:

- The following Oracle utilities and JDBC libraries: `ojdbc8.jar` or `ojdbc11.jar`, `sdoutl.jar`, and `sdoapi.jar`
- One or more ESRI shapefiles (`.shp`, `.shx`, .and `.dbf` files) to be converted
- Usage of the Shapefile Converter
- Examples of the Shapefile Converter

C.1 Usage of the Shapefile Converter

The following is the syntax for the shapefile converter. (Enter the command all on a single line.)

```
> java -cp [ORACLE_HOME]/jdbc/lib/ojdbc8.jar:[ORACLE_HOME]/md/jlib/sdoutl.jar:
[ORACLE_HOME]/md/jlib/sdoapi.jar oracle.spatial.util.SampleShapefileToJGeomFeature -h
db_host -p db_port -s db_sid|-sn db_service_name -u db_username -d db_password -t
db_table -f shapefile_name [-r srid] [-i table_id_column_name][-n start_id] [-g
db_geometry_column] [-x max_x,min_x] [-y max_y,min_y] [-o tolerance] [-k keyword_table]
[-a append][-c commit_int] [-v println_int]
```

Parameters

`-h`: Host machine with an existing Oracle database

`-p`: Port on the host machine (for example, 1521)

`-s`: SID (database name) on the host machine

`-sn`: Service name on the host machine (do not specify `-s` when using `-sn`)

`-u`: Database user

`-d`: Password for the database user

`-t`: Table name for the converted shapefile

`-f`: File name of an input shapefile (with or without extension)

`-r`: Valid Oracle SRID for coordinate system; use 0 if unknown

`-i`: Column name for unique numeric ID, if required

`-n`: Start ID for column specified in -i parameter

`-g`: Preferred SDO_GEOMETRY column name

`-x`: Bounds for the X dimension; use -180,180 if unknown

`-y`: Bounds for the Y dimension; use -90,90 if unknown

`-o`: Load tolerance fields (x and y) in metadata; if not specified, tolerance fields are 0.05

`-k`: Table name that contains Oracle reserved word(s) in a column named KEYWORD

`-a`: Append shapefile data to an existing table

`-c`: Commit interval; by default, commits occur every 1000 conversions and at the end

`-v`: Println interval; by default, a display every 10 conversions

C.2 Examples of the Shapefile Converter

The following examples show the use of the shapefile converter to transform a file named `shapes.shp` to a table named `shapes` containing an SDO_GEOMETRY column named `geom`. The SRID for the Longitude/Latitude (WGS 84) coordinate system is used (8307).

Linux Example

```
> setenv clpath $ORACLE_HOME/jdbc/lib/ojdbc8.jar:$ORACLE_HOME/md/jlib/
sdoutl.jar:$ORACLE_HOME/md/jlib/sdoapi.jar
> java -cp $clpath oracle.spatial.util.SampleShapefileToJGeomFeature -h gis01 -p 1521 -s
orcl -u scott -d <password-for-scott> -t shapes -f shapes.shp -r 8307 -g geom
```

Windows Example

```
> java -classpath %ORACLE_HOME%\jdbc\lib\ojdbc8.jar;%ORACLE_HOME%
\md\jlib\sdoutl.jar;%ORACLE_HOME%\md\jlib\sdoapi.jar
oracle.spatial.util.SampleShapefileToJGeomFeature -h gis01 -p 1521 -s orcl -u scott -d
<password-for-scott> -t shapes -f shapes.shp -r 8307 -g geom
```

D

Routing Engine Administration

This appendix is for advanced users who need to administer the routing engine. It is not intended for most routing users.

> **Note:**
>
> It assumes that you are familiar with the concepts and techniques described in Routing Engine.

The Oracle Spatial routing engine uses subprograms to handle the administration of the routing data. There are subprograms to partition the road data, to build a Network Data Model (NDM) network using the road data, to generate user data for trucking and turn restrictions, and to dump and validate the routing engine data and user data.

- Logging Administration Operations
- Network Data Model (NDM) Network Administration
- Routing Engine Data
- User Data
- Other Functions and Procedures

D.1 Logging Administration Operations

The routing engine logs all of its administration functions to either a specified log file or to a default log file. All administrative logs are written to the directory described by the Oracle directory object SDO_ROUTER_LOG_DIR.

The SDO_ROUTER_LOG_DIR directory must exist; and both the MDSYS and routing engine schema must have the privileges to read and write to this directory from both PL/SQL and Java.

The following subprograms are related to logging administration operations.

- CREATE_SDO_ROUTER_LOG_DIR Procedure
- VALIDATE_SDO_ROUTER_LOG_DIR Procedure

D.1.1 CREATE_SDO_ROUTER_LOG_DIR Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_SDO_ROUTER_LOG_DIR(
  ROUTER_SCHEMA  IN VARCHAR2,
  NEW_DIR_PATH   IN VARCHAR2 DEFAULT NULL);
```

The CREATE_SDO_ROUTER_LOG_DIR procedure must be run from an account that has the Oracle privileges to create directory objects and grant privileges to other database users.

Because this procedure grants privileges to the routing engine and MDSYS schemas, it cannot be run from either of these schemas.

The ROUTER_SCHEMA parameter must be specified and must be a valid schema containing the routing engine data.

The NEW_DIR_PATH parameter is an optional parameter. If the directory path is not specified, a valid SDO_ROUTER_LOG_DIR Oracle directory must already exist in the database. If it does not, an exception is raised. If the directory path is specified, a new SDO_ROUTER_LOG_DIR Oracle directory is created. If SDO_ROUTER_LOG_DIR had already been defined, the new definition replaces the old definition.

After the directory is created, read/write access is granted to the routing engine and MDSYS schemas from both PL/SQL and Java.

In previous versions of the routing engine, users ran the individual steps to create the directory and grant the privileges. This is no longer advised. Use of the CREATE_SDO_ROUTER_LOG_DIR procedure is now the recommended way to manage the Oracle directory needed by the routing engine.

D.1.2 VALIDATE_SDO_ROUTER_LOG_DIR Procedure

Syntax:

```
SDO_ROUTER_PARTITION.VALIDATE_SDO_ROUTER_LOG_DIR(
  LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log');
```

The VALIDATE_SDO_ROUTER_LOG_DIR procedure should be run from both the routing engine and MDSYS schema.

The LOG_FILE_NAME parameter is the name of the log file to open and attempt to write to. You can specify a name or use the default log file, `sdo_router_partition.log`.

If the log file does not exist, it is created and opened in the SDO_ROUTER_LOG_DIR directory. If the log file does exist, it is reopened. The validation procedure attempts to write to the log file from both PL/SQL and Java, and then closes the log file.

If the directory does not exist or if PL/SQL and/or Java fail to write to the log file, an exception is thrown.

D.2 Network Data Model (NDM) Network Administration

The Oracle Routing Engine requires an Oracle Spatial network data model (NDM) network, built on the routing engine data, to process route requests and to generate responses.

- CREATE_ROUTER_NETWORK Procedure
- DELETE_ROUTER_NETWORK Procedure
- Network Creation Example

D.2.1 CREATE_ROUTER_NETWORK Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_ROUTER_NETWORK(
  LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
  NETWORK_NAME IN VARCHAR2 := 'ROUTER_NETWORK');
```

The CREATE_ROUTER_NETWORK procedure must be run from a routing engine schema that contains routing engine Oracle Data Format (ODF) data.

The LOG_FILE_NAME parameter is the name of the log file written during network creation. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose to log network creation in its own log file or write to the default partitioning log file, `sdo_router_partition.log`.

The NETWORK_NAME parameter names the network being created. The name of the network is at the discretion of the user. Oracle recommends including the country code and data version in the name for clarity. For example, for North American data released in the first quarter of 2012 a suitable network name would be ROUTER_NA_Q112.

Creating a network using a name of an already existing network simply replaces the old network with the new network. This is not recommended. The old network should be deleted first (using the DELETE_ROUTER_NETWORK Procedure), then the new network created.

D.2.2 DELETE_ROUTER_NETWORK Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DELTE_ROUTER_NETWORK(
  LOG_FILE_NAME    IN VARCHAR2 := 'sdo_router_partition.log',
  NETWORK_NAME    IN VARCHAR2 := 'ROUTER_NETWORK',
  LOG_DELETE    IN BOOLEAN DEFAULT TRUE);
```

The DELETE_ROUTER_NETWORK procedure must be run from a routing engine schema, and a network matching the network name parameter must exist within the schema.

The LOG_FILE_NAME parameter is the name of the log file written during network deletion. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose to log network deletion in its own log file or write to the default partitioning log file, `sdo_router_partition.log`.

The NETWORK_NAME parameter is name of the network being deleted. If a network of this name does not exist, an exception is thrown and an error message is written to the log file.

The LOG_DELETE parameter controls whether the delete operation is logged to the log file. This parameter is used primarily for debugging.

D.2.3 Network Creation Example

This section describes the steps for creating a sample NDM network for routing engine use.

1. Validate the routing engine log directory in the routing engine schema. SDO_ROUTER_LOG_DIR must exist and have the correct privileges. Log in to the routing engine schema and execute the following statement:

   ```
   EXECUTE SDO_ROUTER_PARTITION.VALIDATE_ROUTER_LOG_DIR(
       'validate_log.log');
   ```

   When validation completes successfully, the `validate_log.log` file should contain the following messages:

   ```
   [INFO] PLSQL logging OK (ROUTER_SCHEMA)
   [INFO] Java logging OK (ROUTER_SCHEMA)
   [INFO] PLSQL logging OK (MDSYS)
   [INFO] Java logging OK (MDSYS)
   ```

2. Validate the routing engine log directory in the MDSYS schema. SDO_ROUTER_LOG_DIR must exist and have the correct privileges. Log in to the MDSYS schema and execute the same statement as is step 1.
3. In the routing engine schema, use the following query to find the name of any existing networks:

   ```
   SELECT SUBSTR(view_name, 0, LENGTH(view_name)-7) Network_Name
    FROM user_views
    WHERE view_name LIKE '%PBLOB$';
   ```

   If no results are returned, go to step 5. If a result similar to the following is returned, go to the next step to delete the network before creating a new network.

   ```
   NETWORK_NAME
   ------------
   <any-network-name>
   ```

4. Use the DELETE_NETWORK procedure to delete an existing network. For example, if the existing network is named ROUTER_NA_Q112:

   ```
   EXECUTE SDO_ROUTER_PARTITION.DELETE_ROUTER_NETWORK(
       'delete_net.log', 'ROUTER_NA_Q112');
   ```

   When deletion completes successfully, the `delete_net.log` file should contain the following message:

   ```
   INFO: deleting the Routeserver network: ROUTER_NA_Q112
   ```

5. Use the CREATE_ROUTER_NETWORK procedure to build a new network. For example:

   ```
   EXECUTE SDO_ROUTER_PARTITION.CREATE_ROUTER_NETWORK(
       'create_net.log', 'ROUTER_NA_112');
   ```

   When the create operation completes successfully, the `create_net.log` file should contain the following messages:

   ```
   INFO: creating the Routeserver network: ROUTER_NA_Q112
   INFO: rebuild edge table statistics
         creating views
         generating metadata
   ```

D.3 Routing Engine Data

The routing engine uses routing engine data and user data. The routing engine data is stored in the EDGE, NODE, SIGN_POST, and PARTITION tables.

The routing engine data models a road network as a directed graph of nodes and edges. Partitioning breaks this road network into 2**N (2^N) subgraphs (local partitions) and one highway partition. The nodes of the road network are partitioned topologically, so each local partition contains the same number of nodes. Each node in the network is in one and only one partition. An edge can be entirely within a partition, an internal edge, or a bridge two partitions (that is, a boundary edge). The partitions are stored in the database as BLOBs, so they can easily be read into and removed from a cache. This allows the routing engine to operate without needing the entire road network to be in memory.

Partitions 1 through N, local partitions, are all roughly the same size. Local partitions are read into the cache as needed when computing a route. These partitions remain in the cache until the cache is full, at which point the least used partitions are swapped out to make room for the partitions needed to compute the current route.

Partition 0 (zero), the highway partition, differs from local partitions in two respects:

- It is not a topological partition of the road network. Instead, it is a subgraph of the road network containing only highway information. Because of this, the highway partition is much larger than a local partition.
- It is read into the cache at routing engine start up and remains resident.

The road network is partitioned in three phases. The first phase partitions the data, computing the number of partitions needed and which partitions contain which nodes and edges. The second phase converts these partitions into BLOBs and writes them to the database. The final phase rebuilds the routing engine network, partitions any user data, and writes the user data BLOBs to the database.

Routing engine data is versioned. During the third phase of partitioning the routing engine version is written to the SDO_ROUTER_DATA_VERSION table and becomes the data version for this data set. If the data set is exported for use in another routing engine schema, this new routing engine's version must be compatible with the data version of the data set.

Routing engine data is provided by data vendors in the Oracle Data Format (ODF) and is already partitioned. Generally, there is no need for a customer to repartition the data. However, there may be cases, such as when performance testing different partition sizes or merging data sets, where you may want to repartition the routing engine data.

> **Note:**
>
> Repartitioning routing engine data can be a very time and resource intensive operation. Depending on the hardware being used, repartitioning a large data set, such as North America or the European Union, can easily run for a day or more.

- PARTITION_ROUTER Procedure
- CLEANUP_ROUTER Procedure
- DUMP_PARTITIONS Procedure
- VALIDATE_PARTITIONS Procedure
- GET_VERSION Procedure
- Routing Engine Data Examples

D.3.1 PARTITION_ROUTER Procedure

Syntax:

```
SDO_ROUTER_PARTITION.PARTION_ROUTER(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    MAX_V_NO      IN NUMBER DEFAULT 10000,
    DRIVING_SIDE  IN VARCHAR2 := 'R',
    NETWORK_NAME  IN VARCHAR := 'ROUTER_NETWORK',
    MAX_MEMORY    IN NUMBER := 1.75,
    CLEANUP       IN BOOLEAN DEFAULT TRUE,
    USE_SECUREFILES            IN BOOLEAN DEFAULT TRUE,
    GENERATE_11G_RESTRICTIONS IN BOOLEAN DEFAULT TRUE);
```

The PARTITION_ROUTER procedure must be run from a routing engine schema that contains routing engine Oracle Data Format data. This procedure partitions the road network and creates the PARTITION table containing the routing engine data in BLOB format.

The LOG_FILE_NAME parameter specifies the name of the log file written during routing engine partitioning. This log file is created in the SDO_ROUTER_LOG_DIR directory. Users can choose a log file name or use the default partitioning log file sdo_router_partition.log.

The MAX_V_NO parameter specifies the maximum number of nodes allowed in a partition. There must be at least (MAX_V_NO+1) nodes in the NODE table.

The DRIVING_SIDE parameter is a legacy parameter. Its only use was to generate Release 11*g* turn restrictions. Valid values are R (right side) and L (left side).The NETWORK_NAME parameter specifies the name of the routing engine network that is created during partitioning.

The MAX_MEMORY parameter specifies the maximum Java heap size, in gigabytes, available to the partitioning process. The default value of 1.75G is enough for most data sets. This parameter only needs to be adjusted when partitioning data sets that are much smaller or much larger than normal.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during the partitioning of the routing engine data are cleaned up. If there is problem while partitioning, leaving these tables in place (specifying CLEANUP=>FALSE) can provide substantial debugging information.

The USE_SECUREFILES parameter lets you create the routing engine's BLOBs in either BASICFILE or SECUREFILE format. Oracle recommends using the SECUREFILE format.

The GENERATE_11G_RESTRICTIONS parameter controls the generation of Release 11*g* turn restriction data. In Oracle Database Release 11*g*, basic turn restrictions were implemented and stored in the PARTITION table. In Oracle Database Release 12*c*, turn restrictions are expanded and are stored in a user data table, ROUTER_TURN_RESTRICTION_DATA. To allow data providers to ship data partitioned under Release 12*c* to users still using a Release 11*g* Route Server, both types of turn restrictions are generated by default. When repartitioning data under Oracle Release 12*c*, for a Release 12*c* Route Server, you may set this parameter to FALSE.

D.3.2 CLEANUP_ROUTER Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CLEANUP_ROUTER(
    ALL_TABLES IN BOOLEAN DEFAULT TRUE);
```

The CLEANUP_ROUTER procedure resets the routing engine's state, ensuring that all the tables and indexes are in good order and all intermediate tables are deleted. This is useful if partitioning fails or if partitioning completed successfully with the CLEANUP flag set to FALSE.

The ALL_TABLES parameter controls what is reset. When set to FALSE, the routing engine is reset to a stable state but leaves the intermediate tables for debugging. This can be useful if partitioning failed. When set to TRUE, the routing engine is reset to a stable state and all intermediate tables used in partitioning are deleted. This can be useful when cleaning up after a successful PARTITION_ROUTER Procedure that was run with the CLEANUP parameter set to FALSE.

D.3.3 DUMP_PARTITIONS Procedure

Syntax:

```
DUMP_PARTITIONS(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    START_PID     IN NUMBER DEFAULT 0,
    END_PID       IN NUMBER DEFAULT -1,
    VERBOSE       IN BOOLEAN DEFAULT FALSE);
```

The DUMP_PARTITIONS procedure dumps the contents of routing engine data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single running of this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START_PID to END_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG_FILE_NAME parameter is the name of the log file written when dumping routing engine partitions. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START_PID parameter is the ID of the first partition to dump. The default START_PID is 0. The START_PID must be less than or equal to END_PID.

The END_PID parameter is the ID of the last partition to dump. The default END_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END_PID is less than START_PID, an error message is written to the log.

The VERBOSE parameter controls what data is dumped. The default value of FALSE dumps a summary of the partition information, including, the number of node and edges and the size of the BLOB. If this parameter is TRUE, in addition to the summary, all the information describing all the nodes and edges in the partition is dumped.

D.3.4 VALIDATE_PARTITIONS Procedure

Syntax:

```
VALIDATE_PARTITIONS(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    START_PID     IN NUMBER DEFAULT 0,
    END_PID       IN NUMBER DEFAULT -1,
    VERBOSE       IN BOOLEAN DEFAULT FALSE);
```

The VALIDATE_PARTITIONS procedure validates the contents of routing engine data partition BLOBs. Validating all the partitions in a large dataset can take some time to run, but it is the fastest way to read every byte in every partition to ensure that the partitions are ready to be used for routing. Validation only needs to be run if you suspect that there may be a problem with the partitions. If validation is run, Oracle recommends running the initial validation on all partitions with the VERBOSE flag set to FALSE. If a problem is found, then rerun the validation on the problem partitions with VERBOSE set to true.

The LOG_FILE_NAME parameter is the name of the log file written while validating the routing engine data partitions. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START_PID parameter is the ID of the first partition to validate. The default START_PID is 0. The START_PID must be less than or equal to END_PID.

The END_PID parameter is the ID of the last partition to validate. The default END_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is validated. If END_PID is less than START_PID, an error message is written to the log.

The VERBOSE parameter controls the level of detail of the validation messages. The default value of FALSE simply logs whether a partition passed or failed validation. If this parameter is TRUE, the validation of each element in the BLOB is logged.

D.3.5 GET_VERSION Procedure

Syntax:

```
GET_VERSION(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log');
```

The GET_VERSION procedure queries the SDO_ROUTER_DATA_VERSION table to get the routing engine data version and writes the result to the log file. (An an alternative, you can use SQL to query the SDO_ROUTER_DATA_VERSION table.)

The LOG_FILE_NAME parameter is the name of the log file where the routing engine data version is written. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

D.3.6 Routing Engine Data Examples

This section contains examples of the following operations.

- Partitioning a Small Data Set
- Partitioning a Full Data Set
- Dumping the Contents of a Partition
- Validating the Contents of a Partition
- Querying the Routing Engine Data Version

D.3.6.1 Partitioning a Small Data Set

Example D-1 shows partitioning of a small data set. The data set in this example is the road network data for a radius of 100 miles around the center of San Francisco. This data set contains about 520,000 nodes and 1,200,00 edges. To partition the routing engine data, execute the statement from within the routing engine schema.

Example D-1   Partitioning a Small Data Set

```
EXECUTE SDO_ROUTER_PARTITION.PARTITION_ROUTER(
   'sdo_router_partition.log', 1000, 'R',
   'ROUTER_SF_NET', .75, FALSE, FALSE, FALSE);

******** Beginning SDO Router partitioning
** Schema: ROUTER_SF_SCHEMA
** Logfile location:/scratch/logs/sdo_router_partition.log
** Nodes per partition: 1000
** Driving side: R
** Router network name: ROUTER_SF_NET
** Max JVM Memory Size: .75GB (805306368 bytes)
** Cleanup temporary files: FALSE
** BLOBs stored in BASICFILE format
** Generating 11g turn restrictions: FALSE
[This header is followed by extensive logging of the partitioning process.]
```

This example produces 1025 partitions, 1 highway partition, and 1024 local partitions. There are, on average, 516 nodes per partition. The driving side is set but is not used because

Release 11*g* turn restrictions were not requested. The Java maximum heap size was set to three quarters of a gigabyte, more than enough to partition such a small data set. The partition BLOBs were written in Basicfile format, and when the partitioning completed the intermediate tables were not cleaned up.

To clean up the intermediate tables left behind by partitioning, enter the following:

```
EXECUTE SDO_ROUTER_PARTITION.CLEANUP_ROUTER()
```

D.3.6.2 Partitioning a Full Data Set

Example D-2 shows partitioning of a full data set. The data set for this example is the entire North American road network. This data set contains about 30 million nodes and 74 million edges. To partition the routing engine data, execute the statement from within the routing engine schema.

Example D-2   Partitioning a Full Data Set

```
EXECUTE SDO_ROUTER_PARTITION.PARTITION_ROUTER(
   'sdo_router_partition.log, 32000, 'R', 'ROUTER_NA_NET');

******** Beginning SDO Router partitioning
** Schema: ROUTER_NA_SCHEMA
** Logfile location:/scratch/logs/sdo_router_partition.log
** Nodes per partition: 32000
** Driving side: R
** Router network name: ROUTER_NA_NET
** Max JVM Memory Size: 1.75GB (1879048192 bytes)
** Cleanup temporary files: TRUE
** BLOBs stored in SECUREFILE format
** Generating 11g turn restrictions: TRUE
[This header is followed by extensive logging of the partitioning process.]
++ Partitioning a data set of this size is time and resource intensive ++
```

This example produces 1025 partitions, 1 highway partition, and 1024 local partitions. There are, on average, 29443 nodes per partition. The driving side is set to 'Right Side' and is used to generate the requested Oracle 11*g* turn restrictions. The default Java heap size of 1.75 gigabytes is used. All routing engine data and user data BLOBs are stored in SECUREFILE format, and all intermediate tables are cleaned up after the successful partitioning.

D.3.6.3 Dumping the Contents of a Partition

Example D-3 shows a dump of partitions 0 through 3 with the default VERBOSE value (FALSE) from the San Francisco data set. Note the BLOB size difference between the highway and local partitions. Also note that the highway partition is completely self-contained so there are no outbound edges. Local partitions have outgoing edges that connect them to other local partitions.

Example D-3   Dumping the Contents of a Partition (VERBOSE = FALSE)

```
EXEC SDO_ROUTER_PARTITION.DUMP_PARTITIONS(
   'dump_part0-3.log', 0, 3);

******** Beginning partition dump
** Logfile location: /scratch/logs/dump_part0-3.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 0
** End partition id: 3
** Verbose mode: FALSE
```

```
[INFO] Starting dump of partition 0
  Number of Nodes: 19392
  Number of Nonboundary Edges: 22706
  Number of Outgoing Boundary Edges: 0
  Number of Incoming Boundary Edges: 0
  Stored Partition ID: 0
  Blob Length: 1748332

[INFO] Starting dump of partition 1
  Number of Nodes: 516
  Number of Nonboundary Edges: 1190
  Number of Outgoing Boundary Edges: 49
  Number of Incoming Boundary Edges: 49
  Stored Partition ID: 1
  Blob Length: 81372

[INFO] Starting dump of partition 2
  Number of Nodes: 516
  Number of Nonboundary Edges: 1099
  Number of Outgoing Boundary Edges: 68
  Number of Incoming Boundary Edges: 68
  Stored Partition ID: 2
  Blob Length: 78388
[INFO] Starting dump of partition 3
  Number of Nodes: 516
  Number of Nonboundary Edges: 1101
  Number of Outgoing Boundary Edges: 60
  Number of Incoming Boundary Edges: 60
  Stored Partition ID: 3
  Blob Length: 77756
```

Example D-4   Dumping the Contents of a Partition (VERBOSE = TRUE)

Example D-4 shows a dump of partition 8 with VERBOSE set to TRUE from the San Francisco data set. Note that the outbound edges log the partition ID where they terminate, and the inbound edges log the partition ID where they originate.

```
EXEC SDO_ROUTER_PARTITION.DUMP_PARTITIONS(
   'dump_part8.log', 8, 8, TRUE);

******** Beginning partition dump
** Logfile location:/scratch/logs/dump_part8.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 8
** End partition id: 8
** Verbose mode: TRUE
[INFO] Starting dump of partition 8
  Number of Nodes: 517
  Number of Non-boundary Edges: 1145
  Number of Outgoing Boundary Edges: 37
  Number of Incoming Boundary Edges: 37
  Stored Partition ID: 8
  Blob Length: 77957

  Node information for partition 8:
    Node ID/X/Y/Highway: 84096388/-120.50809/37.98399/false
    In Edges(3): -120862233, -120862227, 120862232
    Out Edges(3): -120862232, 120862227, 120862233
    *******************************
    Node ID/X/Y/Highway: 84098023/-120.4882/37.99961/true
    In Edges(3): -127829801, -120428259, 776737023
    Out Edges(3): -776737023, 120428259, 127829801
    ******************************
*** Node information for the other 515 nodes...

  Non-boundary Edge information for partition 8:
  Internal Edges(1145):
    Edge ID/Start Node ID/End Node ID: 910681077/942981443/206194644
    Length/Speed Limit/Function Class: 130.3/5/5
    ******************************
    Edge ID/Start Node ID/End Node ID: -105461005/206194651/206194644
    Length/Speed Limit/Function Class: 229.93/11/5
    ******************************
*** Edge information for the other 1143 internal edges...

   Outbound Boundary Edges(37):
    Edge ID/Start Node ID/End Node ID: -724019630/253265936/810705655
    End Node Partition ID/Length: 7/511.07
    Speed Limit/Function Class: 26/2
    ******************************
    Edge ID/Start Node ID/End Node ID: -105462459/252152310/206193109
    End Node Partition ID/Length: 7/814.68
    Speed Limit/Function Class: 11/5
    ******************************
*** Edge information for the other 35 outbound boundary edges...

   Inbound Boundary Edges(37):
    Edge ID/Start Node ID/End Node ID: 724019630/810705655/253265936
    Start Node Partition ID/Length: 7/511.07
    Speed Limit/Function Class: 26/2
    ******************************
    Edge ID/Start Node ID/End Node ID: 105462459/206193109/252152310
    Start Node Partition ID/Length: 7/814.68
    Speed Limit/Function Class: 11/5
    ******************************
*** Edge information for the other 35 inbound boundary edges...
```

D.3.6.4 Validating the Contents of a Partition

Example D-5 shows validation of the contents of all the partitions in the data set with the default VERBOSE value (FALSE).

Example D-5 Validating the Contents of Partitions (VERBOSE = FALSE)

```
EXEC SDO_ROUTER_PARTITION.VALIDATE_PARTITIONS(
   'validate_all_partitions.log');

******** Beginning partition validation
** Logfile location:/scratch/logs/validate_all_partitions.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 0
** End partition id: 1024
** Verbose mode: FALSE
[INFO] Starting validation of partition 0
[INFO] Starting validation of partition 1
[INFO] Starting validation of partition 2
…
[INFO] Starting validation of partition 1022
[INFO] Starting validation of partition 1023
[INFO] Starting validation of partition 1024
[INFO] Partition validation complete
```

Example D-6   Validating the Contents of Partitions (VERBOSE = TRUE)

Example D-6 shows validation of the contents of partitions 7 and 8 with VERBOSE set to TRUE.

```
EXEC SDO_ROUTER_PARTITION.VALIDATE_PARTITIONS(
   'validate_part7-8.log', 7, 8, TRUE);

******** Beginning partition validation
** Logfile location: /scratch/logs/validate_part7-8.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 7
** End partition id: 8
** Verbose mode: TRUE
[INFO] Starting validation of partition 7
  Header node count: OK
  Header edge count: OK
  BLOB partition id: OK
  BLOB length: OK
  BLOB node count: OK
  BLOB information for 516 nodes: OK
  BLOB information for 1154 internal edges: OK
  BLOB information for 66 outbound boundary edges: OK
  BLOB information for 65 inbound boundary edges: OK

[INFO] Starting validation of partition 8
  Header node count: OK
  Header edge count: OK
  BLOB partition id: OK
  BLOB length: OK
  BLOB node count: OK
  BLOB information for 517 nodes: OK
  BLOB information for 1145 internal edges: OK
  BLOB information for 37 outbound boundary edges: OK
  BLOB information for 37 inbound boundary edges: OK

[INFO] Partition validation complete
```

D.3.6.5 Querying the Routing Engine Data Version

Example D-7 queries the routing engine data version number, writing the result to a log file.

```
SELECT * FROM sdo_router_data_version;
```

Example D-7   Querying the Routing Data Version

```
EXEC SDO_ROUTER_PARTITION.GET_VERSION('version.log');

INFO: Routeserver data version: 12.1.0.2.1
```

Alternatively, you could use the following SQL query to get the routing engine data version:

D.4 User Data

User data models restrictions on the road network. Currently, there are two kinds of user data in the routing engine: restricted driving maneuvers (turn restrictions) and trucking user data.

User data is versioned. When user data is partitioned, the routing engine data version from the SDO_ROUTER_DATA_VERSION table is stored in the user data BLOBs. When user data is brought into the cache, the version stored in the user data partition must be compatible with the version in the SDO_ROUTER_DATA_VERSION table.

Partitioning user data is generally a very fast operation. It can be done as part of the partitioning the routing engine data or, if the routing engine data is already partitioned, as a standalone operation. In both cases the user data partitioning uses the partitioned routing engine data as a guide, substantially speeding up the partitioning operation.

The number of user data partitions is equal to or less than the number of routing engine data partitions. If there is no user data associated with a routing engine data partition, then no user data partition is produced. User data local partitions move into and out of the cache with their associated routing engine data partition. The user data highway partition is loaded at routing engine startup and remains resident in the cache.

In Release 12*c* the restricted driving maneuver user data is part of the routing engine ODF data shipped by data vendors. Trucking user data is not shipped with the routing engine ODF data and must be purchased separately. When a Release 12*c* or later routing engine starts, it detects and uses any available user data. All versions of the routing engine before Release 12*c* do not detect the user data and will only use routing engine data to compute the routes.

- Restricted Driving Maneuvers User Data
- CREATE_TURN_RESTRICTION_DATA Procedure
- DUMP_TURN_RESTRICTION_DATA Procedure
- CREATE_TRUCKING_DATA Procedure
- DUMP_TRUCKING_DATA Procedure
- CREATE_TIMEZONE_DATA Procedure
- DUMP_TIMEZONE_DATA Procedure
- User Data Examples

D.4.1 Restricted Driving Maneuvers User Data

A restricted driving maneuver can be as simple as not allowing movement from one edge to another, such as a simple turn restriction that does not allow a left turn. Or it might be a highly complex maneuver involving many edges, such as a no U-turn restriction on a road divided with a median where there is a start edge, an edge over the median, and the edge on the road going the other direction.

The routing engine uses three tables for restricted driving maneuvers. The first two tables, ROUTER_NAV_STRAND and ROUTER_CONDITION contain the raw data to build the restricted maneuvers user data.

The final table, ROUTER_TURN_RESTRICTION_DATA, contains the partitioned restricted maneuver user data stored in BLOB format. Partitioning the restricted maneuver data allows it to move in and out of the cache with the routing engine data of the same partition.

In Release 12*c* the restricted driving maneuver user data is part of the ODF data shipped by the data vendors. When a Release 12*c* routing engine starts, it detects and uses the turn restriction user data. If a Release 11*g*routing engine starts, it will not detect the user data and will only use routing engine data to compute the routes.

Because the restricted driving maneuver user data is part of the ODF data set, it is already partitioned. Generally, there is no reason to repartition this user data. However, if the routing engine data is repartitioned, the user data will also be repartitioned. It is also possible to repartition the turn restriction user data without having to repartition the routing engine data by re-creating the restricted driving maneuver user data.

D.4.2 CREATE_TURN_RESTRICTION_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_TURN_RESTRICTION_DATA(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    CLEANUP       IN BOOLEAN DEFAULT TRUE);
```

The CREATE_TURN_RESTRICTION_DATA procedure must be run from a routing engine schema that contains the restricted driving maneuver raw data tables ROUTER_NAV_STRAND and ROUTER_CONDITION. This procedure partitions the restricted driving maneuver data and creates the ROUTER_TURN_RESTRICTION_DATA table containing the turn restriction user data in BLOB format. Turn restriction user data creation requires access to the data version so the SDO_ROUTER_DATA_VERSION table must exist in the routing engine schema.

The LOG_FILE_NAME parameter is the name of the log file written during turn restriction generation. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or use the default partitioning log file `sdo_router_partition.log`.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during turn restriction generation are cleaned up. If there is problem with turn restriction generation, leaving these tables in place can provide substantial debugging information.

D.4.3 DUMP_TURN_RESTRICTION_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DUMP_TURN_RESTRICTION_DATA(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    START_PID     IN NUMBER DEFAULT 0,
    END_PID       IN NUMBER DEFAULT -1,
    DUMP_SOFT_RESTRICTIONS IN BOOLEAN DEFAULT FALSE);
```

The DUMP_TURN_RESTRICTION_DATA procedure dumps the contents of the turn restriction user data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single call to this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START_PID to END_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG_FILE_NAME parameter specifies the name of the log file written when dumping turn restriction user data partitions. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START_PID parameter is the ID of the first partition to dump. The default START_PID is 0. The START_PID must be less than or equal to END_PID.

The END_PID parameter is the ID of the last partition to dump. The default END_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END_PID is less than START_PID, an error message is written to the log.

The DUMP_SOFT_RESTRICTIONS parameter controls how the turn restriction data is dumped. In turn restrictions that have more than two edges, a soft restriction is a series of edges that partially describe the turn restriction. This is a debugging parameter and should generally be left set to its default value, FALSE.

D.4.4 CREATE_TRUCKING_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_TRUCKING_DATA(
    LOG_FILE_NAME IN VARCHAR2 := ' sdo_router_partition.log',
    CLEANUP       IN BOOLEAN DEFAULT TRUE);
```

The CREATE_TRUCKING_DATA procedure must be run from a routing engine schema that contains the raw trucking data table ROUTER_TRANSPORT. This procedure partitions the trucking data and creates the ROUTER_TRUCKING_DATA table containing the trucking user data in BLOB format. Trucking user data creation requires access to the data version, so the SDO_ROUTER_DATA_VERSION table must exist in the routing engine schema.

The LOG_FILE_NAME parameter is the name of the log file written during trucking restriction generation. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or use the default partitioning log file `sdo_router_partition.log`.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during trucking restriction generation are cleaned up. If there is problem with trucking restriction generation, leaving these tables in place can provide substantial debugging information.

D.4.5 DUMP_TRUCKING_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DUMP_TRUCKING_DATA(
    LOG_FILE_NAME    IN VARCHAR2 := ' sdo_router_partition.log',
    START_PID        IN NUMBER DEFAULT 0,
    END_PID          IN NUMBER DEFAULT -1,
    SKIP_UNSUPPORTED IN BOOLEAN DEFAULT TRUE);
```

The DUMP_TRUCKING_DATA procedure dumps the contents of the trucking restriction user data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single call to this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START_PID to END_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG_FILE_NAME parameter specifies the name of the log file written when dumping trucking restriction user data partitions. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START_PID parameter is the ID of the first partition to dump. The default START_PID is 0. The START_PID must be less than or equal to END_PID.

The END_PID parameter is the ID of the last partition to dump. The default END_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END_PID is less than START_PID, an error message is written to the log.

The SKIP_UNSUPPORTED parameter controls how the trucking restriction data is dumped. The user data contains a number of restrictions included for future work but not currently supported. Setting SKIP_UNSUPPORTED to TRUE (the default) only dumps currently supported trucking restrictions. Setting SKIP_UNSUPPORTED to FALSE causes all trucking restrictions to be dumped.

D.4.6 CREATE_TIMEZONE_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_TIMEZONE_DATA(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    CLEANUP       IN BOOLEAN DEFAULT TRUE);
```

The CREATE_TIMEZONE_DATA procedure creates the user data for the ROUTER_TIMEZONE_DATA Table. It should also be run every time that the data is repartitioned.

The LOG_FILE_NAME parameter is the name of the log file written during the operation. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or use the default partitioning log file `sdo_router_partition.log`.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during the operation are cleaned up. If there is problem with the operation, leaving these tables in place can provide substantial debugging information.

D.4.7 DUMP_TIMEZONE_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DUMP_TIMEZONE_DATA(
    LOG_FILE_NAME     IN VARCHAR2 := ' sdo_router_partition.log',
    START_PID         IN NUMBER DEFAULT 0,
    END_PID           IN NUMBER DEFAULT -1);
```

The DUMP_TIMEZONE_DATA procedure dumps the contents of the time zone data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single call to this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START_PID to END_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG_FILE_NAME parameter specifies the name of the log file written when dumping time zone user data partitions. This log file is created in the SDO_ROUTER_LOG_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START_PID parameter is the ID of the first partition to dump. The default START_PID is 0. The START_PID must be less than or equal to END_PID.

The END_PID parameter is the ID of the last partition to dump. The default END_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END_PID is less than START_PID, an error message is written to the log.

D.4.8 User Data Examples

This section presents examples of operations involving user data. The data set in these examples is the road network data for a radius of 100 miles around the center of San Francisco. This data set contains about 520,000 nodes and 1,200,00 edges, including 82,000 edges with truck restrictions and 30,000 edges with restricted driving maneuvers.

- Rebuilding the Turn Restriction User Data
- Dumping All Hard Turn Restriction User Data BLOBs

- Rebuilding the Trucking User Data
- Dumping the Trucking User Data Restrictions
- Rebuilding the Time Zone User Data
- Dumping All Time Zone User Data BLOBs

D.4.8.1 Rebuilding the Turn Restriction User Data

Example D-8 rebuilds the turn restriction user data. Because cleanup is set to FALSE, the intermediate tables used to rebuild the turn restriction user data will not be deleted. (To delete these tables execute the SDO_ROUTER_PARTITION.CLEANUP_ROUTER Procedure.)

Example D-8 Rebuilding the Turn Restriction User Data

```
EXEC
SDO_ROUTER_PARTITION.CREATE_TURN_RESTRICTION_DATA('rebuild_turn_restriction_data.log',
FALSE);

******** Begin generation of turn restriction user data
** Logfile location: /scratch/logs/rebuild_turn_restriction_data.log
[INFO] Generating turn restriction user data for 995 partitions, data version
(12.1.0.1.2)

[INFO] SQL String: CREATE TABLE new_turn_restriction_data(partition_id NUMBER, num_edges
NUMBER, turn_restriction_data BLOB) LOB(turn_restriction_data) STORE AS (STORAGE
(INITIAL 512K NEXT 128K MAXEXTENTS UNLIMITED) CHUNK 32768 NOCACHE NOLOGGING)
[INFO] ---- Writing 573 edges for partition 0
[INFO] ---- Writing 16 edges for partition 1
[INFO] ---- Writing 10 edges for partition 2

*** Note that partition 3 contains no turn restriction user data

[INFO] ---- Writing 8 edges for partition 4
[INFO] ---- Writing 23 edges for partition 5
[INFO] ---- Writing 39 edges for partition 6
*** Many more Writing partition messages
[INFO] ---- Writing 4 edges for partition 1023
[INFO] ---- Writing 11 edges for partition 1024

INFO: creating the final turn restriction user data table
INFO: create index rtrud_p_idx on router_turn_restriction_data table
******** Completed generation of turn restriction user data
```

D.4.8.2 Dumping All Hard Turn Restriction User Data BLOBs

Example D-9 dumps all of the hard turn restriction user data BLOBs. (Dumping soft restrictions produces much larger dump files and is only useful when debugging problems in the turn restrictions constraints.)

Example D-9 Dumping All Hard Turn Restriction User Data BLOBs

```
EXEC SDO_ROUTER_PARTITION.DUMP_TURN_RESTRICTION_DATA('dump_all_turn_restrictions.log');

******** Beginning turn restriction dump
** Logfile location: /scratch/logs/dump_all_turn_restrictions.log
** Routeserver data version: 12.1.0.1.2                  (A)
** Start partition id: 0
** End partition id: 1024
** Dumping soft restrictions: FALSE
```

```
Starting turn restriction dump for partition 0, blob length 19956 bytes
  Data version: 12.1.0.1.2
  Partition 0 has 573 edges with turn restrictions       (B)
    edge id -937799058 has 1 turn restrictions
      Restriction Type/Attributes: Hard/None
      AppliesTo(959): Trucks, Through Traffic, Taxies, Motorcycles,
                      Emergency Vehicles, Delivery Vehicles, Carpools,
                      Buses, Automobiles
      Subpath(1): 24501308
    *******************************
    edge id -936524317 has 2 turn restrictions           (C)
      Restriction Type/Attributes: Hard/None
      AppliesTo(943): Trucks, Through Traffic, Taxies, Motorcycles,
                      Delivery Vehicles, Carpools, Buses, Automobiles
      Subpath(1): -724922777
      -------
      Restriction Type/Attributes: Hard/None
      AppliesTo(959): Trucks, Through Traffic, Taxies, Motorcycles,
                      Emergency Vehicles, Delivery Vehicles, Carpools,
                      Buses, Automobiles
      Subpath(1): 936524317
    *******************************
    edge id -932185370 has 2 turn restrictions
      Restriction Type/Attributes: Hard/None
      AppliesTo(1023): All Vehicles
      Subpath(1): 836074944
      -------
      Restriction Type/Attributes: Hard/None
      AppliesTo(1023): All Vehicles
      Subpath(1): -24638792
    *******************************
    edge id 834380593 has 1 turn restrictions            (D)
      Restriction Type/Attributes: Hard/None
      AppliesTo(943): Trucks, Through Traffic, Taxies, Motorcycles,
                      Delivery Vehicles, Carpools, Buses, Automobiles
      Subpath(4): 112065672, -112065610, -112008660, -834380591
    *******************************

*** Dump of the remaining restrictions in Partition 0
Starting turn restriction dump for partition 1, blob length 520 bytes
  Partition 1 has 16 edges with turn restrictions        (E)
    edge id -806530190 has 1 turn restrictions
      Restriction Type/Attributes: Hard/None
      AppliesTo(703): Trucks, Taxies, Motorcycles, Emergency Vehicles,
                      Delivery Vehicles, Carpools, Buses, Automobiles
      Subpath(1): 120865027
    *******************************
*** Dump of the remaining restrictions in Partition 1 through 1024
```

In Example D-9:

- **(A)**: The standard user dump header contains the location of the log file and the parameters used in the dump. It also contains the routing engine data version as queried from the SDO_ROUTER_DATA_VERSION table. This data version must match the data version stored in the header of the partition 0 BLOB.
- **(B)**: In the BLOB header section for the partition 0 BLOB, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them. The BLOB header for partition 0 also contains the user data version. This version must match the data version found in the SDO_ROUTER_DATA_VERSION table.

- **(C)**: In the dump of the turn restrictions for edge -936524317., this edge has two simple turn restrictions associated with it. Both restrictions are simple turn restrictions that do not allow movement from the single edge in the subpath to edge -936524317. Also note the difference in the vehicles to which the restrictions apply: the first restriction does not apply to emergency vehicles, but the second restriction does apply to emergency vehicles.
- **(D)**: Edge 834380593 has only one turn restriction, but the restriction being described is much more complicated than a simple turn. If the subpath immediately previous to edge 834380593 matches the subpath that starts at edge -834380591 and goes through edges -112008660, -112065610, 112065672 in precisely that order, then the maneuver is not allowed. If the subpath to the current edge is missing one of the listed subpath edges or if the edges in the subpath are in a different order, then the maneuver is allowed.
- **(E)**: In the BLOB header for local partitions, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them.

D.4.8.3 Rebuilding the Trucking User Data

Example D-10 rebuilds the trucking user data. Since cleanup is using the default value of TRUE the intermediate tables used to rebuild the turn restriction user data are deleted when the build completes.

Example D-10   Rebuilding the Trucking User Data

```
EXEC SDO_ROUTER_PARTITION.CREATE_TRUCKING_DATA('rebuild_trucking_data.log');
******** Begin generation of trucking user data
** Logfile location:/scratch/logs/rebuild_trucking_data.log
[INFO] Generating trucking user data for 974 partitions,
data version (12.1.0.1.2)                                   (A)

[INFO] SQL String: CREATE TABLE new_trucking_data
(partition_id NUMBER, num_edges NUMBER, trucking_data BLOB) LOB(trucking_data) STORE AS
(STORAGE (INITIAL 512K NEXT 128K MAXEXTENTS UNLIMITED) CHUNK 32768 NOCACHE NOLOGGING)

INFO: creating the final trucking user data table
INFO: create index rtud_p_idx on router_trucking_data table
******** Completed generation of trucking user data
```

In Example D-10:

- **(A)**: Note that there are only 974 partitions of trucking user data compared to the 1023 local partitions (see the output in Example D-9) of routing engine data. If a partition is missing in the user data output, this means there is no trucking data for the associated routing engine data partition.

D.4.8.4 Dumping the Trucking User Data Restrictions

Example D-11 dumps the trucking user data restrictions. This example dumps the supported restrictions for partitions 0 through 25. In the dump, Main Type is type of restriction, Subtype is the reason for the restriction, and Value is the means to measure the restriction. For example, a height restriction is a Main Type, the Subtype can be a thing like Bridge or Tunnel or can be Unknown, and Value can be a measure (always metric) like meters for height and width or metric tons for weight. Value can also be 0 for some restrictions (for example legal restrictions) that cannot be physically measured.

Example D-11   Dumping the Trucking User Data Restrictions

```
EXEC SDO_ROUTER_PARTITION.DUMP_TRUCKING_DATA('dump_trucking_data0-25.log', 0, 25);
```

```
******** Beginning trucking data dump
** Logfile location: /scratch/logs/dump_trucking_data0-25.log
** Routeserver data version: 12.1.0.1.2                    (A)
** Start partition id: 0
** End partition id: 25

Starting truck data dump for partition 0, blob length 1019048 bytes
  Data version: 12.1.0.1.2
  Partition 0 has 21808 edges with truck data              (B)
    edge id -939054768 has 4 truck restrictions
      Main Type(10): Physical Height Restriction
      Sub-type(99): Unknown
      Value: 4.65
    *******************************
    edge id -854677940 has 3 truck restrictions
      Main Type(10): Physical Height Restriction
      Sub-type(1): Bridge
      Value: 4.67
    *******************************
    edge id -929320205 has 4 truck restrictions            (C)
      Main Type(10): Physical Height Restriction
      Sub-type(2): Tunnel
      Value: 4.27
      -------
      Main Type(20): Physical Weight Restriction
      Sub-type(99): Unknown
      Value: 4.08
    *******************************

*** The rest of the trucking data for edges in partition 0

Starting truck data dump for partition 2, blob length 296 bytes
                                                           (D)

Starting truck data dump for partition 3, blob length 3272 bytes
  Partition 3 has 91 edges with truck data
    edge id -811551125 has 1 truck restrictions
      Main Type(50): Legal Restriction
      Sub-type(22): All trailers forbidden
      Value: 0.0
    *******************************
    edge id 105439903 has 1 truck restrictions
      Main Type(20): Physical Weight Restriction
      Sub-type(99): Unknown
      Value: 9.07
    *******************************
    edge id -105491810 has 1 truck restrictions            (E)
      Main Type(50): Legal Restriction
      Sub-type(21): All trucks forbidden
      Value: 0.0
    *******************************
    edge id -105449802 has 1 truck restrictions
      Main Type(50): Legal Restriction
      Sub-type(26): All trucks forbidden except deliveries and residents
      Value: 0.0
    *******************************

 *** The rest of the trucking data for edges in partitions 3 through 25
```

In Example D-11:

- **(A)**: The standard user dump header contains the location of the log file and the parameters used in the dump. It also contains the routing engine data version as queried from the SDO_ROUTER_DATA_VERSION table. This data version must match the data version stored in the header of the partition 0 BLOB.
- **(B)**: In the BLOB header section for the partition 0 BLOB, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them. The BLOB header for partition 0 also contains the user data version. This version must match the data version found in the SDO_ROUTER_DATA_VERSION table.

  Edge -939054768 is listed as having 4 truck restrictions, but only one is listed. The other three restrictions are there, but are currently unsupported in the routing engine. To see these restrictions, set the SKIP_UNSUPPORTED to FALSE when requesting the dump.

  For edge -929320205 the Height restriction is because of a Bridge. Edge -939054768 also has a Height restriction, but there is no Subtype specified to explain why.
- **(C)**: This is an example of an edge that has multiple restrictions on it, in this case both a height and weight restriction expressed in meters and metric tons.
- **(D)**: Two things to note here: (1) partition 1 is missing, which means there is no trucking user data for partition 1; and (2) a partition header was printed for partition 2 but there is no data dumped, which means that there are trucking restrictions for partition 2 but the routing engine currently supports none of them.
- **(E)**: This is an example of two kinds of legal restrictions that can be modeled. (1) Edge -105491810 is an example of an exclusive legal restriction. There is a legal restriction on the edge that forbids all trucks. (2) Edge -105449802 is an example of an inclusive legal restriction. There is a legal restriction that excludes trucks on the edge but also lists an exception for delivery and resident trucks.

D.4.8.5 Rebuilding the Time Zone User Data

The following example rebuilds the time zone user data. Before building the time zones user data, make sure that the SDO_TIMEZONES table exists in the data set. This table can be imported from the Oracle Router demo directory.

Example D-12 Rebuilding the Time Zone User Data

```
-- 1) Create a spatial index on the SDO_TIMEZONES table.

EXEC SDO_ROUTER_TIMEZONE.CREATE_SDO_TIMEZONES_INDEX(‘create_timezone_index.log’);

******** Begin indexing of the sdo_timezones table
** Logfile location: /scratch/logs/create_timezone_index.log
[INFO] Creating metadata and spatial index on sdo_timezones for HERE_SF
[INFO] Added metadata for sdo_timezones to user_sdo_geom_metadata
[INFO] Rebuilding the spatial index on node table
[INFO] Added metadata for node to user_sdo_geom_metadata

-- 2) Associate the edges in the data set with their correct time zone.

EXEC
SDO_ROUTER_TIMEZONE.CREATE_ROUTER_TIMEZONES_EDGES('create_router_timezone_edges.log’);

******** Begin generation of router_timezones_edges (timezones raw data)
** Logfile location: /scratch/logs/create_router_timezone_edges.log
[INFO] Creating router_timezones_edges table for HERE_SF
[INFO] Associate nodes to timezones
[INFO] Dropped metadata for router_timezones_nodes from user_sdo_geom_metadata
[INFO] Added metadata for router_timezones_nodes to user_sdo_geom_metadata
```

```
[INFO] Creating node id index on the router_timezones_nodes table
[INFO] Creating spatial index on the router_timezones_nodes table
[INFO] Associate orphan nodes to timezone polygons
[INFO] Duplicate node cleanup
[INFO] Associate edges to timezones
[INFO] Creating edge id index on the router_timezones_edges table
[INFO] Creating partition id index on the router_timezones_edges table
[INFO] Creating timezone id index on the router_timezones_edges table
******** Completed generation of router_timezones_edges

-- 3) Create the actual Router time zone user data.

EXEC SDO_ROUTER_PARTITION.CREATE_TIMEZONE_DATA('rebuild_timezone_data.log’);

******** Begin generation of timezone user data
** Logfile location: /scratch/logs/rebuild_timezone_data.log
[INFO] Generating timezone user data for 65 partitions, data version (12.2.0.0.0)
[INFO] SQL String: CREATE TABLE new_timezone_data(partition_id NUMBER, num_edges NUMBER,
timezone_data BLOB) LOB(timezone_data) STORE AS (STORAGE (INITIAL 512K NEXT 128K
MAXEXTENTS UNLIMITED) CHUNK 32768 NOCACHE NOLOGGING)
[INFO] ---- Writing 3096 timezones for partition 0
[INFO] ---- Writing 2063 timezones for partition 1
[INFO] ---- Writing 1961 timezones for partition 2
[INFO] ---- Writing 2281 timezones for partition 3
…
…
[INFO] ---- Writing 1839 timezones for partition 64
INFO: creating the final timezone user data table
INFO: create index rtd_p_idx on router_timezone_data table
```

D.4.8.6 Dumping All Time Zone User Data BLOBs

The following example dumps all time zone user data BLOBs.

Example D-13   Dumping All Time Zone User Data BLOBs

```
EXEC SDO_ROUTER_PARTITION.DUMP_TIMEZONE_DATA('dump_timezone_data.log');

Starting timezone user data dump for partition 0, blob length 30992 bytes
  Data version: 12.2.0.0.0
  Partition 0 has 3096 edges with timezone user data
    edge id/Timezone -960842086/America/Los_Angeles(0)
    edge id/Timezone -960842085/America/Los_Angeles(0)
    edge id/Timezone -958443422/America/Los_Angeles(0)
…
…
Starting timezone user data dump for partition 64, blob length 18398 bytes
  Partition 64 has 1839 edges with timezone user data
    edge id/Timezone -961912976/America/Los_Angeles(0)
    edge id/Timezone -961912975/America/Los_Angeles(0)
    edge id/Timezone -958078848/America/Los_Angeles(0)
…
…
```

D.5 Other Functions and Procedures

The following functions and procedures are for internal use by the routing engine during the partitioning process. You should not call them directly unless instructed to by Oracle Support.

- GET_PID: Used to get partition ids during partitioning.

- MIN_EIGENVECTOR: Eigenvector used during partitioning.
- GATHER_TABLE_STATS: Deprecated. Used to rebuild table and index statistics.
- All ELOCATION_*: Wrappers for Java code used in partitioning.
- BUILD_TURN_RESTRICTIONS Deprecated. Used to build Release 11*g* turn restrictions.
- GET_EDGE_INFO: Collects edge information for building driving directions for a route.
- GET_GEOMETRY_INFO: Builds the line string geometry for a route.

Glossary

area

An extent or region of dimensional space.

attribute

Descriptive information characterizing a geographical feature such as a point, line, or area.

attribute data

Nondimensional data that provides additional descriptive information about multidimensional data, for example, a class or feature such as a bridge or a road.

batch geocoding

An operation that simultaneously geocodes many records from one table. *See also* geocoding.

boundary

1. The lower or upper extent of the range of a dimension, expressed by a numeric value.
2. The line representing the outline of a polygon.

Cartesian coordinate system

A coordinate system in which the location of a point in *n*-dimensional space is defined by distances from the point to the reference plane. Distances are measured parallel to the planes intersecting a given reference plane. *See also* coordinate system.

colocation

The presence of two or more spatial objects at the same location or at significantly close distances from each other.

contain

A geometric relationship where one object encompasses another and the inner object does not touch any boundaries of the outer. The outer object *contains* the inner object. *See also* inside.

convex hull

A simple convex polygon that completely encloses the associated geometry object.

coordinate

A set of values uniquely defining a point in an *n*-dimensional coordinate system.

coordinate reference system

Synonymous with coordinate system in Oracle Spatial documentation. The term *coordinate reference system* is used extensively by the European Petroleum Survey Group (EPSG).

coordinate system

A reference system for the unique definition for the location of a point in *n*-dimensional space. Also called a spatial reference system. *See also* Cartesian coordinate system, geodetic coordinates, projected coordinates, *and* local coordinates.

cover

A geometric relationship in which one object encompasses another and the inner object touches the boundary of the outer object in one or more places.

data dictionary

A repository of information about data. A data dictionary stores relational information on all objects in a database.

datum transformation

See transformation.

dimensional data

Data that has one or more dimensional components and is described by multiple values.

direction

The direction of an LRS geometric segment is indicated from the start point of the geometric segment to the end point. Measures of points on a geometric segment always increase along the direction of the geometric segment.

disjoint

A geometric relationship where two objects do not interact in any way. Two *disjoint* objects do not share any element or piece of their geometry.

element

A basic building block (point, line string, or polygon) of a geometry.

equal

A geometric relationship in which two objects are considered to represent the same geometric figure. The two objects must be composed of the same number of points; however, the ordering of the points defining geometries of the two objects may differ (clockwise or counterclockwise).

extent

A rectangle bounding a map, the size of which is determined by the minimum and maximum map coordinates.

feature

An object with a distinct set of characteristics in a spatial database.

geocoding

The process of converting tables of address data into standardized address, location, and possibly other data. *See also* batch geocoding.

geodetic coordinates

Angular coordinates (longitude and latitude) closely related to spherical polar coordinates and defined relative to a particular Earth geodetic datum. Also referred to as geographic coordinates.

geodetic datum

A means of representing the figure of the Earth, usually as an oblate ellipsoid of revolution, that approximates the surface of the Earth locally or globally, and is the reference for the system of geodetic coordinates.

geographic coordinates

See geodetic coordinates.

geographic information system (GIS)

A computerized database management system used for the capture, conversion, storage, retrieval, analysis, and display of spatial data.

geographically referenced data

See spatiotemporal data.

geometric segment (LRS segment)

An LRS element that contains start and end measures for its start and end points, and that can contain measures for other points on the segment.

geometry

The geometric representation of the shape of a spatial feature in some coordinate space. A geometry is an ordered sequence of vertices that are connected by straight line segments or circular arcs.

georeferenced data

See spatiotemporal data.

GIS

See geographic information system (GIS).

grid

A data structure composed of points located at the nodes of an imaginary grid. The spacing of the nodes is constant in both the horizontal and vertical directions.

hole

A subelement of a polygon that negates a section of its interior. For example, consider a polygon representing a map of buildable land with an inner polygon (a hole) representing where a lake is located.

homogeneous

Spatial data of one feature type such as points, lines, or regions.

hyperspatial data

In mathematics, any space having more than the three standard X, Y, and Z dimensions. Sometimes referred to as multidimensional data.

index

A database object that is used for fast and efficient access to stored information.

inside

A geometric relationship where one object is surrounded by a larger object and the inner object does not touch the boundary of the outer. The smaller object is *inside* the larger. *See also* contain.

key

A field in a database used to obtain access to stored information.

latitude

North/south position of a point on the Earth defined as the angle between the normal to the Earth's surface at that point and the plane of the equator.

layer

A collection of geometries having the same attribute set and stored in a geometry column.

line

A geometric object represented by a series of points, or inferred as existing between two coordinate points.

line string

One or more pairs of points that define a line segment. *See also* multiline string.

linear feature

Any spatial object that can be treated as a logical set of linear segments.

local coordinates

Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system.

longitude

East/west position of a point on the Earth defined as the angle between the plane of a reference meridian and the plane of a meridian passing through an arbitrary point.

LRS point

A point with linear measure information along a geometric segment. *See also* geometric segment (LRS segment).

measure

The linear distance (in the LRS measure dimension) to a point measured from the start point (for increasing values) or end point (for decreasing values) of the geometric segment.

measure range

The measure values at the start and end of a geometric segment.

minimum bounding rectangle (MBR)

A single rectangle that minimally encloses a geometry or a collection of geometries.

multidimensional data

See hyperspatial data.

multiline string

A geometry object made up of nonconnected line string elements (for example, a street with a gap caused by a city park, such as Sixth Avenue in New York City with Central Park as the gap). *See also* line string.

multipolygon

A polygon collection geometry in which rings must be grouped by polygon, and the first ring of each polygon must be the exterior ring.

neighborhood influence

See spatial correlation.

offset

The perpendicular distance between a point along a geometric segment and the geometric segment. Offsets are positive if the points are on the left side along the segment direction and are negative if they are on the right side. Points are on a geometric segment if their offsets to the segment are zero.

oriented point

A special type of point geometry that includes coordinates representing the locations of the point and a virtual end point, to indicate an orientation vector that can be used for rotating a symbol at the point or extending a label from the point

polygon

A class of spatial objects having a nonzero area and perimeter, and representing a closed boundary region of uniform characteristics.

primary filter

The operation that permits fast selection of candidate records to pass along to the secondary filter. The primary filter compares geometry approximations to reduce computation complexity and is considered a lower-cost filter. Because the primary filter compares geometric approximations, it returns a superset of the exact result set. *See also* secondary filter *and* two-tier query model.

projected coordinates

Planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.

projection

The point on the LRS geometric segment with the minimum distance to the specified point.

proximity

A measure of distance between objects.

query

A set of conditions or questions that form the basis for the retrieval of information from a database.

query window

Area within which the retrieval of spatial information and related attributes is performed.

RDBMS

See Relational Database Management System (RDBMS).

recursion

A process, function, or routine that executes continuously until a specified condition is met.

region

An extent or area of multidimensional space.

Relational Database Management System (RDBMS)

A computer program designed to store and retrieve shared data. In a relational system, data is stored in tables consisting of one or more rows, each containing the same set of columns. Oracle Database is an object-relational database management system. Other types of database systems are called hierarchical or network database systems.

resolution

The number of subdivision levels of data.

scale

The ratio of the distance on a map, photograph, or image to the corresponding image on the ground, all expressed in the same units.

secondary filter

The operation that applies exact computations to geometries that result from the primary filter. The secondary filter yields an accurate answer to a spatial query. The secondary filter operation is computationally expensive, but it is only applied to the primary filter results, not the entire data set. *See also* primary filter *and* two-tier query model.

shape points

Points that are specified when an LRS segment is constructed, and that are assigned measure information.

sort

The operation of arranging a set of items according to a key that determines the sequence and precedence of items.

spatial

A generic term used to reference the mathematical concept of *n*-dimensional data.

spatial binning

The process of discretizing the location values into a small number of groups associated with geographical areas. Also referred to as *spatial discretization*.

spatial correlation

The phenomenon of the location of a specific object in an area affecting some nonspatial attribute of the object. Also referred to as *neighborhood influence*.

spatial data

Data that is referenced by its location in *n*-dimensional space. The position of spatial data is described by multiple values. *See also* hyperspatial data.

spatial data model

A model of how objects are located on a spatial context.

spatial data structures

A class of data structures designed to store spatial information and facilitate its manipulation.

spatial database

A database containing information indexed by location.

spatial discretization

See spatial binning.

spatial join

A query in which each of the geometries in one layer is compared with each of the geometries in the other layer. Comparable to a spatial cross product.

spatial query

A query that includes criteria for which selected features must meet location conditions.

spatial reference system

See coordinate system.

spatiotemporal data

Data that contains time or location (or both) components as one of its dimensions, also referred to as geographically referenced data or georeferenced data.

SQL*Loader

A utility to load formatted data into spatial tables.

tolerance

The distance that two points can be apart and still be considered the same (for example, to accommodate rounding errors). The tolerance value must be a positive number greater than zero. The significance of the value depends on whether or not the spatial data is associated with a geodetic coordinate system.

touch

A geometric relationship where two objects share a common point on their boundaries, but their interiors do not intersect.

transformation

The conversion of coordinates from one coordinate system to another coordinate system. If the coordinate system is georeferenced, transformation can involve datum transformation: the conversion of geodetic coordinates from one geodetic datum to another geodetic datum, usually involving changes in the shape, orientation, and center position of the reference ellipsoid.

two-tier query model

The query model used by Spatial to resolve spatial queries and spatial joins. Two distinct filtering operations (primary and secondary) are performed to resolve queries. The output of both operations yields the exact result set. *See also* primary filter *and* secondary filter.

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