Oracle® REST Data Services

Developer's Guide

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Preface

Oracle REST Data Services Developer's Guide explains how to develop applications using Oracle REST Data Services. (Oracle REST Data Services was called *Oracle Application Express Listener* before Release 2.0.6.)

Topics:

- Audience
- Documentation Accessibility
- Related Documents
- Conventions

Audience

This document is intended for application developers who develop applications using Oracle REST Data Services. This guide assumes you are familiar with web technologies, especially REST (Representational State Transfer), and have a general understanding of Windows and UNIX platforms.

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 and resources relating to Oracle REST Data Services, see the following the Oracle Technology Network (OTN) site:

`http://www.oracle.com/technetwork/developer-tools/rest-data-services/`

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 is displayed on the screen, or text that you enter.

Changes in Release 23.3 Oracle REST Data Services Developer's Guide

Changes in Oracle REST Data Services 23.3

This section lists the changes in Oracle REST Data Services for 23.3 release.

New Features

Starting with ORDS release 23.3, following new features are introduced:

- GraphQL support for REST Enabled Schemas, Tables, and Views. See GraphQL in Oracle REST Data Services
- JSON Web Token (JWT) authentication through 3rd party Identity Providers using OAUTH.CREATE_JWT_PROFILE. See JSON Web Token (JWT) authentication. See JWT Bearer Token Authentication and Authorization Using JWT Profile
- Support for extending ORDS functionality with plugins. See Extending ORDS Functionality with Plugins.

Other Changes

Updated the following section in this release:

- See Third-Party License Information

1 Introduction to Oracle REST Data Services

This chapter provides an overview of Oracle REST Data Services and its features.

Topics:

- About Oracle REST Data Services
- Features of Oracle REST Data Services

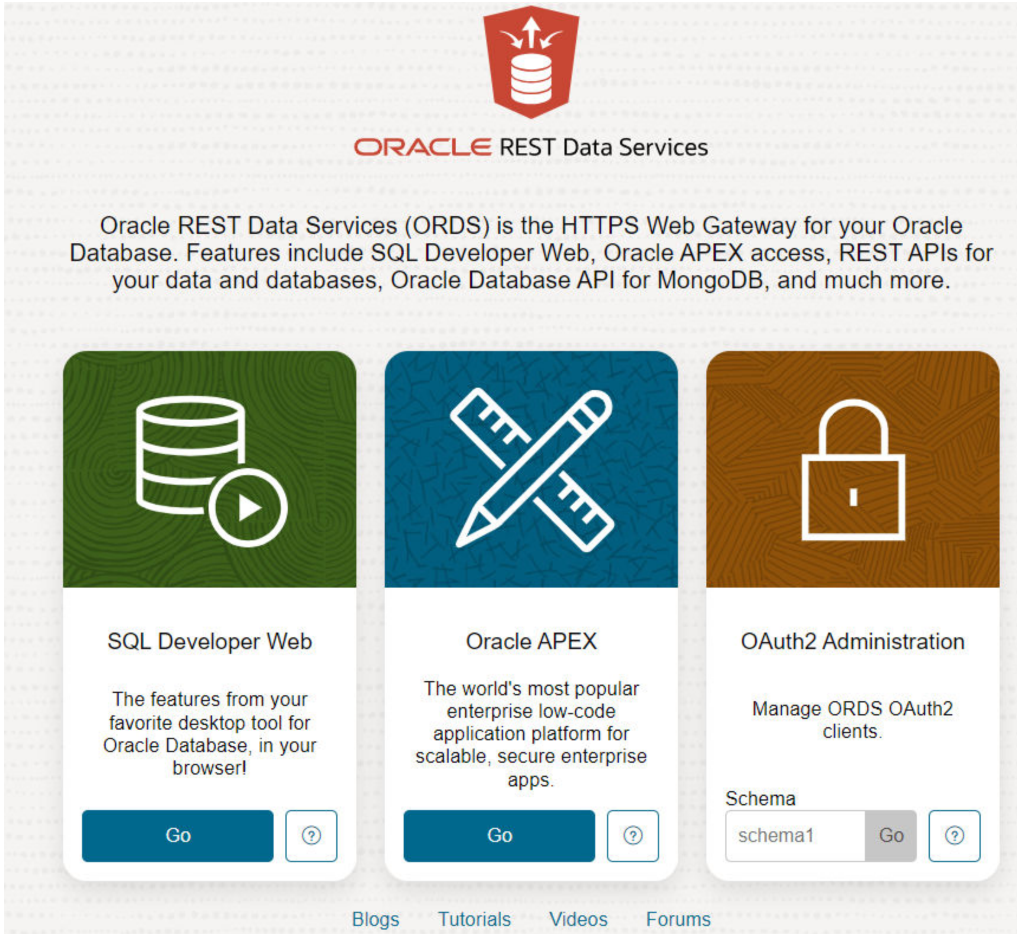
1.1 About Oracle REST Data Services

Oracle REST Data Services (ORDS) is the HTTPS Web Gateway for your Oracle Database, which includes features such as Oracle Database Actions, Oracle APEX access, REST APIs for your data and databases, Oracle Database API for MongoDB, and much more. Oracle REST Data Services is a Java EE-based alternative for Oracle HTTP Server and `mod_plsql`. The Java EE implementation offers increased functionality including a command-line based configuration, enhanced security, file caching, and RESTful web services. Oracle REST Data Services also provides increased flexibility by supporting deployments using Oracle WebLogic Server, Apache Tomcat, and a standalone mode.

The Oracle APEX architecture requires a web server to proxy requests between a web browser and the Oracle APEX engine. Oracle REST Data Services Meets the requirement but its use goes beyond that of Oracle APEX configurations. Oracle REST Data Services simplifies the deployment process because there is no Oracle home required, as connectivity is provided using an embedded JDBC driver.

Starting with release 23.2, ORDS provides a default landing page. The landing page displays the main tools and also lets you know whether a particular tool is enabled or disabled. If a tool is disabled, then you can click the help button (?) to navigate to the corresponding documentation and get help to install or enable the tool.

Figure 1-1 ORDS Landing Page



1.2 Features of Oracle REST Data Services

This section lists the features of Oracle REST Data Services (ORDS).

Database Actions

Database Actions, is a web-based interface that provides development, data tools, administration, and monitoring features for Oracle Database. Additionally, ORDS is provided as a managed feature of the Oracle Autonomous Database Cloud Services.

> **See Also:**
>
> Database Actions Home Page

REST-Enabled SQL

REST-Enabled SQL is a REST API that allows for ad-hoc SQL and SQL Scripts to be executed. You can POST one or more SQL statements to the service. The service then runs the SQL statements against Oracle Database and returns the results and output to the client in a JSON format.

> **Note:**
>
> REST-Enabled SQL Service

Database REST APIs

ORDS includes a collection of more than 500 REST APIs for performing operations such as monitoring and maintaining your Oracle Database, including PDB lifecycle management, performance, security, data dictionary, data pump.

> **See Also:**
>
> Enabling ORDS Database API

REST APIs

Provides the ability to define the REST APIs with SQL and PL/SQL. ORDS marshals SQL and PL/SQL types to and from JSON, auto-paginates the results of your SQL queries, supports GeoJSON for spatial, handles common database errors with appropriate HTTPS responses and much more. Users can also choose to REST enable tables, views, and stored procedures to take advantage of the AutoREST feature.

> **See Also:**
>
> ORDS REST APIs

PL/SQL Gateway

Oracle REST Data Services is a Java EE-based alternative for Oracle HTTP Server and mod_plsql. An Oracle HTTP Server mod_plsql application can be migrated to ORDS by defining the new ORDS configuration files. The mod_plsql database resources such as before procedures, after procedures, request validation functions, owa_custom packages, document upload procedures and document tables require no change when you are migrating to ORDS. PL/SQL gateway enables you to access your APEX applications from an application server such as WebLogic or Tomcat.

> **See Also:**
>
> About the Database Users Used by Oracle REST Data Services

2

Developing Oracle REST Data Services Applications

This section explains how to develop applications that use Oracle REST Data Services (ORDS).

> **See Also:**
>
> If you want to get started quickly, you can try the tutorial in Oracle REST Data Services Quick Start Guide.

> **Note:**
>
> - Ensure that you have installed and configured both Oracle APEX 4.2 or later, and Oracle REST Data Services 3.0 or later, prior to attempting the examples discussed in this chapter.
> - Install the Oracle REST APIs prior to using the Oracle REST APIs for JSON Data Persistence. See *Oracle REST Data Services SODA for REST Developer's Guide*
> - Refer to the Oracle APEX Documentation, if you are new to Oracle APEX.

Topics:

- Introduction to Relevant Software
- Getting Started with RESTful Services
- Creating RESTful Web Services Using Database Actions
- Automatic Enabling of Schema Objects for REST Access (AutoREST)
- Filtering in Queries
- Configuring Secure Access to RESTful Services
- JWT Bearer Token Authentication and Authorization Using JWT Profile
- About Oracle REST Data Services User Roles
- Authenticating Against WebLogic Server User Repositories
- Integrating with Existing Group/Role Models
- Using the Oracle REST Data Services PL/SQL API

2.1 Introduction to Relevant Software

This section explains some key relevant software for developing applications that use Oracle REST Data Services.

Topics:

- Oracle APEX
- REST APIs

Related Topics

- About Oracle REST Data Services

2.1.1 Oracle APEX

ORDS makes your APEX applications available to the various application servers like WebLogic Server or Tomcat, through the PL/SQL Gateway feature. It is a fully-supported, no-cost option available with all editions of Oracle Database. Using only a web browser, you can develop and deploy professional applications that are both fast and secure.

2.1.2 REST APIs

Representational State Transfer (REST) is a style of software architecture for distributed hypermedia systems such as the World Wide Web. An API is described as RESTful when it conforms to the tenets of REST. Although a full discussion of REST is outside the scope of this document, a REST API has the following characteristics:

- Data is modelled as a set of resources. Resources are identified by URIs.
- A small, uniform set of operations are used to manipulate resources (for example, PUT, POST, GET, DELETE).
- A resource can have multiple representations (for example, a blog might have an HTML representation and an RSS representation).
- Services are stateless and since it is likely that the client will want to access related resources, these should be identified in the representation returned, typically by providing hypertext links.

ORDS provides a built-in web application, SQL Developer Web, which is used to build, test, document, and secure your REST APIs.

2.2 Getting Started with RESTful Services

This section introduces RESTful Services, and provides guidelines and examples for developing applications that use RESTful Services.

Topics:

- RESTful Services Terminology
- About Request Path Syntax Requirements
- "Getting Started" Documents Included in Installation

- About cURL and Testing RESTful Services
- Automatic Enabling of Schema Objects for REST Access (AutoREST)
- Manually Creating RESTful Services Using SQL and PL/SQL
- About Working with Dates Using Oracle REST Data Services

Related Topics

- Developing Oracle REST Data Services Applications

2.2.1 RESTful Services Terminology

This section introduces some common terms that are used throughout this document:

- **RESTful service**: An HTTP web service that conforms to the tenets of the RESTful architectural style.
- **Resource module**: An organizational unit that is used to group related resource templates.
- **Resource template**: An individual RESTful service that is able to service requests for some set of URIs (Universal Resource Identifiers). The set of URIs is defined by the URI Pattern of the Resource Template
- **URI pattern**: A pattern for the resource template. Can be either a route pattern or a URI template, although you are encouraged to use route patterns.
- **Route pattern**: A pattern that focuses on decomposing the path portion of a URI into its component parts. For example, a pattern of `/:object/:id?` will match `/emp/101` (matches a request for the item in the `emp` resource with `id` of `101`) and will also match `/emp/` (matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` modifier, which indicates that the `id` parameter is optional).

  For a detailed explanation of route patterns, see `docs\javadoc\plugin-api\route-patterns.html`, under `<sqldeveloper-install>\ords` and under the location (if any) where you manually installed Oracle REST Data Services.
- **URI template**: A simple grammar that defines the specific patterns of URIs that a given resource template can handle. For example, the pattern `employees/{id}` will match any URI whose path begins with `employees/`, such as `employees/2560`.
- **Resource handler**: Provides the logic required to service a specific HTTP method for a specific resource template. For example, the logic of the GET HTTP method for the preceding resource template might be:

  ```
  select empno, ename, dept from emp where empno = :id
  ```
- **HTTP operation**: HTTP (HyperText Transport Protocol) defines standard methods that can be performed on resources: `GET` (retrieve the resource contents), `POST` (store a new resource), `PUT` (update an existing resource), and `DELETE` (remove a resource).

Related Topics

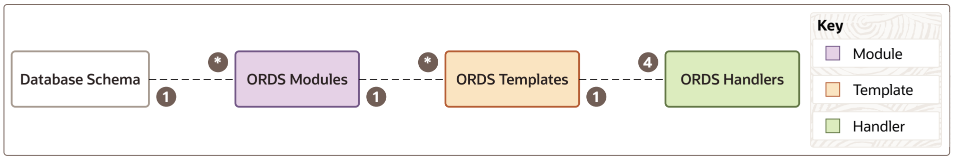
- REST APIs

2.2.2 ORDS RESTful Web Services Architecture Diagrams

This section describes the ORDS RESTful web services architecture diagrams.

The following diagram illustrates the relationship between the different components of the ORDS RESTful Web Services architecture:

Figure 2-1 Relationship Between Components of the ORDS RESTful Web Services



The Database Schema is the schema that you have REST-enabled. It can contain several resource modules. Similarly, a resource module, which is the top-level container for the REST Services offered by ORDS, can contain several resource templates. The resource templates are represented by the trailing part of the URL. Every resource template can contain four resource handlers, namely, `GET`, `POST`, `PUT`, and `DELETE`.

After you create a RESTful Web Service, you can test it by entering the following URL in your browser:

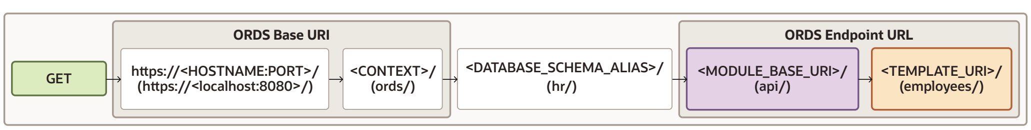
```
https://<HOSTNAME:PORT>/<CONTEXT>/<DATABASE_SCHEMA_ALIAS>/
<MODULE_BASE_URI>/<TEMPLATE_URI>/
```

Where:

- `HOSTNAME:PORT/CONTEXT`: Specifies the address at which ORDS is running. You can also refer to it as the ORDS Base URI.
- `DATABASE_SCHEMA_ALIAS`: Specifies the name that you provided while REST-enabling your database schema. By default, it is the name of the schema in lowercase.
- `MODULE_BASE_URI`: Specifies the URI of the module.
- `TEMPLATE_URI`: Specifies the URI of the template. This value, along with the `MODULE_BASE_URI`, comprises the ORDS Endpoint URL.

The following diagram illustrates how a `GET` operation is performed:

Figure 2-2 Architecture Diagram for a GET Operation



In this case, you will enter the following URL in your browser to perform the GET operation:

```
https://localhost:8080/ords/hr/api/employees/
```

2.2.3 About Request Path Syntax Requirements

To prevent path-based attacks, Oracle REST Data Services performs a number of validation checks on the syntax of the path element of each request URL.

Each path must conform to the following rules:

- Is not empty or whitespace-only
- Does not contain any of the following characters: ?, #, ;, %
- Does not contain the null character (\u0000)
- Does not contain characters in the range: \u0001-\u0031
- Does not end with white space or a period (.)
- Does not contain double forward slash (//) or double back slash(\\)
- Does not contain two or more periods in sequence (.., ..., and so on)
- Total length is {@value #MAX_PATH_LENGTH} characters or less
- Does not match any of the following names (case insensitive), with or without file extensions: CON, PRN, AUX, CLOCK$, NUL, COM0, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, LPT0, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9

If you intend to auto-REST enable objects, then avoid object names that do not comply with these requirements. For example, do not create a table named #EMPS. If you do want to auto-REST enable objects that have non-compliant names, then you must use an alias that complies with the requirements.

These requirements are applied to the URL decoded form of the URL, to prevent attempted circumvention of percent encodings.

2.2.4 "Getting Started" Documents Included in Installation

When you install Oracle REST Data Services, an examples folder is created with subfolders and files that you may find helpful. The installation folder hierarchy includes this:

```
ords
  conf
  docs
  examples
    soda
    getting-started
      ...
```

In this hierarchy:

- `examples\soda`: Contains sample JSON documents used in some examples included in *Oracle REST Data Services SODA for REST Developer's Guide*.
- `examples\getting-started`: Double-click `index.html` for a short document about how to get started developing RESTful Services using Oracle REST Data Services. This document focuses on using SQL Developer to get started. (SQL Developer is the primary tool for managing Oracle REST Data Services. For example, the ability to auto-enable REST support for schemas and tables is available only in SQL Developer.)

2.2.5 About cURL and Testing RESTful Services

Other sections show the testing of RESTful Services using a web browser. However, another useful way to test RESTful Services is using the command line tool named cURL.

This powerful tool is available for most platforms, and enables you to see and control what data is being sent to and received from a RESTful service.

```
curl -i https://server:port/ords/workspace/hr/employees/7369
```

This example produces a response like the following:

```
HTTP/1.1 200 OK
Server: Oracle-REST-Data-Services/2.0.6.78.05.25
ETag: "..."
Content-Type: application/json
Transfer-Encoding: chunked
Date: Thu, 28 Mar 2014 16:49:34 GMT

{
 "empno":7369,
 "ename":"SMITH",
 "job":"CLERK",
 "mgr":7902,
 "hiredate":"1980-12-17T08:00:00Z",
 "sal":800,
 "deptno":20
}
```

The `-i` option tells cURL to display the HTTP headers returned by the server.

Related Topics

- Exploring the Sample RESTful Services in APEX (Tutorial)

> **See Also:**
>
> curl - command line tool and library
> The example in this section uses cURL with the services mentioned in Exploring the Sample RESTful Services in APEX (Tutorial)

2.3 Automatic Enabling of Schema Objects for REST Access (AutoREST)

Enabling REST access to a table, view or PL/SQL function, procedure, or package allows it to be accessed through RESTful services.

AutoREST is a quick and easy way to expose database tables as REST resources. You lose some flexibility and customizability if you use the AutoREST feature, but it reduces your time and effort to a significant extent. AutoRest lets you quickly expose data but (metaphorically) keeps you on a set of guide rails. For example, you cannot customize the output formats or the input formats, or do extra validation.

On the other hand, manually created resource modules require you to specify the SQL and PL/SQL to support the REST resources. Using resource modules requires more effort, but offers more flexibility; for example, you can customize what fields are included, do joins across multiple tables, and validate the incoming data using PL/SQL.

So, as an application developer you must make a choice: use the "guide rails" of AutoREST, or create a resource module to do exactly what you need. If you choose AutoREST, you can just enable a table (or set of tables) within a schema.

Note that enabling a schema is not equivalent to enabling all tables and views in the schema. It just means making Oracle REST Data Services aware that the schema exists and that it may have zero or more resources to expose to HTTP. Those resources may be AutoREST resources or resource module resources.

If you are using Database Actions or SQL Developer, you can AUTOREST enable the database objects with convenient wizards. REST Data Services also provides an ORDS PL/SQL package that can be used to enable objects for REST.

> **Note:**
>
> This feature is only available for Oracle REST Data Services enabled schemas and not for Oracle APEX workspaces.

> **See Also:**
>
> ORDS.ENABLE_OBJECT

To enable Oracle REST Data Services access to one or more specified tables, views, or PL/SQL programs, you can do the following in SQL Developer:

1. Enable the schema (the one associated with the connection) for REST access.

   Schema level: To enable Oracle REST Data Services access to selected objects (that you specify in the next step) in the schema associated with a connection, right-click its name in the Connections navigator and select **REST Services**, then **Enable REST Services**. Once the schema is enabled, you can use that schema or user to login to SQL Developer Web and REST Enable objects in your schema using the web interface.

   (To drop support for Oracle REST Data Services access to objects in the schema associated with a connection, right-click its name in the Connections navigator and select **REST Services**, then **Drop REST Services**.)

2. Individually enable REST access for the desired objects.

   Table or view level: To enable Oracle REST Data Services access to a specified table or view, right-click its name in the Connections navigator and select **Enable REST Services**.

3. **Schema Alias**: You can alias the schema in the URIs for your REST APIs. This prevents your API consumers from knowing your database user accounts.

4. **Authorization Required**: This protects the API Catalog endpoints for your schema. If you enable this option, then the requests to the metadata-catalog endpoint on your schema will require authorization.

For detailed usage information, click the **Help** button in the wizard or dialog box in SQL Developer.

2.3.1 Examples: Accessing Objects Using RESTful Services

This section provides examples of using Oracle REST Data Services queries and other operations against tables and views after you have REST-enabled them.

You can automatically expose table and view objects as RESTful services using SQL Developer. This topic provides examples of accessing these RESTful services.

> **Tip:**
>
> Although these examples illustrate the URL patterns used to access these resources, clients should avoid hard coding knowledge of the structure of these URLs; instead clients should follow the hyperlinks in the resources to navigate between resources. The structure of the URL patterns may evolve and change in future releases.

This topic provides examples of accessing objects using RESTful Services.

- Get Schema Metadata
- Get Object Metadata
- Get Object Data
- Get Table Data Using Paging
- Get Table Data Using Query
- Get Table Row Using Primary Key
- Insert Table Row
- Update/Insert Table Row
- Delete Using Filter
- Post by Batch Load

2.3.1.1 Get Schema Metadata

This example retrieves a list of resources available through the specified schema alias. It shows RESTful services that are created by automatically enabling a table or view, along with RESTful Services that are created by resource modules.

This example retrieves a list of resources available through the specified schema alias.

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/metadata-catalog/`

Example: `GET http://localhost:8080/ords/ordstest/metadata-catalog/`

Result:

```
{
  "items": [
 {
   "name": "EMP",
   "links": [
  {
    "rel": "describes",
    "href": "http://localhost:8080/ords/ordstest/emp/"
  },
  {
    "rel": "canonical",
    "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/",
    "mediaType": "application/json"
  }
   ]
 },
 {
   "name": "oracle.examples.hello",
   "links": [
  {
    "rel": "describes",
    "href": "http://localhost:8080/ords/ordstest/examples/hello/"
  },
  {
    "rel": "canonical",
    "href": "http://localhost:8080/ords/ordstest/metadata-catalog/examples/hello/",
    "mediaType": "application/json"
  }
   ]
 }
  ],
  "hasMore": false,
  "limit": 25,
  "offset": 0,
  "count": 2,
  "links": [
 {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/"
 },
 {
   "rel": "first",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/"
 }
  ]
}
```


The list of resources includes:

- Resources representing tables or views that have been REST enabled.
- Resources defined by resource modules. Note that only resources having a concrete path (that is, not containing any parameters) will be shown. For example, a resource with a path of `/module/some/path/` will be shown, but a resource with a path of `/module/some/:parameter/` will not be shown.

Each available resource has two hyperlinks:

- The link with relation `describes` points to the actual resource.
- The link with relation `canonical` describes the resource.

2.3.1.2 Get Object Metadata

This example retrieves the metadata (which describes the object) of an individual object. The location of the metadata is indicated by the `canonical` link relation.

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/metadata-catalog/<ObjectAlias>/`

Example: `GET http://localhost:8080/ords/ordstest/metadata-catalog/emp/`

Result:


```
{
    "name": "EMP",
    "primarykey": [
        "empno"
    ],
    "members": [
        {
            "name": "empno",
            "type": "NUMBER"
        },
        {
            "name": "ename",
            "type": "VARCHAR2"
        },
        {
            "name": "job",
            "type": "VARCHAR2"
        },
        {
            "name": "mgr",
            "type": "NUMBER"
        },
        {
            "name": "hiredate",
            "type": "DATE"
        },
        {
            "name": "sal",
            "type": "NUMBER"
        },
        {
            "name": "comm",
            "type": "NUMBER"
        },
        {
            "name": "deptno",
            "type": "NUMBER"
        }
    ],
    "links": [
        {
            "rel": "collection",
            "href": "http://localhost:8080/ords/ordstest/metadata-catalog/",
            "mediaType": "application/json"
        },
        {
            "rel": "canonical",
            "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/"
```

```
        },
        {
            "rel": "describes",
            "href": "http://localhost:8080/ords/ordstest/emp/"
        }
    ]
}
```

2.3.1.3 Get Object Data

This example retrieves the data in the object. Each row in the object corresponds to a JSON object embedded within the JSON array

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/`

Example: `GET http://localhost:8080/ords/ordstest/emp/`

Result:

```
{
 "items": [
  {
   "empno": 7499,
   "ename": "ALLEN",
   "job": "SALESMAN",
   "mgr": 7698,
   "hiredate": "1981-02-20T00:00:00Z",
   "sal": 1600,
   "comm": 300,
   "deptno": 30,
   "links": [
    {
     "rel": "self",
     "href": "http://localhost:8080/ords/ordstest/emp/7499"
    }
   ]
  },
  ...
  {
   "empno": 7934,
   "ename": "MILLER",
   "job": "CLERK",
   "mgr": 7782,
   "hiredate": "1982-01-23T00:00:00Z",
   "sal": 1300,
   "comm": null,
   "deptno": 10,
   "links": [
    {
     "rel": "self",
     "href": "http://localhost:8080/ords/ordstest/emp/7934"
    }
   ]
  }
 ],
 "hasMore": false,
 "limit": 25,
 "offset": 0,
 "count": 13,
 "links": [
  {
```

```
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  },
  {
   "rel": "edit",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/"
  },
  {
   "rel": "first",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  }
 ]
}
```

2.3.1.4 Get Table Data Using Paging

This example specifies the `offset` and `limit` parameters to control paging of result data.

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/?offset=<Offset>&limit=<Limit>`

Example: `GET http://localhost:8080/ords/ordstest/emp/?offset=10&limit=5`

Result:

```
{
 "items": [
  {
   "empno": 7900,
   "ename": "JAMES",
   "job": "CLERK",
   "mgr": 7698,
   "hiredate": "1981-12-03T00:00:00Z",
   "sal": 950,
   "comm": null,
   "deptno": 30,
   "links": [
    {
     "rel": "self",
     "href": "http://localhost:8080/ords/ordstest/emp/7900"
    }
   ]
  },
  ...
  {
   "empno": 7934,
   "ename": "MILLER",
   "job": "CLERK",
   "mgr": 7782,
   "hiredate": "1982-01-23T00:00:00Z",
   "sal": 1300,
   "comm": null,
   "deptno": 10,
   "links": [
    {
     "rel": "self",
```

```
      "href": "http://localhost:8080/ords/ordstest/emp/7934"
     }
    ]
   }
  ],
  "hasMore": false,
  "limit": 5,
  "offset": 10,
  "count": 3,
  "links": [
   {
    "rel": "self",
    "href": "http://localhost:8080/ords/ordstest/emp/"
   },
   {
    "rel": "edit",
    "href": "http://localhost:8080/ords/ordstest/emp/"
   },
   {
    "rel": "describedby",
    "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/"
   },
   {
    "rel": "first",
    "href": "http://localhost:8080/ords/ordstest/emp/?limit=5"
   },
   {
    "rel": "prev",
    "href": "http://localhost:8080/ords/ordstest/emp/?offset=5&limit=5"
   }
  ]
 }
```

2.3.1.5 Get Table Data Using Query

This example specifies a filter clause to restrict objects returned.

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/?q=<FilterClause>`

Example: `GET http://localhost:8080/ords/ordstest/emp/?q={"deptno":{"$lte":20}}`

Result:

```
{
 "items": [
  {
   "empno": 7566,
   "ename": "JONES",
   "job": "MANAGER",
   "mgr": 7839,
   "hiredate": "1981-04-01T23:00:00Z",
   "sal": 2975,
   "comm": null,
   "deptno": 20,
   "links": [
    {
     "rel": "self",
     "href": "http://localhost:8080/ords/ordstest/emp/7566"
    }
   ]
```

```
  },
  ...
  {
   "empno": 7934,
   "ename": "MILLER",
   "job": "CLERK",
   "mgr": 7782,
   "hiredate": "1982-01-23T00:00:00Z",
   "sal": 1300,
   "comm": null,
   "deptno": 10,
   "links": [
    {
     "rel": "self",
     "href": "http://localhost:8080/ords/ordstest/emp/7934"
    }
   ]
  }
 ],
 "hasMore": false,
 "limit": 25,
 "offset": 0,
 "count": 7,
 "links": [
  {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/emp/?
q=%7B%22deptno%22:%7B%22%24lte%22:20%7D%7D"
  },
  {
   "rel": "edit",
   "href": "http://localhost:8080/ords/ordstest/emp/?
q=%7B%22deptno%22:%7B%22%24lte%22:20%7D%7D"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/"
  },
  {
   "rel": "first",
   "href": "http://localhost:8080/ords/ordstest/emp/?
q=%7B%22deptno%22:%7B%22%24lte%22:20%7D%7D"
  }
 ]
}
```

2.3.1.6 Get Table Row Using Primary Key

This example retrieves an object by specifying its identifying key values.

> **Note:**
>
> - If a table does not have a primary key, then ORDS uses the ROWID to uniquely address the rows.
> - The primary keys are not compatible with a REST interface if they meet any of the following characteristics:
>   - End with a period
>   - Contain // or \\
>   - Begin with /
>   - Contains two or more periods in sequence (For example: .., ...)
>   - Contains any of the following characters: “<”,“>”,“:”,“"”,“|”,“?”,“*”,“#”,“; or ,“%”
>   Requests that contain such primary keys returns *HTTP 400 Bad Request* as a response. If the primary keys contain any of the preceding incompatible characters, then it is recommended to have a secondary key that does not conflict with the link generation rules.

Pattern: `GET http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/<KeyValues>`

Where `<KeyValues>` is a comma-separated list of key values (in key order).

Example: `GET http://localhost:8080/ords/ordstest/emp/7839`

Result:

```
{
 "empno": 7839,
 "ename": "KING",
 "job": "PRESIDENT",
 "mgr": null,
 "hiredate": "1981-11-17T00:00:00Z",
 "sal": 5000,
 "comm": null,
 "deptno": 10,
 "links": [
  {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/emp/7839"
  },
  {
   "rel": "edit",
   "href": "http://localhost:8080/ords/ordstest/emp/7839"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/item"
  },
  {
   "rel": "collection",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  }
 ]
}
```

2.3.1.7 Insert Table Row

This example inserts data into the object. The body data supplied with the request is a JSON object containing the data to be inserted.

If the object has a primary key, then the POST request can include the primary key value in the body. Or, if the table has an IDENTITY CLAUSE, sequence or trigger, then the primary key column may be omitted. If the table does not have a primary key, then the ROWID of the row is used as the item's identifier.

If the object lacks a trigger to assign primary key values, then the PUT operation described in next section,**Update/Insert Table Row** should be used instead.

Pattern: `POST http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/`

Example:

```
curl -i -H "Content-Type: application/json" -X POST -d "{ \"empno\" :7,
\"ename\": \"JBOND\", \"job\":\"SPY\", \"deptno\" :11 }" "http://localhost:8080/
ords/ordstest/emp/
Content-Type: application/json

{ "empno" :7, "ename": "JBOND", "job":"SPY", "deptno" :11 }
```

Result:

```
{
 "empno": 7,
 "ename": "JBOND",
 "job": "SPY",
 "mgr": null,
 "hiredate": null,
 "sal": null,
 "comm": null,
 "deptno": 11,
 "links": [
  {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/emp/7"
  },
  {
   "rel": "edit",
   "href": "http://localhost:8080/ords/ordstest/emp/7"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/item"
  },
  {
   "rel": "collection",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  }
 ]
}
```

2.3.1.8 Update/Insert Table Row

This example inserts or updates (sometimes called an "upsert") data in the object. The body data supplied with the request is a JSON object containing the data to be inserted or updated.

Pattern: `PUT http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/<KeyValues>`

Example:

```
curl -i -H "Content-Type: application/json" -X PUT -d "{ \"empno\" :7, \"ename\":
\"JBOND\", \"job\":\"SPY\", \"deptno\" :11 }" "http://localhost:8080/ords/
ordstest/emp/7
Content-Type: application/json

{ "empno" :7, "ename": "JBOND", "job":"SPY", "deptno" :11 }
```

Result:

```
{
 "empno": 7,
 "ename": "JBOND",
 "job": "SPY",
 "mgr": null,
 "hiredate": null,
 "sal": null,
 "comm": null,
 "deptno": 11,
 "links": [
  {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/emp/7"
  },
  {
   "rel": "edit",
   "href": "http://localhost:8080/ords/ordstest/emp/7"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/emp/item"
  },
  {
   "rel": "collection",
   "href": "http://localhost:8080/ords/ordstest/emp/"
  }
 ]
}
```

2.3.1.9 Delete Using Filter

This example deletes object data specified by a filter clause.

Pattern: `DELETE http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/?q=<FilterClause>`

Example: `curl -i -X DELETE "http://localhost:8080/ords/ordstest/emp/?q={"deptno":11}"`

Result:

```
{
    "itemsDeleted": 1
}
```

2.3.1.10 Post by Batch Load

This example inserts object data using the batch load feature. The body data supplied with the request is a CSV file. The behavior of the batch operation can be controlled using the optional query parameters, which are described in Table 2-1.

Pattern: `POST http://<HOST>:<PORT>/ords/<SchemaAlias>/<ObjectAlias>/batchload?<Parameters>`

Parameters:

Table 2-1 Parameters for batchload

Parameter	Description
batchesPerCommit	Sets the frequency for commits. Optional commit points can be set after a batch is sent to the database. The default is every 10 batches. 0 indicates commit deferred to the end of the load. Type: Integer.
batchRows	Sets the number of rows in each batch to send to the database. The default is 50 rows per batch. Type: Integer.
dateFormat	Sets the format mask for the date data type. This format is used when converting input data to columns of type date. Type: String.
delimiter	Sets the field delimiter for the fields in the file. The default is the comma (,).
enclosures	embeddedRightDouble
errors	Sets the user option used to limit the number of errors. If the number of errors exceeds the value specified for `errorsMax` (the service option) or by `errors` (the user option), then the load is terminated. To permit no errors at all, specify 0. To indicate that all errors be allowed (up to errorsMax value), specify UNLIMITED (-1) .
errorsMax	A service option used to limit the number of errors allowed by users. It intended as an option for the service provider and not to be exposed as a user option. If the number of errors exceeds the value specified for `errorsMax` (the service option) or by `errors` (the user option), then the load is terminated. To permit no errors at all, specify 0. To indicate that all errors be allowed, specify UNLIMITED (-1).
lineEnd	Sets the line end (terminator). If the file contains standard line end characters (\r. \r\n or \n), then `lineEnd` does not need to be specified.
lineMax	Sets a maximum line length for identifying lines/rows in the data stream. A `lineMax` value will prevent reading an entire stream as a single line when the incorrect `lineEnd` character is being used. The default is unlimited.
locale	Sets the locale.
responseEncoding	Sets the encoding for the response stream.
responseFormat	Sets the format for response stream. This format determines how messages and bad data will be formatted. Valid values: `RAW`, `SQL`.
timestampFormat	Sets the format mask for the time stamp data type. This format is used when converting input data to columns of type time stamp.

Table 2-1 (Cont.) Parameters for batchload

Parameter	Description
timestampTZFormat	Sets the format mask for the time stamp time zone data type. This format is used when converting input data to columns of type time stamp time zone.
truncate	Indicates if and/or how table data rows should be deleted before the load. `False` (the default) does not delete table data before the load; `True` causes table data to be deleted with the DELETE SQL statement; `Truncate` causes table data to be deleted with the TRUNCATE SQL statement.

Example:

```
POST http://localhost:8080/ords/ordstest/emp/batchload?batchRows=25
Content-Type: text/csv

empno,ename,job,mgr,hiredate,sal,comm,deptno
0,M,SPY MAST,,2005-05-01 11:00:01,4000,,11
7,J.BOND,SPY,0,2005-05-01 11:00:01,2000,,11
9,R.Cooper,SOFTWARE,0,2005-05-01 11:00:01,10000,,11
26,Max,DENTIST,0,2005-05-01 11:00:01,5000,,11
```

Result:

```
#INFO Number of rows processed: 4
#INFO Number of rows in error: 0
#INFO Elapsed time: 00:00:03.939 - (3,939 ms) 0 - SUCCESS: Load processed without
errors
```

2.3.2 Filtering in Queries

This section describes and provides examples of filtering in queries against REST-enabled tables and views.

Filtering is the process of limiting a collection resource by using a per-request dynamic filter definition across multiple page resources, where each page contains a subset of items found in the complete collection. Filtering enables efficient traversal of large collections.

To filter in a query, include the parameter `q=`*FilterObject*, where *FilterObject* is a JSON object that represents the custom selection and sorting to be applied to the resource. For example, assume the following resource:

```
https://example.com/ords/scott/emp/
```

The following query includes a filter that restricts the ENAME column to "JOHN":

```
https://example.com/ords/scott/emp/?q={"ENAME":"JOHN"}
```

2.3.2.1 FilterObject Grammar

The `FilterObject` must be a JSON object that complies with the following syntax:

```
FilterObject { orderby , asof, wmembers }
```

The `orderby`, `asof`, and `wmembers` attributes are optional, and their definitions are as follows:

```
orderby
  "$orderby": {orderByMembers}

orderByMembers
    orderByProperty
    orderByProperty , orderByMembers

orderByProperty
    columnName : sortingValue
    columnName : sortingNulls
    columnName : sortingValues

sortingValues
    [sortingValue]
    [sortingNulls]
    [sortingValue, sortingNulls]
    [sortingNulls, sortingValue]

sortingNulls
  "NULLS FIRST"
  "NULLS LAST"

sortingValue
  "ASC"
  "DESC"
  "-1"
  "1"
   -1
   1

asof
  "$asof": date
  "$asof": "datechars"
  "$asof": scn
  "$asof": +int

wmembers
    wpair
    wpair , wmembers

wpair
    columnProperty
    complexOperatorProperty

columnProperty
    columnName : string
    columnName : number
    columnName : date
    columnName : simpleOperatorObject
columnName : complexOperatorObject
    columnName : [complexValues]

columnName
  "\p{Alpha}[[\p{Alpha}]]([[\p{Alnum}]#$_])*$"

complexOperatorProperty
    complexKey : [complexValues]
    complexKey : simpleOperatorObject

complexKey
  "$and"
```

```
  "$or"

complexValues
    complexValue , complexValues

complexValue
    simpleOperatorObject
    complexOperatorObject
    columnObject

columnObject
    {columnProperty}

simpleOperatorObject
    {simpleOperatorProperty}

complexOperatorObject
    {complexOperatorProperty}

simpleOperatorProperty
   "$eq" : string | number | date
   "$ne" : string | number | date
   "$lt" :  number | date
   "$lte" : number | date
   "$gt" : number | date
   "$gte" : number | date
   "$instr" : string
   "$ninstr" : string
   "$like" : string
   "$null" : null
   "$notnull" : null
   "$between" : betweenValue

betweenValue
    [null , betweenNotNull]
    [betweenNotNull , null]
    [betweenRegular , betweenRegular]

betweenNotNull
    number
    date

betweenRegular
    string
    number
    date
```

Data type definitions include the following:

```
string
       JSONString
number
       JSONNumber
date
       {"$date":"datechars"}
scn
       {"$scn": +int}
```

Where:

```
datechars is an RFC3339 date format in UTC (Z)


JSONString
          ""
          " chars "
chars
         char
         char chars
char
         any-Unicode-character except-"-or-\-or-control-character
          \"
          \\
           \/
          \b
          \f
          \n
          \r
          \t
          \u four-hex-digits


JSONNumber
    int
    int frac
    int exp
    int frac exp
int
    digit
    digit1-9 digits
    - digit
    - digit1-9 digits
frac
    . digits
exp
    e digits
digits
    digit
    digit digits
e
    e
    e+
    e-
    E
    E+
    E-
```

The `FilterObject` must be encoded according to Section 2.1 of RFC3986.

2.3.2.2 Examples: FilterObject Specifications

The following are examples of operators in `FilterObject` specifications.

ORDER BY property ($orderby)

Order by with literals

```
{
 "$orderby": {"SALARY":  "ASC","ENAME":"DESC"}
}
```

Order by with numbers

```
{
 "$orderby": {"SALARY":  -1,"ENAME":  1}
}
```

Order by with nulls first

```
{
"$orderby": {"SALARY":  ["ASC", "NULLS FIRST"]}
}
```

Order by with nulls last

```
{
"$orderby": {"SALARY":  ["ASC", "NULLS LAST"]}
}
```

ASOF property ($asof)

With SCN (Implicit)

```
{
  "$asof": 1273919
}
```

With SCN (Explicit)

```
{
  "$asof": {"$scn": "1273919"}
}
```

With Date (Implicit)

```
{
  "$asof": "2014-06-30T00:00:00Z"
}
```

With Date (Explicit)

```
{
  "$asof": {"$date": "2014-06-30T00:00:00Z"}
}
```

EQUALS operator ($eq)

(Implicit and explicit equality supported._

Implicit (Support String and Dates too)

```
{
 "SALARY": 1000
}
```

Explicit

```
{
 "SALARY": {"$eq": 1000}
}
```

Strings

```
{
 "ENAME": {"$eq":"SMITH"}
}
```

Dates

```
{
  "HIREDATE": {"$date": "1981-11-17T08:00:00Z"}
}
```

NOT EQUALS operator ($ne)

Number

```
{
 "SALARY": {"$ne": 1000}
}
```

String

```
{
 "ENAME": {"$ne":"SMITH"}
}
```

Dates

```
{
  "HIREDATE": {"$ne": {"$date":"1981-11-17T08:00:00Z"}}
}
```

LESS THAN operator ($lt)
(Supports dates and numbers only)

Numbers

```
{
  "SALARY": {"$lt": 10000}
}
```

Dates

```
{
  "SALARY": {"$lt": {"$date":"1999-12-17T08:00:00Z"}}
}
```

LESS THAN OR EQUALS operator ($lte)
(Supports dates and numbers only)

Numbers

```
{
  "SALARY": {"$lte": 10000}
}
```

Dates

```
{
  "HIREDATE": {"$lte": {"$date":"1999-12-17T08:00:00Z"}}
}
```

GREATER THAN operator ($gt)
(Supports dates and numbers only)

Numbers

```
{
  "SALARY": {"$gt": 10000}
}
```

Dates

```
{
  "SALARY": {"$gt": {"$date":"1999-12-17T08:00:00Z"}}
}
```

GREATER THAN OR EQUALS operator ($gte)
(Supports dates and numbers only)

Numbers

```
{
  "SALARY": {"$gte": 10000}
}
```

Dates

```
{
  "HIREDATE": {"$gte": {"$date":"1999-12-17T08:00:00Z"}}
}
```

In string operator ($instr)
(Supports strings only)

```
{
  "ENAME": {"$instr":"MC"}
}
```

Not in string operator ($ninstr)
(Supports strings only)

```
{
  "ENAME": {"$ninstr":"MC"}
}
```

LIKE operator ($like)
(Supports strings. Eescape character not supported to try to match expressions with _ or % characters.)

```
{
  "ENAME": {"$like":"AX%"}
}
```

```
#### BETWEEN operator ($between)
(Supports string, dates, and numbers)

Numbers

{
  "SALARY": {"$between": [1000,2000]}
}

Dates

{
  "SALARY": {"$between": [{"$date":"1989-12-17T08:00:00Z"},
{"$date":"1999-12-17T08:00:00Z"}]}
}

Strings

{
  "ENAME": {"$between": ["A","C"]}
}

Null Ranges ($lte equivalent)
(Supported by numbers and dates only)

{
  "SALARY": {"$between": [null,2000]}
}

Null Ranges ($gte equivalent)
(Supported by numbers and dates only)

{
  "SALARY": {"$between": [1000,null]}
}


#### NULL operator ($null)

{
  "ENAME": {"$null": null}
}

#### NOT NULL operator ($notnull)

{
  "ENAME": {"$notnull": null}
}


#### AND operator ($and)
(Supports all operators, including $and and $or)

Column context delegation
(Operators inside $and will use the closest context defined in the JSON tree.)

{
  "SALARY": {"$and": [{"$gt": 1000},{"$lt":4000}]}
}

Column context override
```

```
(Example: salary greater than 1000 and name like S%)

{
  "SALARY": {"$and": [{"$gt": 1000},{"ENAME": {"$like":"S%"}} ] }
}

Implicit and in columns

```
{
  "SALARY": [{"$gt": 1000},{"$lt":4000}]
}
```

High order AND
(All first columns and or high order operators -- $and and $ors -- defined at the
first level of the JSON will be joined and an implicit AND)
(Example: Salary greater than 1000 and name starts with S or T)

{
  "SALARY": {"$gt": 1000},
  "ENAME": {"$or": [{"$like":"S%"}, {"$like":"T%"}]}
}

Invalid expression (operators $lt and $gt lack column context)

{
   "$and": [{"$lt": 5000},{"$gt": 1000}]
}

Valid alternatives for the previous invalid expression

{
   "$and": [{"SALARY": {"$lt": 5000}}, {"SALARY": {"$gt": 1000}}]
}

{
   "SALARY": [{"$lt": 5000},{"$gt": 1000}]
}

{
   "SALARY": {"$and": [{"$lt": 5000},{"$gt": 1000}]}
}

OR operator ($or)
(Supports all operators including $and and $or)

Column context delegation
(Operators inside $or will use the closest context defined in the JSON tree)

{
  "ENAME": {"$or": [{"$eq":"SMITH"},{"$eq":"KING"}]}
}

Column context override
(Example: name starts with S or salary greater than 1000)

{
  "SALARY": {"$or": [{"$gt": 1000},{"ENAME": {"$like":"S%"}}] }
}
```

2.3.3 Auto PL/SQL

This section explains how PL/SQL is made available through HTTP(S) for Remote Procedure call (RPC).

The auto PL/SQL feature uses a standard to provide consistent encoding and data transfer in a stateless web service environment. Using this feature, you can enable Oracle Database stored PL/SQL functions and procedures at package level through Oracle REST Data Services, similar to how you enable the views and tables.

Auto Enabling PL/SQL Subprograms

Oracle REST Data Services supports auto enabling of the following PL/SQL objects, based on their catalog object identifier:

- PL/SQL Procedure
- PL/SQL Function
- PL/SQL Package

The functions, and procedures within the PL/SQL package cannot be individually enabled as they are named objects within a PL/SQL package object. Therefore, the granularity level enables the objects at the package level. This granularity level enables to expose all of its public functions and procedures.

If you want to *only* enable a subset of functions and procedures, then you must create a separate delegate package and enable it to expose only that subset of functions and procedures.

> **Note:**
>
> Overloaded package functions and procedures are not supported.

2.3.3.1 Method and Content Type Supported for Auto Enabling PL/SQL Objects

This section discusses the method and content-type supported by this feature.

The auto enabling of the PL/SQL Objects feature supports POST as the HTTP method. In POST method, input parameters are encoded in the payload and output parameters are decoded from the response.

> **Note:**
>
> The standard data CRUD to HTTP method mappings are not applicable as this feature provides an RPC-style interaction.

The content-type supported is `application/json`.

2.3.3.2 Auto-Enabling the PL/SQL Objects

This section explains how to auto-enable the PL/SQL objects through Oracle REST Data Services.

You can enable the PL/SQL objects in one of the following ways:

- Auto-Enabling Using the PL/SQL API
- Auto-Enabling the PL/SQL Objects Using SQL Developer

2.3.3.2.1 Auto-Enabling Using the PL/SQL API

You can enable a PL/SQL object using the Oracle REST Data Services PL/SQL API.

To enable the PL/SQL package, use the Oracle REST Data Services PL/SQL API as shown in following sample code snippet:

```
BEGIN
  ords.enable_object(
    p_enabled => TRUE,
    p_schema => 'MY_SCHEMA',
    p_object => 'MY_PKG',
    p_object_type => 'PACKAGE',
    p_object_alias => 'my_pkg',
    p_auto_rest_auth => FALSE);
   commit;
END;
/
```

Example 2-1 Enabling the PL/SQL Function

To enable the PL/SQL function, use the Oracle REST Data Services PL/SQL API as shown in following sample code snippet:

```
BEGIN
  ords.enable_object(
    p_enabled => TRUE,
    p_schema => 'MY_SCHEMA',
    p_object => 'MY_FUNC',
    p_object_type => 'FUNCTION',
    p_object_alias => 'my_func',
    p_auto_rest_auth => FALSE);

    commit;
END;
/
```

Example 2-2 Enabling the PL/SQL Procedure

To enable the PL/SQL procedure, use the Oracle REST Data Services PL/SQL API as shown in following sample code snippet:

```
BEGIN
  ords.enable_object(
    p_enabled => TRUE,
    p_schema => 'MY_SCHEMA',
    p_object => 'MY_PROC',
    p_object_type => 'PROCEDURE',
    p_object_alias => 'my_proc',
    p_auto_rest_auth => FALSE);

    commit;
END;
/
```

2.3.3.2.2 Auto-Enabling the PL/SQL Objects Using SQL Developer

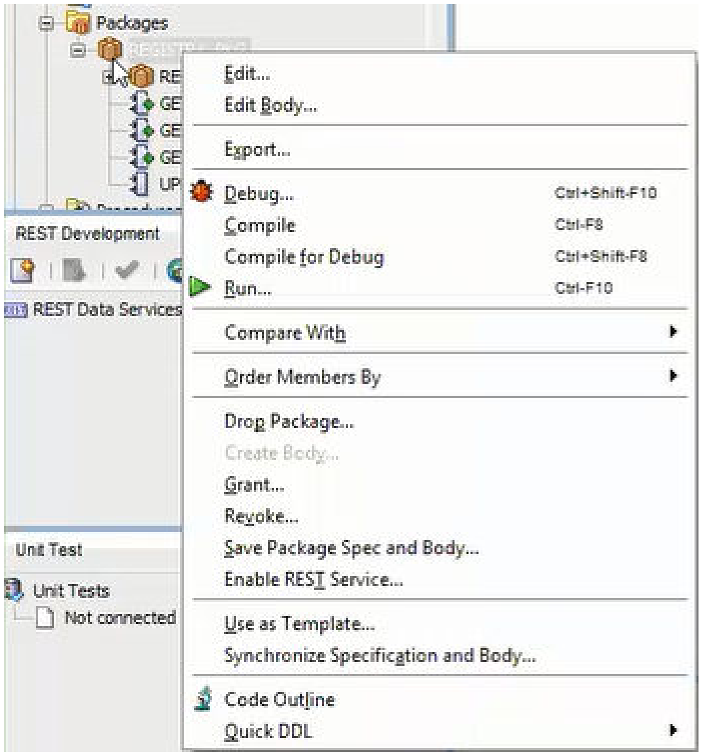
This section describes how to enable the PL/SQL objects using SQL Developer 4.2 and above.

To enable the PL/SQL objects (for example, package) using SQL Developer, perform the following steps:

> **Note:**
>
> You can now enable, packages, functions and procedures. However, the granularity of enabling is either at the whole package level, standalone function level, or at the standalone procedure level.

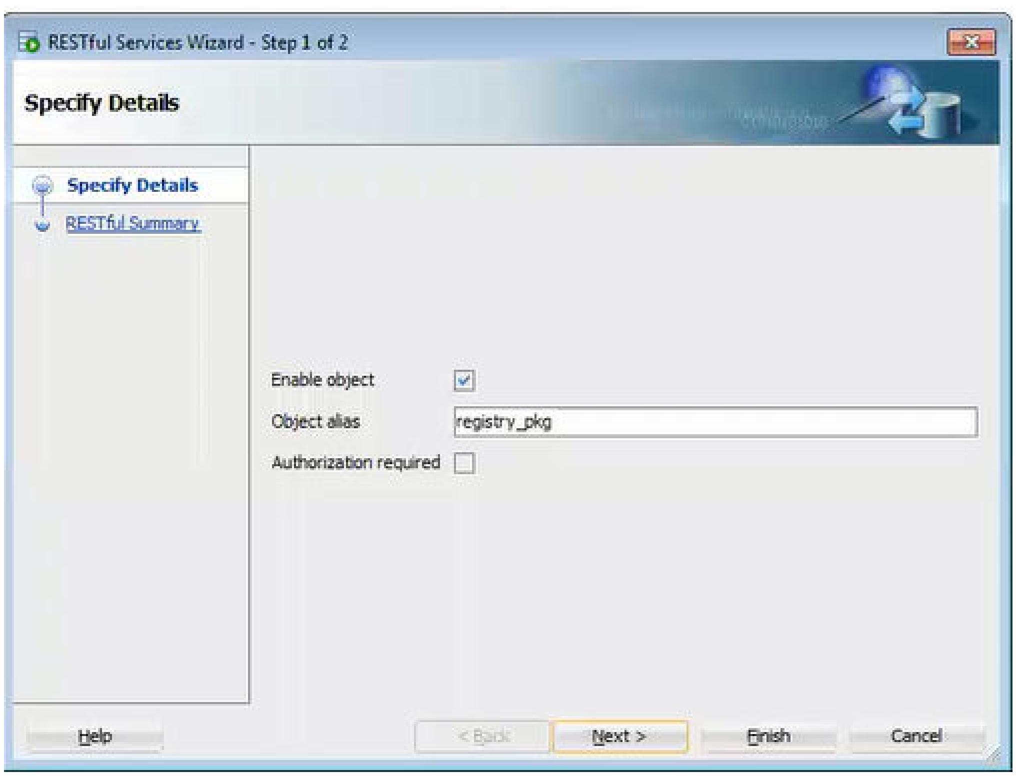
1. In SQL Developer, right-click on a package as shown in the following figure:

Figure 2-3 Selecting the Enable REST Service Option



2. Select **Enable RESTful Services** to display the following wizard page:

Figure 2-4 Auto Enabling the PL/SQL Package Object



- **Enable object**: Enable this option (that is, enable REST access for the package).
- **Object alias**: Accept `registry_pkg` for the object alias.
- **Authorization required**: For simplicity, disable this option.
- On the RESTful Summary page of the wizard, click **Finish**.

2.3.3.3 Generating the PL/SQL Endpoints

HTTP endpoints are generated dynamically per request for the enabled database objects. Oracle REST Data Services uses the connected database catalog to generate the endpoints using a query.

The following rules apply for all the database objects for generating the HTTP endpoints:

- All names are converted to lowercase
- An endpoint is generated if it is not already allocated

Stored Procedure and Function Endpoints

The function or procedure name is generated into the URL in the same way as tables and views in the same namesspace.

Example 2-3 Generating an Endpoint for the Stored Procedure

```
CREATE OR REPLACE PROCEDURE MY_SCHEMA.MY_PROC IS
BEGIN
  NULL;
END;
```

Following endpoint is generated:

```
http://localhost:8080/ords/my_schema/my_proc/
```

Example 2-4 Package Procedure and Function Endpoints

The package, function, and procedure endpoints are generated with package name as a parent. Endpoints for functions and procedures that are not overloaded or where the lowercase name is not already in use are generated.

If you have a package, MY_PKG as defined in the following code snippet:

```
CREATE OR REPLACE  PACKAGE MY_SCHEMA.MY_PKG AS
  PROCEDURE MY_PROC;
  FUNCTION MY_FUNC RETURN VARCHAR2;
  PROCEDURE MY_PROC2;
  PROCEDURE "my_proc2";
  PROCEDURE MY_PROC3(P1 IN VARCHAR);
  PROCEDURE MY_PROC3(P2 IN NUMBER);
END MY_PKG;
```

Then the following endpoints are generated:

```
http://localhost:8080/ords/my_schema/my_pkg/MY_PROC
http://localhost:8080/ords/my_schema/my_pkg/MY_FUNC
```

> **Note:**
>
> Endpoints for the procedure `my_proc2` is not generated because its name is not unique when the name is converted to lowercase, and endpoints for the procedure `my_proc3` is not generated because it is overloaded.

2.3.3.4 Resource Input Payload

The input payload is a JSON document with values adhering to the REST standard.

The payload should contain a name/value pair for each IN or IN OUT parameter as shown in the following code snippet:

```
{
  "p1": "abc",
  "p2": 123,
  "p3": null
}
```

> **Note:**
>
> Where there are no IN or IN OUT parameters, an empty JSON body is required as shown in the following code snippet:
>
> ```
> {
>
> }
> ```

Oracle REST Data Services uses the database catalog metadata to unmarshal the JSON payload into Oracle database types, which is ready to be passed to the database through JDBC.

2.3.3.5 Resource Payload Response

When the PL/SQL object is executed successfully, it returns a JSON body.

The JSON body returned, contains all OUT and IN OUT output parameter values. Oracle REST Data Services uses the database catalog metadata to marshal the execution of the result back into JSON as shown in the following code snippet:

```
{
  "p3" : "abc123",
```

```
  "p4" : 1
}
```

Where there are no OUT or IN OUT parameters, an empty JSON body is returned as shown in the following code snippet:

```
{

}
```

2.3.3.6 Function Return Value

The return value of functions do not have an associated name.

As the return value of functions do not have an associated name, the name `"~ret"` is used as shown in the following code snippet:

```
{
  "~ret" : "abc123"
}
```

2.3.4 Support for JSON-Relational Duality View

ORDS supports AutoREST enabling of JSON-relational duality view functionality. This functionality is supported only with Oracle Database 23c or later.

JSON-relational duality view is a revolutionary Oracle Database feature that combines the benefits of relational databases and NoSQL JSON document stores. This feature allows the storage of normalized data in relational tables while exposing it to applications in JSON. Multiple JSON-relational duality views can be created on the same relational data to address different use cases. In other words, the same relational data can have different JSON representations.

> **See Also:**
>
> JSON-Relational Duality Developer's Guide

2.3.4.1 Table AutoREST Versus JSON-Relational Duality View AutoREST

A JSON-relational duality view is classified as a VIEW in Oracle Database, so it can be AutoRest enabled like any relational view. This section provides a comparison between the AutoREST functionality of JSON-relational duality views with relational tables:

Similarities:

- Exposes the same set of endpoints and methods (`GET`, `PUT`, `POST`, `DELETE`, and `HEAD`)
- Uses the same comma-separated primary key identifier format as that of the associated root table

- Supports the same `Read`, `Create`, `Upsert`, or `Delete` semantics
- Generates the same HTTP `If-None-Match` header ETag digest, where multiple items are processed.
- Injects the *links* hyperlinks field into the response payload

Differences:

- Supported only with Oracle Database 23c or later
- Passes the JSON payload directly between the request or response and the JSON-relational duality view DATA column.
- Uses the JSON-relational duality view ETag value for HTTP `If-Match` and `If-None-Match` header conditional matching, where a single item is processed (`GET`, `PUT`, and `DELETE` methods).
- Uses the SODA extended Query by Example (QBE) syntax for rich filtering and ordering
- Uses a JSON-friendly `batchload` format

2.3.4.2 Support for Enhanced ETag Matching

Oracle REST Data Services (ORDS) integrates with the JSON-relational duality view ETag feature to support optimistic locking and client caching.

HTTP ETag Matching

ORDS uses the JSON-relational duality view generated ETag instead of its own digest value when evaluating matching headers for single item operations such a `GET` (`If-None-Match`) and `PUT/DELETE` (`If-Match`).

`Match` Header	HTTP `False` Response	Header Example
`If-None-Match`	`304 - "Not Modified"`	`If-None-Match: "536001F31A8718819AEEF28EC20D8677"`
`If-Match`	`412 - "Precondition Failed"`	`If-Match: "536001F31A8718819AEEF28EC20D8677"`

> **Note:**
>
> The double-quotes around the ETag value are mandatory.

Database ETag Matching

The Oracle Database also performs ETag matching for `UPDATE` operations where an ETag is available in the `_metadata` object of the request payload, otherwise this field is ignored in all other cases.

Content Example	HTTP 'False' Response
`{ … "_metadata": { "etag": "536001F31A8718819AEEF28EC20D8677" , "asof": "00000000002BECD5" }, … }`	`412 - "Precondition Failed"`

2.3.4.3 Enhanced JSON QBE (Query by Example) Filtering

Oracle REST Data Services (ORDS) exposes the same QBE filtering syntax that Simple Oracle Document Access (SODA) uses, providing the user with a roburst set of JSON operators and functionality that are more appropriate for processing JSON.

Although, the syntax currently only applies to JSON-relational duality views, it is specified in the `q` URL parameter, similar to the relational tables and views.

The following example filters the content of the `race_dv` JSON-relational duality view, where the `points` field is greater than 40:

```
curl http://localhost:8080/ords/janus/race_dv/?q={"points":{"$gt":40}}
```

The following example adds ordering on the `points` field to the preceding example:

```
curl http://localhost:8080/ords/janus/race_dv/?q={"$query":{"points":
{"$gt":40}},"$orderby":[{"path":"points","datatype":"number"}]}
```

See Also:

Simple Oracle Document Access (SODA)

2.3.4.4 Enhanced JSON Batch Loading

As the JSON-relational duality view `DATA` column is mapped directly to the request payload, the same approach should be applied to batch loading. Therefore, ORDS provides an optimized `batchload` endpoint that accepts one of the following JSON content types:

Header Content-Type	Description

`application/json`	Freely formatted JSON array of JSON documents payload. For example:
	
	`[`
	`  {`
	`    "x":1,`
	`    "y":1`
	`  },`
	`  {`
	`    "x":2,`
	`    "y":2`
	`  }`
	`]`

`application/json; boundary=LF`	Linefeed delimited list of JSON documents. Payload example:
	
	`{"x":1,"y":1}`
	`{"x":2,"y":2}`

Each JSON document is passed to the ORDS batch load service as a row and can be fine-tuned with the query parameters in the same way as in any table.

For example, `batchesPerCommit`, `batchRows`, and `truncate` can be used to optimize the batch loading process.

The following example shows the batch loading of the `points_dv` JSON-relational duality view in batches of 25 rows of JSON document:

```
curl -i -X POST --data-binary @points.json -H "Content-Type: application/
json"
      http://localhost:8080/ords/ordstest/points_dv/batchload?batchRows=25
```

The familiar batch process result is returned in the response as shown in the following code snippet:

```
HTTP/1.1 200 OK
...
#INFO Number of rows processed:  2
#INFO Number of rows in error:  0
#INFO Last row processed in final committed batch: 2
SUCCESS: Processed without errors
```

2.4 Manually Creating RESTful Services Using SQL and PL/SQL

This section describes how to manually create RESTful Services using SQL and PL/SQL and shows how to use a JSON document to pass parameters to a stored procedure in the body of a REST request.

This section includes the following topics:

- About Oracle REST Data Services Mechanisms for Passing Parameters
- Using SQL/JSON Database Functions

2.4.1 About Oracle REST Data Services Mechanisms for Passing Parameters

This section describes the main mechanisms that Oracle REST Data Services supports for passing parameters using REST HTTP to handlers that are written by the developer:

- Using JSON to Pass Parameters

  You can use JSON in the body of REST requests, such as the `POST` or `PUT` method, where each parameter is a JSON name/value pair.
- Using Route Patterns to Pass Parameters

  You can use route patterns for required parameters in the URI to specify parameters for REST requests such as the `GET` method, which does not have a body, and in other special cases.
- Using Query Strings for Optional Parameters

  You can use query strings for optional parameters in the URI to specify parameters for REST requests, such as the `GET` method, which does not have a body, and in other special cases.

Prerequisite Setup Tasks To Be Completed Before Performing Tasks for Passing Parameters

This prerequisite setup information assumes you have completed steps 1 and 2 in **Getting Started with RESTful Services** section, where you have REST-enabled the `ordstest` schema and `emp` database table (Step 1) and created and tested the RESTful service from a SQL query (Step 2). You must complete these two steps before performing the tasks about passing parameters described in the subsections that follow.

Related Topics

- Getting Started with RESTful Services

2.4.1.1 Using JSON to Pass Parameters

This section shows how to use a JSON document to pass parameters to a stored procedure in the body of a REST request, such as `POST` or `PUT` method, where each parameter is a name/value pair. This operation performs an update on a record, which in turn returns the change to the record as an `OUT` parameter.

Perform the following steps:

1. **Note:**

   The following stored procedure performs an update on an existing record in the `emp` table to promote an employee by changing any or all of the following: job, salary, commission, department number, and manager. The stored procedure returns the salary change as an `OUT` parameter.

```
create or replace procedure promote ( l_empno IN number,  l_job
IN varchar2,
           l_mgr IN number, l_sal IN number,  l_comm IN number,
l_deptno IN number,
           l_salarychange OUT number)
        is
            oldsalary   number;
        begin
            select nvl(e.sal, 0)into oldsalary FROM emp e
                    where e.empno = l_empno;
            update emp e set
                e.job = nvl(l_job, e.job),
                e.mgr = nvl(l_mgr, e.mgr),
                e.sal = nvl(l_sal, e.sal),
                e.comm = nvl(l_comm, e.comm),
                e.deptno = nvl(l_deptno, e.deptno)
                        where e.empno = l_empno;
            l_salarychange := nvl(l_sal, oldsalary) - oldsalary;
        end;
```

   As a privileged `ordstest` user, connect to the `ordstest` schema and create the `promote` stored procedure.

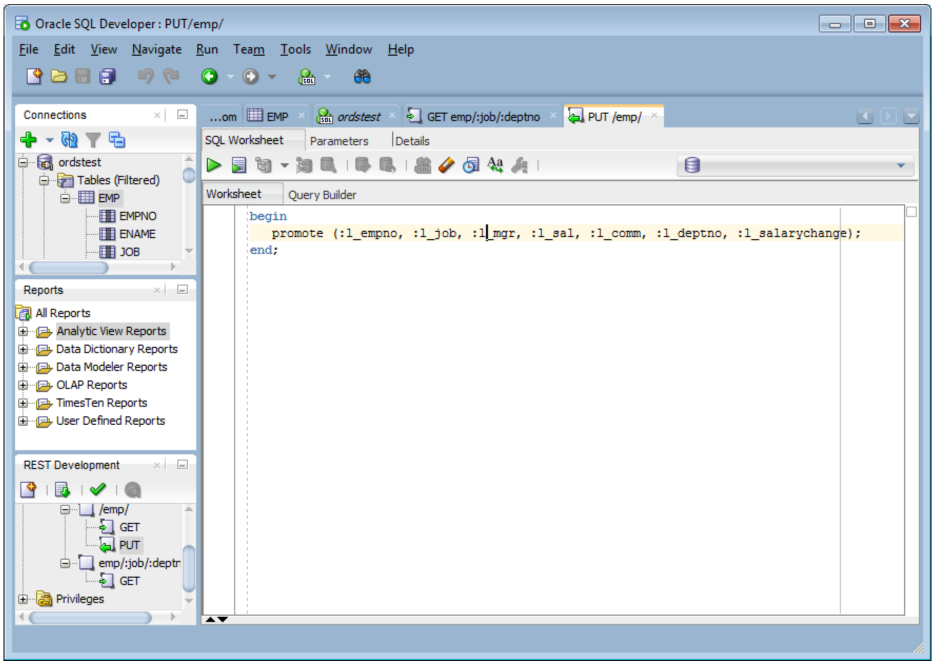
2. Perform the following steps to setup a handler for a `PUT` request on the `emp` resource to pass parameters in the body of the `PUT` method in a JSON document to the `promote` stored procedure.

   a. Using Oracle SQL Developer, in the REST Development section, right click on the `emp` template and select **Add Handler** for the `PUT` method.

   b. In the **Create Resource Handler** dialog, click the green plus symbol to add the MIME type `application/json` and then click **Apply** to send it a JSON document in the body of the `PUT` method.

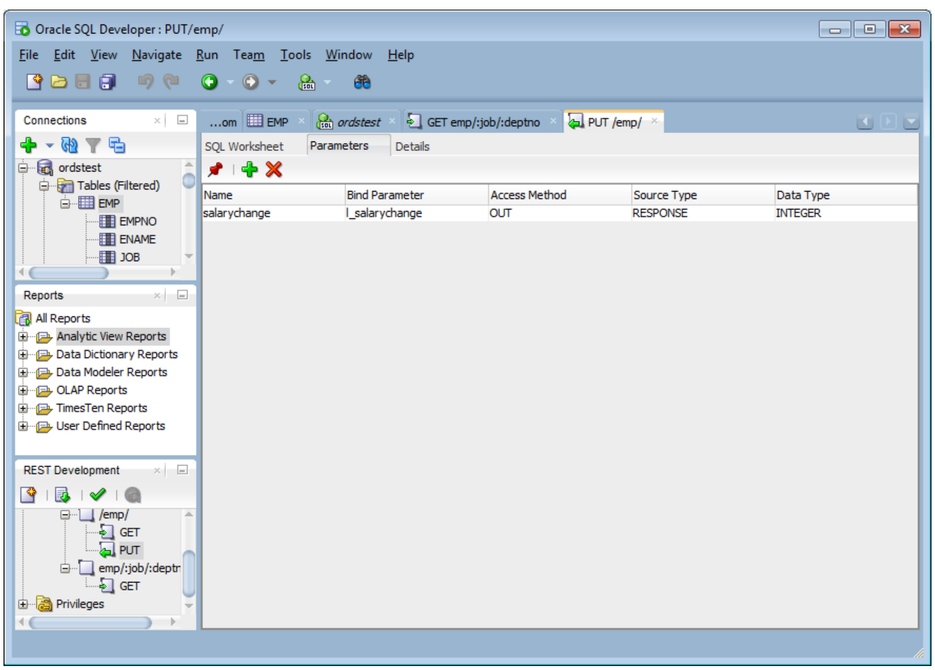
   c. Using the SQL Worksheet, add the following anonymous PL/SQL block: `begin promote (:l_empno, :l_job, :l_mgr, :l_sal, :l_comm, :l_deptno, :l_salarychange); end;` as shown in the following figure.

Figure 2-5 Adding an Anonymous PL/SQL Block to the Handler for the PUT Method



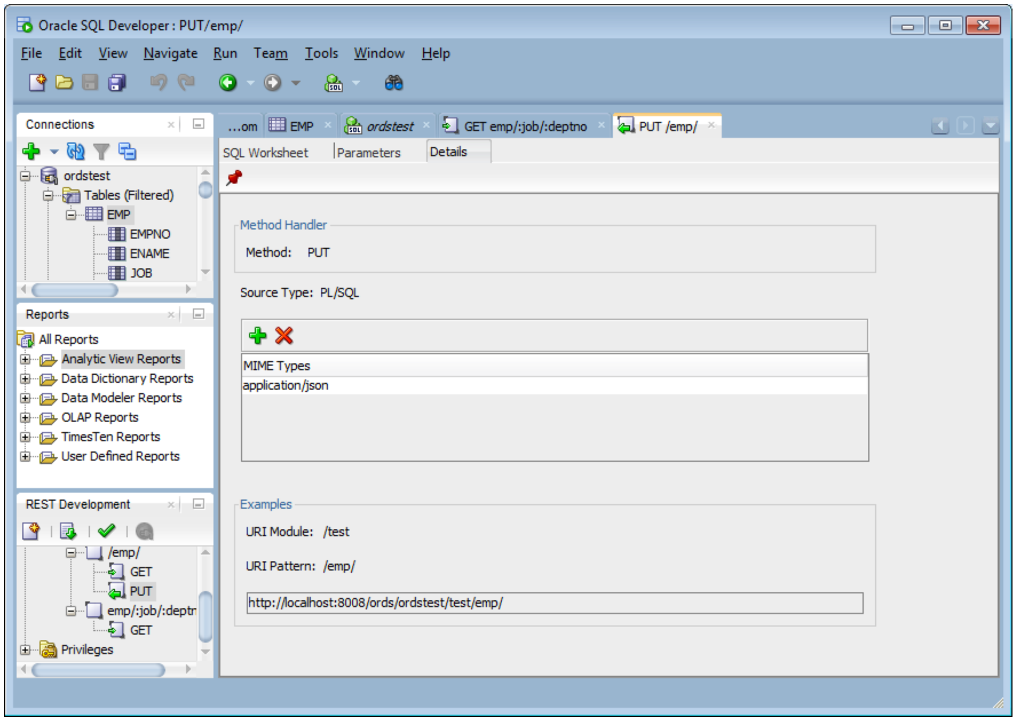
d. Click the **Parameters** tab to set the **Bind Parameter** as `l_salarychange` , the **Access Method** as an `OUT` parameter, the **Source Type** as `RESPONSE`, and **Data Type** as `INTEGER` as shown in the following figure. This is the promote procedure's output which is an integer value equal to the change in salary in a JSON name/value format.

Figure 2-6 Setting the Bind Parameter l_salarychange to Pass for the PUT Method



e. Click the **Details** tab to get the URL to call as shown in the **Examples** section of the following figure. Copy this URL to your clipboard.

Figure 2-7 Obtaining the URL to Call from the Details Tab



f. Right click on the `test` module to upload the module. Do not forget this step.

3. To test the RESTful service, execute the following cURL command in the command prompt:`curl -i -H "Content-Type: application/json" -X PUT -d "{ \"l_empno\" : 7499, \"l_sal\" : 9999, \"l_job\" : \"Director\", \"l_comm\" : 300}`

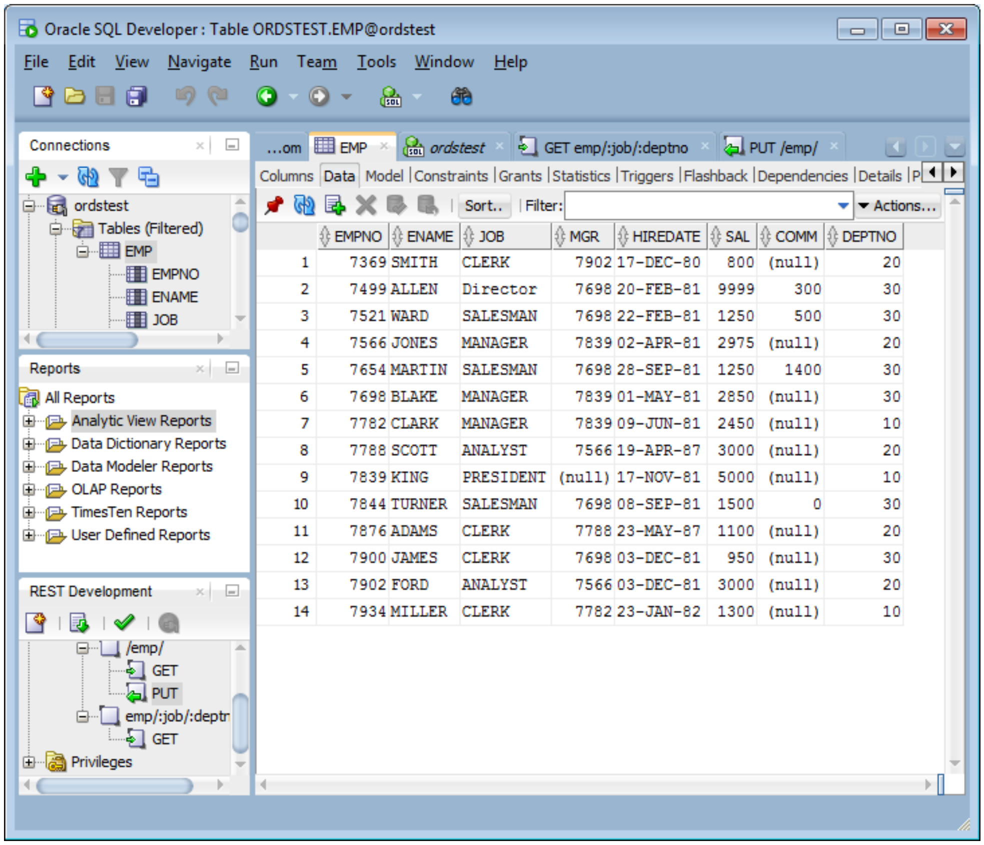
> **Note:**
>
> You can also use any REST client available to test the RESTful service.

The cURL command returns the following response:

```
HTTP/1.1 200 OK
Content-Type: application/json Transfer-Encoding: chunked
{"salarychange":8399}
```

4. In SQL Developer SQL Worksheet, perform the following `SELECT` statement on the `emp` table: `SELECT * from emp` to see that the `PUT` method was executed, then select the **Data** tab to display the records for the `EMP` table.

Figure 2-8 Displaying the Results from a SQL Query to Confirm the Execution of the PUT Method



Note:

- All parameters are optional. If you leave out a name/value pair for a parameter in your JSON document, the parameter is set to `NULL`.
- The name/value pairs can be arranged in any order in the JSON document. JSON allows much flexibility in this regard in the JSON document.
- Only one level of JSON is supported. You can not have nested JSON objects or arrays.

2.4.1.2 Using Route Patterns to Pass Parameters

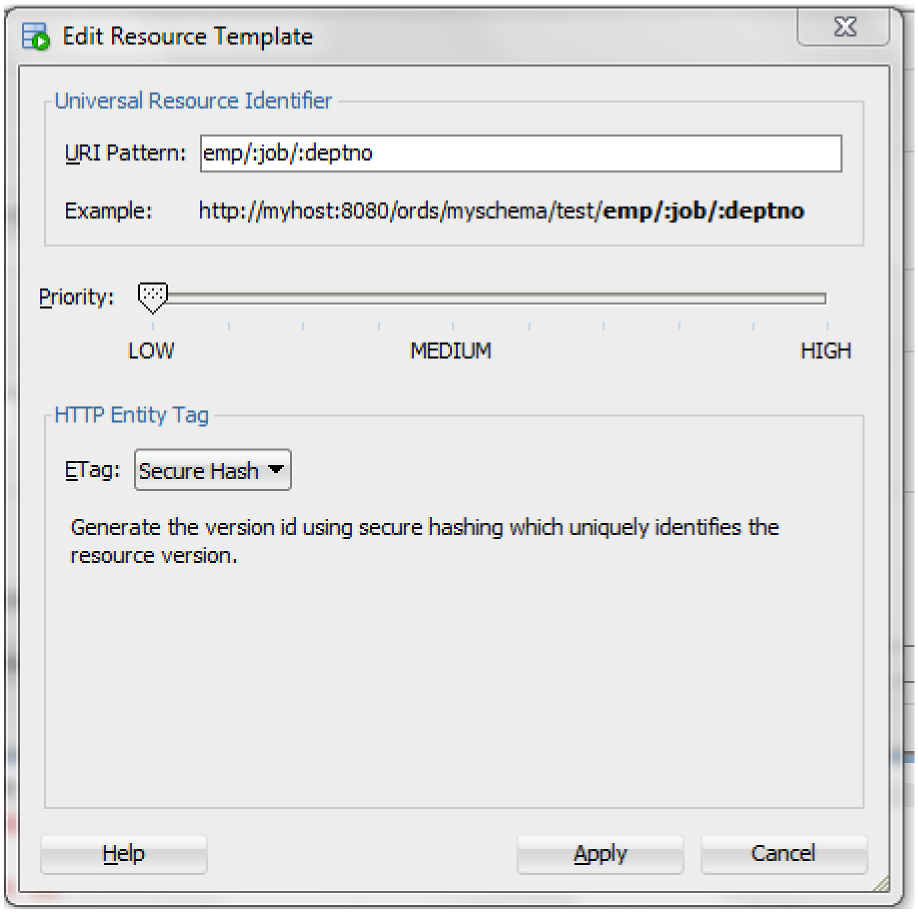
This section describes how to use route patterns in the URI to specify parameters for REST requests, such as with the `GET` method, which does not have a body.

First create a `GET` method handler for a query on the `emp` table that has many bind variables. These steps use a route pattern to specify the parameter values that are required.

Perform the following steps to use a route pattern to send a `GET` method with some required parameter values:

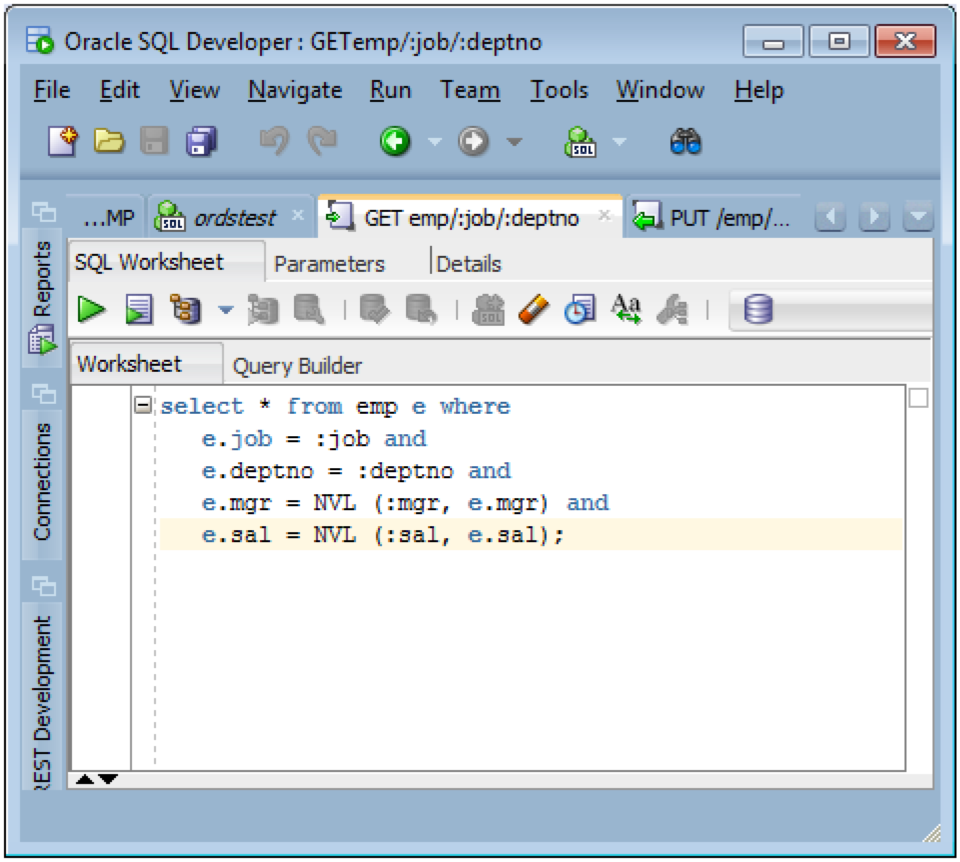
1. In SQL Developer, right click on the test module and select **Add Template** to create a new template that calls `emp`; however, in this case the template definition includes a route pattern for the parameters or bind variables that is included in the URI rather than in the body of the method. To define the required parameters, use a route pattern by specifying a `/:` before the `job` and `deptno` parameters. For example, for the URI pattern, enter: `emp/:job/:deptno` as shown in the following figure.

Figure 2-9 Creating a Template Definition to Include a Route Pattern for Some Parameters or Bind Variables



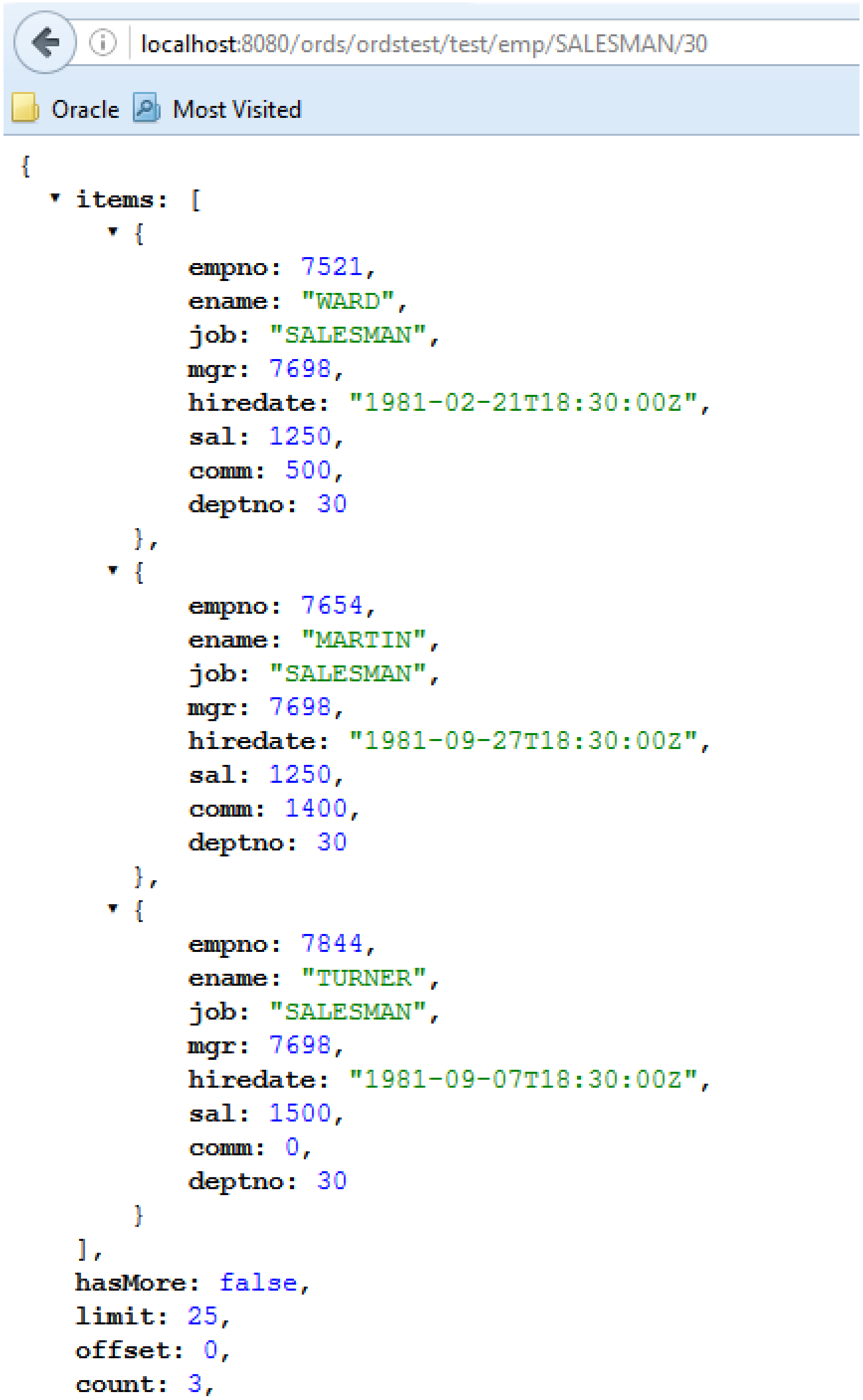
2. Click **Next** to go to **REST Data Services — Step 2 of 3**, and click **Next** to go to **REST Data Services — Step 3 of 3**, then click **Finish** to complete the template.
3. Right click on the `emp/:job/:deptno` template and select `Add Handler` for the `GET` method.
4. Right click on the `GET` method to open the handler.
5. Add the following query to the SQL Worksheet: `select * from emp e where e.job = :job and e.deptno = :deptno and e.mgr = NVL (:mgr, e.mgr) and e.sal = NVL (:sal, e.sal);` as also shown in the following figure.

Figure 2-10 Adding a SQL Query to the Handler



6. Click the **Details** tab to get the URL to call. Copy this URL to your clipboard.
7. Right click on the `test` module to upload the module. Do not forget this step.
8. Test the REST endpoint. In a web browser enter the URL:`http://localhost:8080/ords/ordstest/test/emp/SALESMAN/30` as shown in the following figure.

Figure 2-11 Using Browser to Show the Results of Using a Route Pattern to Send a GET Method with Some Required Parameter Values



The query returns 3 records for the salesmen named Ward, Martin, and Turner.

See Also:

To learn more about Route Patterns see this document in the Oracle REST Data Services distribution at `docs/javadoc/plugin-api/route-patterns.html` and this document **Oracle REST Data Services Route Patterns**

2.4.1.3 Using Query Strings for Optional Parameters

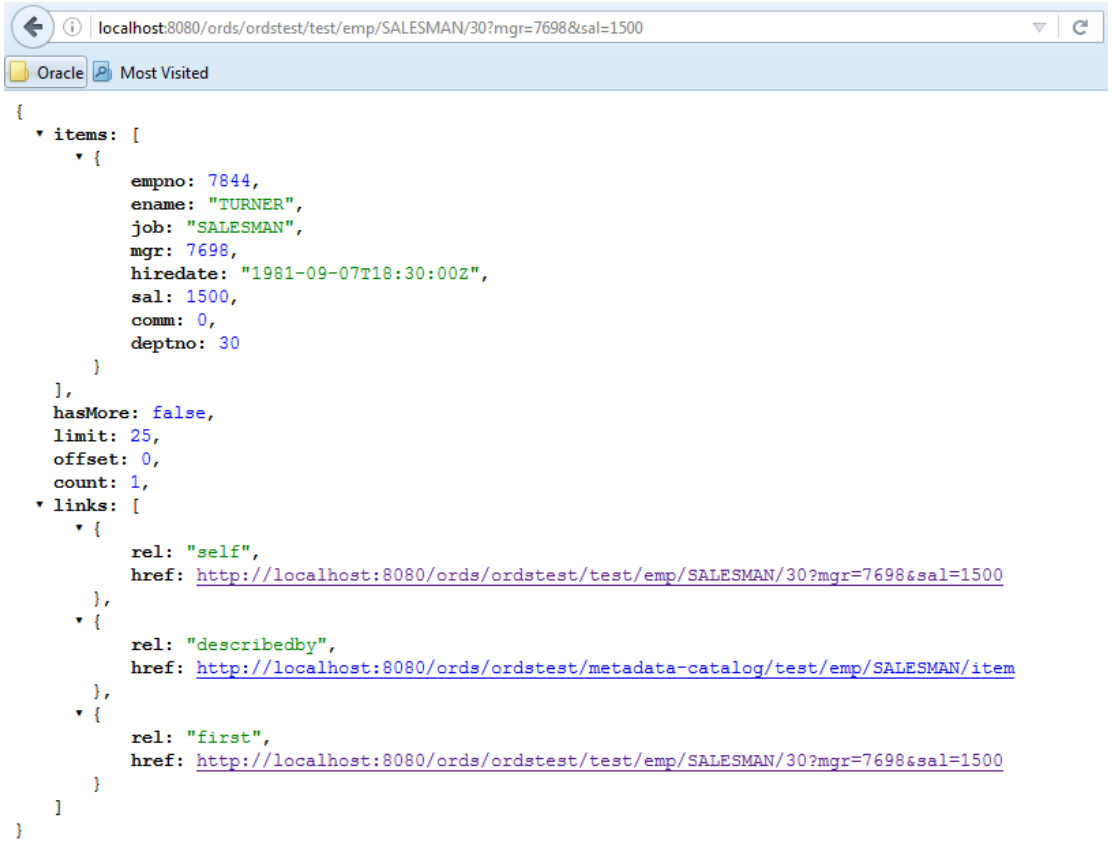
This section describes how to use query strings in the URI to specify parameters for REST requests like the GET method, which does not have a body. You can use query strings for any of the other optional bind variables in the query as you choose.

The syntax for using query strings is: `?parm1=value1&parm2=value2 … &parmN=valueN`.

For example, to further filter the query: `http://localhost:8080/ords/ordstest/test/emp/SALESMAN/30`, to use a query string to send a GET method with some parameter name/value pairs, select employees whose `mgr` (manager) is `7698` and whose `sal` (salary) is `1500` by appending the query string `?mgr=7698&sal=1500` to the URL as follows: `http://localhost:8080/ords/ordstest/test/emp/SALESMAN/30?mgr=7698&sal=1500`.

To test the endpoint, in a web browser enter the following URL: http://localhost:8080/ords/ordstest/test/emp/SALESMAN/30?mgr=7698&sal=1500 as shown in the following figure:

Figure 2-12 Using Browser to Show the Results of Using a Query String to Send a GET Method with Some Parameter Name/Value Pairs



The query returns one record for the salesman named Turner in department 30 who has a salary of 1500 and whose manager is 7698.

Note the following points:

- It is a good idea to URL encode your parameter values. This may not always be required; however, it is the safe thing to do. This prevents the Internet from transforming something, for example, such as a special character in to some other character that may cause a failure. Your REST client may provide this capability or you can search the Internet for the phrase `url encoder` to find tools that can do this for you.
- Never put a backslash at the end of your parameter list in the URI; otherwise, you may get a `404 Not Found` error.

> **See Also:**
>
> - **Lab 4 of the ORDS Oracle By Example (OBE)**
> - **Database Application Development Virtual Image**

2.4.2 Using SQL/JSON Database Functions

This section describes how to use the SQL/JSON database functions available in Oracle Database 19c Release or later to map the nested JSON objects to and from the hierarchical relational tables.

This section includes the following topics:

- Inserting Nested JSON Objects into Relational Tables
- Generating Nested JSON Objects from Hierachical Relational Data

2.4.2.1 Inserting Nested JSON Objects into Relational Tables

This section explains how to insert JSON objects with nested arrays into multiple, hierarchical relational tables.

The two key technologies used to implement this functionality are as follows:

- The `:body` bind variable that Oracle REST Data Services provides to deliver JSON and other content in the body of POST and other REST calls into PL/SQL REST handlers
- JSON_TABLE and other SQL/JSON operators provided in Oracle Database 21c

Some of the advantages of using these technologies for inserting data into relational tables are as follows:

- Requirements for implementing this functionality are very minimal. For example, installation of JSON parser software is not required
- You can use simple, declarative code that is easy to write and understand when the JSON to relational mapping is simple
- Powerful and sophisticated capabilities to handle more complex mappings. This includes:
  - Mechanisms for mapping NULLS and boolean values
  - Sophisticated mechanisms for handling JSON. JSON evolves over time. Hence, the mapping code must be able to handle both the older and newer versions of the JSON documents.

    For example, simple scalar values may evolve to become JSON objects containing multiple scalars or nested arrays of scalar values or objects. SQL/JSON operators that return the scalar value can continue to work even when the simple scalar is embedded within these more elaborate structures. A special mechanism, called the **Ordinality Column**, can be used to determine the structure from where the value was derived.

See Also:

- JSON in the Oracle Database Technology
- Ordinality Column

2.4.2.1.1 Usage of the :body Bind Variable

This section provides some useful tips for using the `:body` bind variable.

Some of the useful tips for using the `:body` bind variable are as follows:

- The `:body` bind variable can be accessed, or de-referenced, only once. Subsequent accesses return a NULL value. So, you must first assign the `:body` bind variable to the local `L_PO` variable before using it in the two JSON_Table operations.
- The `:body` bind variable is a BLOB datatype and you can assign it only to a BLOB variable.

  > **Note:**
  >
  > Since `L_PO` is a BLOB variable, you must use the `FORMAT JSON` phrase after the expression in the JSON_TABLE function. section for more information.

  The `:body` bind variable can be used with other types of data such as image data.
- The `:body_text` bind variable is a CLOB datatype and you can assign it only to a CLOB variable.
- If you use either `:body` or `:body_text`, then you cannot reference individual JSON attributes through the ORDS `:bind` variables.

> **See Also:**
>
> Database SQL Language Reference

2.4.2.1.2 Example of JSON Purchase Order with Nested LineItems

This section shows an example that takes the JSON Purchase Order with Nested LineItems and inserts it into a row of the PurchaseOrder table and rows of the LineItem table.

Example 2-5 Nested JSON Purchase Order with Nested LineItems

```
{"PONumber"          : 1608,
  "Requestor"        : "Alexis Bull",
  "CostCenter"       : "A50",
  "Address"          : {"street"   : "200 Sporting Green",
                         "city"     : "South San Francisco",
                         "state"    : "CA",
                         "zipCode" : 99236,
                         "country" : "United States of America"},
  "LineItems"        : [ {"ItemNumber" : 1,
                           "Part"        : {"Description" : "One Magic
Christmas",
                                             "UnitPrice"   : 19.95,
                                             "UPCCode"     : 1313109289},
                           "Quantity"    : 9.0},
                         {"ItemNumber" : 2,
```

```
                        "Part"        : {"Description" : "Lethal
Weapon",
                                        "UnitPrice"    : 19.95,
                                        "UPCCode"      : 8539162892},
                        "Quantity"    : 5.0}]}'
```

2.4.2.1.3 Table Definitions for PurchaseOrder and LineItems Tables

This section provides definitions for the **PurchaseOrder** and **LineItem** tables.

The definitions for the **PurchaseOrder** and the **LineItems** tables are as follows:

```
CREATE TABLE PurchaseOrder (
     PONo NUMBER (5),
     Requestor VARCHAR2 (50),
     CostCenter VARCHAR2 (5),
     AddressStreet VARCHAR2 (50),
     AddressCity VARCHAR2 (50),
     AddressState VARCHAR2 (2),
     AddressZip VARCHAR2 (10),
     AddressCountry VARCHAR2 (50),
     PRIMARY KEY (PONo));

CREATE TABLE LineItem (
     PONo NUMBER (5),
     ItemNumber NUMBER (10),
     PartDescription VARCHAR2 (50),
     PartUnitPrice NUMBER (10),
     PartUPCCODE NUMBER (10),
     Quantity NUMBER (10),
     PRIMARY KEY (PONo,ItemNumber));
```

2.4.2.1.4 PL/SQL Handler Code for a POST Request

This section gives an example PL/SQL handler code for a POST request. The handler code is used to insert a purchase order into a row of the PurchaseOrder table and rows of the LineItem table.

Example 2-6 PL/SQL Handler Code Used for a POST Request

```
Declare
  L_PO     BLOB;

Begin
  L_PO := :body;

INSERT INTO PurchaseOrder
      SELECT * FROM json_table(L_PO  FORMAT JSON, '$'
         COLUMNS (
           PONo            Number    PATH '$.PONumber',
           Requestor       VARCHAR2  PATH '$.Requestor',
           CostCenter      VARCHAR2  PATH '$.CostCenter',
           AddressStreet   VARCHAR2  PATH '$.Address.street',
           AddressCity     VARCHAR2  PATH '$.Address.city',
```

```
           AddressState    VARCHAR2  PATH '$.Address.state',
           AddressZip      VARCHAR2  PATH '$.Address.zipCode',
           AddressCountry  VARCHAR2  PATH '$.Address.country'));

INSERT INTO LineItem
SELECT * FROM json_table(L_PO  FORMAT JSON, '$'
         COLUMNS (
           PONo  Number PATH '$.PONumber',
           NESTED              PATH '$.LineItems[*]'
             COLUMNS (
               ItemNumber        Number   PATH '$.ItemNumber',
               PartDescription   VARCHAR2   PATH '$.Part.Description',
               PartUnitPrice     Number   PATH '$.Part.UnitPrice',
               PartUPCCode       Number   PATH '$.Part.UPCCode',
               Quantity          Number   PATH '$.Quantity')));
commit;
end;
```

2.4.2.1.5 Creating the REST API Service to Invoke the Handler

This section explains how to create the REST API service to invoke the handler, using the Oracle REST Data Services.

To setup the REST API service, a URI is defined to identify the resource the REST calls will be operating on. The URI is also used by Oracle REST Data Services to route the REST HTTP calls to specific handlers. The general format for the URI is as follows:

```
<server>:<port>/ords/<schema>/<module>/<template>/<parameters>
```

Here, `<server>:<port>` is where the Oracle REST Data Service is installed. For testing purposes, you can use **demo** and **test** in place of **module** and **template** respectively in the URI. Modules are used to group together related templates that define the resources the REST API will be operating upon.

To create the REST API service, use one of the following methods:

- Use the Oracle REST Data Services PL/SQL API to define the REST service and a handler for the POST insert. Then connect to the `jsontable` schema on the database server that contains the PurchaseOrder and LineItem tables.

  > **Note:**
  >
  > JSON_TABLE and other SQL/JSON operators use single quote so these must be escaped. For example, every single quote (’) must be replaced with double quotes (“).

- Use the Oracle REST Data Services, REST Development pane in SQL Developer to define the REST service.

2.4.2.1.6 Defining the REST Service and Handler using PL/SQL API

This section shows how to define the REST Service and Handler for the POST insert using the Oracle REST Data Services PL/SQL API.

You can alternatively use the Oracle REST Data Services REST development pane in SQL Developer to create the modules, templates and handlers.

```
BEGIN
  ORDS.ENABLE_SCHEMA(
      p_enabled             => TRUE,
      p_schema              => 'ORDSTEST',
      p_url_mapping_type    => 'BASE_PATH',
      p_url_mapping_pattern => 'ordstest',
      p_auto_rest_auth      => FALSE);

  ORDS.DEFINE_MODULE(
      p_module_name    => 'demo',
      p_base_path      => '/demo/',
      p_items_per_page =>  25,
      p_status         => 'PUBLISHED',
      p_comments       => NULL);
  ORDS.DEFINE_TEMPLATE(
      p_module_name    => 'demo',
      p_pattern        => 'test',
      p_priority       => 0,
      p_etag_type      => 'HASH',
      p_etag_query     => NULL,
      p_comments       => NULL);
  ORDS.DEFINE_HANDLER(
      p_module_name    => 'demo',
      p_pattern        => 'test',
      p_method         => 'POST',
      p_source_type    => 'plsql/block',
      p_items_per_page =>  0,
      p_mimes_allowed  => '',
      p_comments       => NULL,
      p_source         => '
declare
    L_PO BLOB := :body;
begin

INSERT INTO PurchaseOrder
      SELECT * FROM json_table(L_PO  FORMAT JSON, ''$''
         COLUMNS (
           PONo                  Number           PATH ''$.PONumber'',
           Requestor            VARCHAR2  PATH ''$.Requestor'',
           CostCenter          VARCHAR2   PATH ''$.CostCenter'',
           AddressStreet      VARCHAR2  PATH ''$.Address.street'',
           AddressCity          VARCHAR2  PATH ''$.Address.city'',
           AddressState         VARCHAR2  PATH ''$.Address.state'',
           AddressZip            VARCHAR2  PATH ''$.Address.zipCode'',
           AddressCountry     VARCHAR2  PATH ''$.Address.country''));
```

```
INSERT INTO LineItem
SELECT * FROM json_table(L_PO  FORMAT JSON, ''$''
         COLUMNS (
           PONo  Number PATH ''$.PONumber'',
           NESTED                      PATH ''$.LineItems[*]''
             COLUMNS (
               ItemNumber       Number      PATH ''$.ItemNumber'',
               PartDescription  VARCHAR2    PATH ''$.Part.Description'',
               PartUnitPrice      Number     PATH ''$.Part.UnitPrice'',
               PartUPCCode      Number     PATH ''$.Part.UPCCode'',
               Quantity                Number    PATH ''$.Quantity'')));

commit;
end;'
      );


  COMMIT;
END;
```

Related Topics

- Using the Oracle REST Data Services PL/SQL API
- About Oracle REST Data Services Mechanisms for Passing Parameters
- ORDS PL/SQL Package Reference

2.4.2.2 Generating Nested JSON Objects from Hierachical Relational Data

This section explains how to query the relational tables in hierarchical (parent/child) relationships and return the data in a nested JSON format using the Oracle REST Data Services.

The two key technologies used to implement this functionality are as follows:

- SQL/JSON functions are available with Oracle Database. You can use `json_objects` for generating JSON objects from the relational tables, and `json_arrayagg`, for generating nested JSON arrays from nested (child) relational tables.
- The Oracle REST Data Services media source type used for enabling the REST service handler to execute a SQL query that in turn returns the following types of data:
  - The HTTP Content-Type of the data, which in this case is **application/json**
  - The JSON data returned by the `json_object`

Some of the advantages of using this approach are as follows:

- Requirements for implementing this functionality is very minimal. For example, installation of JSON parser software is not required.
- Simple, declarative coding which is easy to write and understand which makes the JSON objects to relational tables mapping simple.
- Powerful and sophisticated capabilities to handle more complex mappings. This includes mechanisms for mapping NULLS and boolean values.

  For example, a NULL in the Oracle Database can be converted to either the absence of the JSON element or to a JSON NULL value. The Oracle Database does not store

Boolean types but the SQL/JSON functions allow string or numeric values in the database to be mapped to Boolean TRUE or FALSE values.

2.4.2.2.1 Bypassing JSON Generation for Relational Data

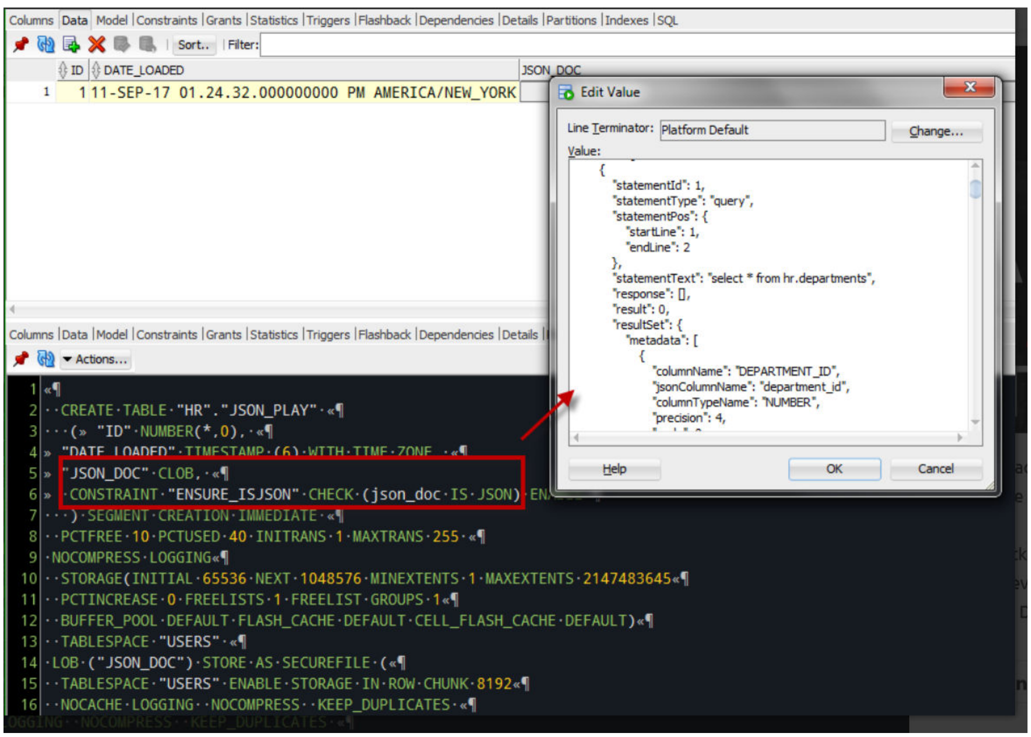
This section describes and provides solutions for handling responses that are already in a JSON format.

ORDS auto-formats your SQL or PL/SQL results and response to a JSON format before returning to your application. However, in some cases, the complete response body or part of it is already in a JSON format. Following are two such use cases:

Use Case 1: When the response is already in a JSON format

Following figure shows an example where the complete response is already in a JSON format:

Figure 2-13 Complete Response Body in JSON Format



You must adjust your GET query text to include "application/json" before including the JSON itself as shown in the following example GET query:

```
Select 'application/json',
             upper(json_doc)
   from json_play
```

The Media resource in this case is application/json and the browser handles it similar to a BLOB or a PDF.

Use Case 2: One or more columns of the response is already in a JSON format.

If one or more columns are in a JSON format, then such columns in the source query need to be aliased to indicate that the attribute must not be converted to a JSON format.

For example:

```
Select id,
                jsons "{}jsons"
           from table_with_json
```

The alias text is used to name the nested JSON document attribute.

2.4.2.2.2 Example to Generate Nested JSON Objects from the Hierachical Relational Tables

This section describes how to query or GET the data we inserted into the PurchaseOrder and LineItem relational tables in the form of nested JSON purchase order.

Example 2-7   GET Handler Code using Oracle REST Data Services Query on Relational Tables for Generating a Nested JSON object

```
SELECT 'application/json', json_object('PONumber' VALUE po.PONo,
       'Requestor' VALUE po.Requestor,
       'CostCenter' VALUE po.CostCenter,
       'Address' VALUE
           json_object('street' VALUE po.AddressStreet,
                 'city' VALUE po.AddressCity,
                 'state' VALUE po.AddressState,
                 'zipCode' VALUE po.AddressZip,
                 'country' VALUE po.AddressCountry),
        'LineItems' VALUE (select json_arrayagg(
            json_object('ItemNumber' VALUE li.ItemNumber,
                   'Part' VALUE
                     json_object('Description' VALUE li.PartDescription,
                                 'UnitPrice' VALUE li.PartUnitPrice,
                                 'UPCCode' VALUE li.PartUPCCODE),
                   'Quantity' VALUE li.Quantity))
                   FROM LineItem li WHERE po.PONo = li.PONo))
             FROM PurchaseOrder po
               WHERE po.PONo = :id
```

2.4.2.2.3 PL/SQL API Calls for Defining Template and GET Handler

This section provides an example of Oracle REST Data Services PL/SQL API call for creating a new template in the module created.

Example 2-8   PL/SQL API Call for Creating a New `test/:id` Template and GET Handler in the `demo` Module

```
Begin
ords.define_template(
 p_module_name => 'demo',
 p_pattern => 'test/:id');
```

```
ords.define_handler(
 p_module_name => 'demo',
 p_pattern => 'test/:id',
 p_method  => 'GET',
 p_source_type => ords.source_type_media,
 p_source => '

   SELECT ''application/json'', json_object(''PONumber'' VALUE po.PONo,
          ''Requestor'' VALUE po.Requestor,
          ''CostCenter'' VALUE po.CostCenter,
          ''Address'' VALUE
              json_object(''street'' VALUE po.AddressStreet,
                          ''city'' VALUE po.AddressCity,
                          ''state'' VALUE po.AddressState,
                          ''zipCode'' VALUE po.AddressZip,
                          ''country'' VALUE po.AddressCountry),
          ''LineItems'' VALUE (select json_arrayagg(
              json_object(''ItemNumber'' VALUE li.ItemNumber,
                     ''Part'' VALUE
                       json_object(''Description'' VALUE
li.PartDescription,
                                   ''UnitPrice'' VALUE
li.PartUnitPrice,
                                   ''UPCCode'' VALUE li.PartUPCCODE),
                      ''Quantity'' VALUE li.Quantity))
                      FROM LineItem li WHERE po.PONo = li.PONo))
               FROM PurchaseOrder po
                 WHERE po.PONo = :id '
   );

Commit;
End;
```

2.4.2.3 Testing the RESTful Services

This section shows how to test the **POST** and **GET** RESTful Services to access the Oracle database and get the results in a JSON format.

This section includes the following topics:

- Insertion of JSON Object into the Database
- Generating JSON Object from the Database

2.4.2.3.1 Insertion of JSON Object into the Database

This section shows how to test insertion of JSON purchase order into the database.

URI Pattern: `http://<HOST>:<PORT>/ords/<SchemaAlias>/<module>/<template>`

Example:

Method: POST

URI Pattern: `http://localhost:8080/ords/ordstest/demo/test/`

To test the RESTful service, create a file such as `po1.json` with the following data for PONumber 1608 :

```
{"PONumber"        : 1608,
 "Requestor"       : "Alexis Bull",
 "CostCenter"      : "A50",
 "Address"         : {"street"  : "200 Sporting Green",
                                  "city"    : "South San Francisco",
                                  "state"   : "CA",
                                  "zipCode" : 99236,
                                  "country" : "United States of America"},
      "LineItems"  : [ {"ItemNumber" : 1,
                          "Part"     : {"Description" : "One Magic
Christmas",
                                        "UnitPrice"   : 19.95,
                                        "UPCCode"     : 13131092899},
                                        "Quantity"   : 9.0},
                                        {"ItemNumber" : 2,
                                          "Part"       : {"Description" :
"Lethal Weapon",
                                                          "UnitPrice"   :
19.95,
                                                          "UPCCode"     :
85391628927},
                                          "Quantity"   : 5.0}]}'
```

Then, execute the following cURL command in the command prompt:

```
curl -i -H "Content-Type: application/json" -X POST -d @po1.json "http://
localhost:8080/ords/ordstest/demo/test/"
```

The cURL command returns the following response:

```
HTTP/1.1 200 OK
Transfer-Encoding: chunked
```

2.4.2.3.2 Generating JSON Object from the Database

This section shows the results of a GET method to fetch the JSON object from the database..

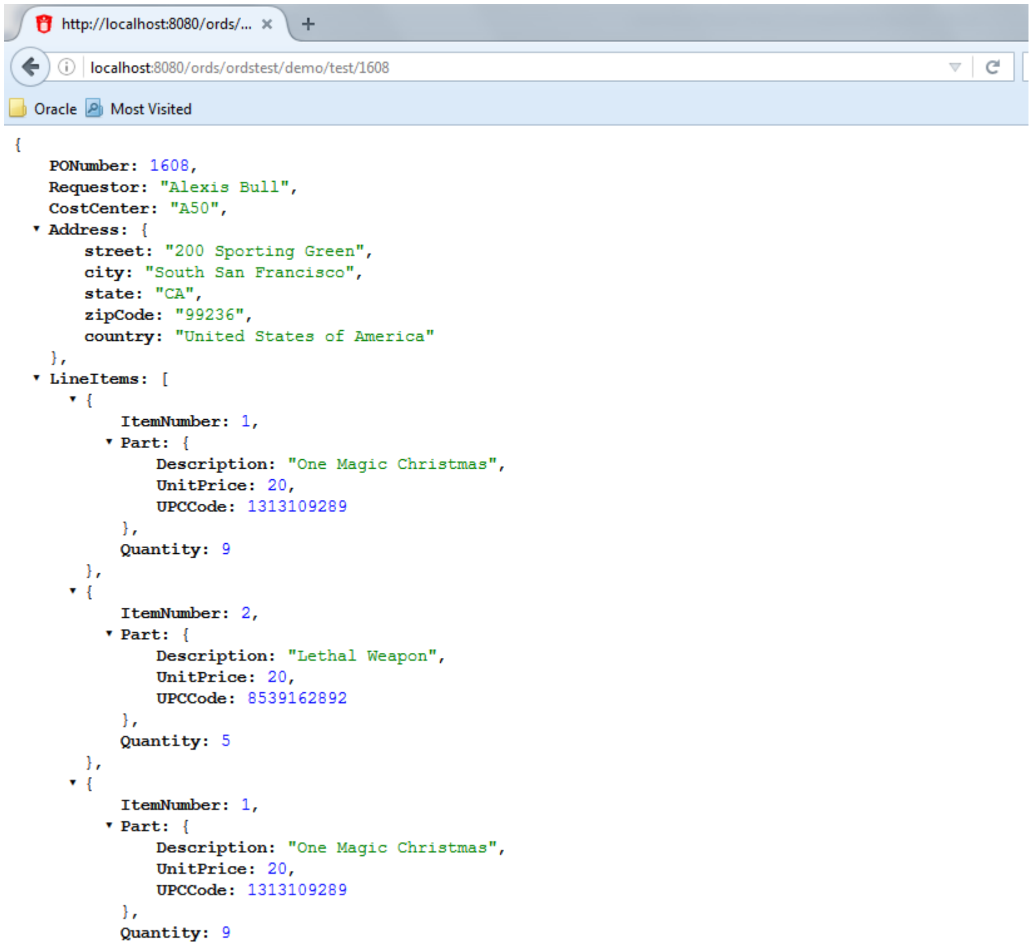
Method: `GET`

URI Pattern: `http://<HOST>:<PORT>/ords/<SchemaAlias>/<module>/<template>/<parameters>`

Example:

To test the RESTful service, in a web browser, enter the URL http://localhost:8080 /ords/ordstest/demo/test/1608 as shown in the following figure:

Figure 2-14   Generating Nested JSON Objects



2.5 About Working with Dates Using Oracle REST Data Services

Oracle REST Data Services enables developers to create REST interfaces to Oracle Database, Oracle Database 12c JSON Document Store as quickly and easily as possible. When working with Oracle Database, developers can use the AutoREST feature for tables or write custom modules using SQL and PL/SQL routines for more complex operations.

Oracle REST Data Services uses the RFC3339 standard for encoding dates in strings. Typically, the date format used is dd-mmm-yyyy, for example, 15-Jan-2017. Oracle REST Data Services automatically converts JSON strings in the specified format to Oracle date data types when performing operations such as inserting or updating values in Oracle Database. When converting back to JSON strings, Oracle REST Data Services automatically converts Oracle date data types to the string format.

Note:

Oracle Database supports a date data type while JSON does not support a date data type.

This section includes the following topics:

- About Datetime Handling with Oracle REST Data Services
- About Setting the Time Zone

2.5.1 About Datetime Handling with Oracle REST Data Services

As data arrives from a REST request, Oracle REST Data Services may parse ISO 8601 strings and convert them to the `TIMESTAMP` data type in Oracle Database. This occurs with AutoREST (`POST` and `PUT`) as well as with bind variables in custom modules. Remember that `TIMESTAMP` does not support time zone related components, so the `DATETIME` value is set to the time zone Oracle REST Data Services uses during the conversion process.

When constructing responses to REST requests, Oracle REST Data Services converts `DATETIME` values in Oracle Database to ISO 8601 strings in Zulu. This occurs with AutoREST (`GET`) and in custom modules that are mapped to SQL queries (GET). In the case of `DATE` and `TIMESTAMP` data types, which do not have time zone related components, the time zone is assumed to be that in which Oracle REST Data Services is running and the conversion to Zulu is made from there.

Here are some general recommendations when working with Oracle REST Data Services for REST (that is, not APEX):

- Ensure that Oracle REST Data Services uses the appropriate time zone as per the data in the database (for example, the time zone you want dates going into the database).
- Do not alter NLS settings (that is, the time_zone) mid-stream.

Note that while ISO 8601 strings are mentioned, Oracle REST Data Services actually supports strings. RFC3339 strings are a conformant subset of ISO 8601 strings. The default format returned by `JSON.stringify(date)` is supported.

WARNING:

It is important to keep the time zone that Oracle REST Data Services uses in sync with the session time zone to prevent issues with implicit data conversion to `TIMESTAMP WITH TIME ZONE` or `TIMESTAMP WITH LOCAL TIME ZONE`. Oracle REST Data Services does this automatically by default but developers can change the session time zone with an `ALTER SESSION` statement.

See Aslo:

Internet Date/Time Format

2.5.2 About Setting the Time Zone

When Oracle REST Data Services is started, the JVM it runs in obtains and caches the time zone Oracle REST Data Services uses for various time zone conversions. By default, the time zone is set to UTC when running ORDS in standalone. This can be overridden by setting the environment variable `JVM_TIMEZONE` before running the `ords serve` command. Of course, the instructions for changing the time zone vary by the operating system.

If for any reason you do not want to use the same time zone as the OS, it is possible to override the default using the Java environment variable `Duser.timezone`. Exactly how that variable is set depends on whether you are running in standalone mode or in a Java application server. The following topics show some examples.

Standalone Mode

When running Oracle REST Data Services in standalone mode, it is possible to set Java environment variables by specifying them as command line options before the `-jar` option.

Example 2-9 Setting the Duser.timezone Java Environment Variable in Standalone Mode

The following code example shows how to set the timezone in standalone mode on the command line.

```
$ java -Duser.timezone=America/New_York -jar ords.war standalone
```

Java Application Server — Tomcat 8

In a Java application server, Tomcat 8, and possibly earlier and later versions too, it is possible to set the time zone using the environment variable `CATALINA_OPTS`. The recommended way to do this is not to modify the `CATALINA_BASE/bin/catalina.sh` directly, but instead to set environment variables by creating a script named `setenv.sh` in `CATALINA_BASE/bin`.

Example 2-10 Setting the Duser.timezone Java Environment Variable in a Java Application Server

The following code example shows the contents of the `setenv.sh` script for setting the timezone in a Java Application server — Tomcat 8.

```
CATALINA_TIMEZONE="-Duser.timezone=America/New_York"
CATALINA_OPTS="$CATALINA_OPTS $CATALINA_TIMEZONE
```

2.5.3 Exploring the Sample RESTful Services in APEX (Tutorial)

Oracle highly recommends to develop Oracle REST Data Services application using SQL Developer Web because it supports the most recent Oracle REST Data Services releases, that is, 3.0.X. APEX provides a tutorial that is useful for learning some basic concepts of REST and Oracle REST Data Services. However, the tutorial uses the earlier Oracle REST Data Services releases, that is, 2.0.X. Following are some of the useful tips discussed on how to use the tutorial:

If your APEX instance is configured to automatically add the sample application and sample database objects to workspaces, then a sample resource module named: `oracle.example.hr` will be visible in the list of Resource Modules. If that resource module is not listed, then you can click the **Reset Sample Data** task on the right side of the RESTful Services Page to create the sample resource module.

1. Click on `oracle.example.hr` to view the Resource Templates and Resource Handlers defined within the module. Note how the module has a URI prefix with the value: `hr/`. This means that all URIs serviced by this module starts with the characters `hr/`.
2. Click on the resource template named `employees/{id}`. Note how the template has a URI Template with the value: `employees/{id}`. This means that all URIs starting with `hr/employees/` are serviced by this Resource Template.

   The HTTP methods supported by a resource template are listed under the resource template. In this case, the only supported method is the `GET` method.
3. Click on the `GET` Resource Handler for `hr/employees/{id}` to view its configuration.

   The **Source Type** for this handler is `Query One Row`. This means that the resource is expected to be mapped to a single row in the query result set. The Source for this handler is:

   ```
   select * from emp
            where empno = :id
   ```

   Assuming that the `empno` column is unique, the query should only produce a single result (or no result at all if no match is found for `:id`). To try it out, press the **Test** button. The following error message should be displayed:

   400 - Bad Request - Request path contains unbound parameters: id

   If you look at the URI displayed in the browser, it will look something like this:

   ```
   https://server:port/ords/workspace/hr/employees/{id}
   ```

   where:

   - `server` is the DNS name of the server where Oracle APEX is deployed
   - `port` is the port the server is listening on
   - `workspace` is the name of the Oracle APEX workspace you are logged into

   Note the final part of the URI: `hr/employees/{id}`. The error message says that this is not a valid URI, the problem is that you did not substitute in a concrete value for the parameter named `{id}`. To fix that, press the browser **Back** button, then click **Set Bind Variables**.
4. For the bind variable named `:id`, enter the value `7369`, and press **Test**.

   A new browser window appears displaying the following JSON (JavaScript Object Notation):

   ```
   {
    "empno":7369,
    "ename":"SMITH",
    "job":"CLERK",
    "mgr":7902,
    "hiredate":"1980-12-17T08:00:00Z",
    "sal":800,
    "deptno":20
   }
   ```

Note also the URI displayed in the browser for this resource:

```
https://server:port/ords/workspace/hr/employees/7369
```

The `{id}` URI Template parameter is bound to the SQL `:id` bind variable, and in this case it has been given the concrete value of `7369`, so the query executed by the RESTful Service becomes:

```
select * from emp
          where empno = 7369
```

The results of this query are then rendered as JSON as shown above.

> **Tip:**
>
> Reading JSON can be difficult. To make it easier to read, install a browser extension that *pretty prints* the JSON. For example, Mozilla Firefox and Google Chrome both have extensions:
>
> - JSONView
> - JSON Formatter

Now see what happens when you enter the URI of a resource that does not exist.

5. On the Set Bind Variables page, change the value of `:id` from `7369` to `1111`, and press **Test**.

   As before, a new window pops up, but instead of displaying a JSON resource, it displays an error message reading:

   ```
   404 - Not Found
   ```

   This is the expected behavior of this handler: when a value is bound to `:id` that does not exist in the `emp` table, the query produces no results and consequently the standard HTTP Status Code of `404 - Not Found` is returned.

   So, you have a service that will provide information about individual employees, if you know the ID of an employee, but how do you discover the set of valid employee ids?

6. Press **Cancel** to return to the previous page displaying the contents of the Resource Module.

7. Click on the template named `employees/`.

   The following steps look at the resource it generates, and later text will help you understand its logic.

8. Click on the GET handler beneath `employees/`, and click **Test**.

   A resource similar to the following is displayed (If you haven't already done so, now would be a good time to install a JSON viewer extension in your browser to make it easier to view the output):

   ```
   {
    "next":
     {"$ref":
       "https://server:port/ords/workspace/hr/employees/?page=1"},
    "items": [
   ```

```
  {
   "uri":
    {"$ref":
      "https://server:port/ords/workspace/hr/employees/7369"},
   "empno": 7369,
   "ename": "SMITH"
  },
  {
   "uri":
    {"$ref":
      "https://server:port/ords/workspace/hr/employees/7499"},
   "empno": 7499,
   "ename": "ALLEN"
  },
  ...
  {
   "uri":
    {"$ref":
      "https://server:port/ords/workspace/hr/employees/7782"},
   "empno": 7782,
   "ename": "CLARK"
  }
 ]
}
```

This JSON document contains a number of things worth noting:

- The first element in the document is named `next` and is a URI pointing to the next page of results. (An explanation of how paginated results are supported appears in later steps)
- The second element is named `items` and contains a number of child elements. Each child element corresponds to a row in the result set generated by the query.
- The first element of each child element is named `uri` and contains a URI pointing to the service that provides details of each employee. Note how the latter part of the URI matches the URI Template: `employees/{id}`. In other words, if a client accesses any of these URIs, the request will be serviced by the `employees/{id}` RESTful service previously discussed.

So, this service addresses the problem of identifying valid employee IDs by generating a resource that lists all valid employee resources. The key thing to realize here is that it does not do this by just listing the ID value by itself and expecting the client to be able to take the ID and combine it with prior knowledge of the `employees/{id}` service to produce an employee URI; instead, it lists the URIs of each employee.

Because the list of valid employees may be large, the service also breaks the list into smaller pages, and again uses a URI to tell the client where to find the next page in the results.

To see at how this service is implemented, continue with the next steps.

9. Press the **Back** button in your browser to return to the `GET` handler definition.

   Note the Source Type is `Query`, this is the default Source Type, and indicates that the resource can contain zero or more results. The Pagination Size is `7`, which means that there will be seven items on each page of the results. Finally, the Source for the handler looks like this:

```
select empno "$uri", empno, ename from (
 select emp.*,
        row_number() over (order by empno) rn
```

```
       from emp
) tmp
where
 rn between :row_offset and :row_count
```

In this query:

- The first line states that you want to return three columns. The first column is the employee id: `empno`, but aliased to a column name of `$uri` (to be explained later), the second column is again the employee ID, and the third column is the employee name, `ename`.
- Columns in result sets whose first character is `$` (dollar sign) are given special treatment. They are assumed to denote columns that must be transformed into URIs, and these are called Hyperlink Columns. Thus, naming columns with a leading `$` is a way to generate hyperlinks in resources.

  When a Hyperlink Column is encountered, its value is prepended with the URI of the resource in which the column is being rendered, to produce a new URI. For example, recall that the URI of this service is `https://server:port/ords/workspace/hr/employees/`. If the value of `empno` in the first row produced by the this service's query is `7369`, then the value of `$uri` becomes: `https://server:port/ords/workspace/hr/employees/7369`.
- JSON does not have a URI data type, so a convention is needed to make it clear to clients that a particular value represents a URI. Oracle REST Data Services uses the JSON Reference proposal, which states that any JSON object containing a member named `$ref`, and whose value is a string, is a URI. Thus, the column: `$uri` and its value: `https://server:port/ords/workspace/hr/employees/7369` is transformed to the following JSON object:

  ```
  {"uri":
       {"$ref":
        "https://server:port/ords/workspace/hr/employees/7369"
       }
      }
  ```
- The inner query uses the `row_number()` analytical function to count the number of rows in the result set, and the outer WHERE clause constrains the result set to only return rows falling within the desired page of results. Oracle REST Data Services defines two implicit bind parameters, `:row_offset` and `:row_count`, that always contain the indicies of the first and last rows that should be returned in a given page's results.

  For example, if the current page is the first page and the pagination size is `7`, then the value of `:row_offset` will be `1` and the value of `:row_count` will be `7`.

To see a simpler way to do both hyperlinks and paged results, continue with the following steps.

10. Click on the `GET` handler of the `employeesfeed/` resource template.

    Note that the Source Type of this handler is `Feed` and Pagination Size is `25`.
11. Change the pagination size to `7`, and click **Apply Changes**.

    The Source of the handler is just the following:

```
select empno, ename from emp
                    order by deptno, ename
```

As you can see, the query is much simpler than the previous example; however, if you click **Test**, you will see a result that is very similar to the result produced by the previous example.

- The `Feed` Source Type is an enhanced version of the `Query` Source Type that automatically assumes the first column in a result set should be turned into a hyperlink, eliminating the need to alias columns with a name starting with `$`. In this example, the `empno` column is automatically transformed into a hyperlink by the `Feed` Source Type.
- This example demonstrates the ability of Oracle REST Data Services to automatically paginate result sets if a Pagination Size of greater than zero is defined, and the query does *not* explicitly dereference the `:row_offset` or `:row_count` bind parameters. Because both these conditions hold true for this example, Oracle REST Data Services enhances the query, wrapping it in clauses to count and constrain the number and offset of rows returned. Note that this ability to automatically paginate results also applies to the `Query` Source Type.

> **See Also:**
>
> JSON Reference

2.6 Creating RESTful Web Services Using Database Actions

You can create RESTful web services using the Modules, Templates and Handlers pages available in Database Actions.

> **See Also:**
>
> Creating RESTful Web Services

2.7 Configuring Secure Access to RESTful Services

This section describes how to configure secure access to RESTful Services

RESTful APIs consist of resources, each resource having a unique URI. A set of resources can be protected by a privilege. A privilege defines the set of roles, at least one of which an authenticated user must possess to access a resource protected by a privilege or can be provided as a scope in a valid JWT bearer token.

Configuring a resource to be protected by a particular privilege requires creating a privilege mapping. A privilege mapping defines a set of patterns that identifies the resources that a privilege protects.

Topics:

- Authentication
- About Privileges for Accessing Resources
- About Users and Roles for Accessing Resources
- About the File-Based User Repository

- Tutorial: Protecting and Accessing Resources

2.7.1 Authentication

Users can be authenticated through first party cookie-based authentication or third party OAuth 2.0-based authentication

Topics:

- First Party Cookie-Based Authentication
- Third Party OAuth 2.0-Based Authentication

2.7.1.1 First Party Cookie-Based Authentication

A first party is the author of a RESTful API. A first party application is a web application deployed on the same web origin as the RESTful API. A first party application is able to authenticate and authorize itself to the RESTful API using the same cookie session that the web application is using. The first party application has full access to the RESTful API.

2.7.1.2 Third Party OAuth 2.0-Based Authentication

A third party is any party other than the author of a RESTful API. A third party application cannot be trusted in the same way as a first party application; therefore, there must be a mediated means to selectively grant the third party application limited access to the RESTful API.

The OAuth 2.0 protocol defines flows to provide conditional and limited access to a RESTful API. In short, the third party application must first be registered with the first party, and then the first party (or an end user of the first party RESTful service) approves the third party application for limited access to the RESTful API, by issuing the third party application a short-lived access token.

> **See Also:**
>
> The OAuth 2.0 Authorization Framework

2.7.1.2.1 Two-Legged and Three-Legged OAuth Flows

Some flows in OAuth are defined as two-legged and others as three-legged.

Two-legged OAuth flows involve two parties: the party calling the RESTful API (the third party application), and the party providing the RESTful API. Two-legged flows are used in server to server interactions where an end user does not need to approve access to the RESTful API. In OAuth 2.0 this flow is called the client credentials flow. It is most typically used in business to business scenarios.

Three-legged OAuth flows involve three parties: the party calling the RESTful API, the party providing the RESTful API, and an end user party that owns or manages the data to which the RESTful API provides access. Three-legged flows are used in client to server interactions where an end user must approve access to the RESTful API. In OAuth 2.0, the authorization code flow and the implicit flow are three-legged flows. These flows are typically used in business to consumer scenarios.

For resources protected by three-legged flows, when an OAuth client is registering with a RESTful API, it can safely indicate the protected resources that it requires access to, and the end user has the final approval decision about whether to grant the client access. However, for resources protected by two-legged flows, the owner of the RESTful API must approve of which resources each client is authorized to access.

Additionally, ORDS supports integration with Identity Providers that can issue JWT access tokens to the party calling the RESTful API for the purposes of accessing the RESTful API. A JWT Profile can be created for a REST-Enabled Schema to define how to validate JWT bearer tokens.

2.7.2 About Privileges for Accessing Resources

A privilege for accessing resources consists of the following data:

- Name: The unique identifier for the Privilege. This value is required.
- Label: The name of the privilege presented to an end user when the user is being asked to approve access to a privilege when using OAuth. This value is required if the privilege is used with a three-legged OAuth flow.
- Description: A description of the purpose of the privilege. It is also presented to the end user when the user is being asked to approve access to a privilege. This value is required if the privilege is used with a three-legged OAuth flow.
- Roles: A set of role names associated with the privilege. An authenticated party must have at least one of the specified roles in order to be authorised to access resources protected by the privilege. A value is required, although it may be an empty set, which indicates that a user must be authenticated but that no specific role is required to access the privilege.

For two-legged OAuth flows, the third party application (called a *client* in OAuth terminology) must possess at least one of the required roles.

For three-legged OAuth flows, the end user that approves the access request from the third party application must possess at least one of the required roles.

Related Topics

- Two-Legged and Three-Legged OAuth Flows

2.7.3 About Users and Roles for Accessing Resources

A privilege enumerates a set of roles, and users can possess roles. Oracle REST Data Services delegates the task of user management to the application server on which Oracle REST Data Services is deployed.

Oracle REST Data Services is able to authenticate users defined and managed by the application server and to identify the roles and groups to which the authenticated user belongs. The user responsible for deploying Oracle REST Data Services on an application server must also configure the user repository on the application server.

Because an application server can be configured in many ways to define a user repository or integrate with an existing user repository, this document cannot describe how to configure a user repository in an application server. See the application server documentation for detailed information.

2.7.4 About the File-Based User Repository

Oracle REST Data Services provides a a simple file-based user repository mechanism. However, this user repository is only intended for the purposes of demonstration and testing, and is not supported for production use.

See the command-line help for the user command for more information on how to create a user in this repository:

```
ords config user --help
```

Format:

```
ords config user add <name> <roles>
```

Example:

```
ords config user add ords_dev "SQL Developer"
```

Arguments:

- `<user>` is the user ID of the user.
- `<roles>` is the list of roles that the user has. Use a comma to separate multiple roles in the list.

Related Topics

- Tutorial: Protecting and Accessing Resources

2.7.5 Tutorial: Protecting and Accessing Resources

This tutorial demonstrates creating a privilege to protect a set of resources, and accessing the protected resource with the following OAuth features:

- Client credentials
- Authorization code
- Implicit flow

It also demonstrates access the resource using first-party cookie-based authentication.

Topics:

- OAuth Flows and When to Use Each
- Assumptions for This Tutorial
- Steps for This Tutorial

2.7.5.1 OAuth Flows and When to Use Each

This topic explains when to use various OAuth flow features.

Use *first party cookie-based authentication* when accessing a RESTful API from a web application hosted on the same origin as the RESTful API.

Use the *authorization code* flow when you need to permit third party web applications to access a RESTful API and the third party application has its own web server where it can keep its client credentials secure. This is the typical situation for most web applications, and it provides the most security and best user experience, because the third party application can use refresh tokens to extend the life of a user session without having to prompt the user to reauthorize the application.

Use the *implicit flow* when the third party application does not have a web server where it can keep its credentials secure. This flow is useful for third party single-page-based applications. Because refresh tokens cannot be issued in the Implicit flow, the user will be prompted more frequently to authorize the application.

Native mobile or desktop applications should use the authorization code or implicit flows. They will need to display the sign in and authorization prompts in a web browser view, and capture the access token from the web browser view at the end of the authorization process.

Use the *client credentials* flow when you need to give a third party application direct access to a RESTful API without requiring a user to approve access to the data managed by the RESTful API. The third party application must be a server-based application that can keep its credentials secret. The client credentials flow *must not* be used with a native application, because the client credentials can *always* be discovered in the native executable.

2.7.5.2 Assumptions for This Tutorial

This tutorial assumes the following:

- Oracle REST Data Services is deployed at the following URL: `https://example.com/ords/`
- A database schema named ORDSTEST has been enabled for use with Oracle REST Data Services, and its RESTful APIs are exposed under: `https://example.com/ords/ordstest/`
- The ORDSTEST schema contains a database table named EMP, which was created as follows:

```
create table emp (
  empno    number(4,0),
  ename    varchar2(10 byte),
  job      varchar2(9 byte),
  mgr      number(4,0),
  hiredate date,
  sal      number(7,2),
  comm     number(7,2),
  deptno   number(2,0),
  constraint pk_emp primary key (empno)
  );
```

- The resources to be protected are located under: `https://example.com/ords/ordstest/examples/employees/`

2.7.5.3 Steps for This Tutorial

Follow these steps to protect and access a set of resources.

1. **Enable the schema**. Connect to the ORDSTEST schema and execute the following PL/SQL statements;

```
begin
  ords.enable_schema;
  commit;
end;
```

2. **Create a resource.** Connect to the ORDSTEST schema and execute the following PL/SQL statements:

```
begin
ords.create_service(
      p_module_name => 'examples.employees' ,
      p_base_path  => '/examples/employees/',
      p_pattern =>  '.' ,
      p_items_per_page => 7,
      p_source  =>  'select * from emp order by empno desc');
commit;
end;
```

The preceding code creates the `/examples/employees/` resource, which you will protect with a privilege in a later step.

You can verify the resource by executing following cURL command:

```
curl -i https://example.com/ords/ordstest/examples/employees/
```

The result should be similar to the following (edited for readability):

```
Content-Type: application/json
Transfer-Encoding: chunked

{
 "items":
   [

{"empno":7934,"ename":"MILLER","job":"CLERK","mgr":7782,"hiredate":"1982-01-2
3T00:00:00Z","sal":1300,"comm":null,"deptno":10},
    ...
   ],
 "hasMore":true,
 "limit":7,
 "offset":0,
 "count":7,
 "links":
   [
    {"rel":"self","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"describedby","href":"https://example.com/ords/ordstest/metadata-
catalog/examples/employees/"},
    {"rel":"first","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"next","href":"https://example.com/ords/ordstest/examples/
employees/?offset=7"}
   ]
}
```

3. **Create a privilege.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
  ords.create_role('HR Administrator');

  ords.create_privilege(
      p_name => 'example.employees',
      p_role_name => 'HR Administrator',
      p_label => 'Employee Data',
      p_description => 'Provide access to employee HR data');
```

```
  commit;
end;
```

The preceding code creates a role and a privilege, which belong to the ORDSTEST schema.

- The role name must be unique and must contain printable characters only.
- The privilege name must be unique and must conform to the syntax specified by the OAuth 2.0 specification, section 3.3 for scope names.
- Because you will want to use this privilege with the three-legged authorization code and implicit flows, you must provide a label and a description for the privilege. The label and description are presented to the end user during the approval phase of three-legged flows.
- The values should be plain text identifying the name and purpose of the privilege.

You can verify that the privilege was created correctly by querying the USER_ORDS_PRIVILEGES view.

```
select id,name from user_ords_privileges where name = 'example.employees';
```

The result should be similar to the following:

```
ID
NAME



----- -----------------
10260 example.employees
```

The ID value will vary from database to database, but the NAME value should be as shown.

4. **Associate the privilege with resources.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
 ords.create_privilege_mapping(
      p_privilege_name => 'example.employees',
      p_pattern => '/examples/employees/*');
  commit;
end;
```

The preceding code associates the `example.employees` privilege with the resource pattern `/examples/employees/`.

You can verify that the privilege was created correctly by querying the USER_ORDS_PRIVILEGE_MAPPINGS view.

```
select privilege_id, name, pattern from user_ords_privilege_mappings;
```

The result should be similar to the following:

```
PRIVILEGE_ID NAME                 PATTERN
------------ -------------------- ---------------------
10260        example.employees    /examples/employees/*
```

The PRIVILEGE_ID value will vary from database to database, but the NAME and PATTERN values should be as shown.

You can confirm that the `/examples/employees/` resource is now protected by the `example.employees` privilege by executing the following cURL command:

```
curl -i https://example.com/ords/ordstest/examples/employees/
```

The result should be similar to the following (reformatted for readability):

```
HTTP/1.1 401 Unauthorized
Content-Type: text/html
Transfer-Encoding: chunked

<!DOCTYPE html>
<html>
...
</html>
```

You can confirm that the protected resource can be accessed through first party authentication, as follows.

a. **Create an end user.** Create a test user with the HR Administrator role, required to access the `examples.employees` privilege using the file-based user repository. Execute the following command at a command prompt

   ```
   ords config user add hr_admin "HR Administrator"
   ```

   When prompted for the password, enter and confirm it.

b. **Sign in as the end user.** Enter the following URL in a web browser:

   ```
   https://example.com/ords/ordstest/examples/employees/
   ```

   On the page indicating that access is denied, click the link to sign in.

   Enter the credentials registered for the HR_ADMIN user, and click Sign In.

   Confirm that the page redirects to `https://example.com/ords/ordstest/examples/employees/` and that the JSON document is displayed.

5. **Register the OAuth client.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
 oauth.create_client(
      p_name => 'Client Credentials Example',
      p_grant_type => 'client_credentials',
      p_privilege_names => 'example.employees',
      p_support_email => 'support@example.com');
 commit;
end;
```

The preceding code registers a client named `Client Credentials Example`, to access the `examples.employees` privilege using the client credentials OAuth flow.

You can verify that the client was registered and has requested access to the `examples.employees` privilege by executing the following SQL statement:

```
select client_id,client_secret from user_ords_clients where name = 'Client
Credentials Example';
```

The result should be similar to the following:

```
CLIENT_ID                        CLIENT_SECRET
-------------------------------- ------------------------
o_CZBVkEMN23tTB-IddQsQ..         4BJXceufbmTki-vruYNLIg..
```

The CLIENT_ID and CLIENT_SECRET values represent the secret credentials for the OAuth client. These values must be noted and kept secure. You can think of them as the userid and password for the client application.

6. **Grant the OAuth client a required role.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
 oauth.grant_client_role(
     'Client Credentials Example',
     'HR Administrator');
 commit;
end;
```

The preceding code registers a client named `Client Credentials Example`, to access the `examples.employees` privilege using the client credentials OAuth flow.

You can verify that the client was granted the role by executing the following SQL statement:

```
select * from user_ords_client_roles where client_name = 'Client Credentials
Example';
```

The result should be similar to the following:

```
 CLIENT_ID CLIENT_NAME                 ROLE_ID   ROLE_NAME
---------- --------------------------- --------  ----------------------
     10286 Client Credentials Example    10222   HR Administrator
```

7. **Obtain an OAuth access token using client credentials.**

The OAuth protocol specifies the HTTP request that must be used to create an access token using the client credentials flow[rfc6749-4.4.].

The request must be made to a well known URL, called the token endpoint. For Oracle REST Data Services the path of the token endpoint is always oauth/token, relative to the root path of the schema being accessed. The token endpoint for this example is:

```
https://example.com/ords/ordstest/oauth/token
```

Execute the following cURL command:

```
curl -i --user clientId:clientSecret --data "grant_type=client_credentials"
https://example.com/ords/ordstest/oauth/token
```

In the preceding command, replace `clientId` with the CLIENT_ID value in USER_ORDS_CLIENTS for `Client Credentials Example`, and replace `clientSecret` with the CLIENT_SECRET value shown in USER_ORDS_CLIENTS for `Client Credentials Example`. The output should be similar to the following:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
 "access_token": "2YotnFZFEjr1zCsicMWpAA",
 "token_type":   "bearer",
 "expires_in":3600
}
```

In the preceding output, the access token is of type `bearer`, and the value is specified by the `access_token` field. This value will be different for every request. The `expires_in` value indicates the number of seconds until the access token expires; in this case the token will expire in one hour (3600 seconds).

8. **Access a protected resource using the access token.** Execute the following cURL command:

```
curl -i -H"Authorization: Bearer accessToken" https://example.com/ords/
ordstest/examples/employees/
```

In the preceding command, replace `accessToken` with the value of the `access_token` field shown in the preceding step. The output should be similar to the following:

```
Content-Type: application/json
Transfer-Encoding: chunked

{
 "items":
   [

{"empno":7934,"ename":"MILLER","job":"CLERK","mgr":7782,"hiredate":"1982-01-2
3T00:00:00Z","sal":1300,"comm":null,"deptno":10},
    ...
   ],
 "hasMore":true,
 "limit":7,
 "offset":0,
 "count":7,
 "links":
   [
    {"rel":"self","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"describedby","href":"https://example.com/ords/ordstest/metadata-
catalog/examples/employees/"},
    {"rel":"first","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"next","href":"https://example.com/ords/ordstest/examples/
employees/?offset=7"}
   ]
}
```

9. **Register the client for authorization code.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
 oauth.create_client(
    p_name => 'Authorization Code Example',
    p_grant_type => 'authorization_code',
    p_owner => 'Example Inc.',
    p_description => 'Sample for demonstrating Authorization Code Flow',
    p_redirect_uri => 'http://example.org/auth/code/example/',
    p_support_email => 'support@example.org',
    p_support_uri => 'http://example.org/support',
    p_privilege_names => 'example.employees'
    );
 commit;
end;
```

The preceding code registers a client named `Authorization Code Example`, to access the `examples.employees` privilege using the authorization code OAuth flow. For an actual application, a URI must be provided to redirect back to with the authorization code, and a valid support email address must be supplied; however, this example uses fictitious data and the sample `example.org` web service.

You can verify that the client is now registered and has requested access to the `examples.employees` privilege by executing the following SQL statement:

```
select id, client_id, client_secret from user_ords_clients where name =
'Authorization Code Example';
```

The result should be similar to the following:

```
        ID CLIENT_ID                        CLIENT_SECRET
---------- -------------------------------- --------------------------------
     10060 IGHso4BRgrBC3Jwg0Vx_YQ.. GefAsWv8FJdMSB30Eg6lKw..
```

To grant access to the privilege, an end user must approve access. The CLIENT_ID and CLIENT_SECRET values represent the secret credentials for the OAuth client. These values must be noted and kept secure. You can think of them as the userid and password for the client application.

10. **Obtain an OAuth access token using an authorization code.** This major step involves several substeps. (You must have already created the HR_ADMIN end user in a previous step.)

    a. **Obtain an OAuth authorization code.**

       The end user must be prompted (via a web page) to sign in and approve access to the third party application. The third party application initiates this process by directing the user to the OAuth Authorization Endpoint. For Oracle REST Data Services, the path of the authorization endpoint is always `oauth/auth`, relative to the root path of the schema being accessed. The token endpoint for this example is:

       ```
       https://example.com/ords/ordstest/oauth/auth
       ```

       The OAuth 2.0 protocol specifies that the Authorization request URI must include certain parameters in the query string:

       The `response_type` parameter must have a value of `code`.

       The `client_id` parameter must contain the value of the applications client identifier. This is the `client_id` value determined in a previous step.

       The `state` parameter must contain a unique unguessable value. This value serves two purposes: it provides a way for the client application to uniquely identify each authorization request (and therefore associate any application specific state with the value; think of the value as the application's own session identifier); and it provides a means for the client application to protect against Cross Site Request Forgery (CSRF) attacks. The `state` value will be returned in the redirect URI at the end of the authorization process. The client must confirm that the value belongs to an authorization request initiated by the application. If the client cannot validate the state value, then it should assume that the authorization request was initiated by an attacker and ignore the redirect.

       To initiate the Authorization request enter the following URL in a web browser:

       ```
       https://example.com/ords/ordstest/oauth/auth?
       response_type=code&client_id=cliendId&state=uniqueRandomValue
       ```

In the preceding URI, replace `clientId` with the value of the CLIENT_ID column that was noted previously, and replace `uniqueRandromValue` with a unique unguessable value. The client application must remember this value and verify it against the `state` parameter returned as part of the redirect at the end of the authorization flow.

If the `client_id` is recognized, then a sign in prompt is displayed. Enter the credentials of the HR_ADMIN end user, and click Sign In; and on the next page click Approve to cause a redirect to redirect URI specified when the client was registered. The redirect URI will include the authorization code in the query string portion of the URI. It will also include the same `state` parameter value that the client provided at the start of the flow. The redirect URI will look like the following:

```
http://example.org/auth/code/example/?
code=D5doeTSIDgbxWiWkPl9UpA..&state=uniqueRandomValue
```

The client application must verify the value of the `state` parameter and then note the value of the `code` parameter, which will be used in to obtain an access token.

b. **Obtain an OAuth access token.**

After the third party application has an authorization code, it must exchange it for an access token. The third party application's server must make a HTTPS request to the Token Endpoint. You can mimic the server making this request by using a cURL command as in the following example:

```
curl --user clientId:clientSecret --data
"grant_type=authorization_code&code=authorizationCode" https://
example.com/ords/ordstest/oauth/token
```

In the preceding command, replace `clientId` with the value of the CLIENT_ID shown in USER_ORDS_CLIENTS for `Authorization Code Example`, replace `clientSecret` with the value of the CLIENT_SECRET shown in USER_ORDS_CLIENTS for `Authorization Code Example`, and replace `authorizationCode` with the value of the authorization code noted in a previous step (the value of the `code` parameter).

The result should be similar to the following:

```
HTTP/1.1 200 OK
Content-Type: application/json

{
 "access_token": "psIGSSEXSBQyib0hozNEdw..",
 "token_type":   "bearer",
 "expires_in":3600,
 "refresh_token": "aRMg7AdWPuDvnieHucfV3g.."
}
```

In the preceding result, the access token is specified by the `access_token` field, and a refresh token is specified by the `refresh_token` field. This refresh token value can be used to extend the user session without requiring the user to reauthorize the third party application.

c. **Access a protected resource using the access token.**

After the third party application has obtained an OAuth access token, it can use that access token to access the protected `/examples/employees/` resource:

```
curl -i -H"Authorization: Bearer accessToken" https://example.com/ords/
ordstest/examples/employees/
```

In the preceding command, `accessToken` with the value of the `access_token` field shown in a previous step.

The result should be similar to the following:

```
Content-Type: application/json
Transfer-Encoding: chunked

{
 "items":
   [

{"empno":7934,"ename":"MILLER","job":"CLERK","mgr":7782,"hiredate":"1982-01-23T
00:00:00Z","sal":1300,"comm":null,"deptno":10},
    ...
   ],
 "hasMore":true,
 "limit":7,
 "offset":0,
 "count":7,
 "links":
   [
    {"rel":"self","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"describedby","href":"https://example.com/ords/ordstest/metadata-
catalog/examples/employees/"},
    {"rel":"first","href":"https://example.com/ords/ordstest/examples/
employees/"},
    {"rel":"next","href":"https://example.com/ords/ordstest/examples/
employees/?offset=7"}
   ]
}
```

d. **Extend the session using a refresh token.**

At any time, the third party application can use the refresh token value to generate a new access token with a new lifetime. This enables the third party application to extend the user session at will. To do this, the third party application's server must make an HTTPS request to the Token Endpoint. You can mimic the server making this request by using a cURL command as in the following example:

```
curl --user clientId:clientSecret --data
"grant_type=refresh_token&refresh_token=refreshToken" https://example.com/ords/
ordstest/oauth/token
```

In the preceding command, replace `clientId` with the value of the CLIENT_ID shown in USER_ORDS_CLIENTS for `Client Credentials Client`, replace `clientSecret` with the value of the CLIENT_SECRET shown in USER_ORDS_CLIENTS for `Client Credentials Client`, and replace `refreshToken` with the value of `refresh_token` obtained in a previous step.

The result should be similar to the following:

```
HTTP/1.1 200 OK
Content-Type: application/json
```

```
{
 "access_token":  "psIGSSEXSBQyib0hozNEdw..",
 "token_type":    "bearer",
 "refresh_token": "aRMg7AdWPuDvnieHucfV3g..",
 "expires_in":    3600
}
```

In the preceding result, the access token is specified by the `access_token` field, a new refresh token is specified by the `refresh_token` field. This refresh token value can be used to extend the user session without requiring the user to reauthorize the third party application. (Note that the previous access token and refresh token are now invalid; the new values must be used instead.)

11. **Register the client for implicit flow.** While connected to the ORDSTEST schema, execute the following PL/SQL statements:

```
begin
 oauth.create_client(
    p_name => 'Implicit Example',
    p_grant_type => 'implicit',
    p_owner => 'Example Inc.',
    p_description => 'Sample for demonstrating Implicit Flow',
    p_redirect_uri => 'http://example.org/implicit/example/',
    p_support_email => 'support@example.org',
    p_support_uri => 'http://example.org/support',
    p_privilege_names => 'example.employees'
    );
 commit;
end;
```

The preceding code registers a client named `Implicit Example` to access the `examples.employees` privilege using the implicit OAuth flow. For an actual application, a URI must be provided to redirect back to with the authorization code, and a valid support email address must be supplied; however, this example uses fictitious data and the sample `example.org` web service.

You can verify that the client is now registered and has requested access to the `examples.employees` privilege by executing the following SQL statement:

```
select id, client_id, client_secret from user_ords_clients where name =
'Implicit Example';
```

The result should be similar to the following:

```
        ID CLIENT_ID CLIENT_SECRET
---------- -------------------------------- --------------------------------
     10062 7Qz--bNJpFpv8qsfNQpS1A..
```

To grant access to the privilege, an end user must approve access.

12. **Obtain an OAuth access token using implicit flow.** (You must have already created the HR_ADMIN end user in a previous step.)

The end user must be prompted (via a web page) to sign in and approve access to the third party application. The third party application initiates this process by directing the user to the OAuth Authorization Endpoint. For Oracle REST Data Services, the path of the authorization endpoint is always `oauth/auth`, relative to the root path of the schema being accessed. The token endpoint for this example is:

```
https://example.com/ords/ordstest/oauth/auth
```

The OAuth 2.0 protocol specifies that the Authorization request URI must include certain parameters in the query string:

The `response_type` parameter must have a value of `token`.

The `client_id` parameter must contain the value of the applications client identifier. This is the `client_id` value determined in a previous step.

The `state` parameter must contain a unique unguessable value. This value serves two purposes: it provides a way for the client application to uniquely identify each authorization request (and therefore associate any application specific state with the value; think of the value as the application's own session identifier); and it provides a means for the client application to protect against Cross Site Request Forgery (CSRF) attacks. The `state` value will be returned in the redirect URI at the end of the authorization process. The client must confirm that the value belongs to an authorization request initiated by the application. If the client cannot validate the state value, then it should assume that the authorization request was initiated by an attacker and ignore the redirect.

To initiate the Authorization request enter the following URL in a web browser:

```
https://example.com/ords/ordstest/oauth/auth?
response_type=token&client_id=cliendId&state=uniqueRandomValue
```

In the preceding URI, replace `clientId` with the value of the CLIENT_ID column that was noted previously, and replace `uniqueRandromValue` with a unique unguessable value. The client application must remember this value and verify it against the `state` parameter returned as part of the redirect at the end of the authorization flow.

If the `client_id` is recognized, then a sign in prompt is displayed. Enter the credentials of the HR_ADMIN end user, and click Sign In; and on the next page click Approve to cause a redirect to redirect URI specified when the client was registered. The redirect URI will include the access token in the query string portion of the URI. It will also include the same `state` parameter value that the client provided at the start of the flow. The redirect URI will look like the following:

```
http://example.org/auth/code/example/
#access_token=D5doeTSIDgbxWiWkPl9UpA..&type=bearer&expires_in=3600&state=uniqueRand
omValue
```

The client application must verify the value of the `state` parameter and then note the value of the access token.

13. **Access a protected resource using an access token.** Execute the following cURL command:

```
curl -i -H "Authorization: Bearer accessToken" https://example.com/ords/ordstest/
examples/employees/
```

In the preceding command, replace `accessToken` with the value of the `access_token` field shown in the preceding step. The output should be similar to the following:

```
Content-Type: application/json
Transfer-Encoding: chunked

{
 "items":
   [

{"empno":7934,"ename":"MILLER","job":"CLERK","mgr":7782,"hiredate":"1982-01-23T00:0
0:00Z","sal":1300,"comm":null,"deptno":10},
```

```
      ...
    ],
  "hasMore":true,
  "limit":7,
  "offset":0,
  "count":7,
  "links":
    [
     {"rel":"self","href":"https://example.com/ords/ordstest/examples/
employees/"},
     {"rel":"describedby","href":"https://example.com/ords/ordstest/metadata-
catalog/examples/employees/"},
     {"rel":"first","href":"https://example.com/ords/ordstest/examples/
employees/"},
     {"rel":"next","href":"https://example.com/ords/ordstest/examples/
employees/?offset=7"}
    ]
}
```

Related Topics

- Using the Oracle REST Data Services PL/SQL API

> **See Also:**
>
> Managing OAuth Clients

2.8 JWT Bearer Token Authentication and Authorization Using JWT Profile

ORDS release 23.3 introduces support for JSON Web Token (JWT). JWT bearer tokens enable the ORDS developers to delegate authentication and authorization to any OAuth2-compliant Identity Provider to issue a JWT access token that ORDS can validate to provide access to ORDS protected resources.

ORDS acts as a resource server in a typical OpenID connect or OAuth2 flow, making it convenient for the developers to access the ORDS APIs from their web applications.

You can create a JWT Profile for any REST-Enabled schema to provide ORDS with a mechanism to validate JWT bearer tokens. If a JWT bearer token is validated, then ORDS accepts the following:

- The JWT subject claim as the authenticated user making the request
- The JWT scope claims as the REST-Enabled schemas ORDS privileges that the user has consented to the application using the privileges on their behalf

Topics:

- About JSON Web Tokens (JWTs)
- Prerequisites for JWT Authentication
- Creating an ORDS JWT Profile
- JWT Identity Provider Details
- Making Requests to ORDS Using a JWT Bearer Token

2.8.1 About JSON Web Tokens (JWTs)

This section introduces you to the JSON Web Tokens.

A JSON Web Token (JWT) is a compact, URL-safe means of representing claims to be transferred between two parties. The claims in a JWT are encoded as a JSON object. ORDS supports the use of any OAuth2-compliant identity providers such as, OCI IAM with Identity Domains, Oracle Identity Cloud Service (IDCS), Auth0, and Okta. If a JWT is required to access a resource, ORDS validates the JWT using a corresponding public verification key provided by the authorization server.

A JWT comprises of the following:

- A header, that identifies the type of token and the cryptographic algorithm used to generate the signature.
  - The header is required to contain the following reserved claims.

    > **Note:**
    >
    > A claim is a key value pair, where the key is the name of the claim.

    - `alg` (algorithm)
    - `kid` (key id)
  - The header can optionally contain the following reserved claims that ORDS takes into account
    - `x5t` (x.509 certificate thumbprint)
    - `typ` (type)
  - The header can also contain custom claims with user-defined names.
- A payload containing claims about the identity of the end user, and the properties of the JWT.
  - A payload is required to contain the following reserved names of the claims:
    - `sub` (subject)
    - `aud` (audience)
    - `iss` (issuer)
    - `iat` (issued at)
    - `exp` (expiration time)
  - The payload can optionally contain the following reserved claims that ORDS takes into account
    - `scope` or `scp`
    - `nbf` (not before)
  - A payload can also contain custom claims with user-defined names
- A signature, to validate the authenticity of the JWT (derived by base64 encoding the header and the payload).

When using JWTs to control access to the target schema APIs or resources, the JWT Profile in the REST-Enabled schema specifies that the reserved claims in the payload of the JWT must have particular values before ORDS considers the JWT to be valid.

ORDS only accepts the following:

– `alg` (algorithm) values of `RS256`, `RS384` and `RS512`
– `kid` (key id) value that can be matched to a corresponding public verification key
– `x5t` (x.509 certificate thumbprint) if present to a corresponding public verification key
– `typ` (type) if present, requires the value to be `JWT`
– `aud` (audience) that matches the target schemas JWT Profile audience
– `iss` (issuer) that matches the target schema JWT Profile issuer
– `iat` (issued at) identifies the time when the JWT was issued and is not be accepted before this time. This claim is used to determine the age of the JWT and enforce the JWT Profile allowed age if it is set.
– `exp` (expiration time) identifies the expiration time when or after which the JWT is not accepted for processing.
– `nbf` (not before) if present, identifies the time before which the JWT is not accepted for processing.

When a JWT is validated and the payload of JWT contains the scope claim, the ORDS privilege name protecting the resource is verified as being provided in the scope claim before processing.

2.8.2 Prerequisites for JWT Authentication

This section lists the prerequisites for JWT authentication.

Before ORDS can accept authentication and authorization using JWTs:

- An OAuth2-compliant identity provider (for example, OCI IAM with Identity Domains, Oracle Identity Cloud Service (IDCS), Auth0) must have already been set up to issue JWTs for users who are allowed to access the ORDS resources.
- If you want to use custom claims in authorization policies, the identity provider must be set up to add the custom claims to the JWTs that it issues.

See Also:

- Managing Applications
- Oracle Identity Cloud Service
- Auth0, an identity platform to manage access to your applications.

To validate a JWT using a corresponding public verification key provided by the issuing identity provider:

- the signing algorithm used to generate the signature of JWT must be one of `RS256`, `RS384`, or `RS512`
- the public verification key must have a minimum length of 2048 bits and must not exceed 4096 bits
- the public verification key must be specified using the JSON Web Key (JWK) format and ORDS can access it without authentication

The JWK URI

- The URI must be routable from the subnet containing ORDS
- Certain key parameters must be present in the JWKS to verify the signature of the JWT. See Parameters for Verifying JWT Signatures.
- By default, the JWKS can be up to 10000 bytes in size

2.8.3 Creating an ORDS JWT Profile

This section explains how to create an ORDS JWT Profile.

A JWT Profile can be created within a REST-Enabled schema using the `OAUTH.CREATE_JWT_PROFILE` procedure. Alternatively, `OAUTH_ADMIN.CREATE_JWT_PROFILE` can be used to create a JWT Profile in other REST-Enabled schemas as long as the user has the `ORDS_ADMINISTRATOR` role.

> **Note:**
>
> Only one JWT Profile can be defined per schema. To update an existing JWT Profile, the existing JWT Profile must be deleted before creating a new one.

Example:

```
BEGIN
OAUTH.CREATE_JWT_PROFILE(
    p_issuer => 'https://identity.oraclecloud.com/',
    p_audience => 'ords/myapplication/api' ,
    p_jwk_url =>'https://
idcs-10a10a10a10a10a10a10a.identity.oraclecloud.com/admin/v1/SigningCert/
jwk'
);
COMMIT;
END;
/
```

This JWT Profile specifies the issuer, audience, and the JWK URL.

Additionally, an allowed skew and age can be specified. The `p_issuer` must be a non null value and must match the `iss` claim in the JWT bearer token. The `p_audience` must be a non null value and must match with the `aud` claim in the JWT bearer token.

The `p_jwk_url` must be a non null value starting with `https://` and identify the public verification key provided by the authorization server in a JSON Web Key (JWK) format.

Once the JWT Profile has been created, requests made to the schema protected resources can be accessed by providing a valid JWT bearer token with the scope to access the protected resource.

> **Note:**
>
> A JWT scope claim is a JSON string containing a space-separated list of scopes. A protected ORDS resource is protected with a named ORDS privilege. To access the protected ORDS resource, the JWT scope claim must contain a scope with the same name as the protecting ORDS privilege. The scope of an ORDS privilege are case sensitive.

> **See Also:**
>
> OAUTH PL/SQL Package Reference

2.8.4 JWT Identity Provider Details

The identity provider that issued the JWT, determines the values that are allowed to specify for the issuer (`iss`), and the audience (`aud`) claims in the JWT. The identity provider that issued the JWT also determines the URI from where to retrieve the JSON Web Key Set (JWKS) to verify the signature of the JWT.

Identity Provider	Issuer (iss) claim	Audience (aud) Claim	Format of URI from which to Retrieve the JWKS
Okta	`https://<your-okta-tenant-name>.com`	Customer-specific. The audience configured for the Authorization Server in the Okta Developer Console.	`https://<your-okta-tenant-name>.com/oauth2/<auth-server-id> /v1/keys`
IDCS	`https://identity.oraclecloud.com/`	Customer-specific. Refer to "Validating Access Tokens" section in Oracle Identity Cloud Service documentation.	`https://<tenant-base-url>/admin/v1/SigningCert/jwk` To obtain the JWKS without logging in to Oracle Identity Cloud Service, refer to "Change Default Settings" in Oracle Identity Cloud Service documentation.
OCI IAM with Identity Domains	`https://identity.oraclecloud.com`	Customer-specific. See "Managing Applications" section in OCI IAM with Identity Domains documentation.	`https://<tenant-base-url>/admin/v1/SigningCert/jwk`

Identity Provider	Issuer (iss) claim	Audience (aud) Claim	Format of URI from which to Retrieve the JWKS
Auth0	`https://<your-account-name>.auth0.com/`	Customer-specific.	`https://<your-account-name>.auth0.com/.well-known/jwks.json`

See Also:

- Validating Access Tokens in Oracle Identity Cloud Service documentation.
- Change Default Settings in Oracle Identity Cloud Service documentation.
- Managing Applications in OCI IAM with Identity Domains documentation.

2.8.4.1 Parameters for Verifying JWT Signatures

This section lists the key parameters required to verify the JWT signatures.

To verify the signature on a JWT, ORDS requires that the key parameters are present in the JWKS returned from an URI.

Key Parameter	Notes
`kid`	The identifier of the key used to sign the JWT. The value must match the `kid` claim in the JWT header. For example, `master_key`.
`kty`	The type of the key used to sign the JWT. Note that RSA is currently the only supported key type.
`n`	The public key modulus.
`e`	The public key exponent.
`alg`	The signing algorithm (if present) must be set to one of `RS256`, `RS384` or `RS512`.

2.8.4.2 JWT Scopes and ORDS Privileges

You must configure the identity provider that issued the JWT, so as to provide the scope that matches the desired ORDS privilege. If a resource is protected in ORDS using an ORDS privilege, then that privilege name must be defined as a scope. The scope is then available for the application to request on behalf of the user. The issued JWT must then provide that as a scope claim.

Typically, identity providers allow APIs, resources, or scopes to be defined for a particular audience. For example: ORDS REST-Enabled schema defined API. These APIs, resources, or scopes can then be made available to specific applications or clients. The application can then request access tokens on behalf of an authenticated user for that audience and scope.

More than one scope can be requested and provided in the JWT. The protected ORDS resource is accessible as long as one of the scopes matches the ORDS privilege protecting the resource.

2.8.4.3 JWT Subject

ORDS accepts the subject (sub) claim in a valid JWT bearer token as the unique identifier for the user who consented for the application to access their data.

The value of the subject claim in a valid JWT bearer token is bound to the *:current_user* implicit parameter and the `REMOTE_IDENT OWA CGI` environment variable.

2.8.5 Making Requests to ORDS Using a JWT Bearer Token

Once a JWT Profile has been created for a REST-Enabled schema, the protected ORDS resources in that schema can be accessed by providing a valid JWT bearer token with the request.

Request to an ORDS protected resource is made from a third party application on behalf of a user. The third party application has configured its authentication using an Identity Provider. The same Identity Provider can be configured to issue JWT access tokens for ORDS. After the third party application has acquired a JWT access token from the Identity Provider, it can include the JWT as a bearer token in requests to ORDS. Third party application can request suitable JWT access tokens with the required scope to access the ORDS resource.

```
curl -X GET http://localhost:8080/ords/myapplication/api/sales /  --
header "Authorization: Bearer
      $JWT"
```

2.9 About Oracle REST Data Services User Roles

Oracle REST Data Services defines a small number of predefined user roles:

- `RESTful Services` - This is the default role associated with a protected RESTful service.
- `OAuth2 Client Developer` - Users who want to register OAuth 2.0 applications must have this role.
- `oracle.dbtools.autorest.any.schema` - Users who want to access all AutoREST services.
- `SQL Developer` - Users who want to use Oracle SQL Developer to develop RESTful services must have this role.
- `SODA Developer` - This is the default role that is required to access the SODA REST API. For more information about this role, see *Oracle REST Data Services SODA for REST Developer's Guide*.
- `SQL Administrator` - This role is for the Database API and is required for the pdb lifecycle management operations.

Topics:

- About Oracle APEX Users and Oracle REST Data Services Roles
- Controlling RESTful Service Access with Roles

2.9.1 About Oracle APEX Users and Oracle REST Data Services Roles

By default, Oracle APEX users do not have any of the Oracle REST Data Services predefined user roles. This means that, by default, APEX users cannot:

- Invoke protected RESTful Services
- Register OAuth 2.0 applications
- Use Oracle SQL Developer to develop RESTful services.

This applies to all APEX users, including APEX developers and administrators. It is therefore important to remember to follow the steps below to add APEX users to the appropriate user groups, so that they can successfully perform the above actions.

Topics:

- Granting APEX Users Oracle REST Data Services Roles
- Automatically Granting APEX Users Oracle REST Data Services Roles

2.9.1.1 Granting APEX Users Oracle REST Data Services Roles

To give an APEX User any of the roles above, the user must be added to the equivalent APEX user group. For example, to give the `RESTEASY_ADMIN` user the `RESTful Services` role, follow these steps:

1. Log in to the `RESTEASY` workspace as a `RESTEASY_ADMIN`.
2. Navigate to **Administration** and then **Manage Users and Groups**.
3. Click the Edit icon to the left of the `RESTEASY_ADMIN` user.
4. For **User Groups**, select `RESTful Services`.
5. Click **Apply Changes**.

2.9.1.2 Automatically Granting APEX Users Oracle REST Data Services Roles

Adding APEX users to the appropriate user groups can be an easily overlooked step, or can become a repetitive task if there are many users to be managed.

To address these issues, you can configure Oracle REST Data Services to automatically grant APEX users a predefined set of RESTful Service roles by modifying the `defaults.xml` configuration file.

In that file, Oracle REST Data Services defines three property settings to configure roles:

- `apex.security.user.roles` - A comma separated list of roles to grant ordinary users, that is, users who are not developers or administrators.
- `apex.security.developer.roles` - A comma separated list of roles to grant users who have the `Developer` account privilege. `Developer`s also inherit any roles defined by the `apex.security.user.roles` setting.

- `apex.security.administrator.roles` - A comma separated list of roles to grant users who have the `Administrator` account privilege. `Administrator`s also inherit any roles defined by the `apex.security.user.roles` and `apex.security.developer.roles` settings.

For example, to automatically give all users the `RESTful Services` privilege and all developers and administrators the `OAuth2 Client Developer` and `SQL Developer` roles, add the following to the `defaults.xml` configuration file:

```
<!-- Grant all Application Express Users the ability
        to invoke protected RESTful Services -->
<entry key="apex.security.user.roles">RESTful Services</entry>
<!-- Grant Application Express Developers and Administrators the ability
        to register OAuth 2.0 applications and use Oracle SQL Developer
        to define RESTful Services -->
<entry key="apex.security.developer.roles">
   OAuth2 Client Developer, SQL Developer</entry>
```

Oracle REST Data Services must be restarted after you make any changes to the `defaults.xml` configuration file.

2.9.2 Controlling RESTful Service Access with Roles

The built-in `RESTful Service` role is a useful default for identifying users permitted to access protected RESTful services.

However, it will often also be necessary to define finer-grained roles to limit the set of users who may access a specific RESTful service.

Topics:

- About Defining RESTful Service Roles
- Associating Roles with RESTful Privileges

2.9.2.1 About Defining RESTful Service Roles

A RESTful Service **role** is an APEX user group. To create a user group to control access to the Gallery RESTful Service, follow these steps. (

1. Log in to the `RESTEASY` workspace as a workspace administrator.
2. Navigate to **Administration** and then **Manage Users and Groups**.
3. Click the **Groups** tab.
4. Click **Create User Group**.
5. For **Name**, enter `Gallery Users`.
6. Click **Create Group**.

2.9.2.2 Associating Roles with RESTful Privileges

After a user group has been created, it can be associated with a RESTful privilege. To associate the Gallery Users role with the `example.gallery` privilege, follow these steps.

1. Navigate to **SQL Workshop** and then **RESTful Services**.

2. In the Tasks section, click **RESTful Service Privileges**.
3. Click **Gallery Access**.
4. For **Assigned Groups**, select `Gallery Users`.
5. Click **Apply Changes**.

With these changes, users must have the Gallery Users role to be able to access the Gallery RESTful service.

2.10 Authenticating Against WebLogic Server User Repositories

Oracle REST Data Services can use APIs provided by WebLogic Server to verify credentials (username and password) and to retrieve the set of groups and roles that the user is a member of.

This section walks through creating a user in the built-in user repositories provided by WebLogic Server, and verifying the ability to authenticate against that user.

This document does not describe how to integrate WebLogic Server with the many popular user repository systems such as LDAP repositories, but Oracle REST Data Services can authenticate against such repositories after WebLogic Server has been correctly configured. See your application server documentation for more information on what user repositories are supported by the application server and how to configure access to these repositories.

Topics:

- Authenticating Against WebLogic Server

2.10.1 Authenticating Against WebLogic Server

Authenticating a user against WebLogic Server involves the following major steps:

1. Creating a WebLogic Server User
2. Verifying the WebLogic Server User

2.10.1.1 Creating a WebLogic Server User

To create a sample WebLogic Server user, follow these steps:

1. Start WebLogic Server if it is not already running
2. Access the WebLogic Server Administration Console (typically `http://server:7001/console`), enter your credentials.
3. In the navigation tree on the left, click the **Security Realms** node
4. If a security realm already exists, go to the next step. If a security realm does not exist, create one as follows:
   a. Click **New**.
   b. For **Name**, enter `Test-Realm`, then click **OK**.
   c. Click **Test-Realm**.
   d. Click the **Providers** tab.
   e. Click **New**, and enter the following information:

Name: `test-authenticator`

Type: `DefaultAuthenticator`

f. Restart WebLogic Server if you are warned that a restart is necessary.
g. Click **Test-Realm**.

5. Click the **Users and Groups** tab.
6. Click **New**, and enter the following information:
   - **Name**: `3rdparty_dev2`
   - **Password**: Enter and confirm the desired password for this user.
7. Click **OK**.
8. Click the **Groups** tab.
9. Click **New**., and enter the following information:
   - **Name**: OAuth2 Client Developer (case sensitive)
10. Click **OK**.
11. Click the **Users** tab.
12. Click the **3rdparty_dev2** user.
13. Click the **Groups** tab.
14. In the **Chosen** list, add `OAuth2 Client Developer` .
15. Click **Save**.

You have created a user named `3rdparty_dev2` and made it a member of a group named `OAuth2 Client Developer`. This means the user will acquire the `OAuth2 Client Developer` role, and therefore will be authorized to register OAuth 2.0 applications.

Now verify that the user can be successfully authenticated.

2.10.1.2 Verifying the WebLogic Server User

To verify that the WebLogic Server user created can be successfully authenticated, follow these steps:

1. In your browser, go to a URI in the following format:

   ```
   https://server:port/ords/resteasy/ui/oauth2/clients/
   ```

2. Enter the credentials of the `3rdparty_dev2` user, and click **Sign In**.

The OAuth 2.0 Client Registration page should be displayed, with no applications listed. If this page is displayed, you have verified that authentication against the WebLogic Server user repository is working.

However, if the sign-on prompt is displayed again with the message `User is not authorized to access resource`, then you made mistake (probably misspelling the Group List value).

2.11 Integrating with Existing Group/Role Models

The examples in other sections demonstrate configuring the built-in user repositories of WebLogic Server. In these situations you have full control over how user groups are named. If a user is a member of a group with the exact same (case sensitive) name as a role, then the user is considered to have that role.

However, when integrating with existing user repositories, RESTful service developers will often not have any control over the naming and organization of user groups in the user repository. In these situations a mechanism is needed to map from existing "physical" user groups defined in the user repository to the "logical" roles defined by Oracle REST Data Services and/or RESTful Services.

In Oracle REST Data Services, this group to role mapping is performed by configuring a configuration file named `role-mapping.xml`.

Topics:

- About `role-mapping.xml`

2.11.1 About `role-mapping.xml`

`role-mapping.xml` is a Java XML Properties file where each property key defines a pattern that matches against a set of user groups, and each property value identifies the roles that the matched user group should be mapped to. It must be located in the same folder as the `defaults.xml` configuration file. The file must be manually created and edited.

Consider this example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
 <entry key="webdevs">RESTful Services</entry>
</properties>
```

This role mapping is straightforward, stating that any user who is a member of a group named: `webdevs` is given the role `RESTful Services`, meaning that all members of the `webdevs` group can invoke `RESTful Services`.

A mapping can apply more than one role to a group. For example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
 <entry key="webdevs">RESTful Services, SQL Developer</entry>
</properties>
```

This rule gives members of the `webdevs` group both the `RESTful Services` and `SQL Developer` roles.

Topics:

- Parameterizing Mapping Rules
- Dereferencing Parameters
- Indirect Mappings

2.11.1.1 Parameterizing Mapping Rules

Having to explicitly map from each group to each role may not be scalable if the number of groups or roles is large. To address this concern, you can parameterize rules. Consider this example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
 <entry key="{prefix}.webdevs">RESTful Services</entry>
</properties>
```

This example says that any group name that ends with `.webdevs` will be mapped to the `RESTful Services` role. For example, a group named: `HQ.webdevs` would match this rule, as would a group named: `EAST.webdevs`.

The syntax for specifying parameters in rules is the same as that used for URI Templates; the parameter name is delimited by curly braces (`{}`).

2.11.1.2 Dereferencing Parameters

Any parameter defined in the group rule can also be dereferenced in the role rule. Consider this example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
 <entry key="cn={userid},ou={group},dc=MyDomain,dc=com">{group}</entry>
</properties>
```

This example maps the organizational unit component of an LDAP distinguished name to a role. It says that the organizational unit name maps directly to a role with same name. Note that it refers to a `{userid}` parameter but never actually uses it; in effect, it uses `{userid}` as a wildcard flag.

For example, the distinguished name `cn=jsmith,ou=Developers,dc=MyDomain,dc=com` will be mapped to the logical role named `Developers`.

2.11.1.3 Indirect Mappings

To accomplish the desired role mapping, it may sometimes be necessary to apply multiple intermediate rules. Consider this example:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
 <entry key="cn={userid},ou={group},dc=example,dc=com">{group}</entry>
 <entry key="{prefix},ou={group},dc=acquired,dc=com">{group}</entry>
 <entry key="Developers">RESTful Services, SQL Developer</entry>
</properties>
```

This example maps the organizational unit component of an LDAP distinguished name to some roles. Complicating matters is the fact that users can come from two different organizations, resulting in differing distinguishing name patterns.

- Users from `example.com` always have a single common name (CN) identifying their user id, followed by the organizational unit (OU) and the domain name (DC). For example: `cn=jsmith,ou=Developers,dc=example,dc=com`.
- Users from `acquired.com` have varying numbers of common name (CN) prefixes, but the organizational unit is the field you are interested in. For example: `cn=ProductDev,cn=abell,ou=Engineering,dc=acquired,dc=com`.
- Both organizations identify software engineers with `ou=Developers`.

You want to map engineers in both organizations to the `RESTful Services` and `SQL Developer` roles.

- The first rule maps engineers in the `example.com` organization to the intermediate `Developers` role.
- The second rule maps engineers in the `acquired.com` organization to the intermediate `Developers` role.
- The final rule maps from the intermediate `Developers` role to the `RESTful Services` and `SQL Developer` roles.

2.12 Integrating Oracle REST Data Services and WebLogic Server

Oracle REST Data Services (ORDS) recommends that for complex or enterprise user identity integrations, customers can leverage the capabilities of WebLogic server. WebLogic server has a rich and diverse set of capabilities to integrate with existing enterprise identity solutions. When Oracle REST Data Services is deployed on the WebLogic server, it can leverage the capabilities of WebLogic server to get secure access to ORDS based RESTful Services.

Once ORDS is configured to work with WebLogic server, the WebLogic server can provide the authenticated user identity and roles. Based on the memberships of the user role, ORDS authorizes access to the protected RESTful Services.

2.12.1 Configuring ORDS to Integrate with WebLogic Server

This section explains how to configure ORDS to work with WebLogic server for authentication.

To configure ORDS to work with WebLogic server authentication, use the `--weblogic-auth` option as shown in the following command when you are generating the deployable `ords.war` file:

```
ords war --weblogic-auth <path for new war file>.
```

Specify the `--help` option to get help on the `ords war` command:

```
ords war --help.
```

Using the `--weblogic-auth` option with the `ords war` command, the `--weblogic-auth` option re-configures the `web.xml` deployment descriptor in the generated web application file that helps the WebLogic server to pass any established user identity to ORDS.
After executing the preceding command, the generated web application file must be re-deployed to the WebLogic server.

Determining the Identity and Roles of the User

ORDS uses APIs provided by WebLogic server to retrieve the WLSUser and WLSGroup for the established user identity.

ORDS treats the WLSGroup to be equivalent to the role that the user possesses. For example, if a user or users belongs to a WLSGroup named "Sales Assistant", then ORDS considers such user to have a role named "Sales Assistant".

Retrieving the Authenticated User Information

The user visits the single sign-on login form and obtains a cookie or an access token that asserts the identity and roles. The cookie or the token is then passed to the WebLogic server. The WebLogic server is configured to validate the cookie or token and then map it to a specific user to determine what roles the user possesses. The WebLogic Server performs this operation before passing the request to ORDS. Once ORDS receives the request, it calls the APIs provided by WebLogic server to retrieve the WLSUser and WLSGroup to retrieve the information of the user identity and roles from the WebLogic server.

Related Topics

- Oracle WebLogic APIs
- API to retrieve the WLSUser
- API to retrieve the WLSGroup

2.13 Using the Oracle REST Data Services PL/SQL API

Oracle REST Data Services has a PL/SQL API (application programming interface) that you can use as an alternative to the SQL Developer graphical interface for all the operations. The available subprograms are included in the following PL/SQL packages:

- ORDS, documented in ORDS PL/SQL Package Reference
- OAUTH, documented in OAUTH PL/SQL Package Reference

To use the Oracle REST Data Services PL/SQL API:

> **Note:**
>
> You must be logged in as the user to the schema that you want to enable or to the ORDS services to be published when using the ORDS package. ORDS is granted `EXECUTE` privileges for public, which means any user can REST enable their schema and publish REST APIs. You may revoke this public grant if that is undesirable for your environments. If you want to work on another schema, then use the ORDS_ADMIN package, which requires the ORDS Administrator database role.

- Install Oracle REST Data Services in the database that you will use to develop RESTful services.
- Enable one or more database schemas for REST access.

Topics:

- Creating a RESTful Service Using the PL/SQL API
- Testing the RESTful Service

Related Topics

- Automatic Enabling of Schema Objects for REST Access (AutoREST)

2.13.1 Creating a RESTful Service Using the PL/SQL API

You can create a RESTful service by connecting to a REST-enabled schema and using the ORDS.CREATE_SERVICE procedure.

The following example creates a simple "Hello-World"-type service:

```
begin
 ords.create_service(
      p_module_name => 'examples.routes' ,
      p_base_path   => '/examples/routes/',
      p_pattern     => 'greeting/:name',
      p_source => 'select ''Hello '' || :name || '' from '' ||
nvl(:whom,sys_context(''USERENV'',''CURRENT_USER'')) "greeting" from dual');
 commit;
end;
/
```

The preceding example does the following:

- Creates a resource module named examples.routes.
- Sets the base path (also known as the URI prefix) of the module to `/examples/routes/`.
- Creates a resource template in the module, with the route pattern `greeting/:name`.
- Creates a GET handler and sets its source as a SQL query that forms a short greeting:
  - `GET` is the default value for the `p_method` parameter, and it is used here because that parameter was omitted in this example.
  - `COLLECTION_FEED` is the default value for the `p_method` parameter, and it is used here because that parameter was omitted in this example
- An optional parameter named `whom` is specified.

Related Topics

- ORDS.CREATE_SERVICE

2.13.2 Testing the RESTful Service

To test the RESTful service that you created, start Oracle REST Data Services if it is not already started:

```
ords -c \path\to\ords\config serve
```

Enter the URI of the service in a browser. The following example displays a "Hello" greeting to `Joe`, by default from the current user because no `whom` parameter is specified.:

```
http://localhost:8080/ords/ordstest/examples/routes/greeting/Joe
```

In this example:

- Oracle REST Data Services is running on localhost and listening on port 8080.
- Oracle REST Data Services is deployed at the context-path `/ords`.
- The RESTful service was created by a database schema named `ordstest`.
- Because the URL does not include the optional whom parameter, the :whom bind parameter is bound to the null value, which causes the query to use the value of the current database user (`sys_context(''USERENV'',''CURRENT_USER''))`) instead.

If you have a JSON viewing extension installed in your browser, you will see a result like the following:

```
{
 "items": [
  {
   "greeting": "Hello Joe from ORDSTEST"
  }
 ],
 "hasMore": false,
 "limit": 25,
 "offset": 0,
 "count": 1,
 "links": [
  {
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/examples/routes/greeting/"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/examples/routes/
greeting/"
  },
  {
   "rel": "first",
   "href": "http://localhost:8080/ords/ordstest/examples/routes/greeting/Joe"
  }
 ]
}
```

The next example is like the preceding one, except the optional parameter `whom` is specified to indicate that the greeting is from `Jane`.

```
http://localhost:8080/ords/ordstest/examples/routes/greeting/Joe?whom=Jane
```

This time, the result will look like the following:

```
{
 "items": [
  {
   "greeting": "Hello Joe from Jane"
  }
 ],
 "hasMore": false,
 "limit": 25,
 "offset": 0,
 "count": 1,
 "links": [
  {
```

```
   "rel": "self",
   "href": "http://localhost:8080/ords/ordstest/examples/routes/greeting/"
  },
  {
   "rel": "describedby",
   "href": "http://localhost:8080/ords/ordstest/metadata-catalog/examples/routes/
greeting/"
  },
  {
   "rel": "first",
   "href": "http://localhost:8080/ords/ordstest/examples/routes/greeting/Joe"
  }
 ]
}
```

Notice that in this result, what follows "from" is `Jane` and not `ORDSTEST`, because the `:whom` bind parameter was bound to the `Jane` value.

2.14 Oracle REST Data Services Database Authentication

This section describes how to use the database authentication feature to provide basic authentication for PL/SQL gateway calls.

Database authentication feature is similar to dynamic basic authentication provided by mod-plsql where the user is prompted for the database credentials to authenticate and authorize access to PL/SQL stored procedures.

2.14.1 Installing Sample Database Scripts

This section describes how to install the sample database scripts.

The unzipped Oracle REST Data Services installation kit contains the sample database scripts that create a basic demo scenario for the database authentication.

The following code snippet shows how to install the sample database schema:

```
 examples\db_auth $ cd sql/
sql $ sql system/<password>

SQLcl: Release Release 18.1.1 Production on Fri Mar 23 14:03:18 2018

Copyright (c) 1982, 2018, Oracle.  All rights reserved.

Password? (**********?) ******
Connected to:
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production


SQL> @install <chosen-password>
```

> **Note:**
>
> - You need to adjust the SQLcl connect string and the user credentials to suit your environment. For this demo scenario, SQLcl connects to the database with service name `orcl`
> - `<chosen-password>` is the password you assigned to `EXAMPLE_USER1` and `EXAMPLE_USER2` database users. Make a note of this password value for later reference.

The sample database schema creates the following database users:

- **SAMPLE_PLSQL_APP**: A database schema where the protected `SAMPLE_PROC` will be installed.
- **EXAMPLE_USER1**: A database user granted with execute privilege on `SAMPLE_PLSQL_APP.SAMPLE_PROC` procedure.
- **EXAMPLE_USER2**: A second database user granted with execute privilege on `SAMPLE_PLSQL_APP.SAMPLE_PROC` procedure.

2.14.2 Enabling the Database Authentication

This section describes how to enable the database authentication feature.

To enable the database authentication feature, do one of the following:

- For fresh installation of Oracle REST Data Services, update the `/u01/ords/params/ords_params` properties file with the following entry:

  ```
  jdbc.auth.enabled=true
  ```

- For existing Oracle REST Data Services installation, run the following commands assuming `ords/bin` is in `$PATH`, run the following command:

  ```
  ords -c c:\ords\config config --db-pool default set jdbc.auth.enabled
  true
  ```

  Output:

  ```
  ORDS: Production Release 22.1 on Mon Mar 07 17:01:52 2022

  Copyright (c) 2010, 2022, Oracle.  All rights reserved.

  Configuration:
    /C:/ords/config/

  The setting named: jdbc.auth.enabled was set to: true in
  configuration: default
  ```

This setting is applicable to PL/SQL gateway pools (for example, `apex.xml`), it does not apply to other pool types such as the `ORDS_PUBLIC_USER` pool (for example, `apex_pu.xml`).

> **Note:**
>
> The `jdbc.auth.enabled` setting can be configured per database pool. Alternatively, it can be configured in `defaults.xml` file so that it is enabled for all pools.

Example 2-11 Setting Enabled for all Pools

This example code snippet shows how `jdbc.auth.enabled` setting is enabled for all pools.

```
ords $ java -jar ords.war set-property jdbc.auth.enabled true
Mar 23, 2018 2:23:49 PM oracle.dbtools.rt.config.setup.SetProperty execute
INFO: Modified: /tmp/cd/ords/defaults.xml, setting: jdbc.auth.enabled = true
```

After you update the configuration settings, restart the Oracle REST Data Services for the changes to take effect.

2.14.3 Configuring the Request Validation Function

This section describes how to temporarily disable the request validation function.

If you want to invoke only a whitelisted set of stored procedures in the database through the PL/SQL gateway, then you must configure Oracle REST Data Services to use a request validation function (especially when you are using Oracle APEX).

The demo sample procedure used for testing the database authentication feature is not whitelisted, so you must temporarily disable the request validation function.

To disable the request validation function, perform the following steps:

1. Navigate to the `<Current Configuration directory>/global` directory.
2. Open the `settings.xml` file, which stores the Oracle REST Data Services configuration information.
3. Look for `security.requestValidationFunction` entry and remove it from the file.
4. Save the file.
5. Restart Oracle REST Data Services, if it is already running.

> **Note:**
>
> In production environment, you must use a custom request validation function that whitelists the stored procedures you want to access for your application

2.14.4 Testing the Database Authenticated User

This section describes how to test if the database user is authenticated.

Assuming that Oracle REST Data Service is running in a standalone mode on local host and on port 8080, access the following URL in your web browser:

```
http://localhost:8080/ords/sample_plsql_app.sample_proc
```

The browser prompts you to enter credentials. Enter `example_user1` for user name and enter the password value you noted while installing the sample schema.

The browser displays 'Hello EXAMPLE_USER1!' to demonstrate that the database user was authenticated and the identity of the user was propagated to the database through the OWA CGI variable named `REMOTE_USER`..

2.14.5 Uninstalling the Sample Database Schema

To uninstall the database schema, run the commands as shown in the following code snippet:

```
db_auth $ cd sql/
sql $ sql system/<password>

SQLcl: Release Release 18.1.1 Production on Fri Mar 23 14:03:18 2018

Copyright (c) 1982, 2018, Oracle.  All rights reserved.

Password? (**********?) ******
Connected to:
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit
Production
SQL> @uninstall
```

2.15 Overview of Pre-hook Functions

This section explains how to use PL/SQL based pre-hook functions that are invoked prior to an Oracle REST Data Services (ORDS) based REST call.

A pre-hook function is typically used to implement application logic that needs to be applied across all REST endpoints of an application. For example a pre-hook enables the following functionality:

- **Configure application specific database session state**: Configure the session to support a VPD policy.
- **Custom authentication and authorization**: As the pre-hook is invoked prior to dispatching the REST service, it is used to inspect the request headers and determine the user who is making the request, and also find if that user is authorized to make the request.
- **Auditing or metrics gathering**: To track information regarding the REST APIs invoked.

Topics:

- Configuring the Pre-hook Function
- Using a Pre-hook Function
- Processing of a Request
- Identity Assertion of a User
- Aborting Processing of a Request
- Ensuring Pre-hook is Executable

- Exceptions Handling by Pre-hook Function
- Pre-hook Function Efficiency
- Pre-Hook Examples

2.15.1 Configuring the Pre-hook Function

This section describes how to configure a pre-hook function.

The pre-hook function is configured using `procedure.rest.preHook` setting. The value of this setting must be the name of a stored PL/SQL function.

2.15.2 Using a Pre-hook Function

This section explains how the pre-hook function is used.

A pre-hook must be a PL/SQL function with no arguments and must return a `BOOLEAN` value. The function must be executable by the database user to whom the request is mapped. For example, if the request is mapped to an ORDS enabled schema, then that schema must be granted the execute privilege on the pre-hook function (or to `PUBLIC`).

If the function returns `true`, then it indicates that the normal processing of the request must continue. If the function returns `false`, then it indicates that further processing of the request must be aborted.

ORDS invokes a pre-hook function in an OWA (Oracle Web Agent) that is a PL/SQL Gateway Toolkit environment. This means that the function can introspect the request headers and the OWA CGI environment variables, and use that information to drive its logic. The function can also use the OWA PL/SQL APIs to generate a response for the request (for example, in a case where the pre-hook function needs to abort further processing of the request, and provide its own response).

2.15.3 Processing of a Request

The pre-hook function must return `true` if it determines that the processing of a request must continue. In such cases, any OWA response produced by the pre-hook function is ignored (except for cases as detailed in the section Identity Assertion of a User), and the REST service is invoked as usual.

2.15.4 Identity Assertion of a User

This section describes how pre-hook function can make assertions about the identity of the user.

When continuing processing, a pre-hook can make assertions about the identity and the roles assigned to the user who is making the request. This information is used in the processing of the REST service. A pre-hook function can determine this by setting one or both of the following OWA response headers.

- `X-ORDS-HOOK-USER`: Identifies the user making the request, the value is bound to the `:current_user` implicit parameter and the `REMOTE_IDENT` OWA CGI environment variable.

- `X-ORDS-HOOK-ROLES`: Identifies the roles assigned to the user. This information is used to determine the authorization of the user to access the REST service. If this header is present then `X-ORDS-HOOK-USER` must also be present.

> **Note:**
>
> `X-ORDS-HOOK-USER` and `X-ORDS-HOOK-ROLES` headers are not included in the response of the REST service. These headers are only used internally by ORDS to propagate the user identity and roles.
>
> Using these response headers, a pre-hook can integrate with the role based access control model of ORDS. This enables the application developer to build rich integrations with third party authentication and access control systems.

2.15.5 Aborting Processing of a Request

This section explains how the pre-hook function aborts the processing of a request.

If a pre-hook determines that the processing of the REST service should not continue, then the function must return `false` value. This value indicates to ORDS that further processing of the request must not be attempted.

If the pre-hook does not produce any OWA output, then ORDS generates a `403 Forbidden` error response page. If the pre-hook produces any OWA response, then ORDS returns the OWA output as the response. This enables the pre-hook function to customize the response that client receives when processing of the REST service is aborted.

2.15.6 Ensuring Pre-hook is Executable

If a schema cannot invoke a pre-hook function, then ORDS generates a `503 Service Unavailable` response for *any* request against that schema. Since a pre-hook has been configured, it would not be safe for ORDS to continue processing the request without invoking the pre-hook function. It is very important that the pre-hook function is executable by all ORDS enabled schemas. If the pre-hook function is not executable, then the REST services defined in those schemas will not be available.

2.15.7 Exceptions Handling by Pre-hook Function

When a pre-hook raises an error condition, for example, when a run-time error occurs, a `NO DATA FOUND` exception is raised. In such cases, ORDS cannot proceed with processing of the REST service as it would not be secure. ORDS inteprets any exception raised by the pre-hook function as a signal that the request is forbidden and generates a `403 Forbidden` response, and does not proceed with invoking the REST service. Therefore, if the pre-hook raises an unexpected exception, it forbids access to that REST service. It is highly recommended that all pre-hook functions must have a robust exception handling block so that any unexpected error conditions are handled appropriately and do not make REST Services unavailable.

2.15.8 Pre-hook Function Efficiency

A pre-hook function is invoked for every REST service call. Therefore, the pre-hook function must be designed to be efficient. If a pre-hook function is inefficient, then it has a negative effect on the performance of the REST service call. Invoking the pre-hook involves at least one additional database round trip. It is critical that the ORDS instance and the database are located close together so that the round-trip latency overhead is minimized.

2.15.9 Pre-Hook Examples

This section provides some sample PL/SQL functions that demonstrate different ways in which the pre-hook functionality can be leveraged.

Source code for the examples provided in the following sections is included in the unzipped Oracle REST Data Services distribution archive `examples/pre_hook/sql` sub-folder.

2.15.9.1 Installing the Examples

This section describes how to install the pre-hook examples.

To install the pre-hook examples, execute `examples/pre_hook/sql/install.sql` script. The following code snippet shows how to install the examples using Oracle SQLcl command line interface:

```
pre_hook $ cd examples/pre_hook/sql/
sql $ sql system/<password>

SQLcl: Release Release 18.1.1 Production on Fri Mar 23 14:03:18 2018

Copyright (c) 1982, 2018, Oracle.  All rights reserved.

Password? (**********?) ******
Connected to:
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production


SQL> @install <chosen-password>
```

- You need to adjust the SQLcl connect string and the user credentials to suit your environment. For these demo scenarios, SQLcl connects to the database with service name `orcl`.
- `<chosen-password>` is the password you assigned to the `PRE_HOOK_TEST` database user. Make a note of this password value for later reference.
- The `examples/pre_hook/sql/install.sql` command creates the following two databases schemas:
  - The `PRE_HOOK_DEFNS` schema where the pre-hook function is defined along with a database table named `custom_auth_users`, where user identities are stored. This table is populated with a single user `joe.bloggs@example.com`, whose password is the value assigned for `<chosen-password>`.

– The PRE_HOOK_TESTS schema where ORDS based REST services that are used to demonstrate the pre-hooks are defined.

2.15.9.1.1 Example: Denying all Access

The simplest pre-hook is one that unilaterally denies access to any REST Service.

To deny access to any REST service, the function must always return false as shown in the following code snippet:

```
create or replace function deny_all_hook return boolean as
begin
 return false;
end;
/
grant execute on deny_all_hook to public;
```

Where:

- The deny_all_hook pre-hook function always returns false value.
- Execute privilege is granted to all users. So, any ORDS enabled schema can invoke this function

Configuring ORDS

To enable deny_all_hook pre-hook function, perform the following steps:

1. Locate the folder where the Oracle REST Data Services configuration file is stored.
2. Open the settings.xml file and add:

   ```
   <entry key="procedure.rest.preHook">pre_hook_defns.deny_all_hook</
   entry>
   ```

3. Save the file.
4. Restart Oracle REST Data Services.

Try it out

The install script creates an ORDS enabled schema and a REST service which can be accessed at the following URL (assuming ORDS is deployed on localhost and listening on port 8080) :

```
http://localhost:8080/ords/pre_hook_tests/prehooks/user
```

Access the URL in a browser. You should get a response similar to the following:

```
403 Forbidden
```

This demonstrates that the deny_all_hook pre-hook function was invoked and it prevented the access to the REST service by returning a false value.

2.15.9.1.2 Example: Allowing All Access

Modify the source code of the `deny_all_hook` pre-hook function to allow access to all REST service requests as shown in the following code snippet:

```
create or replace function deny_all_hook return boolean as
begin
 return true;
end;
/
```

Try it out

Access the following test URL in a browser:

```
http://localhost:8080/ords/pre_hook_tests/prehooks/user
```

The response should include JSON similar to the following code snippet:

```
{
 "authenticated_user": "no user authenticated"
}
```

> **Note:**
>
> The REST service executes because the pre-hook function authorized it.

Related Topics

- Identity Assertion of a User
  This section describes how pre-hook function can make assertions about the identity of the user.

2.15.9.1.3 Example: Asserting User Identity

The following code snippet demonstrates how the pre-hook function makes assertions about the user identity and the roles they possess:

```
create or replace function identity_hook return boolean as
begin
 if custom_auth_api.authenticate_owa then
  custom_auth_api.assert_identity;
  return true;
 end if;
 custom_auth_api.prompt_for_basic_credentials('Test Custom Realm');
 return false;
end;
```

The pre-hook delegates the task of authenticating the user to the `custom_auth_api.authenticate_owa` function. If the function indicates that the user is authenticated, then it invokes the `custom_auth_api.assert_identity` procedure to propagate the user identity and roles to ORDS.

Configuring ORDS

To enable pre-hook function, perform the following steps:

1. Locate the folder where the Oracle REST Data Services configuration file is stored.
2. Open the `settings.xml` file and add:

   ```
   <entry key="procedure.rest.preHook">pre_hook_defns.identity_hook</
   entry></entry>
   ```

3. Save the file.
4. Restart Oracle REST Data Services.

Try it out

The install script creates an ORDS enabled schema and a REST service that can be accessed at the following URL (assuming ORDS is deployed on localhost and listening on port 8080):

`http://localhost:8080/ords/pre_hook_tests/prehooks/user`

In a web browser access the preceding URL.

> **Note:**
>
> The first time you access the URL, the browser will prompt you to enter your credentials. Enter the user name as `joe.bloggs@example.com` and for the password, use the value you assigned for `<chosen-password>` when you executed the install script. Click the link to sign in.

In response a JSON document is displayed with the JSON object in it.

```
{"authenticated_user":"joe.bloggs@example.com"}
```

2.15.9.2 Uninstalling the Examples

This section explains how to uninstall the examples.

The following code snippet shows how to uninstall the examples:

```
pre_hook $ cd sql/
sql $ sql system/<password>

SQLcl: Release Release 18.1.1 Production on Fri Mar 23 14:03:18 2018

Copyright (c) 1982, 2018, Oracle.  All rights reserved.

Password? (**********?) ******
Connected to:
```

```
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production

SQL> @uninstall
```

2.16 Generating Hyperlinks

Oracle REST Data Services (ORDS) provides a mechanism to transform relational result sets into JSON representations, and provides hyperlinks that automatically paginates the result set to allow navigation between the pages of the result set.

For many use cases, it is required to treat certain columns in the result set as hyperlinks. ORDS provides the following simple yet powerful mechanisms for adding hyperlinks to REST resources:

- **Primary Key Hyperlinks**: A column with the reserved alias `$.id` identifies the primary key column of a single row in the result set. Such column values are used to form a hyperlink that points to a child resource of the current resource that provides specific details about that particular row in the result set.
- **Arbitrary Hyperlinks**: A column whose alias starts with the reserved character `$` is treated as a hyperlink. The subsequent characters in the column alias indicates the link relation type.

2.16.1 Primary Key Hyperlinks

This section describes how to add primary key hyperlinks.

Typically, when you are modelling a REST API, you need to model the Resource Collection Pattern that enumerates the hyperlinks to the other resources.

In a simple use case, a query is against a single table that contains a single column with primary key that is used to identify each row. The collection resource provides summary information of each row, and provides a self link for each row. The self link points to the resource that provides more detailed information about the row. For example, if we use the `EMP` table, we can define a service as shown in the following code snippet:

```
begin
    ords.define_service(
        p_module_name => 'links.example',
        p_base_path => 'emp-collection/',
        p_pattern => '.',
        p_source => 'select empno "$.id", empno id, ename employee_name from
emp order by empno ename';
     commit;
end;
```

Where:

- The reserved value `'.'` is used for the `p_pattern` value. This indicates the path of the resource template in the base path of the resource module, `emp-collection/` in this example.
- The `EMPNO` column is aliased as `$.id`, to produce a hyperlink.

Following code snippet shows the output produced after invoking the preceding service:

```
{
    "items": [{
        "id": 7369,
        "employee_name": "SMITH",
        "links": [{
            "rel": "self",
            "href": "http://localhost:8080/ords/ordstest/emp-
collection/7369"
        }]
    },
    ...
    ],
    "hasMore": false,
    "limit": 25,
    "offset": 0,
    "count": 14,
    "links": [{
        "rel": "self",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/"
    }, {
        "rel": "describedby",
        "href": "http://localhost:8080/ords/ordstest/metadata-catalog/
emp-collection/"
    }, {
        "rel": "first",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/"
    }]
}
```

Observe that the value of `EMPNO` column is concatenated with the URL of the service to produce a new hyperlink with relation `self`. The value is not simply concatenated, it is resolved using the algorithm specified in RFC3986. Therefore, Oracle REST Data Services (ORDS) can take the value of the column, and apply the resolution algorithm to produce a new absolute URL.

See Also:

Section 5 of rfc3986

If you attempt to navigate to this URL, it results in a 404 HTTP status because a resource handler for that endpoint has not yet been defined. The following code snippet shows a sample resource handler:

```
begin
  ords.define_template(
      p_module_name    => 'links.example',
      p_pattern        => ':id');
  ords.define_handler(
      p_module_name    => 'links.example',
```

```
      p_pattern        => ':id',
      p_source_type    => ords.source_type_collection_item,
      p_source         => 'select emp.empno "$.id", emp.* from emp where
empno = :id');
  commit;
end;
```

2.16.1.1 Composite Primary Keys

This section describes the support for composite primary keys.

If multiple columns in a query form the primary key of a row, then each of those columns must be aliased by `$.id.N`, where N is the position of the column in the key. ORDS combines such values to form the relative path of the item URL.

Example:

```
SELECT
             ID1 "$.id.1",
             ID2 "$.id.2",
             ID3 "$.id.3",
             ...
```

Related Topics

- Route Patterns Specification

2.16.2 Arbitrary Hyperlinks

This section describes how to create hyperlinks to point to a resource one level up in the heirarchy.

Rich hypermedia documents have many different hyperlinks. ORDS provides a mechanism to turn any column value into a hyperlink. Any column whose alias starts with the `$` character is treated as a hyperlink. The following example code snippet shows how an employee resource can provide a hyperlink to their manager:

```
begin
  ords.define_handler(
      p_module_name    => 'links.example',
      p_pattern        => ':id',
      p_source_type    => ords.source_type_collection_item,
      p_source         => 'select emp.empno "$.id", emp.*, emp.mgr
"$related" from emp where empno = :id');commit;end;
```

ORDS treats the column named `$related` to a hyperlink and the column value is treated as a path relative to the containing base URI of the resource. Similar to how `$.id` column value is transformed into an absolute URI by applying the algorithm specified in RFC 3986.

> **See Also:**
>
> Section 5.2 of rfc3986.

The following example code snippet shows the updated employee resource:

```
{
    "empno": 7369,
    "ename": "SMITH",
    "job": "CLERK",
    "mgr": 7902,
    "hiredate": "1980-12-17T00:00:00Z",
    "sal": 800,
    "comm": null,
    "deptno": 20,
    "links": [{
        "rel": "self",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/
7369"
    }, {
        "rel": "describedby",
        "href": "http://localhost:8080/ords/ordstest/metadata-catalog/
emp-collection/item"
    }, {
        "rel": "collection",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/"
    }, {
        "rel": "related",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/
7902"
    }]
}
```

Note that the new `related` link points to the manager resource of the employee. The manager resource in turn has a related link that points to their manager, and so on up the management chain until you reach employee number 7839 who is the president of the company and whose `mgr` column is `null`. If the column value is null, then ORDS will not create a hyperlink.

```
{
    "empno": 7839,
    "ename": "KING",
    "job": "PRESIDENT",
    "mgr": null,
    "hiredate": "1981-11-17T00:00:00Z",
    "sal": 5000,
    "comm": null,
    "deptno": 10,
    "links": [{
        "rel": "self",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/
7839"
    }, {
        "rel": "describedby",
        "href": "http://localhost:8080/ords/ordstest/metadata-catalog/
emp-collection/item"
    }, {
        "rel": "collection",
```

```
        "href": "http://localhost:8080/ords/ordstest/emp-collection/"
    }]
}
```

2.16.2.1 About the related Link Relation

This section explains the use of existing registered link relation types instead of extension link relation types.

As per RFC 8288 Section 2.1.2, any extension link relation must be an URI and not a simple value. This means that a link relation such as `manager` is not a legal link relation according to the specification. A custom link relation type will reduce interoperability. If your application uses a non-registered link relation type, then only a few clients will be able to understand the custom link relation type. Conversely, if you use registered link relation types, then more clients can navigate to your link relations. Oracle recommends using existing registered link relation types instead of extension link relation types.

Related Topics

- rfc8288

2.16.2.2 URL Resolution

This section describes how ORDS resolves column values using URI resolution algorithm.

Related Topics

- rfc3986

2.16.2.2.1 Child Paths

This section describes how to use the relative paths to refer to the child resources.

Following code snippet shows the use of relative paths to refer to child resources:

```
select'child/resource'"$related" from dual
```

Assuming that the base URL of the containing resource is `https://example.com/ords/some_schema_alias/some/resource`, then the link is as shown in the following code snippet:

```
{
 "rel": "related",
 "href": "https://example.com/ords/some_schema_alias/some/child/resource"
}
```

2.16.2.2.2 Ancestor Paths

This section provides examples to show how ORDS lets you use `../` and `./` syntax to refer to parent paths of the current resource.

Following is an example code snippet:

```
select'../'"$up", './'"$self" from dual
```

Assuming the base URL of the containing resource is `https://example.com/ords/some_schema_alias/some/collection/`, then the links will be as shown in the following code snippet:

```
{
 "rel": "up",
 "href": "https://example.com/ords/some_schema_alias/some/"
},
{
 "rel": "self",
 "href": "https://example.com/ords/some_schema_alias/some/collection/"
}
```

2.16.2.2.3 Absolute URLs

This section provides examples for the absolute paths.

A hyperlink value can be an absolute path or a fully qualified URL as shown in the following code snippet:

```
select'/cool/stuff'"$related", 'https://oracle.com/rest'"$related"
from dual
```

Assuming the base URL of the containing resource is, `https://example.com/ords/some_schema_alias/some/collection/` the links will be as shown in the following code snippet:

```
{
 "rel": "related",
 "href": "https://example.com/cool/stuff"
},
{
 "rel": "related",
 "href": "https://oracle.com/rest"
}
```

You can have multiple links for the same link relation.

2.16.2.2.4 Context Root Relative Paths

This section provides example for the context root relative path.

The context root relative path is the URL of the root resource of an ORDS enabled schema.

The following code snippet shows the context root path for the example discussed in the preceding sections:

```
https://example.com/ords/some_schema_alias/
```

ORDS provides the following syntax to express the resource paths relative to the URL:

```
select'^/another/collection/'"$related"from dual
```

Assuming the base URL of the containing resource is `https://example.com/ords/some_schema_alias/some/collection/`, the link is as shown in the following code snippet:

```
{
 "rel": "related",
 "href": "https://example.com/ords/some_schema_alias/another/collection"
}
```

Any path starting with `^/1` is resolved relative to the context root path.

2.16.2.2.5 Dynamic Paths

This section describes how you can have dynamic values for the hyperlinks.

Examples provided in the preceding sections use literal values for the hyperlinks. The hyperlink value can be completely dynamic, formed from any value that is a string (or can be automatically converted to a string). For example, instead of pointing directly to the employee resource, for managers only, you can point to a more specialized resource that can show additional information such as the total number of reports. The GET handler can be redefined for the `emp-collection` or `:id` resource as shown in the following code snippet:

```
begin
  ords.define_handler(
      p_module_name    => 'links.example',
      p_pattern        => ':id',
      p_source_type    => ords.source_type_collection_item,
      p_source         => 'select emp.empno "$.id", emp.*, decode(emp.mgr,
null, null, '^/managers/' || emp.mgr) "$related" from emp where empno
= :id');
     commit;
end;
```

Where:

- The value of the `$related` column is formed from `^/managers/: emp.mgr` unless the value of `emp.mgr` is `null`. In such a case, a `null` value is substituted that causes ORDS not to generate the hyperlink.

The following code snippet shows the updated employee resource:

```
{
    "empno": 7566,
    "ename": "JONES",
    "job": "MANAGER",
    "mgr": 7839,
    "hiredate": "1981-04-01T23:00:00Z",
    "sal": 2975,
    "comm": null,
    "deptno": 20,
    "links": [{
        "rel": "self",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/7566"
    }, {
        "rel": "describedby",
```

```
        "href": "http://localhost:8080/ords/ordstest/metadata-catalog/
emp-collection/item"
    }, {
        "rel": "collection",
        "href": "http://localhost:8080/ords/ordstest/emp-collection/"
    }, {
        "rel": "related",
        "href": "http://localhost:8080/ords/ordstest/managers/7839"
    }]
}
```

> **Note:**
>
> The `related` link now points to the dynamically generated path, that is, to the `managers/:id` resource.

2.17 About HTTP Error Responses

ORDS can now generate HTTP error responses in JSON or HTML format. Prior to ORDS release 20.4, only HTML responses were supported. To preserve the backward compatibility, by default, ORDS attempts to automatically determines the best format to render the error responses.

You can configure `error.responseFormat` setting and force ORDS to always render the error responses in either HTML or JSON format.

2.17.1 About error.responseFormat

The `error.responseFormat` setting is a global setting that supports the following values:

- html - Force all error responses to be in HTML format.
- json - Force all error responses to be in JSON format.
- auto (default value) - Automatically determine most appropriate format for a request.

2.17.1.1 HTML Mode

When `error.responseFormat` value is set to `html`, all the error responses are rendered in HTML format. This setting can be used to match the behaviour of ORDS 20.3.1 and prior releases. The HTML format displays properly in web-browsers. However, for non-human clients, HTML format is verbose and challenging to parse.

2.17.1.2 json Mode

When `error.responseFormat` value is set to `json`, all the error responses are rendered in JSON format. The JSON format complies with the Problem Details for HTTP APIs standard. The JSON format is terse, and straightforward for non-human clients to parse. However, it does not display properly in browsers and is not user friendly for non-technical users.

2.17.1.3 auto Mode

The default value for `error.responseFormat` is `auto`. When this value is configured, ORDS applies the following rules and automatically chooses the most appropriate format to use:

- If the client supplies an `Accept` request header, where `application/json` or `application/problem+json` is the most preferred media type, then the response must be in JSON format.
- If the client supplies an `Accept` request header where `text/html` is the most preferred media type, then the response must be in HTML format.
- If the client supplies a `X-Requested-With` header, then the response must be in JSON format. Presence of this header indicates that the request is initiated from the JavaScript code and so JSON would be the appropriate response format.
- If the client supplies an `Origin` header, then the response must be in JSON format. Presence of this header indicates that the request is initiated from the JavaScript code and so JSON would be the appropriate response format.
  - There is one exception to this rule, if the request method is `POST` and the `Content-Type` of the request is `application/x-www-form-urlencoded`, then the response will be in HTML format.
- If the client supplies a `User-Agent` header whose value starts with `curl/`, then the response must be in JSON format. cURL is a popular command line tool for making the HTTP requests. The terser JSON format is more readable in a command line environment. If none of the preceding rules apply, then the response will be in HTML format.

> **See Also:**
>
> cURL

3 Implicit Parameters

This chapter describes the implicit parameters used in REST service handlers that are not explicitly declared. Oracle REST Data Services (ORDS) adds these parameters automatically to the resource handlers.

3.1 List of Implicit Parameters

The following table lists the implicit parameters:

> **Note:**
>
> Parameter names are case sensitive. For example, :CURRENT_USER is not a valid implicit parameter.

Table 3-1 List of Implicit Parameters

Name	Type	Access Mode	HTTP Header	Description	Introduced
`:body`	BLOB	IN	N/A	Specifies the body of the request as a temporary BLOB.	2.0
`:body_text`	CLOB	IN	N/A	Specifies the body of the request as a temporary CLOB.	18.3

Table 3-1 (Cont.) List of Implicit Parameters

Name	Type	Access Mode	HTTP Header	Description	Introduced
`:content_type`	VARCHAR	IN	`Content-Type`	Specifies the MIME type of the request body, as indicated by the Content-Type request header.	2.0
`:current_user`	VARCHAR	IN	N/A	Specifies the authenticated user for the request. If no user is authenticated, then the value is set to null.	2.0
`:forward_location`	VARCHAR	OUT	`X-ORDS-FORWARD-LOCATION`	Specifies the location where Oracle REST Data Services must forward a GET request to produce the response for this request.	18.3

Table 3-1 (Cont.) List of Implicit Parameters

Name	Type	Access Mode	HTTP Header	Description	Introduced
`:fetch_offset`	NUMBER	IN	N/A	Specifies the zero-based offset of the first row to be displayed on a page.	18.3
`:fetch_size`	NUMBER	IN	N/A	Specifies the maximum number of rows to be retrieved on a page.	18.3
`:page_offset`	NUMBER	IN	N/A	Specifies the zero based page offset in a paginated request. **Note:** The `:page_offset` parameter is deprecated. Use `:row_offset` parameter instead.	2.0

Table 3-1 (Cont.) List of Implicit Parameters

Name	Type	Access Mode	HTTP Header	Description	Introduced
`:page_size`	NUMBER	IN	N/A	Specifies the maximum number of rows to be retrieved on a page. The `:page_size` parameter is deprecated. Use `:fetch_size` `parameter` instead.	2.0
`:row_offset`	NUMBER	IN	N/A	Specifies the one-based index of the first row to be displayed in a paginated request.	3.0
`:row_count`	NUMBER	IN	N/A	Specifies the one-based index of the last row to be displayed in a paginated request.	3.0

Table 3-1 (Cont.) List of Implicit Parameters

Name	Type	Access Mode	HTTP Header	Description	Introduced
`:status_code`	NUMBER	OUT	`X-ORDS-STATUS-CODE`	Specifies the HTTP status code for the request.	18.3

3.1.1 About the :body parameter

The `:body` implicit parameter is used in the resource handlers to receive the contents of the request body as a temporary BLOB.

> **Note:**
>
> Only POST or PUT requests can have a request body. The HTTP specification does not permit request bodies on GET or DELETE requests.

Example 3-1 Example

The following example illustrates a PL/SQL block that stores the request body in a database table:

```
begin
 insert into tab (content) values (:body);
end;
```

> **Note:**
>
> The `:body` implicit parameter **must** be dereferenced exactly once in a PL/SQL block. If it is dereferenced more than once, then the second and subsequent dereferences will appear to be empty. This is because the client sends the request body only once. If you need this value more than once, then assign it to a local variable, and dereference the local variable instead.
>
> You can use either one of the implicit parameters `:body` or `:body_text`. Otherwise, the PL/SQL block displays an error message "Duplicate steam parameter".
>
> If you use either `:body` or `:body_text`, then you cannot use `:bind` notation to read attributes of the JSON payload of the request.

The following example will **not** work as intended because it dereferences the `:body` parameter twice:

```
begin
 insert into tab1(content) values (:body); -- request body will be
inserted
 insert into tab2(content) values (:body); -- an empty blob will be
inserted
end;
```

To avoid this limitation, the `:body` parameter value must be assigned to a local PL/SQL variable before it is used. This enables the local variable to be dereferenced more than once:

```
declare
 l_content blob := :body;
begin
 insert into tabl(content) values(l_content);
 insert into tab2(content) values(l_content);
end;
```

3.1.2 About the :body_text Parameter

The `:body_text` implicit parameter is used in the resource handlers to receive the contents of the request body as a temporary CLOB. Typically, the content of the request body is textual (for example JSON or HTML content) and so, receiving the request body as a CLOB saves the resource handler author from the effort of converting the `:body` BLOB parameter to a CLOB instance.

> **Note:**
>
> `:body_text` implicit parameter must only be dereferenced once inside the entire PL/SQL block. If you need this value more than once, assign it to a local variable, and dereference the local variable instead.

You can use either one of the implicit parameters `:body` or `:body_text`. Otherwise, the PL/SQL block displays an error message "Duplicate steam parameter".

It is recommended to use `:body_text` (a character representation) rather than `:body` (a binary representation) particularly where the PL/SQL block uses JSON functions to process the request body efficiently.

3.1.3 About the :content_type Parameter

The `:content_type` implicit parameter provides the value of the Content-Type request header supplied with the request. If no Content-Type header is present in the request, then a null value is returned.

3.1.4 About the :current_user Parameter

The `:current_user` implicit parameter provides the identity of the user authenticated for the request.

> **Note:**
>
> In a scenario, where the user is not authenticated, the value is set to null. For example, if the request is for a public resource, then the value will be set to null.

3.1.5 About the :status_code Parameter

The `:status_code` implicit parameter enables a resource handler to indicate the HTTP status code value to include in a response. The value must be one of the numeric values defined in the **HTTP Specification** document.

3.1.6 About the :forward_location Parameter

The `:forward_location` implicit parameter provides a mechanism for PL/SQL based resource handlers to produce a response for a request.

Consider a POST request that results in the creation of a new resource. Typically, the response of a POST request for REST APIs contains the location of the newly created resource (in the Location response header) along with the representation of the new resource. The presence of the Location header in the response indicates that there must be a GET resource handler that can produce a response for the specified location.

Instead of applying logic to the POST resource handler to render the representation of the new resource in the response, the resource handler can delegate that task to the existing GET Resource Handler.

The following resource handler defines a POST handler that delegates the generation of the response to a GET resource handler:

```
ords.define_handler(
  p_module_name => 'tickets.collection',
  p_pattern => '.',
  p_method  => 'POST',
  p_mimes_allowed => 'application/json',
  p_source_type => ords.source_type_plsql,
  p_source => '
   declare
    l_owner varchar2(255);
    l_payload clob;
    l_id number;
   begin
    l_payload := :body_text;
    l_owner := :current_user;
    l_id := ticket_api.create_ticket(
```

```
      p_json_entity => l_payload,
      p_author => l_owner
    );
    :forward_location := ''./'' || l_id;
    :status_code := 201;
  end;
 '
);
```

Where:

- The `ords.define_handler` API is used to add a POST handler to an existing resource module named `tickets.collection`.
- The `p_pattern` with value '.' indicates that the POST handler should be bound to the root resource of the resource module. If the base path of the `tickets.collection`' is `/tickets/`, then the POST handler is bound to the `/tickets/` URL path.
- The `p_mimes_allowed` value indicates that the POST request must have a Content-Type header value of `application/json`'.
- The `p_source_type` value indicates that the source of the POST handler is a PL/SQL block.
- The `p_source` value contains the source of the PL/SQL block:

  Where:

  > **Note:**
  >
  > The `:body_text` implicit parameter is assigned to a local variable, so that it can be dereferenced more than once.

  – The identity of the user, making the POST request, is determined from the `:current_user` implicit parameter.

  – The PL/SQL block, delegates the task of storing the request payload to a PL/SQL package level function. The PL/SQL block should only contain logic to bridge from the HTTP request to the PL/SQL package invocation.

  > **Note:**
  >
  > When all the data modification operations are wrapped in a PL/SQL API, the PL/SQL block can be independently unit tested. Long and complicated PL/SQL blocks are an anti-pattern indicative of code that is difficult to test and maintain.

  – The PL/SQL package level function returns the ID of the newly created resource.

  – The `:forward_location` implicit parameter is assigned the value of `'./' || l_id`. For example, if the value of `l_id` is 4256, then the value of `:forward_location` is `/tickets/4256` .

When ORDS evaluates the preceding PL/SQL block and checks the value assigned to the `:forward_location` implicit parameter, it initiates a GET request against the specified location (for example, `/tickets/4256`) and return the response generated by the GET request as the response of the POST request. In addition, ORDS includes a location response header with the fully resolved URL of the `:forward_location` value.

– The `:status_code` implicit parameter is assigned the HTTP response status code value. The 201 (Created) status code indicates that a new resource is created. This value will override the status code generated by the GET request.

3.1.7 About the Pagination Implicit Parameters

The following table lists the pagination implicit parameters:

> **Note:**
>
> Oracle REST Data Services reserves the use of the query parameters, `page`, `offset`, and `limit`. It is not permitted to define REST services that use named bind parameters with any of the preceding query parameter names. Alternatively, REST services must use the appropriate pagination implicit parameters defined in the following table:

Table 3-2 Pagination Implicit Parameters

Name	Description	Status
`:page_offset`	Specifies the zero based page offset in a pagination request.	Deprecated
`:page_size`	Specifies the maximum number of rows to be retrieved on a page.	Deprecated
`:row_offset`	Specifies the index of the first row to be displayed in a pagination request.	Not Recommended
`:row_count`	Specifies the index of the last row to displayed in a pagination request.	Not Recommended
`:fetch_offset`	Specifies the zero based index of the first row to be displayed on a page.	Recommended
`:fetch_size`	Specifies the maximum number of rows to be retrieved on a page.	Recommended

3.1.7.1 About the :page_offset Parameter

The `:page_offset` implicit parameter is provided for backward compatibility, so it is used only with `source_type_query` source type resource handlers.

> **Note:**
>
> - The `source_type_query` source type is deprecated, instead use the `source_type_collection` feed parameter.
> - The `:page_offset` implicit parameter is deprecated, instead use the `:row_offset` implicit parameter.

3.1.7.2 About the :page_size Parameter

The `:page_size` implicit parameter is used to indicate the maximum number of rows to be retrieved on a page. `:page_size` parameter is provided for backward compatibility. This parameter is deprecated, instead use `:fetch_size` implicit parameter.

3.1.7.3 About the :row_offset Parameter

The `:row_offset` implicit parameter indicates the number of the first row to be displayed on a page. The `:row_offset` implicit parameter is used when you are using both a wrapper pagination query and `row_number()` (used in Oracle 11g and earlier releases). Starting Oracle 12c or later releases, Oracle recommends using the `:fetch_offset` implicit parameter and a row limiting clause instead of the `:row_offset` parameter.

3.1.7.4 About the :row_count Parameter

The `:row_count` implicit parameter is used to indicate the number of rows to be displayed on a page. The `:row_count` value is the value of the sum of `:row_offset` and the pagination size. The `:row_count` implicit parameter is useful when implementing pagination using a wrapper pagination query and `row_number()` method that was used in Oracle database 11g and earlier releases. Starting Oracle Database release 12c or later, Oracle recommends that you use `:fetch_size` parameter and a row limiting clause instead.

3.1.7.5 About the :fetch_offset Parameter

The `:fetch_offset` implicit parameter is used to indicate the zero based offset of the first row to display in a given page. The `:fetch_offset` implicit parameter is used when you implement pagination using a row limiting clause, which is recommended for use with Oracle 12c and later releases.

3.1.7.6 About the :fetch_size Parameter

The `:fetch_size` implicit parameter is used to indicate the maximum number of rows to retrieve on a page. ORDS always sets the value of `:fetch_size` to the pagination size plus one. The presence or absence of the extra row helps ORDS in determining if there is a subsequent page in the results or not.

> **Note:**
>
> The extra row that is queried is never displayed on the page.

3.1.7.7 About Automatic Pagination

This section describes the automatic pagination process.

If a GET resource handler source type, `source_type_collection_feed` or `source_type_query` has a non zero pagination size (`p_items_per_page`) and the source of the GET resource handler does not dereference any of the implicit pagination parameters discussed in the preceding sections, then ORDS automatically wraps the query in a pagination clause to constrain the query results to include only the values from the requested page. With automatic pagination, the resource handler author needs to specify only the pagination size, and ORDS automatically handles the remaining effort in paginating the resource.

> **Note:**
>
> All resource modules have a default pagination size (`p_items_per_page`) of 25. So, by default automatic pagination is enabled.

3.1.7.8 About Manual Pagination

This section describes the manual pagination process.

In some scenarios, a GET resource handler needs to perform pagination on its own rather than delegating the pagination process to ORDS. In such cases, the source of the GET resource handler will dereference one or more implicit pagination parameters discussed in the preceding sections.

> **Note:**
>
> The GET resource handler must specify the desired pagination size so that ORDS can correctly calculate the required values for the implicit pagination parameters.

Examples

Manual pagination example using row limiting clause

The following example defines a REST service that uses a row limiting clause to paginate the query result set. This is the recommended way to implement manual pagination:

```
begin
 ords.define_service(
   p_module_name => 'example.paging',
   p_base_path => '/example/',
   p_pattern => '/paged',
   p_items_per_page => 7,
```

```
   p_source => 'select * from emp e order by empno desc
offset :fetch_offset rows fetch next :fetch_size rows only'
 );
 commit;
end;
```

Manual pagination example using row_number() method

The following example defines a REST service that uses a wrapper query and `row_number()` method. This approach is not recommended.

```
begin
ords.define_service(
   p_module_name => 'example.paging',
   p_base_path => '/example/',
   p_pattern => '/paged',
   p_items_per_page => 7,
   p_source => 'select * from (select q_.* , row_number() over (order
by 1) rn__ from (select * from emp e order by empno desc) q_ )where
rn__ between :row_offset and :row_count'
 );
 commit;
end;
```

4

ORDS PL/SQL Package Reference

The ORDS PL/SQL package contains subprograms (procedures and functions) for developing RESTful services using Oracle REST Data Services.

Related Topics

- Using the Oracle REST Data Services PL/SQL API

4.1 ORDS.CREATE_ROLE

Format

```
ORDS.CREATE_ROLE(
   p_role_name IN sec_roles.name%type);
```

Description

CREATE_ROLE creates an Oracle REST Data Services role with the specified name.

Parameters

p_role_name
Name of the role.

Usage Notes

After the role is created, it can be associated with any Oracle REST Data Services privilege.

Examples

The following example creates a role.

```
EXECUTE ORDS.CREATE_ROLE(p_role_name=>'Tickets User');
```

4.2 ORDS.CREATE_SERVICE

> **Note:**
>
> ORDS.CREATE_SERVICE is deprecated. Use ORDS.DEFINE_SERVICE instead.

Format

```
ORDS.CREATE_SERVICE(
   p_module_name        IN ords_modules.name%type,
   p_base_path          IN ords_modules.uri_prefix%type,
   p_pattern            IN ords_templates.uri_template%type,
   p_method             IN ords_handlers.method%type DEFAULT 'GET',
   p_source_type        IN ords_handlers.source_type%type
```

```
                          DEFAULT ords.source_type_collection_feed,
  p_source               IN ords_handlers.source%type,
  p_items_per_page       IN ords_modules.items_per_page%type DEFAULT 25,
  p_status               IN ords_modules.status%type DEFAULT 'PUBLISHED',
  p_etag_type            IN ords_templates.etag_type%type DEFAULT 'HASH',
  p_etag_query           IN ords_templates.etag_query%type DEFAULT NULL,
  p_mimes_allowed        IN ords_handlers.mimes_allowed%type DEFAULT NULL,
  p_module_comments      IN ords_modules.comments%type DEFAULT NULL,
  p_template_comments    IN ords_modules.comments%type DEFAULT NULL,
  p_handler_comments     IN ords_modules.comments%type DEFAULT NULL);
```

Description

Creates a new RESTful service.

Parameters

p_module_name
The name of the RESTful service module. Case sensitive. Must be unique.

p_base_path
The base of the URI that is used to access this RESTful service. Example: `hr/` means that all URIs starting with `hr/` will be serviced by this resource module.

p_pattern
A matching pattern for the resource template. For example, a pattern of `/objects/:object/:id?` will match `/objects/emp/101` (matches a request for the item in the `emp` resource with `id` of 101) and will also match `/objects/emp/` (matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` or question mark modifier, which indicates that the `id` parameter is optional).

p_method
The HTTP method to which this handler will respond. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_source_type
The HTTP request method for this handler. Valid values:

- `source_type_collection_feed`. Executes a SQL query and transforms the result set into an Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_collection_item`. Executes a SQL query returning one row of data into a Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_media`. Executes a SQL query conforming to a specific format and turns the result set into a binary representation with an accompanying HTTP Content-Type header identifying the Internet media type of the representation. Result Format: Binary
- `source_type_plsql`. Executes an anonymous PL/SQL block and transforms any OUT or IN/OUT parameters into a JSON representation. Available only when the HTTP method is DELETE, PUT, or POST. Result Format: JSON

- `source_type_query || source_type_csv_query`. Executes a SQL query and transforms the result set into either an Oracle REST Data Services legacy JavaScript Object Notation (JSON) or CSV representation, depending on the format selected. Available when the HTTP method is GET. Result Format: JSON or CSV
- `source_type_query_one_row`. Executes a SQL query returning one row of data into an Oracle REST Data Services legacy JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_feed`. Executes a SQL query and transforms the results into a JSON Feed representation. Each item in the feed contains a summary of a resource and a hyperlink to a full representation of the resource. The first column in each row in the result set must be a unique identifier for the row and is used to form a hyperlink of the form: `path/to/feed/{id}`, with the value of the first column being used as the value for `{id}`. The other columns in the row are assumed to summarize the resource and are included in the feed. A separate resource template for the full representation of the resource should also be defined. Result Format: JSON

p_source
The source implementation for the selected HTTP method.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: NULL (defers to the resource module setting).

p_status
The publication status. Valid values: 'PUBLISHED' (default) or 'NOT_PUBLISHED'.

p_etag_type
A type of entity tag to be used by the resource template. An entity tag is an HTTP Header that acts as a version identifier for a resource. Use entity tag headers to avoid retrieving previously retrieved resources and to perform optimistic locking when updating resources. Valid values: 'HASH' or 'QUERY' or 'NONE'.

- HASH - Known as Secure HASH: The contents of the returned resource representation are hashed using a secure digest function to provide a unique fingerprint for a given resource version.
- QUERY - Manually define a query that uniquely identifies a resource version. A manually defined query can often generate an entity tag more efficiently than hashing the entire resource representation.
- NONE - Do not generate an entity tag.

p_etag_query
A query that is used to generate the entity tag.

p_mimes_allowed
A comma-separated list of MIME types that the handler will accept. Applies to PUT and POST only.

p_module_comments
Comment text.

p_template_comments
Comment text.

p_handler_comments
Comment text.

Usage Notes

Creates a resource module, template, and handler in one call.

This procedure is deprecated. Use ORDS.DEFINE_SERVICE instead.

Examples

The following example creates a simple service.

```
BEGIN
  ORDS.CREATE_SERVICE(
    p_module_name => 'my.tickets',
    p_base_path => '/my/tickets/',
    p_pattern => '.',
    p_source => 'select t.id "$.id", t.id, t.title from tickets t' ||
                ' where t.owner = :current_user order by t.updated_on desc'
  );
END;
/
```

4.3 ORDS.DEFINE_HANDLER

Format

```
ORDS.DEFINE_HANDLER(
p_module_name      IN ords_modules.name%type,
p_pattern          IN ords_templates.uri_template%type,
p_method           IN ords_handlers.method%type DEFAULT 'GET',
p_source_type      IN ords_handlers.source_type%type
DEFAULT ords.source_type_collection_feed,
p_source           IN ords_handlers.source%type,
p_items_per_page   IN ords_handlers.items_per_page%type DEFAULT NULL,
p_mimes_allowed    IN ords_handlers.mimes_allowed%type DEFAULT NULL,
p_comments         IN ords_handlers.comments%type DEFAULT NULL);
```

Description

DEFINE_HANDLER defines a module handler. If the handler already exists, then the handler and any existing handlers will be replaced by this definition; otherwise, a new handler is created.

Parameters

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
Matching pattern for the owning resource template.

p_method
The HTTP method to which this handler will respond. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_source_type
The HTTP request method for this handler. Valid values:

- `source_type_collection_feed`. Executes a SQL query and transforms the result set into an Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_collection_item`. Executes a SQL query returning one row of data into a Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_media`. Executes a SQL query conforming to a specific format and turns the result set into a binary representation with an accompanying HTTP Content-Type header identifying the Internet media type of the representation. Result Format: Binary
- `source_type_plsql`. Executes an anonymous PL/SQL block and transforms any OUT or IN/OUT parameters into a JSON representation. Available only when the HTTP method is DELETE, PUT, or POST. Result Format: JSON
- `source_type_query || source_type_csv_query`. Executes a SQL query and transforms the result set into either an Oracle REST Data Services legacy JavaScript Object Notation (JSON) or CSV representation, depending on the format selected. Available when the HTTP method is GET. Result Format: JSON or CSV
- `source_type_query_one_row`. Executes a SQL query returning one row of data into an Oracle REST Data Services legacy JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_feed`. Executes a SQL query and transforms the results into a JSON Feed representation. Each item in the feed contains a summary of a resource and a hyperlink to a full representation of the resource. The first column in each row in the result set must be a unique identifier for the row and is used to form a hyperlink of the form: `path/to/feed/{id}`, with the value of the first column being used as the value for `{id}`. The other columns in the row are assumed to summarize the resource and are included in the feed. A separate resource template for the full representation of the resource should also be defined. Result Format: JSON

p_source
The source implementation for the selected HTTP method.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: NULL (defers to the resource module setting).

p_mimes_allowed
Comma-separated list of MIME types that the handler will accept. Applies to PUT and POST only.

p_comments
Comment text.

Usage Notes

Only one handler for each HTTP method (source type) is permitted.

Examples

The following example defines a POST handler to the `/my/tickets/` resource to accept new tickets.

```
BEGIN
  ORDS.DEFINE_HANDLER(
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method  => 'POST',
    p_mimes_allowed => 'application/json',
    p_source_type => ords.source_type_plsql,
    p_source => '
      declare
        l_owner varchar2(255);
        l_payload blob;
        l_id number;
      begin
        l_payload := :body;
        l_owner := :owner;
        if ( l_owner is null ) then
          l_owner := :current_user;
        end if;
        l_id := ticket_api.create_ticket(
          p_json_entity => l_payload,
          p_author => l_owner
        );
        :location := ''./'' || l_id;
        :status := 201;
      end;
      '
  );
END;
/
```

4.4 ORDS.DEFINE_MODULE

Format

```
ORDS.DEFINE_MODULE(
   p_module_name     IN ords_modules.name%type,
   p_base_path       IN ords_modules.uri_prefix%type,
   p_items_per_page  IN ords_modules.items_per_page%type DEFAULT 25,
   p_status          IN ords_modules.status%type DEFAULT 'PUBLISHED',
   p_comments        IN ords_modules.comments%type DEFAULT NULL);
```

Description

DEFINE_MODULE defines a resource module. If the module already exists, then the module and any existing templates will be replaced by this definition; otherwise, a new module is created.

Parameters

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_base_path
The base of the URI that is used to access this RESTful service. Example: `hr/` means that all URIs starting with `hr/` will be serviced by this resource module.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: 25.

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

p_comments
Comment text.

Usage Notes

(None.)

Examples

The following example creates a simple module.

```
BEGIN
  ORDS.DEFINE_MODULE(
    p_module_name => 'my.tickets',
    p_base_path => '/my/tickets/'
  );
END;
/
```

4.5 ORDS.DEFINE_PARAMETER

Format

```
ORDS.DEFINE_PARAMETER(
   p_module_name        IN ords_modules.name%type,
   p_pattern            IN ords_templates.uri_template%type,
   p_method             IN ords_handlers.method%type,
   p_name               IN ords_parameters.name%type ,
   p_bind_variable_name IN ords_parameters.bind_variable_name%type
                              DEFAULT NULL,
   p_source_type        IN ords_parameters.source_type%type DEFAULT 'HEADER',
   p_param_type         IN ords_parameters.param_type%type DEFAULT 'STRING',
   p_access_method      IN ords_parameters.access_method%type DEFAULT 'IN',
   p_comments           IN ords_parameters.comments%type DEFAULT NULL);
```

Description

DEFINE_PARAMETER defines a module handler parameter. If the parameter already exists, then the parameter will be replaced by this definition; otherwise, a new parameter is created.

Parameters

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
Matching pattern for the owning resource template.

p_method
The owning handler HTTP Method. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_name
The name of the parameter, as it is named in the URI Template or HTTP Header. Used to map names that are not valid SQL parameter names.

p_bind_variable_name
The name of the parameter, as it will be referred to in the SQL. If NULL is specified, then the parameter is unbound.

p_source_type
The type that is identified if the parameter originates in the URI Template or a HTTP Header. Valid values: `HEADER`, `RESPONSE`, `URI`.

p_param_type
The native type of the parameter. Valid values: `STRING`, `INT`, `DOUBLE`, `BOOLEAN`, `LONG`, `TIMESTAMP`, `RESULTSET`.

p_access_method
The parameter access method. Indicates if the parameter is an input value, output value, or both. Valid values: `IN`, `OUT`, `INOUT`.

p_comments
Comment text.

Usage Notes

All parameters must have unique names and variable names for the same handler.

Examples

The following example defines an outbound parameter on the POST handler to store the location of the created ticket.

```
BEGIN
  ORDS.DEFINE_PARAMETER(
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method => 'POST',
    p_name => 'X-APEX-FORWARD',
    p_bind_variable_name => 'location',
    p_source_type => 'HEADER',
    p_access_method => 'OUT'
  );
END;
/
```

The following example defines an outbound parameter on the POST handler to store the HTTP status of the operation.

```
BEGIN
  ORDS.DEFINE_PARAMETER(
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method => 'POST',
    p_name => 'X-APEX-STATUS-CODE',
    p_bind_variable_name => 'status',
    p_source_type => 'HEADER',
    p_access_method => 'OUT'
  );
END;
/
```

4.6 ORDS.DEFINE_PRIVILEGE

Format

```
ORDS.DEFINE_PRIVILEGE(
   p_privilege_name     IN sec_privileges.name%type,
   p_roles              IN owa.vc_arr,
   p_patterns           IN owa.vc_arr,
   p_modules            IN owa.vc_arr,
   p_label              IN sec_privileges.label%type DEFAULT NULL,
   p_description        IN sec_privileges.description%type DEFAULT NULL,
   p_comments           IN sec_privileges.comments%type DEFAULT NULL);
or
ORDS.DEFINE_PRIVILEGE(
   p_privilege_name     IN sec_privileges.name%type,
   p_roles              IN owa.vc_arr,
   p_patterns           IN owa.vc_arr,
   p_label              IN sec_privileges.label%type DEFAULT NULL,
   p_description        IN sec_privileges.description%type DEFAULT NULL,
   p_comments           IN sec_privileges.comments%type DEFAULT NULL);
or
ORDS.DEFINE_PRIVILEGE(
   p_privilege_name     IN sec_privileges.name%type,
   p_roles              IN owa.vc_arr,
   p_label              IN sec_privileges.label%type DEFAULT NULL,
   p_description        IN sec_privileges.description%type DEFAULT NULL,
   p_comments           IN sec_privileges.comments%type DEFAULT NULL);
```

Description

DEFINE_PRIVILEGE defines an Oracle REST Data Services privilege. If the privilege already exists, then the privilege and any existing patterns and any associations with modules and roles will be replaced by this definition; otherwise, a new privilege is created.

Parameters

p_privilege_name
Name of the privilege. No spaces allowed.

p_roles
The names of the roles, at least one of which the privilege requires. May be empty, in which case the user must be authenticated but does not require any specific role; however, must not be null. Unauthenticated users will be denied access.

p_patterns
A list of patterns.

p_modules
A list of module names referencing modules created for the current schema.

p_label
Name of this security constraint as displayed to an end user. May be null.

p_description
A brief description of the purpose of the resources protected by this constraint.

p_comments
Comment text.

Usage Notes

`p_roles`, `p_patterns`, and `p_modules` do not accept null values. If no value is to be passed, then either choose the appropriate procedure specification or pass an empty `owa.vc_arr` value.

Examples

The following example creates a privilege connected to roles, patterns, and modules:

```
DECLARE
  l_priv_roles owa.vc_arr;
  l_priv_patterns owa.vc_arr;
  l_priv_modules owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';
  l_priv_patterns(1) := '/my/*';
  l_priv_patterns(2) := '/comments/*';
  l_priv_patterns(3) := '/tickets_feed/*';
  l_priv_patterns(4) := '/tickets/*';
  l_priv_patterns(5) := '/categories/*';
  l_priv_patterns(6) := '/stats/*';

  l_priv_modules(1) := 'my.tickets';

  ords.create_role('Tickets User');

  ords.define_privilege(
    p_privilege_name     => 'tickets.privilege',
    p_roles              => l_priv_roles,
    p_patterns           => l_priv_patterns,
    P_modules            => l_priv_modules,
    p_label              => 'Task Ticketing Access',
    p_description        => 'Provides the ability to create, ' ||
                            'update and delete tickets ' ||
                            'and post comments on tickets'
  );
END;
/
```

The following example creates a privilege connected to roles and patterns:

```
DECLARE
  l_priv_roles owa.vc_arr;
  l_priv_patterns owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';
  l_priv_patterns(1) := '/my/*';
  l_priv_patterns(2) := '/comments/*';
  l_priv_patterns(3) := '/tickets_feed/*';
  l_priv_patterns(4) := '/tickets/*';
  l_priv_patterns(5) := '/categories/*';
  l_priv_patterns(6) := '/stats/*';

  ords.create_role('Tickets User');

  ords.define_privilege(
    p_privilege_name     => 'tickets.privilege',
    p_roles              => l_priv_roles,
    p_patterns           => l_priv_patterns,
    p_label              => 'Task Ticketing Access',
    p_description        => 'Provides the ability to create, ' ||
                            'update and delete tickets ' ||
                            'and post comments on tickets'
  );
END;
/
```

The following example creates a privilege connected to roles:

```
DECLARE
  l_priv_roles owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';

  ords.create_role('Tickets User');

  ords.define_privilege(
    p_privilege_name     => 'tickets.privilege',
    p_roles              => l_priv_roles,
    p_label              => 'Task Ticketing Access',
    p_description        => 'Provides the ability to create, ' ||
                            'update and delete tickets ' ||
                            'and post comments on tickets'
  );
END;
/
```

4.7 ORDS.DEFINE_SERVICE

Format

```
ORDS.DEFINE_SERVICE(
   p_module_name        IN ords_modules.name%type,
   p_base_path          IN ords_modules.uri_prefix%type,
   p_pattern            IN ords_templates.uri_template%type,
   p_method             IN ords_handlers.method%type DEFAULT 'GET',
   p_source_type        IN ords_handlers.source_type%type
                             DEFAULT ords.source_type_collection_feed,
   p_source             IN ords_handlers.source%type,
```

```
p_items_per_page     IN ords_modules.items_per_page%type DEFAULT 25,
p_status             IN ords_modules.status%type DEFAULT 'PUBLISHED',
p_etag_type          IN ords_templates.etag_type%type DEFAULT 'HASH',
p_etag_query         IN ords_templates.etag_query%type DEFAULT NULL,
p_mimes_allowed      IN ords_handlers.mimes_allowed%type DEFAULT NULL,
p_module_comments    IN ords_modules.comments%type DEFAULT NULL,
p_template_comments  IN ords_modules.comments%type DEFAULT NULL,
p_handler_comments   IN ords_modules.comments%type DEFAULT NULL);
```

Description

DEFINE_SERVICE defines a resource module, template, and handler in one call. If the module already exists, then the module and any existing templates will be replaced by this definition; otherwise, a new module is created.

Parameters

p_module_name
Name of the RESTful service module. Case sensitive. Must be unique.

p_base_path
The base of the URI that is used to access this RESTful service. Example: `hr/` means that all URIs starting with `hr/` will be serviced by this resource module.

p_pattern
A matching pattern for the resource template. For example, a pattern of `/objects/:object/:id?` will match `/objects/emp/101` (matches a request for the item in the `emp` resource with `id` of 101) and will also match `/objects/emp/`. (Matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` modifier, which indicates that the `id` parameter is optional.)

p_method
The HTTP Method to which this handler will respond. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_source_type
The HTTP request method for this handler. Valid values:

- `source_type_collection_feed`. Executes a SQL query and transforms the result set into an Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_collection_item`. Executes a SQL query returning one row of data into a Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_media`. Executes a SQL query conforming to a specific format and turns the result set into a binary representation with an accompanying HTTP Content-Type header identifying the Internet media type of the representation. Result Format: Binary
- `source_type_plsql`. Executes an anonymous PL/SQL block and transforms any OUT or IN/OUT parameters into a JSON representation. Available only when the HTTP method is DELETE, PUT, or POST. Result Format: JSON

- `source_type_query || source_type_csv_query`. Executes a SQL query and transforms the result set into either an Oracle REST Data Services legacy JavaScript Object Notation (JSON) or CSV representation, depending on the format selected. Available when the HTTP method is GET. Result Format: JSON or CSV
- `source_type_query_one_row`. Executes a SQL query returning one row of data into an Oracle REST Data Services legacy JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_feed`. Executes a SQL query and transforms the results into a JSON Feed representation. Each item in the feed contains a summary of a resource and a hyperlink to a full representation of the resource. The first column in each row in the result set must be a unique identifier for the row and is used to form a hyperlink of the form: `path/to/feed/{id}`, with the value of the first column being used as the value for `{id}`. The other columns in the row are assumed to summarize the resource and are included in the feed. A separate resource template for the full representation of the resource should also be defined. Result Format: JSON

p_source
The source implementation for the selected HTTP method.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: NULL (defers to the resource module setting).

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

p_etag_type
A type of entity tag to be used by the resource template. An entity tag is an HTTP Header that acts as a version identifier for a resource. Use entity tag headers to avoid retrieving previously retrieved resources and to perform optimistic locking when updating resources. Valid values are `HASH`, `QUERY`, `NONE`:

- `HASH` (known as Secure HASH): The contents of the returned resource representation are hashed using a secure digest function to provide a unique fingerprint for a given resource version.
- `QUERY`: Manually define a query that uniquely identifies a resource version. A manually defined query can often generate an entity tag more efficiently than hashing the entire resource representation.
- `NONE`: Do not generate an entity tag.

p_etag_query
Query that is used to generate the entity tag.

p_mimes_allowed
Comma-separated list of MIME types that the handler will accept. Applies to PUT and POST only.

p_module_comments
Comment text.

p_template_comments
Comment text.

p_handler_comments
Comment text.

Usage Notes

Creates a resource module, template, and handler in one call.

Use this procedure instead of the deprecated ORDS.CREATE_SERVICE procedure.

Examples

The following example defines a REST service that retrieves the current user's tickets.

```
BEGIN
  ORDS.DEFINE_SERVICE(
    p_module_name => 'my.tickets',
    p_base_path => '/my/tickets/',
    p_pattern => '.',
    p_source => 'select t.id "$.id", t.id, t.title from tickets t' ||
                ' where t.owner = :current_user order by t.updated_on desc'
  );
END;
/
```

The following example defines a REST service that retrieves tickets filtered by category.

```
BEGIN
  ORDS.DEFINE_SERVICE(
    p_module_name => 'by.category',
    p_base_path => '/by/category/',
    p_pattern => ':category_id',
    p_source => 'select ''../../my/tickets/'' ||
                  t.id "$.id", t.id, t.title' ||
                ' from tickets t, categories c, ticket_categories tc' ||
                ' where c.id = :category_id and c.id = tc.category_id and' ||
                ' tc.ticket_id = t.id order by t.updated_on desc'
  );
END;
/
```

4.8 ORDS.DEFINE_TEMPLATE

Format

```
ORDS.DEFINE_TEMPLATE(
   p_module_name   IN ords_modules.name%type,
   p_pattern       IN ords_templates.uri_template%type,
   p_priority      IN ords_templates.priority%type DEFAULT 0,
   p_etag_type     IN ords_templates.etag_type%type DEFAULT 'HASH',
   p_etag_query    IN ords_templates.etag_query%type DEFAULT NULL,
   p_comments      IN ords_templates.comments%type DEFAULT NULL);
```

Description

DEFINE_TEMPLATE defines a resource template. If the template already exists, then the template and any existing handlers will be replaced by this definition; otherwise, a new template is created.

Parameters

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
A matching pattern for the resource template. For example, a pattern of `/objects/:object/:id?` will match `/objects/emp/101` (matches a request for the item in the `emp` resource with `id` of 101) and will also match `/objects/emp/`. (Matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` modifier, which indicates that the `id` parameter is optional.)

p_priority
The priority for the order of how the resource template should be evaluated: 0 (low priority. the default) through 9 (high priority).

p_etag_type
A type of entity tag to be used by the resource template. An entity tag is an HTTP Header that acts as a version identifier for a resource. Use entity tag headers to avoid retrieving previously retrieved resources and to perform optimistic locking when updating resources. Valid values are `HASH`, `QUERY`, `NONE`:

- `HASH` (known as Secure HASH): The contents of the returned resource representation are hashed using a secure digest function to provide a unique fingerprint for a given resource version.
- `QUERY`: Manually define a query that uniquely identifies a resource version. A manually defined query can often generate an entity tag more efficiently than hashing the entire resource representation.
- `NONE`: Do not generate an entity tag.

p_etag_query
Query that is used to generate the entity tag.

p_comments
Comment text.

Usage Notes

he resource template pattern must be unique with a resource module.

Examples

The following example defines a resource for displaying ticket items.

```
BEGIN
  ORDS.DEFINE_TEMPLATE(
    p_module_name => 'my.tickets',
    p_pattern => '/:id'
  );
END;
/
```

4.9 ORDS.DELETE_MODULE

Format

```
ORDS.DELETE_MODULE(
   p_module_name   IN ords_modules.name%type);
```

Description

DELETE_MODULE deletes a resource module.

Parameters

p_module_name
Name of the owning RESTful service module. Case sensitive.

Usage Notes

If the module does not already exist or is accessible to the current user, then no exception is raised.

Examples

The following example deletes a resource module.

```
EXECUTE ORDS.DELETE_MODULE(p_module_name=>'my.tickets');
```

4.10 ORDS.DELETE_PRIVILEGE

Format

```
ORDS.DELETE_PRIVILEGE(
   p_name   IN sec_privileges.name%type);
```

Description

DELETE_PRIVILEGE deletes a provilege.

Parameters

p_name
Name of the privilege.

Usage Notes

If the privilege does not already exist or is not accessible to the current user, then no exception is raised.

Examples

The following example deletes a privilege.

```
EXECUTE ORDS.DELETE_PRIVILEGE(p_name=>'tickets.privilege');
```

4.11 ORDS.DELETE_ROLE

Format

```
ORDS.DELETE_ROLE(
   p_role_name IN sec_roles.name%type);
```

Description

DELETE_ROLE deletes the named role.

Parameters

p_name
Name of the role.

Usage Notes

This will also delete any association between the role and any privileges that reference the role.

No exception is produced if the role does not already exist.

Examples

The following example deletes a role.

```
EXECUTE ORDS.DELETE_ROLE(p_role_name=>'Tickets User');
```

4.12 ORDS.DROP_REST_FOR_SCHEMA

Format

```
ORDS.DROP_REST_FOR_SCHEMA(
   p_schema ords_schemas.parsing_schema%type DEFAULT NULL);
```

Description

DROP_REST_FOR_SCHEMA deletes all auto-REST Oracle REST Data Services metadata for the associated schema.

Parameters

p_schema
Name of the schema.

Usage Notes

This procedure effectively "undoes" the actions performed by the `ORDS.Enable_Schema` procedure.

Examples

The following example deletes all auto-REST Oracle REST Data Services metadata for the TICKETS schema.

```
EXECUTE ORDS.DROP_REST_FOR_SCHEMA('tickets');
```

Related Topics

- ORDS.ENABLE_SCHEMA

4.13 ORDS.ENABLE_OBJECT

Format

```
ORDS.ENABLE_OBJECT(
   p_enabled         IN boolean DEFAULT TRUE,
   p_schema          IN ords_schemas.parsing_schema%type DEFAULT NULL,
   p_object          IN ords_objects.parsing_object%type,
   p_object_type     IN ords_objects.type%type DEFAULT 'TABLE',
   p_object_alias    IN ords_objects.object_alias%type DEFAULT NULL,
   p_auto_rest_auth  IN boolean DEFAULT NULL);
```

Description

`ENABLE_OBJECT` enables Oracle REST Data Services access to a specified function, materialized view, package, procedure, table, or view in a schema.

Parameters

p_enabled
`TRUE` to enable access; `FALSE` to disable access.

p_schema
Name of the schema for the table or view.

p_object
Name of the table or view.

p_object_type
Type of the object. Valid values: `FUNCTION`, `MVIEW`, `PACKAGE`, `PROCEDURE`, `TABLE` (default), or `VIEW`.

p_object_alias
Alias of the object.

p_auto_rest_auth
Controls whether Oracle REST Data Services should require user authorization before allowing access to the Oracle REST Data Services metadata for this object. If this value is `TRUE`, then the service is protected by the following roles:

- `oracle.dbtools.autorest.any.schema`
- `oracle.dbtools.role.autorest.<SCHEMANAME>.<OBJECTNAME>`

Usage Notes

Only database users with the DBA role can enable/access to objects that they do now own.

Examples

The following example enables a table named CATEGORIES.

```
EXECUTE ORDS.ENABLE_OBJECT(p_object=>'CATEGORIES');
```

The following example enables a view named TICKETS_FEED.

```
BEGIN
  ORDS.ENABLE_OBJECT(
    p_object => 'TICKETS_FEED',
    p_object_type => 'VIEW'
  );
END;
/
```

4.14 ORDS.DROP_REST_FOR_OBJECT

Format

```
ORDS.DROP_REST_FOR_OBJECT(
   p_object ords_objects.parsing_object%type);
```

Description

DROP_REST_FOR_OBJECT deletes all auto-REST Oracle REST Data Services metadata for the associated schema object.

Parameters

p_object
Name of the table or view.

Usage Notes

This procedure effectively "undoes" the actions performed by the `ORDS.ENABLE_OBJECT` procedure.

Examples

The following example deletes all auto-REST Oracle REST Data Services metadata for the curent user CATEGORIES table.

```
BEGIN
  ORDS.DROP_REST_FOR_OBJECT(
    p_object=>'CATEGORIES'
  );
END;
/
```

4.15 ORDS.ENABLE_SCHEMA

Format

```
ORDS.ENABLE_SCHEMA(
   p_enabled             IN boolean DEFAULT TRUE,
   p_schema              IN ords_schemas.parsing_schema%type DEFAULT NULL,
   p_url_mapping_type    IN ords_url_mappings.type%type DEFAULT 'BASE_PATH',
   p_url_mapping_pattern IN ords_url_mappings.pattern%type DEFAULT NULL,
   p_auto_rest_auth      IN boolean DEFAULT NULL);
```

Description

ENABLE_SCHEMA enables Oracle REST Data Services to access the named schema.

Parameters

p_enabled
`TRUE` to enable Oracle REST Data Services access; `FALSE` to disable Oracle REST Data Services access.

p_schema
Name of the schema. If the `p_schema` parameter is omitted, then the current schema is enabled.

p_url_mapping_type
URL Mapping type: `BASE_PATH` or `BASE_URL`.

p_url_mapping_pattern
URL mapping pattern.

p_auto_rest_auth
For a schema, controls whether Oracle REST Data Services should require user authorization before allowing access to the Oracle REST Data Services metadata catalog of this schema.

Usage Notes

Only database users with the DBA role can enable or disable a schema other than their own.

Examples

The following example enables the current schema.

```
EXECUTE ORDS.ENABLE_SCHEMA;
```

4.16 ORDS.PUBLISH_MODULE

Format

```
ORDS.PUBLISH_MODULE(
   p_module_name   IN ords_modules.name%type,
   p_status        IN ords_modules.status%type DEFAULT 'PUBLISHED');
```

Description

PUBLISH_MODULE changes the publication status of an Oracle REST Data Services resource module.

Parameters

p_module_name
Current name of the RESTful service module. Case sensitive.

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

Usage Notes

(None.)

Examples

The following example publishes a previously defined module named `my.tickets`.

```
EXECUTE ORDS.PUBLISH_MODULE(p_module_name=>'my.tickets');
```

4.17 ORDS.RENAME_MODULE

Format

```
ORDS.RENAME_MODULE(
   p_module_name    IN ords_modules.name%type,
   p_new_name       IN ords_modules.name%type DEFAULT NULL,
   p_new_base_path  IN ords_modules.uri_prefix%type DEFAULT NULL);
```

Description

RENAME_MODULE lets you change the name or the base path, or both, of an Oracle REST Data Services resource module.

Parameters

p_module_name
Current name of the RESTful service module. Case sensitive.

p_new_name
New name to be assigned to the RESTful service module. Case sensitive. If this parameter is null, the name is not changed.

p_new_base_path
The base of the URI to be used to access this RESTful service. Example: hr/ means that all URIs starting with hr/ will be serviced by this resource module. If this parameter is null, the base path is not changed.

Usage Notes

Both the new resource module name and the base path must be unique within the enabled schema.

Examples

The following example renames resource module `my.tickets` to `old.tickets`.

```
BEGIN
  ORDS.RENAME_MODULE(
    p_module_name =>'my.tickets',
    p_new_name=>'old.tickets',
    p_new_base_path=>'/old/tickets/');
END;
/
```

4.18 ORDS.RENAME_PRIVILEGE

Format

```
ORDS.RENAME_PRIVILEGE(
   p_name      IN sec_privileges.name%type,
   p_new_name  IN sec_privileges.name%type);
```

Description

RENAME_PRIVILEGE renames a privilege.

Parameters

p_name
Current name of the privilege.

p_new_name
New name to be assigned to the privilege.

Usage Notes

(None.)

Examples

The following example renames the privilege `tickets.privilege` to `old.tickets.privilege`.

```
BEGIN
  ORDS.RENAME_PRIVILEGE(
    p_name =>'tickets.privilege',
    p_new_name=>'old.tickets.privilege');
END;
/
```

4.19 ORDS.RENAME_ROLE

Format

```
ORDS.RENAME_ROLE(
   p_role_name  IN sec_roles.name%type,
   p_new_name   IN sec_roles.name%type);
```

Description

RENAME_ROLE renames a role.

Parameters

p_role_name
Current name of the role.

p_new_name
New name to be assigned to the role.

Usage Notes

`p_role_name` must exist.

Examples

The following example renames an existing role.

```
BEGIN
  ORDS.RENAME_ROLE(
    p_role_name=>'Tickets User',
    p_new_name=>'Legacy Tickets User');
END;
/
```

4.20 ORDS.SET_MODULE_ORIGINS_ALLOWED

Format

```
ORDS.SET_MODULE_ORIGINS_ALLOWED(
   p_module_name     IN ords_modules.name%type,
   p_origins_allowed IN sec_origins_allowed_modules.origins_allowed%type);
```

Description

SET_MODULE_ORIGINS_ALLOWED configures the allowed origins for a resource module. Any existing allowed origins will be replaced.

Parameters

p_module_name
Name of the resource module.

p_origins_allowed
A comma-separated list of URL prefixes. If the list is empty, any existing origins are removed.

Usage Notes

To indicate no allowed origins for a resource module (and remove any existing allowed origins), specify an empty `p_origins_allowed` value.

Examples

The following restricts the resource module `my.tickets` to two specified origins.

```
BEGIN
  ORDS.SET_MODULE_ORIGINS_ALLOWED(
    p_module_name     => 'my.tickets',
    p_origins_allowed => 'http://example.com,https://example.com');
END;
/
```

4.21 ORDS.SET_URL_MAPPING

Format

```
ORDS.SET_URL_MAPPING(
   p_schema              IN ords_schemas.parsing_schema%type DEFAULT NULL,
   p_url_mapping_type    IN ords_url_mappings.type%type,
   p_url_mapping_pattern IN ords_url_mappings.pattern%type);
```

Description

SET_URL_MAPPING configures how the specified schema is mapped to request URLs.

Parameters

p_schema
Name of the schema to map. The default is the schema of the current user.

p_url_mapping_type
URL Mapping type: `BASE_PATH` or `BASE_URL`.

p_url_mapping_pattern
URL mapping pattern.

Usage Notes

Only DBA users can update the mapping of a schema other than their own.

Examples

The following example creates a `BASE_PATH` mapping for the current user.

```
BEGIN
  ORDS.SET_URL_MAPPING(
    p_url_mapping_type    => 'BASE_PATH',
    p_url_mapping_pattern => 'https://example.com/ords/ticketing'
  );
END;
/
```

4.22 ORDS.SET_SESSION_DEFAULTS

Format

```
ORDS.SET_SESSION_DEFAULTS(
       p_runtime_user IN varchar2);
```

Description

Set defaults that apply for the duration of the database session.

Parameters

p_schema
Name of the schema to map. The default is the schema of the current user.

p_runtime_user
Sets a runtime user as the target when you REST enable or disable the schemas. Otherwise all runtime users are targeted.

Usage Notes

`NULL` values have no effect. Use `RESET_SESSION_DEFAULTS` to reset values and start again.

Examples

The following example sets the `HR` user as the only grantee target for the “connect through” proxy privilege when a schema is REST enabled or disabled:

```
BEGIN
  ORDS.SET_SESSION_DEFAULTS(
    p_runtime_user => 'HR');
END;
/
```

4.23 ORDS.RESET_SESSION_DEFAULTS

Format

```
ORDS.RESET_SESSION_DEFAULTS;
```

Description

Reset session defaults back to the initial values.

Parameters

None.

Usage Notes

Use the `SET_SESSION_DEFAULTS` function to set the default values that are reset using this function.

Examples

The following example resets all the session default values:

```
BEGIN
      ORDS.RESET_SESSION_DEFAULTS;
END;
/
```

4.24 ORDS.SET_PROPERTY

Format

```
ORDS.SET_PROPERTY(
      p_key             IN ords_prop_facts.key%type,
      p_value           IN ords_prop_values.value%type);
```

Description

`SET_PROPERTY` sets the value of the SCHEMA scoped property for the current enabled schema. The value must not be `NULL`.

Parameters

p_key
The property key.

p_value
The new property value.

Examples

The following example sets a property value:

```
BEGIN
  ORDS.SET_PROPERTY(
     p_key => 'a.key',
     p_value => 'a value');
END;
/
```

4.25 ORDS.UNSET_PROPERTY

Format

```
ORDS.UNSET_PROPERTY(
         p_key  IN ords_prop_facts.key%type);
```

Description

`UNSET_PROPERTY` unsets the value of the SCHEMA scoped property for the current enabled schema.

Parameters

p_key
The property key.

Examples

The following example unsets a property value:

```
BEGIN
  ORDS.UNSET_PROPERTY(
    p_key => 'a.key');
END;
/
```

5

Oracle REST Data Services Administration PL/SQL Package Reference

The Oracle REST Data Services (ORDS) ADMIN PL/SQL package contains subprograms (procedures and functions) for developing and administering the RESTful services using Oracle REST Data Services for a privileged user.

Before a database user can invoke the `ORDS_ADMIN` package, they must be granted the `ORDS_ADMINISTRATOR_ROLE` database role.

The following example grants the `ORDS_ADMINISTRATOR_ROLE` role to the `ADMIN` user:

```
GRANT ORDS_ADMINSTRATOR_ROLE TO ADMIN;
```

The `ORDS_ADMIN` package is identical to the ORDS package except for the `AUTHID CURRENT_USER` right, without the deprecated methods and a `p_schema` parameter for every method where the target schema must be specified and some additional methods.

Related Topics

- ORDS PL/SQL Package Reference

5.1 ORDS_ADMIN.CREATE_ROLE

Format

```
ORDS_ADMIN.CREATE_ROLE(
   p_schema    IN ords_schemas.parsing_schema%type,
   p_role_name IN sec_roles.name%type);
```

Description

CREATE_ROLE creates an Oracle REST Data Services role with the specified name.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_role_name
Name of the role.

Usage Notes

After the role is created, it can be associated with any Oracle REST Data Services privilege.

Examples

The following example creates a role.

```
BEGIN
  ORDS_ADMIN.CREATE_ROLE(
    p_schema => 'tickets',
    p_role_name => 'Tickets User');
END;
/
```

5.2 ORDS_ADMIN.DEFINE_HANDLER

Format

```
ORDS_ADMIN.DEFINE_HANDLER(
p_schema           IN ords_schemas.parsing_schema%type,
p_module_name      IN ords_modules.name%type,
p_pattern          IN ords_templates.uri_template%type,
p_method           IN ords_handlers.method%type DEFAULT 'GET',
p_source_type      IN ords_handlers.source_type%type
DEFAULT ords_admin.source_type_collection_feed,
p_source           IN ords_handlers.source%type,
p_items_per_page   IN ords_handlers.items_per_page%type DEFAULT NULL,
p_mimes_allowed    IN ords_handlers.mimes_allowed%type DEFAULT NULL,
p_comments         IN ords_handlers.comments%type DEFAULT NULL);
```

Description

DEFINE_HANDLER defines a module handler. If the handler already exists, then the handler and any existing handlers will be replaced by this definition; otherwise, a new handler is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
Matching pattern for the owning resource template.

p_method
The HTTP method to which this handler will respond. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_source_type
The HTTP request method for this handler. Valid values:

- `source_type_collection_feed`. Executes a SQL query and transforms the result set into an Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_collection_item`. Executes a SQL query returning one row of data into a Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_media`. Executes a SQL query conforming to a specific format and turns the result set into a binary representation with an accompanying HTTP Content-Type header identifying the Internet media type of the representation. Result Format: Binary
- `source_type_plsql`. Executes an anonymous PL/SQL block and transforms any OUT or IN/OUT parameters into a JSON representation. Available only when the HTTP method is DELETE, PUT, or POST. Result Format: JSON
- `source_type_query || source_type_csv_query`. Executes a SQL query and transforms the result set into either an Oracle REST Data Services legacy JavaScript Object Notation (JSON) or CSV representation, depending on the format selected. Available when the HTTP method is GET. Result Format: JSON or CSV
- `source_type_query_one_row`. Executes a SQL query returning one row of data into an Oracle REST Data Services legacy JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_feed`. Executes a SQL query and transforms the results into a JSON Feed representation. Each item in the feed contains a summary of a resource and a hyperlink to a full representation of the resource. The first column in each row in the result set must be a unique identifier for the row and is used to form a hyperlink of the form: `path/to/feed/{id}`, with the value of the first column being used as the value for `{id}`. The other columns in the row are assumed to summarize the resource and are included in the feed. A separate resource template for the full representation of the resource should also be defined. Result Format: JSON

p_source
The source implementation for the selected HTTP method.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: NULL (defers to the resource module setting).

p_mimes_allowed
Comma-separated list of MIME types that the handler will accept. Applies to PUT and POST only.

p_comments
Comment text.

Usage Notes

Only one handler for each HTTP method (source type) is permitted.

Examples

The following example defines a POST handler to the `/my/tickets/` resource to accept new tickets.

```
BEGIN
  ORDS_ADMIN.DEFINE_HANDLER(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method  => 'POST',
    p_mimes_allowed => 'application/json',
    p_source_type => ords_admin.source_type_plsql,
    p_source => '
      declare
        l_owner varchar2(255);
        l_payload blob;
        l_id number;
      begin
        l_payload := :body;
        l_owner := :owner;
        if ( l_owner is null ) then
          l_owner := :current_user;
        end if;
        l_id := ticket_api.create_ticket(
          p_json_entity => l_payload,
          p_author => l_owner
        );
        :location := ''./'' || l_id;
        :status := 201;
      end;
      '
  );
END;
/
```

5.3 ORDS_ADMIN.DEFINE_MODULE

Format

```
ORDS_ADMIN.DEFINE_MODULE(
   p_schema          IN ords_schemas.parsing_schema%type,
   p_module_name     IN ords_modules.name%type,
   p_base_path       IN ords_modules.uri_prefix%type,
   p_items_per_page  IN ords_modules.items_per_page%type DEFAULT 25,
   p_status          IN ords_modules.status%type DEFAULT 'PUBLISHED',
   p_comments        IN ords_modules.comments%type DEFAULT NULL);
```

Description

DEFINE_MODULE defines a resource module. If the module already exists, then the module and any existing templates will be replaced by this definition; otherwise, a new module is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_base_path
The base of the URI that is used to access this RESTful service. Example: `hr/` means that all URIs starting with `hr/` will be serviced by this resource module.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: 25.

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

p_comments
Comment text.

Usage Notes

(None.)

Examples

The following example creates a simple module.

```
BEGIN
  ORDS_ADMIN.DEFINE_MODULE(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_base_path => '/my/tickets/'
  );
END;
/
```

5.4 ORDS_ADMIN.DEFINE_PARAMETER

Format

```
ORDS_ADMIN.DEFINE_PARAMETER(
   p_schema             IN ords_schemas.parsing_schema%type,
   p_module_name        IN ords_modules.name%type,
   p_pattern            IN ords_templates.uri_template%type,
   p_method             IN ords_handlers.method%type,
   p_name               IN ords_parameters.name%type ,
   p_bind_variable_name IN ords_parameters.bind_variable_name%type
                              DEFAULT NULL,
   p_source_type        IN ords_parameters.source_type%type DEFAULT 'HEADER',
   p_param_type         IN ords_parameters.param_type%type DEFAULT 'STRING',
   p_access_method      IN ords_parameters.access_method%type DEFAULT 'IN',
   p_comments           IN ords_parameters.comments%type DEFAULT NULL);
```

Description

DEFINE_PARAMETER defines a module handler parameter. If the parameter already exists, then the parameter will be replaced by this definition; otherwise, a new parameter is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
Matching pattern for the owning resource template.

p_method
The owning handler HTTP Method. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_name
The name of the parameter, as it is named in the URI Template or HTTP Header. Used to map names that are not valid SQL parameter names.

p_bind_variable_name
The name of the parameter, as it will be referred to in the SQL. If NULL is specified, then the parameter is unbound.

p_source_type
The type that is identified if the parameter originates in the URI Template or a HTTP Header. Valid values: `HEADER`, `RESPONSE`, `URI`.

p_param_type
The native type of the parameter. Valid values: `STRING`, `INT`, `DOUBLE`, `BOOLEAN`, `LONG`, `TIMESTAMP`.

p_access_method
The parameter access method. Indicates if the parameter is an input value, output value, or both. Valid values: `IN`, `OUT`, `INOUT`.

p_comments
Comment text.

Usage Notes

All parameters must have unique names and variable names for the same handler.

Examples

The following example defines an outbound parameter on the POST handler to store the location of the created ticket.

```
BEGIN
  ORDS_ADMIN.DEFINE_PARAMETER(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method => 'POST',
    p_name => 'X-APEX-FORWARD',
    p_bind_variable_name => 'location',
    p_source_type => 'HEADER',
```

```
    p_access_method => 'OUT'
  );
END;
/
```

The following example defines an outbound parameter on the POST handler to store the HTTP status of the operation.

```
BEGIN
  ORDS_ADMIN.DEFINE_PARAMETER(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_pattern => '.',
    p_method => 'POST',
    p_name => 'X-APEX-STATUS-CODE',
    p_bind_variable_name => 'status',
    p_source_type => 'HEADER',
    p_access_method => 'OUT'
  );
END;
/
```

5.5 ORDS_ADMIN.DEFINE_PRIVILEGE

Format

```
ORDS_ADMIN.DEFINE_PRIVILEGE(
   p_schema            IN ords_schemas.parsing_schema%type,
   p_privilege_name    IN sec_privileges.name%type,
   p_roles             IN owa.vc_arr,
   p_patterns          IN owa.vc_arr,
   p_modules           IN owa.vc_arr,
   p_label             IN sec_privileges.label%type DEFAULT NULL,
   p_description       IN sec_privileges.description%type DEFAULT NULL,
   p_comments          IN sec_privileges.comments%type DEFAULT NULL);
or
ORDS_ADMIN.DEFINE_PRIVILEGE(
   p_schema            IN ords_schemas.parsing_schema%type,
   p_privilege_name    IN sec_privileges.name%type,
   p_roles             IN owa.vc_arr,
   p_patterns          IN owa.vc_arr,
   p_label             IN sec_privileges.label%type DEFAULT NULL,
   p_description       IN sec_privileges.description%type DEFAULT NULL,
   p_comments          IN sec_privileges.comments%type DEFAULT NULL);
or
ORDS_ADMIN.DEFINE_PRIVILEGE(
   p_schema            IN ords_schemas.parsing_schema%type,
   p_privilege_name    IN sec_privileges.name%type,
   p_roles             IN owa.vc_arr,
   p_label             IN sec_privileges.label%type DEFAULT NULL,
   p_description       IN sec_privileges.description%type DEFAULT NULL,
   p_comments          IN sec_privileges.comments%type DEFAULT NULL);
```

Description

DEFINE_PRIVILEGE defines an Oracle REST Data Services privilege. If the privilege already exists, then the privilege and any existing patterns and any associations with modules and roles will be replaced by this definition; otherwise, a new privilege is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_privilege_name
Name of the privilege. No spaces allowed.

p_roles
The names of the roles, at least one of which the privilege requires. May be empty, in which case the user must be authenticated but does not require any specific role; however, must not be null. Unauthenticated users will be denied access.

p_patterns
A list of patterns.

p_modules
A list of module names referencing modules created for the current schema.

p_label
Name of this security constraint as displayed to an end user. May be null.

p_description
A brief description of the purpose of the resources protected by this constraint.

p_comments
Comment text.

Usage Notes

`p_roles`, `p_patterns`, and `p_modules` do not accept null values. If no value is to be passed, then either choose the appropriate procedure specification or pass an empty `owa.vc_arr` value.

Examples

The following example creates a privilege connected to roles, patterns, and modules:

```
DECLARE
  l_priv_roles owa.vc_arr;
  l_priv_patterns owa.vc_arr;
  l_priv_modules owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';
  l_priv_patterns(1) := '/my/*';
  l_priv_patterns(2) := '/comments/*';
  l_priv_patterns(3) := '/tickets_feed/*';
  l_priv_patterns(4) := '/tickets/*';
  l_priv_patterns(5) := '/categories/*';
  l_priv_patterns(6) := '/stats/*';

  l_priv_modules(1) := 'my.tickets';

  ords_admin.create_role(
    p_schema    => 'tickets',
    p_role_name => 'Tickets User'
  );
```

```
  ords_admin.define_privilege(
    p_schema              => 'tickets',
    p_privilege_name      => 'tickets.privilege',
    p_roles               => l_priv_roles,
    p_patterns            => l_priv_patterns,
    P_modules             => l_priv_modules,
    p_label               => 'Task Ticketing Access',
    p_description         => 'Provides the ability to create, ' ||
                             'update and delete tickets ' ||
                             'and post comments on tickets'
  );
END;
/
```

The following example creates a privilege connected to roles and patterns:

```
DECLARE
  l_priv_roles owa.vc_arr;
  l_priv_patterns owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';
  l_priv_patterns(1) := '/my/*';
  l_priv_patterns(2) := '/comments/*';
  l_priv_patterns(3) := '/tickets_feed/*';
  l_priv_patterns(4) := '/tickets/*';
  l_priv_patterns(5) := '/categories/*';
  l_priv_patterns(6) := '/stats/*';

  ords_admin.create_role(
    p_schema    => 'tickets',
    p_role_name => 'Tickets User'
  );

  ords_admin.define_privilege(
    p_schema              => 'tickets',
    p_privilege_name      => 'tickets.privilege',
    p_roles               => l_priv_roles,
    p_patterns            => l_priv_patterns,
    p_label               => 'Task Ticketing Access',
    p_description         => 'Provides the ability to create, ' ||
                             'update and delete tickets ' ||
                             'and post comments on tickets'
  );
END;
/
```

The following example creates a privilege connected to roles:

```
DECLARE
  l_priv_roles owa.vc_arr;
BEGIN
  l_priv_roles(1) := 'Tickets User';

  ords_admin.create_role(
    p_schema    => 'tickets',
    p_role_name => 'Tickets User'
  );

  ords_admin.define_privilege(
    p_schema              => 'tickets',
    p_privilege_name      => 'tickets.privilege',
```

```
    p_roles              => l_priv_roles,
    p_label              => 'Task Ticketing Access',
    p_description        => 'Provides the ability to create, ' ||
                            'update and delete tickets ' ||
                            'and post comments on tickets'
  );
END;
/
```

5.6 ORDS_ADMIN.DEFINE_SERVICE

Format

```
ORDS_ADMIN.DEFINE_SERVICE(
   p_schema              IN ords_schemas.parsing_schema%type,
   p_module_name         IN ords_modules.name%type,
   p_base_path           IN ords_modules.uri_prefix%type,
   p_pattern             IN ords_templates.uri_template%type,
   p_method              IN ords_handlers.method%type DEFAULT 'GET',
   p_source_type         IN ords_handlers.source_type%type
                              DEFAULT ords_admin.source_type_collection_feed,
   p_source              IN ords_handlers.source%type,
   p_items_per_page      IN ords_modules.items_per_page%type DEFAULT 25,
   p_status              IN ords_modules.status%type DEFAULT 'PUBLISHED',
   p_etag_type           IN ords_templates.etag_type%type DEFAULT 'HASH',
   p_etag_query          IN ords_templates.etag_query%type DEFAULT NULL,
   p_mimes_allowed       IN ords_handlers.mimes_allowed%type DEFAULT NULL,
   p_module_comments     IN ords_modules.comments%type DEFAULT NULL,
   p_template_comments   IN ords_modules.comments%type DEFAULT NULL,
   p_handler_comments    IN ords_modules.comments%type DEFAULT NULL);
```

Description

DEFINE_SERVICE defines a resource module, template, and handler in one call. If the module already exists, then the module and any existing templates will be replaced by this definition; otherwise, a new module is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the RESTful service module. Case sensitive. Must be unique.

p_base_path
The base of the URI that is used to access this RESTful service. Example: `hr/` means that all URIs starting with `hr/` will be serviced by this resource module.

p_pattern
A matching pattern for the resource template. For example, a pattern of `/objects/:object/:id?` will match `/objects/emp/101` (matches a request for the item in the `emp` resource with `id` of 101) and will also match `/objects/emp/`. (Matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` modifier, which indicates that the `id` parameter is optional.)

p_method
The HTTP Method to which this handler will respond. Valid values: `GET` (retrieves a representation of a resource), `POST` (creates a new resource or adds a resource to a collection), `PUT` (updates an existing resource), `DELETE` (deletes an existing resource).

p_source_type
The HTTP request method for this handler. Valid values:

- `source_type_collection_feed`. Executes a SQL query and transforms the result set into an Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_collection_item`. Executes a SQL query returning one row of data into a Oracle REST Data Services Standard JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_media`. Executes a SQL query conforming to a specific format and turns the result set into a binary representation with an accompanying HTTP Content-Type header identifying the Internet media type of the representation. Result Format: Binary
- `source_type_plsql`. Executes an anonymous PL/SQL block and transforms any OUT or IN/OUT parameters into a JSON representation. Available only when the HTTP method is DELETE, PUT, or POST. Result Format: JSON
- `source_type_query || source_type_csv_query`. Executes a SQL query and transforms the result set into either an Oracle REST Data Services legacy JavaScript Object Notation (JSON) or CSV representation, depending on the format selected. Available when the HTTP method is GET. Result Format: JSON or CSV
- `source_type_query_one_row`. Executes a SQL query returning one row of data into an Oracle REST Data Services legacy JSON representation. Available when the HTTP method is GET. Result Format: JSON
- `source_type_feed`. Executes a SQL query and transforms the results into a JSON Feed representation. Each item in the feed contains a summary of a resource and a hyperlink to a full representation of the resource. The first column in each row in the result set must be a unique identifier for the row and is used to form a hyperlink of the form: `path/to/feed/{id}`, with the value of the first column being used as the value for `{id}`. The other columns in the row are assumed to summarize the resource and are included in the feed. A separate resource template for the full representation of the resource should also be defined. Result Format: JSON

p_source
The source implementation for the selected HTTP method.

p_items_per_page
The default pagination for a resource handler HTTP operation GET method, that is, the number of rows to return on each page of a JSON format result set based on a database query. Default: NULL (defers to the resource module setting).

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

p_etag_type
A type of entity tag to be used by the resource template. An entity tag is an HTTP Header that acts as a version identifier for a resource. Use entity tag headers to avoid retrieving previously retrieved resources and to perform optimistic locking when updating resources. Valid values are `HASH`, `QUERY`, `NONE`:

- `HASH` (known as Secure HASH): The contents of the returned resource representation are hashed using a secure digest function to provide a unique fingerprint for a given resource version.
- `QUERY`: Manually define a query that uniquely identifies a resource version. A manually defined query can often generate an entity tag more efficiently than hashing the entire resource representation.
- `NONE`: Do not generate an entity tag.

p_etag_query
Query that is used to generate the entity tag.

p_mimes_allowed
Comma-separated list of MIME types that the handler will accept. Applies to PUT and POST only.

p_module_comments
Comment text.

p_template_comments
Comment text.

p_handler_comments
Comment text.

Usage Notes

Creates a resource module, template, and handler in one call.

Examples

The following example defines a REST service that retrieves the current user's tickets.

```
BEGIN
  ORDS_ADMIN.DEFINE_SERVICE(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_base_path => '/my/tickets/',
    p_pattern => '.',
    p_source => 'select t.id "$.id", t.id, t.title from tickets t' ||
                ' where t.owner = :current_user order by t.updated_on desc'
  );
END;
/
```

The following example defines a REST service that retrieves tickets filtered by category.

```
BEGIN
  ORDS_ADMIN.DEFINE_SERVICE(
    p_schema => 'tickets',
    p_module_name => 'by.category',
    p_base_path => '/by/category/',
    p_pattern => ':category_id',
    p_source => 'select ''../../my/tickets/'' ||
                  t.id "$.id", t.id, t.title' ||
                ' from tickets t, categories c, ticket_categories tc' ||
                ' where c.id = :category_id and c.id = tc.category_id and' ||
                ' tc.ticket_id = t.id order by t.updated_on desc'
```

```
  );
END;
/
```

5.7 ORDS_ADMIN.DEFINE_TEMPLATE

Format

```
ORDS_ADMIN.DEFINE_TEMPLATE(
   p_schema       IN ords_schemas.parsing_schema%type,
   p_module_name  IN ords_modules.name%type,
   p_pattern      IN ords_templates.uri_template%type,
   p_priority     IN ords_templates.priority%type DEFAULT 0,
   p_etag_type    IN ords_templates.etag_type%type DEFAULT 'HASH',
   p_etag_query   IN ords_templates.etag_query%type DEFAULT NULL,
   p_comments     IN ords_templates.comments%type DEFAULT NULL);
```

Description

DEFINE_TEMPLATE defines a resource template. If the template already exists, then the template and any existing handlers will be replaced by this definition; otherwise, a new template is created.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the owning RESTful service module. Case sensitive.

p_pattern
A matching pattern for the resource template. For example, a pattern of `/objects/:object/:id?` will match `/objects/emp/101` (matches a request for the item in the `emp` resource with `id` of 101) and will also match `/objects/emp/`. (Matches a request for the `emp` resource, because the `:id` parameter is annotated with the `?` modifier, which indicates that the `id` parameter is optional.)

p_priority
The priority for the order of how the resource template should be evaluated: 0 (low priority. the default) through 9 (high priority).

p_etag_type
A type of entity tag to be used by the resource template. An entity tag is an HTTP Header that acts as a version identifier for a resource. Use entity tag headers to avoid retrieving previously retrieved resources and to perform optimistic locking when updating resources. Valid values are `HASH`, `QUERY`, `NONE`:

- `HASH` (known as Secure HASH): The contents of the returned resource representation are hashed using a secure digest function to provide a unique fingerprint for a given resource version.
- `QUERY`: Manually define a query that uniquely identifies a resource version. A manually defined query can often generate an entity tag more efficiently than hashing the entire resource representation.

- `NONE`: Do not generate an entity tag.

p_etag_query
Query that is used to generate the entity tag.

p_comments
Comment text.

Usage Notes

he resource template pattern must be unique with a resource module.

Examples

The following example defines a resource for displaying ticket items.

```
BEGIN
  ORDS_ADMIN.DEFINE_TEMPLATE(
    p_schema => 'tickets',
    p_module_name => 'my.tickets',
    p_pattern => '/:id'
  );
END;
/
```

5.8 ORDS_ADMIN.DELETE_MODULE

Format

```
ORDS_ADMIN.DELETE_MODULE(
   p_schema       IN ords_schemas.parsing_schema%type,
   p_module_name  IN ords_modules.name%type);
```

Description

DELETE_MODULE deletes a resource module.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the owning RESTful service module. Case sensitive.

Usage Notes

If the module does not already exist or is accessible to the current user, then no exception is raised.

Examples

The following example deletes a resource module.

```
BEGIN
  ORDS_ADMIN.DELETE_MODULE(
    p_schema => 'tickets',
    p_module_name => 'my.tickets'
  );
```

```
END;
/
```

5.9 ORDS_ADMIN.DELETE_PRIVILEGE

Description

DELETE_PRIVILEGE deletes a privilege.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_name
Name of the privilege.

Usage Notes

If the privilege does not already exist, then no exception is raised.

Examples

The following example deletes a privilege.

```
BEGIN
  ORDS_ADMIN.DELETE_PRIVILEGE(
    p_schema => 'tickets',
    p_name => 'tickets.privilege'
  );
END;
/
```

5.10 ORDS_ADMIN.DELETE_ROLE

Format

```
ORDS_ADMIN.DELETE_ROLE(
   p_schema    IN ords_schemas.parsing_schema%type,
   p_role_name IN sec_roles.name%type);
```

Description

DELETE_ROLE deletes the named role.

Parameters

p_name
Name of the role.

Usage Notes

This will also delete any association between the role and any privileges that reference the role.

No exception is produced if the role does not already exist.

Examples

The following example deletes a role.

```
BEGIN
  ORDS_ADMIN.DELETE_ROLE(
    p_schema => 'tickets',
    p_role_name => 'Tickets User'
  );
END;
/
```

5.11 ORDS_ADMIN.DROP_REST_FOR_SCHEMA

Format

```
ORDS_ADMIN.DROP_REST_FOR_SCHEMA(
   p_schema ords_schemas.parsing_schema%type);
```

Description

DROP_REST_FOR_SCHEMA deletes all auto-REST Oracle REST Data Services metadata for the associated schema.

Parameters

p_schema
Name of the schema.

Usage Notes

This procedure effectively "undoes" the actions performed by the `ORDS.Enable_Schema` procedure.

Examples

The following example deletes all auto-REST Oracle REST Data Services metadata for the TICKETS schema.

```
BEGIN
  ORDS_ADMIN.DROP_REST_FOR_SCHEMA(
    p_schema => 'tickets'
  );
END;
/
```

5.12 ORDS_ADMIN.ENABLE_OBJECT

Format

```
ORDS_ADMIN.ENABLE_OBJECT(
   p_enabled         IN boolean DEFAULT TRUE,
   p_schema          IN ords_schemas.parsing_schema%,
   p_object          IN ords_objects.parsing_object%type,
   p_object_type     IN ords_objects.type%type DEFAULT 'TABLE',
   p_object_alias    IN ords_objects.object_alias%type DEFAULT NULL,
   p_auto_rest_auth  IN boolean DEFAULT NULL);
```

Description

`ENABLE_OBJECT` enables Oracle REST Data Services access to a specified function, materialized view, package, procedure, table, or view in a schema.

Parameters

p_enabled
`TRUE` to enable access; `FALSE` to disable access.

p_schema
Name of the schema for the table or view. This parameter is mandatory.

p_object
Name of the table or view.

p_object_type
Type of the object. Valid values: `FUNCTION`, `MVIEW`, `PACKAGE`, `PROCEDURE`, `TABLE` (default), or `VIEW`.

p_object_alias
Alias of the object.

p_auto_rest_auth
Controls whether Oracle REST Data Services should require user authorization before allowing access to the Oracle REST Data Services metadata for this object. If this value is `TRUE`, then the service is protected by the following roles:

- `oracle.dbtools.autorest.any.schema`
- `oracle.dbtools.role.autorest.<SCHEMANAME>.<OBJECTNAME>`

Usage Notes

None.

Examples

The following example enables a table named CATEGORIES.

```
BEGIN
  ORDS_ADMIN.ENABLE_OBJECT(
    p_schema => 'tickets',
    p_object=>'CATEGORIES'
  );
END;
/
```

The following example enables a view named TICKETS_FEED.

```
BEGIN
  ORDS_ADMIN.ENABLE_OBJECT(
    p_schema => 'tickets',
    p_object => 'TICKETS_FEED',
    p_object_type => 'VIEW'
  );
END;
/
```

5.13 ORDS_ADMIN.DROP_REST_FOR_OBJECT

Format

```
ORDS_ADMIN.DROP_REST_FOR_OBJECT(
   p_schema          IN ords_schemas.parsing_schema%,
   p_object          IN ords_objects.parsing_object%type);
```

Description

DROP_REST_FOR_OBJECT deletes all auto-REST Oracle REST Data Services metadata for the associated schema object.

Parameters

p_schema
Name of the schema.

p_object
Name of the table or view.

Usage Notes

This procedure effectively "undoes" the actions performed by the `ORDS_ADMIN.ENABLE_OBJECT` procedure.

Examples

The following example deletes all auto-REST Oracle REST Data Services metadata for the TICKETS schema CATEGORIES table.

```
BEGIN
  ORDS_ADMIN.DROP_REST_FOR_OBJECT(
    p_schema => 'tickets',
    p_object=>'CATEGORIES'
  );
END;
/
```

5.14 ORDS_ADMIN.ENABLE_SCHEMA

Format

```
ORDS_ADMIN.ENABLE_SCHEMA(
   p_enabled              IN boolean DEFAULT TRUE,
   p_schema               IN ords_schemas.parsing_schema%type,
   p_url_mapping_type     IN ords_url_mappings.type%type DEFAULT 'BASE_PATH',
   p_url_mapping_pattern  IN ords_url_mappings.pattern%type DEFAULT NULL,
   p_auto_rest_auth       IN boolean DEFAULT NULL);
```

Description

ENABLE_SCHEMA enables Oracle REST Data Services to access the named schema.

Parameters

p_enabled
TRUE to enable Oracle REST Data Services access; FALSE to disable Oracle REST Data Services access.

p_schema
Name of the schema. This parameter is mandatory.

p_url_mapping_type
URL Mapping type: BASE_PATH or BASE_URL.

p_url_mapping_pattern
URL mapping pattern.

p_auto_rest_auth
For a schema, controls whether Oracle REST Data Services should require user authorization before allowing access to the Oracle REST Data Services metadata catalog of this schema.

Usage Notes

None.

Examples

The following example enables the current schema.

```
BEGIN
  ORDS_ADMIN.ENABLE_SCHEMA(
    p_schema => 'tickets'
  );
END;
/
```

5.15 ORDS_ADMIN.PUBLISH_MODULE

Format

```
ORDS_ADMIN.PUBLISH_MODULE(
   p_schema        IN ords_schemas.parsing_schema%type,
   p_module_name   IN ords_modules.name%type,
   p_status        IN ords_modules.status%type DEFAULT 'PUBLISHED');
```

Description

PUBLISH_MODULE changes the publication status of an Oracle REST Data Services resource module.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Current name of the RESTful service module. Case sensitive.

p_status
Publication status. Valid values: `PUBLISHED` (default) or `NOT_PUBLISHED`.

Usage Notes

(None.)

Examples

The following example publishes a previously defined module named `my.tickets`.

```
BEGIN
  ORDS_ADMIN.PUBLISH_MODULE(
    p_schema => 'tickets',
    p_module_name => 'my.tickets'
  );
END;
/
```

5.16 ORDS_ADMIN.RENAME_MODULE

Format

```
ORDS_ADMIN.RENAME_MODULE(
   p_schema         IN ords_schemas.parsing_schema%type,
   p_module_name    IN ords_modules.name%type,
   p_new_name       IN ords_modules.name%type DEFAULT NULL,
   p_new_base_path  IN ords_modules.uri_prefix%type DEFAULT NULL);
```

Description

RENAME_MODULE lets you change the name or the base path, or both, of an Oracle REST Data Services resource module.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Current name of the RESTful service module. Case sensitive.

p_new_name
New name to be assigned to the RESTful service module. Case sensitive. If this parameter is null, the name is not changed.

p_new_base_path
The base of the URI to be used to access this RESTful service. Example: hr/ means that all URIs starting with hr/ will be serviced by this resource module. If this parameter is null, the base path is not changed.

Usage Notes

Both the new resource module name and the base path must be unique within the enabled schema.

Examples

The following example renames resource module `my.tickets` to `old.tickets`.

```
BEGIN
  ORDS_ADMIN.RENAME_MODULE(
    p_schema => 'tickets',
    p_module_name =>'my.tickets',
    p_new_name=>'old.tickets',
    p_new_base_path=>'/old/tickets/');
END;
/
```

5.17 ORDS_ADMIN.RENAME_PRIVILEGE

Format

```
ORDS_ADMIN.RENAME_PRIVILEGE(
   p_schema     IN ords_schemas.parsing_schema%type,
   p_name       IN sec_privileges.name%type,
   p_new_name   IN sec_privileges.name%type);
```

Description

RENAME_PRIVILEGE renames a privilege.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_name
Current name of the privilege.

p_new_name
New name to be assigned to the privilege.

Usage Notes

(None.)

Examples

The following example renames the privilege `tickets.privilege` to `old.tickets.privilege`.

```
BEGIN
  ORDS_ADMIN.RENAME_PRIVILEGE(
    p_schema => 'tickets',
    p_name =>'tickets.privilege',
    p_new_name=>'old.tickets.privilege');
END;
/
```

5.18 ORDS_ADMIN.RENAME_ROLE

Format

```
ORDS_ADMIN.RENAME_ROLE(
   p_schema     IN ords_schemas.parsing_schema%type,
   p_role_name  IN sec_roles.name%type,
   p_new_name   IN sec_roles.name%type);
```

Description

RENAME_ROLE renames a role.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_role_name
Current name of the role.

p_new_name
New name to be assigned to the role.

Usage Notes

`p_role_name` must exist.

Examples

The following example renames an existing role.

```
BEGIN
  ORDS_ADMIN.RENAME_ROLE(
    p_schema=>'tickets',
    p_role_name=>'Tickets User',
    p_new_name=>'Legacy Tickets User');
END;
/
```

5.19 ORDS_ADMIN.SET_MODULE_ORIGINS_ALLOWED

Format

```
ORDS_ADMIN.SET_MODULE_ORIGINS_ALLOWED(
   p_schema          IN ords_schemas.parsing_schema%type,
   p_module_name     IN ords_modules.name%type,
   p_origins_allowed IN sec_origins_allowed_modules.origins_allowed%type);
```

Description

SET_MODULE_ORIGINS_ALLOWED configures the allowed origins for a resource module. Any existing allowed origins will be replaced.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_module_name
Name of the resource module.

p_origins_allowed
A comma-separated list of URL prefixes. If the list is empty, any existing origins are removed.

Usage Notes

To indicate no allowed origins for a resource module (and remove any existing allowed origins), specify an empty `p_origins_allowed` value.

Examples

The following restricts the resource module `my.tickets` to two specified origins.

```
BEGIN
  ORDS_ADMIN.SET_MODULE_ORIGINS_ALLOWED(
    p_schema          => 'tickets',
    p_module_name     => 'my.tickets',
    p_origins_allowed => 'http://example.com,https://example.com');
END;
/
```

5.20 ORDS_ADMIN.SET_URL_MAPPING

Format

```
ORDS_ADMIN.SET_URL_MAPPING(
   p_schema              IN ords_schemas.parsing_schema%,
   p_url_mapping_type    IN ords_url_mappings.type%type,
   p_url_mapping_pattern IN ords_url_mappings.pattern%type);
```

Description

SET_URL_MAPPING configures how the specified schema is mapped to request URLs.

Parameters

p_schema
Name of the schema to map. This parameter is mandatory.

p_url_mapping_type
URL Mapping type: `BASE_PATH` or `BASE_URL`.

p_url_mapping_pattern
URL mapping pattern.

Usage Notes

(None.)

Examples

The following example creates a `BASE_PATH` mapping for the tickets user.

```
BEGIN
  ORDS_ADMIN.SET_URL_MAPPING(
    p_schema              => 'tickets',
    p_url_mapping_type    => 'BASE_PATH',
    p_url_mapping_pattern => 'https://example.com/ords/ticketing'
  );
END;
/
```

5.21 ORDS_ADMIN.ENABLE_HOUSEKEEPING_JOB

Format

```
ORDS_ADMIN.ENABLE_HOUSEKEEPING_JOB(p_enabled IN boolean DEFAULT TRUE);
```

Description

`ENABLE_HOUSEKEEPING_JOB` creates and enables or disables the ORDS `DBMS_SCHEDULER` housekeeping job. The job name is `ORDS_HOUSEKEEPING_JOB` which replaces the deprecated job, `CLEAN_OLD_ORDS_SESSIONS`.

Parameters

p_enabled
`TRUE` to enable ORDS HOUSEKEEPING_JOB; `FALSE` to disable it. A NULL value will create and enable the job if it does not already exist otherwise its enablement state will remain changed.

Usage Notes

The job runs every hour and performs housekeeping actions on the ORDS metadata repository. No commit is required.

Examples

The following example enables the housekeeping job:

```
EXECUTE ORDS_ADMIN.ENABLE_HOUSEKEEPING_JOB;
```

5.22 ORDS_ADMIN.DROP_HOUSEKEEPING_JOB

Format

```
ORDS_ADMIN.DROP_HOUSEKEEPING_JOB;
```

Description

`DROP_HOUSEKEEPING_JOB` drops the ORDS `DBMS_SCHEDULER` housekeeping job. The job name is `ORDS_HOUSEKEEPING_JOB`.

Parameters

None.

Usage Notes

No commit is required.

Examples

The following example drops the housekeeping job:

```
EXECUTE ORDS_ADMIN.DROP_HOUSEKEEPING_JOB;
```

5.23 ORDS_ADMIN.PERFORM_HOUSEKEEPING

Format

```
ORDS_ADMIN.PERFORM_HOUSEKEEPING;
```

Description

`PERFORM_HOUSEKEEPING` performs ORDS housekeeping actions immediately. The following action is performed:

- Removes expired sessions that are older than one day.

Parameters

None.

Usage Notes

No commit is required.

Examples

The following example performs the housekeeping actions immediately against the ORDS metadata repository:

```
EXECUTE ORDS_ADMIN.PERFORM_HOUSEKEEPING;
```

5.24 ORDS_ADMIN.SET_SESSION_DEFAULTS

Format

```
ORDS_ADMIN.SET_SESSION_DEFAULTS(
       p_runtime_user IN varchar2);
```

Description

Sets the default values that apply for the duration of the database session.

Parameters

p_runtime_user
Sets a runtime user as the target while REST enabling or disabling the schemas. Otherwise all runtime users are targeted.

Usage Notes

`NULL` values have no effect. Use `RESET_SESSION_DEFAULTS` function to reset the values and start again.

Examples

The following example sets the `HR` user as the only grantee target for the “connect through” proxy privilege when a schema is REST enabled or disabled:

```
BEGIN
  ORDS_ADMIN.SET_SESSION_DEFAULTS(
    p_runtime_user => 'HR');
END;
/
```

5.25 ORDS_ADMIN.RESET_SESSION_DEFAULTS

Format

```
ORDS_ADMIN.RESET_SESSION_DEFAULTS
```

Description

Resets the session defaults back to the initial values.

Parameters

None.

Usage Notes

Use `SET_SESSION_DEFAULTS` function to set the default values that were reset using this function.

Examples

The following example resets all the session default values:

```
BEGIN
  ORDS_ADMIN.RESET_SESSION_DEFAULTS;
END;
/
```

5.26 ORDS_ADMIN.PROVISION_ADMIN_ROLE

Format

```
ORDS_ADMIN.PROVISION_ADMIN_ROLE(
       p_ user IN varchar2);
```

Description

Provision a database user with the ORDS Administrator role so that it can administer ORDS.

Parameters

p_user
The name of the user to be provisioned.

Usage Notes

User `ORDS_PUBLIC_USER` cannot be configured using this interface.

Examples

The following example provisions the ORDS administrator role to the `HR` user:

```
BEGIN
  ORDS_ADMIN.PROVISION_ADMIN_ROLE(
  p_user => 'HR'
  );
END;
/
```

5.27 ORDS_ADMIN.PROVISION_RUNTIME_ROLE

Format

```
ORDS_ADMIN.PROVISION_RUNTIME_ROLE(
       p_user                  IN  varchar2,
       p_proxy_enabled_schemas IN  boolean DEFAULT TRUE);
```

Description

Provision a database user so that it can act as an ORDS runtime user.

Parameters

p_user
The name of the user to be provisioned.

p_proxy_enabled_schemas
When the value is set to `TRUE`, “connect through” proxy grants are added for any enabled schemas.

Usage Notes

`ORDS_PUBLIC_USER` is an example of a runtime user. Additional changes to the ORDS configuration are required to use a user other than the `ORDS_PUBLIC_USER`.

Examples

The following example provisions the ORDS runtime role to the `HR` user and grants it the “connect through” proxy privilege for all the enabled schemas:

```
BEGIN
  ORDS_ADMIN.PROVISION_RUNTIME_ROLE(
   p_user => 'HR',
   p_proxy_enabled_schemas => TRUE
 );
END;
/
```

5.28 ORDS_ADMIN.UNPROVISION_ ROLES

Format

```
ORDS_ADMIN.UNPROVISION_ROLES(
       p_user               IN  varchar2,
       p_administrator_role IN  boolean DEFAULT NULL,
       p_runtime_role       IN  boolean DEFAULT NULL);
```

Description

Unprovision the ORDS database roles.

Parameters

p_user
The name of the user to be unprovisioned.

p_administrator_role
Unprovision as an admin user.

p_runtime_role
Unprovision as a runtime user.

Usage Notes

`NULL` boolean values are evaluated to `TRUE` unless any value is set to `TRUE`. In such case, `NULL` values are evaluated to `FALSE`. So, by default all the roles are unprovisioned unless an explicit choice is made.

Examples

The following example unprovisions the ORDS administrator role from the `HR` user:

```
BEGIN
  ORDS_ADMIN.UNPROVISION_ROLES (
    p_user => 'HR',
    p_administrator_role => TRUE);
END;
/
```

5.29 ORDS_ADMIN.CONFIG_PLSQL_GATEWAY

Format

```
ORDS_ADMIN.CONFIG_PLSQL_GATEWAY(
   p_runtime_user        IN varchar2 DEFAULT NULL,
   p_plsql_gateway_user  IN varchar2,
   p_comments            IN varchar2 DEFAULT NULL);
```

Description

Configures the database proxy user that must be used for PL/SQL Gateway calls serviced by the specified runtime user.

Parameters

p_runtime_user
Name of the runtime user to be configured.

p_plsql_gateway_user
Name of the proxy user.

p_comments
Comment text.

Usage Notes

When `p_runtime_user` is `NULL`, then the value provided through `ORDS_ADMIN.SET_SESSION_DEFAULTS` is used. Otherwise, `ORDS_PUBLIC_USER` is used. When `p_plsql_gateway_user` is `NULL`, then the PL/SQL Gateway for the runtime user is unconfigured.

Examples

The following example configures the PL/SQL Gateway for `ORDS_PUBLIC_USER` runtime user:

```
BEGIN
  ords_admin.config_plsql_gateway(
    p_runtime_user     => 'ORDS_PUBLIC_USER',
    p_plsql_gateway_user => 'GATEWAY_USER'
  );
END;
/
```

The following example unconfigures the PL/SQL Gateway for `ORDS_PUBLIC_USER` runtime user:

```
BEGIN
  ords_admin.config_plsql_gateway(
    p_runtime_user     => 'ORDS_PUBLIC_USER',
    p_plsql_gateway_user => NULL
  );
END;
/
```

5.30 ORDS_ADMIN.SET_PROPERTY

Format

```
ORDS_ADMIN.SET_PROPERTY(
      p_schema          IN ords_schemas.parsing_schema%type,
```

```
      p_key             IN ords_prop_facts.key%type,
      p_value           IN ords_prop_values.value%type);
```

Description

`SET_PROPERTY` sets the value of the SCHEMA scoped property for the specified enabled schema. The value must not be NULL.

Parameters

p_schema
The name of the owning enabled schema. This parameter is mandatory.

p_key
The property key.

p_value
The new property value.

Usage Notes

(None.)

Examples

The following example sets a property value:

```
BEGIN
  ORDS_ADMIN.SET_PROPERTY(
    p_schema => 'tickets',
    p_key => 'a.key',
    p_value => 'a value'
  );
END;
/
```

5.31 ORDS_ADMIN.SET_PROPERTY

Format

```
ORDS_ADMIN.SET_PROPERTY(
      p_key             IN ords_prop_facts.key%type,
      p_value           IN ords_prop_values.value%type);
```

Description

`SET_PROPERTY` sets the value of the non-SCHEMA scoped property. The value must not be NULL.

Parameters

p_key
The property key.

p_value
The new property value.

Usage Notes

(None.)

Examples

The following example sets a property value:

```
BEGIN
  ORDS_ADMIN.SET_PROPERTY(
    p_key => 'a.key',
    p_value => 'a value'
  );
END;
/
```

5.32 ORDS_ADMIN.UNSET_PROPERTY

Format

```
ORDS_ADMIN.UNSET_PROPERTY(
      p_schema          IN ords_schemas.parsing_schema%type,
      p_key             IN ords_prop_facts.key%type);
```

Description

`UNSET_PROPERTY` unsets the value of the SCHEMA scoped property for the specified enabled schema.

Parameters

p_schema
The name of the owning enabled schema. This parameter is mandatory.

p_key
The property key.

Usage Notes

(None.)

Examples

The following example unsets a property value:

```
BEGIN
  ORDS_ADMIN.UNSET_PROPERTY(
    p_schema => 'tickets',
    p_key => 'a.key'
  );
```

```
END;
/
```

6

OAUTH PL/SQL Package Reference

The OAUTH PL/SQL package contains procedures for implementing OAuth authentication using Oracle REST Data Services.

Related Topics

- Using the Oracle REST Data Services PL/SQL API

6.1 OAUTH.CREATE_CLIENT

Format

```
OAUTH.CREATE_CLIENT(
   p_name            IN VARCHAR2,
   p_grant_type      IN VARCHAR2,
   p_owner           IN VARCHAR2 DEFAULT NULL,
   p_description     IN VARCHAR2 DEFAULT NULL,
   p_origins_allowed IN VARCHAR2 DEFAULT NULL,
   p_redirect_uri    IN VARCHAR2 DEFAULT NULL,
   p_support_email   IN VARCHAR2 DEFAULT NULL,
   p_support_uri     IN VARCHAR2  DEFAULT NULL,
   p_privilege_names IN VARCHAR2
   p_token_duration   IN NUMBER,
   p_refresh_duration IN NUMBER,
   p_code_duration    IN NUMBER)
```

Description

Creates an OAuth client registration.

Parameters

p_name
Name for the client, displayed to the end user during the approval phase of three-legged OAuth. Must be unique.

p_grant_type
Must be one of `authorization_code`, `implicit`, or `client_credentials`.

p_owner
Name of the party that owns the client application.

p_description
Description of the purpose of the client, displayed to the end user during the approval phase of three-legged OAuth. May be null if `p_grant_type` is `client_credentials`; otherwise, must not be null.

p_origins_allowed
A comma-separated list of URL prefixes. If the list is empty, then any existing origins are removed.

p_redirect_uri
Client-controlled URI to which redirect containing an OAuth access token or error will be sent. May be null if `p_grant_type` is `client_credentials`; otherwise, must not be null.

p_support_email
The email where end users can contact the client for support.

p_support_uri
The URI where end users can contact the client for support. Example: `http://www.myclientdomain.com/support/`

p_privilege_names
List of comma-separated privileges that the client wants to access.

p_token_duration
Duration of the access token in seconds. `NULL` duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 3600 seconds.

p_refresh_duration
Duration of refresh token in seconds. `NULL` duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 86400 seconds.

p_code_duration
Duration of the code token in seconds applicable only when `grant_type` value is `authorization code`. If the value is set to `NULL` or the `grant_type` value is not `authorization_code`, then the lifetime is the one defined in the ORDS instance. By default, the value is 300.

Usage Notes

To have the operation take effect, use the COMMIT statement after calling this procedure.

Examples

The following example creates an OAuth client registration.

```
BEGIN
  OAUTH.create_client(
    'CLIENT_TEST',
    'authorization_code',
    'test_user',
    'This is a test description.',
    '',
    'https://example.org/my_redirect/#/',
    'test@example.org',
    'https://example.org/help/#/',
    'MyPrivilege',
    NULL,
    NULL,
    NULL
    );
    COMMIT;
END;
/
```

6.2 OAUTH.DELETE_CLIENT

Format

```
OAUTH.DELETE_CLIENT(
   p_name IN VARCHAR2);
```

Description

Deletes an OAuth client registration.

Parameters

p_name
Name of the client registration to be deleted.

Usage Notes

To have the operation take effect, use the COMMIT statement after calling this procedure.

Examples

The following example deletes an OAuth client registration.

```
BEGIN
  OAUTH.delete_client(
    'CLIENT_TEST'
    );
  COMMIT;
END;
/
```

6.3 OAUTH.GRANT_CLIENT_ROLE

Format

```
OAUTH.GRANT_CLIENT_ROLE(
   p_client_name IN VARCHAR2,
   p_role_name   IN VARCHAR2);
```

Description

Grant an OAuth client the specified role, enabling clients performing two-legged OAuth to access privileges requiring the role.

Parameters

p_client_name
Name of the OAuth client.

p_role_name
Name of the role to be granted.

Usage Notes

To have the operation take effect, use the COMMIT statement after calling this procedure.

Examples

The following example creates a role and grants that role to an OAuth client.

```
BEGIN
  ORDS.create_role(p_role_name => 'CLIENT_TEST_ROLE');

  OAUTH.grant_client_role(
    'CLIENT_TEST',
    'CLIENT_TEST_ROLE'
    );
  COMMIT;
END;
/
```

6.4 OAUTH.RENAME_CLIENT

Format

```
OAUTH.RENAME_CLIENT(
   p_name     IN VARCHAR2,
   p_new_name IN VARCHAR2);
```

Description

Renames a client.

Parameters

p_name
Current name for the client.

p_new_name
New name for the client.

Usage Notes

The client name is displayed to the end user during the approval phase of three-legged OAuth.

To have the operation take effect, use the COMMIT statement after calling this procedure.

Examples

The following example renames a client.

```
BEGIN
  OAUTH.rename_client(
    'CLIENT_TEST',
    'CLIENT_TEST_RENAMED'
    );
  COMMIT;
END;
/
```

6.5 OAUTH.REVOKE_CLIENT_ROLE

Format

```
OAUTH.REVOKE_CLIENT_ROLE(
   p_client_name  IN VARCHAR2,
   p_role_name    IN VARCHAR2);
```

Description

Revokes the specified role from an OAuth client, preventing the client from accessing privileges requiring the role through two-legged OAuth.

Parameters

p_client_name
Name of the OAuth client.

p_role_name
Name of the role to be revoked

Usage Notes

To have the operation take effect, use the COMMIT statement after calling this procedure.

Examples

The following example revokes a specified role from an OAuth client.

```
BEGIN
  OAUTH.revoke_client_role(
    'CLIENT_TEST_RENAMED',
    'CLIENT_TEST_ROLE'
    );
  COMMIT;
END;
/
```

6.6 OAUTH.UPDATE_CLIENT

Format

```
OAUTH.UPDATE_CLIENT(
  p_name             IN VARCHAR2,
  p_description      IN VARCHAR2,
  p_origins_allowed  IN VARCHAR2,
  p_redirect_uri     IN VARCHAR2,
  p_support_email    IN VARCHAR2,
  p_suppor_uri       IN VARCHAR2,
  p_privilege_names  IN t_ords_vchar_tab DEFAULT NULL,
  p_token_duration   IN NUMBER,
  p_refresh_duration IN NUMBER,
  p_code_duration    IN NUMBER
);
```

Description

Updates the client information (except name). Any null values will not alter the existing client property.

Parameters

p_name
Name of the client that requires the owner, description, origins allowed, support e-mail, support URI, and/or privilege modification.

p_description
Description of the purpose of the client, displayed to the end user during the approval phase of three-legged OAuth.

p_origins_allowed
A comma-separated list of URL prefixes. If the list is empty, then any existing origins are removed.

p_redirect_uri
Client-controlled URI to which a redirect containing the OAuth access token/error will be sent. If this parameter is null, the existing `p_redirect_uri` value (if any) is not changed.

p_support_email
The email address where end users can contact the client for support.

p_support_uri
The URI where end users can contact the client for support. Example: `http://www.myclientdomain.com/support/`

p_privilege_names
List of names of the privileges that the client wishes to access.

p_token_duration
Duration of the access token in seconds. `NULL` duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 3600 seconds.

p_refresh_duration
Duration of refresh token in seconds. NULL duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 86400 seconds.

p_code_duration
Duration of the code token in seconds applicable only when `grant_type` is `authorization code`. If the value is set to `NULL` or the `grant_type` is not `authorization_code`, then the lifetime is the one defined in the ORDS instance. By default, the value is 300.

Usage Notes

To have the operation take effect, use the COMMIT statement after calling this procedure.

If you want to rename the client, use the `OAUTH.RENAME_CLIENT` procedure.

Example to Update the Description of the Specified Client

The following example updates the description of the client with the name matching the value for `p_name`.

```
BEGIN
  ORDS_METADATA.OAUTH.update_client(
    p_name => 'CLIENT_TEST_RENAMED',
    p_description => 'The description was altered',
    p_origins_allowed => null,
    p_redirect_uri => null,
    p_support_email => null,
    p_support_uri => null,
    p_privilege_names => null,
    p_token_duration => null,
    p_refresh_duration => null,
    p_code_duration    => null);
  COMMIT;
END;
/
```

Example 6-1 Example to Add Multiple Privileges

The following example adds a second privilege:

```
declare
 my_privs t_ords_vchar_tab  := t_ords_vchar_tab ();
begin
 my_privs.EXTEND (3);
 my_privs(1):='tst.privilege1';
 my_privs(2):='tst.privilege2';

 oauth.update_client(
    p_name => 'Test_Client',
    p_description => 'Description altered.',
    p_origins_allowed => NULL,
    p_redirect_uri => '/abc/efg/',
    p_privilege_names => my_privs,
    p_token_duration => NULL,
    p_refresh_duration => NULL,
    p_code_duration    => NULL);
commit;
end;
```

Related Topics

- OAUTH.RENAME_CLIENT

6.7 OAUTH.ROTATE_CLIENT_SECRET

Format

```
OAUTH.ROTATE_CLIENT_SECRET(
      p_client_id       IN NUMBER,
      p_editing_user    IN VARCHAR2,
      p_revoke_sessions IN BOOLEAN DEFAULT TRUE);
```

Description

`ROTATE_CLIENT_SECRET` regenerates a new client secret and deletes all existing client sessions by default.

Parameters

p_client_id
The ID of the client modified.

p_editing_user
The user requesting this change.

p_revoke_sessions
Controls if the approval for the existing client sessions must be revoked. Default value is `TRUE`.

Example

The following example rotates a client secret:

```
BEGIN
  OAUTH.ROTATE_CLIENT_SECRET(
  p_client_id => 1234567890,
  p_editing_user => 'USERA',
  p_revoke_sessions => TRUE
  );
END;
/
```

6.8 OAUTH.UPDATE_CLIENT_SECRET

Format

```
OAUTH.UPDATE_CLIENT_SECRET(
      p_client_name  IN VARCHAR2,
      p_editing_user  IN VARCHAR2,
      p_client_secret  IN VARCHAR2);
```

Description

`UPDATE_CLIENT_SECRET` sets a new value for the secret of the client. By default, it deletes all the existing client sessions.

Parameters

p_client_name
The name of the client in the current schema.

p_editing_user
The user requesting this change.

p_client_secret
The value of the new secret for the client.

Usage Notes
For the operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example updates the secret of a particular client:

```
BEGIN
  OAUTH.UPDATE_CLIENT_SECRET(
        p_client_name   => 'CLIENT_TEST',
        p_editing_user   => 'USERA ',
        p_client_secret  => 'RaFhM690PA6cN1ffpkNx3Q..');
END;
/
```

6.9 OAUTH.IMPORT_CLIENT

Format

```
OAUTH.IMPORT_CLIENT(
    p_name                  IN VARCHAR2,
    p_client_id             IN VARCHAR2,
    p_client_secret         IN VARCHAR2 DEFAULT NULL,
    p_grant_type            IN VARCHAR2,
    p_owner                 IN VARCHAR2 DEFAULT NULL,
    p_description           IN VARCHAR2 DEFAULT NULL,
    p_origins_allowed       IN VARCHAR2 DEFAULT NULL,
    p_redirect_uri          IN VARCHAR2 DEFAULT NULL,
    p_support_email         IN VARCHAR2 DEFAULT NULL,
    p_support_uri           IN VARCHAR2 DEFAULT NULL,
    p_privilege_names       IN VARCHAR2,
    p_token_duration        IN NUMBER DEFAULT NULL,
    p_refresh_duration      IN NUMBER DEFAULT NULL,
    p_code_duration         IN NUMBER DEFAULT NULL);
```

Description

Imports an existing client into this schema, preserving the identifier and optionally a secret. If the secret is not provided, then a new one is generated.

Parameters

p_name
Name for the client displayed to the end user during the approval phase of three-legged OAuth. The name must must be unique.

p_client_id
A unique client identifier.

p_client_secret
Optional parameter. If not provided, then a random secret is generated.

p_grant_type
The value must be one of `authorization_code`, `implicit`, or `client_credentials`.

p_owner
Name of the party that owns the client application.

p_description
Description of the purpose of the client. Displayed to the end user during the approval phase of three-legged OAuth. Can be `null` if `p_grant_type` value is `client_credentials`. Otherwise, it must not be null.

p_origins_allowed
A comma-separated list of URL prefixes.

p_redirect_uri
Client-controlled URI with a redirect containing an OAuth access token or error is sent. Can be a null if the value of `p_grant_type` is `client_credentials`. Otherwise, it must not be null.

p_support_email
The email where the end users can contact the client for support.

p_support_uri
The URI where the end users can contact the client for support.
Example URI:`http://www.myclientdomain.com/support/`

p_privilege_names
List of comma-separated privileges that the client wants to access.

p_token_duration
Duration of the access token in seconds. `NULL` duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 3600 seconds.

p_refresh_duration
Duration of refresh token in seconds. `NULL` duration fallsback to the value in the ORDS instance. By default, it can be set through a property or set to 86400 seconds.

p_code_duration
Duration of the code token in seconds is applicable only when `grant_type` value is authorization code. If the value is set to `NULL` or if the value of `grant_type` is not `authorization_code`, then the lifetime is the one defined in the ORDS instance. By default, the value is 300.

Usage Notes

For this operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example, imports an OAuth client without custom durations or origins:

```
BEGIN
  OAUTH.IMPORT_CLIENT(
      p_name                  => 'CLIENT_TEST',
```

```
      p_client_id             => 'awVMtPlqullIqPXhAwh4zA..',
      p_grant_type            => 'authorization_code',
      p_owner                 => 'RESTEASY',
      p_description           => 'This is a test description.',
      p_origins_allowed       => NULL,
      p_redirect_uri          => 'https://example.org/my_redirect/',
      p_support_email         => 'test@example.org',
      p_support_uri           => 'https://example.org/help/',
      p_privilege_names       => 'MyPrivilege');

  COMMIT;
END;
/
```

6.10 OAUTH.CREATE_JWT_PROFILE

Format

```
OAUTH.CREATE_JWT_PROFILE (
       p_issuer       IN VARCHAR2,
       p_audience     IN VARCHAR2,
       p_jwk_url      IN VARCHAR2,
       p_description  IN VARCHAR2 DEFAULT NULL,
       p_allowed_skew IN NUMBER DEFAULT NULL,
       p_allowed_age  IN NUMBER DEFAULT NULL
   )
```

Description

Creates a new JWT Profile for the schema if it does not already exist. If a JWT Profile already exists, then it must be deleted first.

Parameters

p_issuer
The issuer of acceptable JWT access tokens. This value must match the `iss` claim provided in the JWT.

p_audience
The audience of acceptable JWT access tokens. This value must match the `aud` claim provided in the JWT.

p_jwk_url
This is the url to the jwk(s) used to validate acceptable JWT access tokens. It must start with "https://"

p_desciption
A description of the JWT Profile. This value can be null.

p_allowed_skew
The number of seconds allowed to skew time claims provided in the JWT. This can help mediate issues with differences in the clock used by ORDS and the token issuer. The default

value of null, specifies that the ORDS global setting `security.jwt.allowed.skew` is taken. A value less than or equal to 0 means, it is disabled. A max of 60 seconds can be specified.

p_allowed_age
The maximum allowed age of a JWT in seconds, regardless of expired claim. The age of the JWT is taken from the JWT issued at claim. The default value of null means the ORDS global setting of `security.jwt.allowed.age` is taken. A value less than or equals to 0 means, it is disabled.

Usage Notes

For this operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example, deletes any existing JWT Profile for the schema and creates a new JWT Profile for the schema. Any requests made to the resources in this schema can use a JWT bearer token for authorization. The JWT token must be signed and its signature must be verifiable using a public key provided by `p_jwk_url`. The JWTs issuer and audience claims must also match the `p_issuer` and `p_audience` values. The JWT must provide a scope that matches the ORDS Privilege protected by the resource.

```
BEGIN
  OAUTH.DELETE_JWT_PROFILE();
  OAUTH.CREATE_JWT_PROFILE(
      p_issuer => 'https://identity.oraclecloud.com/',
      p_audience => 'ords/myapplication/api' ,
      p_jwk_url =>'https://
idcs-10a10a10a10a10a10a10a.identity.oraclecloud.com/admin/v1/
SigningCert/jwk'
  );
  COMMIT;
END;
/
```

6.11 OAUTH.DELETE_JWT_PROFILE

Format

```
OAUTH.DELETE_JWT_PROFILE ()
```

Description

Deletes the JWT Profile for the schema if one exists.

Usage Notes

For this operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example, deletes any existing JWT Profile for the schema:

```
BEGIN
  OAUTH.DELETE_JWT_PROFILE();
  COMMIT;
END;
/
```

JWT bearer tokens are not be accepted when authorizing requests to the protected resources.

7 OAUTH_ADMIN PL/SQL Package Reference

The `OAUTH_ADMIN` PL/SQL package contains subprograms (procedures and functions) for implementing OAuth authentication using Oracle REST Data Services for a privileged user.

Before a database user can invoke the `OAUTH_ADMIN` package, they must be granted the `ORDS_ADMINISTRATOR_ROLE` database role.

The following example, grants the `ORDS_ADMINISTRATOR_ROLE` role to the ADMIN user:

```
GRANT ORDS_ADMINSTRATOR_ROLE TO ADMIN;
```

The `OAUTH_ADMIN` package is defined with the `AUTHID CURRENT_USER` right and each method requires a `p_schema` parameter where the target schema must be specified.

> **See also:**
>
> Using the Oracle REST Data Services PL/SQL API

7.1 OAUTH_ADMIN.CREATE_JWT_PROFILE

Format

```
OAUTH_ADMIN.CREATE_JWT_PROFILE (
       p_schema        IN VARCHAR2,
       p_issuer        IN VARCHAR2,
       p_audience      IN VARCHAR2,
       p_jwk_url       IN VARCHAR2,
       p_description   IN VARCHAR2 DEFAULT NULL,
       p_allowed_skew  IN NUMBER DEFAULT NULL,
       p_allowed_age   IN NUMBER DEFAULT NULL
   )
```

Description

Creates a new JWT Profile for the specified schema, if one does not already exist. If a JWT Profile already exists, it must be deleted first.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

p_issuer
The issuer of acceptable JWT access tokens. This value must match the `iss` claim provided in the JWT.

p_audience
The audience of acceptable JWT access tokens. This value must match the `aud` claim provided in the JWT.

p_jwk_url
This is the url to the jwk(s) used to validate the acceptable JWT access tokens. the url must start with "`https://`".

p_desciption
A description of the JWT Profile. This can be nul.

p_allowed_skew
The number of seconds allowed to skew time claims provided in the JWT. This can help mediate issues with differences in the clock used by ORDS and the token issuer. The default value of null, specifies that the ORDS global setting `security.jwt.allowed.skew` is taken. A value less than or equal to 0 means it is disabled. A max of 60 seconds can be specified.

p_allowed_age
The maximum allowed age of a JWT in seconds, regardless of expired claim. The age of the JWT is taken from the JWT issued at claim. The default value of null means that the ORDS global setting of `security.jwt.allowed.age` is taken. A value less than or equals to 0 means it is disabled.

Usage Notes

For this operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example, deletes any existing JWT Profile for the `HR` schema and creates a new JWT Profile for the `HR` schema:

```
BEGIN
  OAUTH_ADMIN.DELETE_JWT_PROFILE(p_schema=>'HR');
  OAUTH_ADMIN.CREATE_JWT_PROFILE(
      p_schema =>'HR',
      p_issuer => 'https://identity.oraclecloud.com/',
      p_audience => 'ords/myapplication/api' ,
      p_jwk_url =>'https://
idcs-10a10a10a10a10a10a10a.identity.oraclecloud.com/admin/v1/
SigningCert/jwk'
  );
  COMMIT;
END;
/
```

Any requests made to resources in the `HR` schema can use a JWT bearer token for authorization. The JWT token must be signed and its signature must be verifiable using a public key provided by `p_jwk_url`. The issuer of JWT and audience claims must match the `p_issuer` and `p_audience` values. The JWT must provide a scope that matches the ORDS Privilege protected by the resource.

7.2 OAUTH_ADMIN.DELETE_JWT_PROFILE

Format

```
OAUTH_ADMIN.DELETE_JWT_PROFILE ( p_schema       IN VARCHAR2) ;
```

Description

Deletes the JWT Profile for the specified schema, if it exists.

Parameters

p_schema
Name of the schema. This parameter is mandatory.

Usage Notes

For this operation to take effect, use the `COMMIT` statement after calling this procedure.

Example

The following example, deletes any existing JWT Profile for the schema `HR`:

```
BEGIN
  OAUTH_ADMIN.DELETE_JWT_PROFILE(p_schema=>'HR');
  COMMIT;
END;
/
```

JWT bearer tokens are not accepted while authorizing requests to the protected resources in the `HR` schema.

8

Enabling ORDS Database API

This section describes how to enable the Oracle REST Data Services (ORDS) Database API.

ORDS database API is a database management and monitoring REST API embedded into Oracle REST Data Services. Depending on the database version and configuration, ORDS database API provides services such as manage pluggable databases, export data and review database performance. By default, the ORDS database API feature is disabled when you install ORDS for the first time.

8.1 Basic Setup to Enable ORDS Database API

This section explains the basic setup to enable the ORDS database API.

To enable the ORDS database API, set the `database.api.enabled` property to `true` and then restart ORDS:

```
ords config set database.api.enabled true
```

To access the ORDS database API, you can use one of the following available authentication methods available:

- Database authentication using database username and password
- Through a mid-tier user with the SQL Administrator, or System Administrator role

> **Note:**
>
> There are certain endpoints that are accessible only by certain roles. The REST APIs for Oracle Database documentation provides information on which roles can access each endpoint.

To enable database authentication, you must set the `restEnabledSql.active` property to `true` as shown in the following code snippet and then restart ORDS:

```
ords config set restEnabledSql.active true
```

For the database authentication, ensure that the administrator schema is ORDS enabled and is granted with the DBA role in an 11gR2 environment or the PDB_DBA role for 12c and higher versions of the database before the schema is used to execute the database API queries in the database. This is done for each non-CDB or pluggable database in which you want to use the database. For more information, refer to "REST-Enabling the Oracle Database Schema" and "ORDS_ADMIN.ENABLE_SCHEMA" sections.

> **Note:**
>
> In the following example, sqlplus command-line utility is used to connect to the SALESPDB database as the system user to configure the PDBADMIN user in that database. The mechanism to connect to the database and performing the steps will differ depending on your environment settings.

For example, to use PDBADMIN schema, in the SALESPDB database for ORDS Database API services, use the following commands in the database.

```
sqlplus system@SALESPDB
GRANT PDB_DBA TO PDBADMIN;
BEGIN
ORDS_ADMIN.ENABLE_SCHEMA(p_schema => 'PDBADMIN');
END;
/
```

The PDBADMIN user is now ready to use the ORDS database API services.

To list the tables in the database, send a `GET` request to `https://<server>/ords/salespdb/pdbadmin/_/db-api/stable/database/objects/tables/`

On request, you must provide the username and password. If you are using a browser, ORDS provides a link to login and authenticate the request. Once you are authenticated, your browser will have an access cookie, and you do not have to specify the user credentials until that cookie expires.

The same service can be accessed through command line utilities such as curl:

```
curl --user pdbadmin:password https://<server>/ords/salespdb/
pdbadmin/_/db-api/stable/database/objects/tables/
```

An OpenAPI V3 document that describes the available ORDS database API services can be accessed at `https://<server>/ords/<my database>/<my admin schema>/_/db-api/stable/metadata-catalog/openapi.json`. With the exception of `https://<server>/ords/<my database>/<my admin schema>/_/db-api/stable/databases/pdbs/`, all other ORDS database API services are made available.

Related Topics

- REST-Enabling the Oracle Database Schema
- ORDS_ADMIN.ENABLE_SCHEMA

8.2 Advanced Setup to Enable the ORDS Database API

This section describes the configuration options for using ORDS database API with various database topologies.

> **Note:**
>
> **Disabling management services**: When the value of `database.api.management.services.disabled` property is set to `true`, the following ORDS Database API services are disabled:
>
> - **DBCA Jobs**: DELETE, GET and POST
> - **DBCA Templates**: GET
> - **Oracle Home Environment**: GET
> - **PDB Lifecycle**: DELETE, GET, POST
> - **Open Service Broker**- DELETE, GET and PUT

8.2.1 Pluggable Database Lifecycle Management

This section describes how to enable the Pluggable Database (PDB) lifecycle management operations. Pluggable Database management is performed in the Container Database (CDB) and includes create, clone, plug, unplug and delete operations.

You cannot have an ORDS enabled schema in the container database. To perform the PDB lifecycle management operations, the default CDB administrator credentials, `db.cdb.adminUser` and `db.cdb.adminUser.password` must be defined in the connection pool. In this case, specifying an user schema in the URI is not required.

To define the default CDB administrator credentials, perform the following steps:

1. Create the CDB administrator user and grant the SYSDBA privilege. In this example, the user is called `C##DBAPI_CDB_ADMIN`. However, any suitable common user name can be used.

   ```
   CREATE USER C##DBAPI_CDB_ADMIN IDENTIFIED BY <PASSWORD>;
   GRANT SYSDBA TO C##DBAPI_CDB_ADMIN CONTAINER = ALL;
   ```

2. Set the `db.cdb.adminUser` and `db.cdb.adminUser.password` properties for the connection pool.

   ```
   ords config set db.cdb.adminUser "C##DBAPI_CDB_ADMIN as SYSDBA"
   ords config secret db.cdb.adminUser.password
   ```

The ORDS role, SQL Administrator must be used to access the `https://<server>/ords/_/db-api/stable/database/pdbs/` services.

8.2.2 Disabling PDB Lifecycle Management

This section describes how to disable the PDB lifecycle management services.

You can enable ORDS database API and disable the PDB related services at `https://<server>/ords/_/db-api/stable/databases/pdbs/`.

When the optional CDB administrator credentials are not set, a `HTTP 503 Service Unavailable` response is produced if a user attempts to access `https://<server>/ords/_/db-api/stable/databases/pdbs/`.

To clearly indicate that the PDB operations are disabled for the ORDS installation, set the `database.api.management.services.disabled` property to `true` as shown in the following code snippet and then restart ORDS:

```
ords config set database.api.management.services.disabled true
```

This produces a response, `HTTP 503 Service Unavailable` with an explanatory reason.

8.3 Creating a Default Administrator

This section describes how to create and use the default administrator user for the non-CDB or PDB connections.

The ORDS database API service operations are not schema specific. By configuring the default administrator credentials, `db.adminUser` and `db.adminUser.password` in the connection pool, you can execute the corresponding SQL statements as the default administrator user. The ORDS database API endpoints can be executed using a specified ORDS enabled schema if the schema has the DBA role. However, it is not necessary to do so when the default administrator credentials are configured.

> **Note:**
>
> The user credentials must be the same across all the pluggable databases and therefore it is recommended to create the common user in the CDB.

To create the default administrator and grant the DBA role, perform the following steps:

1. Create the default administrator user and grant the DBA role. In this example, the user is called `C##_DBAPI_DEFAULT_ADMIN`. However, any suitable common user name can be used as shown in the following code snippet:

   ```
   CREATE USER C##_DBAPI_DEFAULT_ADMIN IDENTIFIED BY <PASSWORD> CONTAINER = ALL;

   GRANT DBA TO C##_DBAPI_DEFAULT_ADMIN CONTAINER = ALL;
   ```

2. Set the `db.adminUser` and `db.adminUser.password` properties for the connection pool as shown in the following code snipet:

   ```
   ords config set db.adminUser C##_DBAPI_DEFAULT_ADMIN
   ords config secret db.adminUser.password
   ```

A schema is not required to be provided in the URI request.

For example, `https://<server>/ords/salespdb/_/db-api/stable/database/datapump/jobs/` lists all the data pump jobs in the `salespdb`, and queries in that database are executed as the `db.adminUser` user.

The ORDS role `SQL Administrator`, is required to use the database API services.

8.4 Configuration of Database API Environment Services

This section describes how to configure ORDS Database API environment services.

Starting with ORDS 19.2 release, on a system with ORDS installed, you can perform the set of environment services operations.

For example, the following endpoint lists all the databases discovered in the Oracle Home:

```
https://<server>/ords/_/db-api/stable/environment/databases/
```

You must have the ORDS System Administrator role to use the ORDS database API environment services. The environment services provide information about the database Oracle Home on the host machine and a RESTful interface to the Oracle Database Configuration Assistant to create or delete the databases.

Similar to pluggable database lifecycle management, the environment services can be disabled.

To disable the environment services, set the `database.api.management.services.disabled` property to `true` as follows and then restart ORDS:

```
ords config set database.api.management.services.disabled true
```

8.5 Configuration of Database API with Open Service Broker API Compatible Platforms

This section describes how to configure and use the ORDS database API with Open Service Broker API compatible platforms.

The ORDS database API provides a service broker for each registered connection pool. Service brokers compliant with the Open Service Broker API specification, allow platforms to provision a new instance of a service. With ORDS as an Open Service Broker to an Oracle database, customers can provision pluggable databases and database users. The nature of the database dictates the service offering that the ORDS database API provides.

Table 8-1 Open Service Broker Service Catalog

Database Type	Service	Plans	Prerequisites
Container Database	**`create-pluggable-database`**. Create a new pluggable database in the Oracle multitenant container database.	**`clone-database`** Create a new pluggable database in the container database by cloning another local pluggable database. Any ORDS REST enabled schemas in the source database is REST enabled in the new database. **`create-database`** Create a new pluggable database from `PDB$SEED`. The pluggable database administrator account is automatically rest enabled.	Pluggable database lifecycle management must be configured.
Non-Container or Pluggable Database	**`create-oracle-database-user`** Create and configure an Oracle database user with an account through which the user can log in to the database.	**`create-standard-database-user`** Create an Oracle database user with the specified roles and privileges. The objects of the user are stored in the default database tablespace. The temporary segments of the user are stored in the default temporary database tablespace. **`create-ords-enabled-database-user`** Create an Oracle database user with an ORDS enabled schema. The objects of the user are stored in the default database tablespace. The temporary segments of the user are stored in the default temporary database tablespace.	None

To register the service broker URL with your Open Service Broker compliant platform, it depends on how the pool is registered with ORDS and the database type. Oracle

recommends that you use HTTPS with Open Service Broker endpoints. The process of registering a service broker differs depending on the platform.
The Service Broker URL for ORDS follows the following pattern:

- **`create-oracle-database-user`**
  To register the non-CDB or PDB service catalog, you must use the service broker URL for the non-CDB or PDB pool. The format is as follows:

  ```
  https://<server>/ords/<my database>/<my admin schema>/_/db-api/stable/
  openservicebroker/
  ```

  Using the SALESPDB example with PDBADMIN as an ORDS enabled schema, the URL is as follows:

  ```
  https://<server>/ords/salespdb/pdbadmin/_/db-api/stable/openservicebroker/
  ```

  > **Note:**
  >
  > `<my database>` can be the default database connection.

  This configuration is common when customers are using ORDS directly with a single database. With this configuration, the example URL is `https://<server>/ords/pdbadmin_/db-api/stable/openservicebroker/`.

- **Supported Open Service Broker Operations**
  ORDS database API supports the synchronous provisioning operation. Other Open Service Broker operations such as deprovisioning and service binding are not supported.

- **Disabling the Service Broker for a Specific Pool**
  To disable the Open Service Broker services available for a specific pool, set the feature. `openservicebroker.exclude` property to `true` by specifying the pool name as follows:

  ```
  ords config --db-pool <pool-name> set feature.openservicebroker.exclude true
  ```
  And then restart ORDS.

  When you use ORDS directly with a container database and pluggable database mapping at runtime, disabling the Open Service Broker for the container disables the broker for all pluggable databases in the container. In such case, the configuration is defined in the container database pool configuration file.

9 REST-Enabled SQL Service

The REST-Enabled SQL service is a HTTPS web service that provides access to the Oracle Database SQL engine. You can POST SQL statements to the service. The service then runs the SQL statements against Oracle Database and returns the result to the client in a JSON format.

Statically defined RESTful services use predefined SQL statements that are useful when you need a fixed and repeatable service. The REST- Enabled SQL service enables you to define SQL statements dynamically and run them against the database without predefined SQL statements. This makes your data more accessible over REST.

Typical Use Case: Your Oracle Database is in the cloud and you want to make it available through a REST API over HTTPS.

Predefined REST APIs provide common operations such as returning the results of reports and providing an API for updating common tables in your database. There is a need for client developers to run their own queries or queries that can only be written at run time. In these cases, a REST- Enabled SQL service is useful.

> **Note:**
>
> If you have Oracle REST Data Services installed and if you do not have SQL*Net (JDBC, OCI) to establish an network connection to Oracle Database, then a REST-Enabled SQL service provides an easy mechanism to query and run SQL, SQL*Plus, and SQLcl statements against the REST-enabled Oracle Database schema.

Topics:

- REST-Enabled SQL Service Terminology
- Configuring the REST-Enabled SQL Service
- Using cURL with REST-Enabled SQL Service
- Getting Started with the REST-Enabled SQL Service
- REST-Enabled SQL Service Examples
- REST-Enabled SQL Request and Response Specifications
- REST-Enabled SQL Request and Response Specifications
- REST-Enabled SQL Service and MySQL Database

9.1 REST-Enabled SQL Service Terminology

This section introduces some common terms that are used throughout this document.

- **REST- Enabled SQL service**: A HTTPS web service that provides SQL access to the database. SQL statements can be posted to the service, and the results are returned in a JSON format to the client.
- **HTTPS**: Hyper Text Transfer Protocol Secure (HTTPS) is the secure version of **HTTP**, the protocol over which data is sent between your browser and the website to which you are connected. The ***'S'*** stands for secure. It means that all communications between your browser and Oracle REST Data Services are encrypted.
- **cURL**: cURL is a command-line tool used to transfer data. It is free and open source software that can be downloaded from the following location: curl_haxx.
- **SQL*Net (or Net8)**: SQL*Net is the networking software of Oracle that enables remote data access between programs and Oracle Database.

9.2 Configuring the REST-Enabled SQL Service

By default, the REST- Enabled SQL service is turned off. To configure the REST-Enabled SQL service settings, see Configuring REST Enabled SQL Service Settings.

9.3 Using cURL with REST-Enabled SQL Service

This section explains how to use cURL commands to access the REST-Enabled SQL service.

You can use the HTTPS POST method to access the REST-Enabled SQL service. To access the REST-Enabled SQL service, you can use the command-line tool named cURL. This powerful tool is available for most platforms, and enables you to connect and control the data that you send to and receive from a REST-Enabled SQL service.

Example 9-1 Example cURL Command

Request: `curl -i -X POST --user ORDSTEST:ordstest --data-binary "select sysdate from dual" -H "Content-Type: application/sql" -k https://localhost:8088/ords/ordstest/_/sql`

Where:

- The `-i` option displays the HTTP headers returned by the server.
- The `-k` option enables cURL to proceed and operate even for server connections that are otherwise considered to be insecure.

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
```

```
                "statementType":"query",
                "statementPos":{
                    "startLine":1,
                    "endLine":2
                },
                "statementText":"select sysdate from dual",
                "response":[
                ],
                "result":0,
                "resultSet":{
                    "metadata":[
                        {
                            "columnName":"SYSDATE",
                            "jsonColumnName":"sysdate",
                            "columnTypeName":"DATE",
                            "precision":0,
                            "scale":0,
                            "isNullable":1
                        }
                    ],
                    "items":[
                        {
                            "sysdate":"2017-07-21T08:06:44Z"
                        }
                    ],
                    "hasMore":false,
                    "limit":1500,
                    "offset":0,
                    "count":1
                }
            }
        ]
    }
```

9.4 Getting Started with the REST-Enabled SQL Service

The REST- Enabled SQL service is provided only through HTTPS POST method.

> **Note:**
>
> In ORDS, a RESTful service is stateless. In a stateless environment, each HTTPS request from a client maps to a new database session. Therefore, a session begins and ends with every SQL statement or script execution, that is, the worksheet is auto-committed.
>
> As the session state is not maintained, session attributes do not persist and commands such as ROLLBACK and COMMIT do not apply. If a SQL statement or script executes successfully, an implicit commit is performed. If it executes with an error, an implicit rollback is performed. Therefore, when you need, include the ROLLBACK and COMMIT commands or session attributes in the PL/SQL code block that is sent to the database for a session.

Topics:

- REST-Enabling the Oracle Database Schema
- REST-Enabled SQL Authentication
- REST-Enabled SQL Endpoint

9.4.1 REST-Enabling the Oracle Database Schema

You must REST-enable the Oracle database schema on which you want to use the REST- Enabled SQL service. To REST-enable the Oracle Database schema, you can use SQL Developer or the PL/SQL API.

The following code snippet shows how to REST-enable the Oracle Database schema `ORDSTEST`:

```
SQL> CONNECT ORDSTEST/*****;
Connected
SQL> exec ords.enable_schema;
anonymous block completed
SQL> commit;
Commit complete.
SQL>
```

Related Topics

- Auto-Enabling Using the PL/SQL API

9.4.2 REST-Enabled SQL Authentication

This section explains how to authenticate the schema on which you want to use the REST-Enabled SQL service.

Before using the REST-Enabled SQL service, you must authenticate using the SQL Developer role.

The Following are the different types of authentications available:

- **First Party Authentication (Basic Authentication)**: For this authentication, create a user in Oracle REST Data Services with the **SQL Developer** role. This Oracle REST Data Services user will be able to run SQL for any Oracle database schema that is REST-enabled.
- **Schema Authentication**: For this authentication, use the Oracle Database schema name in uppercase and the Oracle database schema password (for example, `HR` and `HRPassword`). This type of user will be able to run SQL for the specified schema. It will be given the SQL Developer role by Oracle REST Data Services.
- **OAuth 2 Client Credentials**: For this authentication, perform the following steps to grant the SQL Developer role to the client in Oracle REST Data Services:
    1. Create a client using `OAUTH.create_client`.
    2. Grant the **SQL Developer** role to the client.

3. Acquire the access token using the `client_id` and `client_secret` of the client.
4. Specify the access token in subsequent REST-Enabled SQL requests.

9.4.3 REST-Enabled SQL Endpoint

This section shows the format or pattern used to access the REST- Enabled SQL service.

If Oracle REST Data Services is running in a Java EE Application Server, then the REST-Enabled SQL service is only accessible through HTTPS. If Oracle REST Data Services is running in standalone mode, then Oracle REST Data Services can be configured to use HTTPS. The examples in this document use this configuration.

The following example URL locates the REST-Enabled SQL service for the specified schema alias:

Pattern: `https://<HOST>/ords/<SchemaAlias>/_/sql`

Example: `https://host/ords/ordstest/_/sql`

Where: The default port is 443

Content Type and Payload Data Type Supported

The HTTPS POST request consists of the following:

- Header Content-Type
  - `application/sql`: for SQL statements
  - `application/json`: for JSON documents
- Payload data type
  - **SQL**: SQL, PL/SQL, SQL*Plus, SQLcl statements
  - **JSON document**: A JSON document with SQL statements and other options such as bind variables

9.5 REST-Enabled SQL Service Examples

This section provides different HTTPS POST request examples that use Oracle REST Data Services standalone setup with secure HTTPS access.

The payload data of the HTTPS POST request message can be in one of the following formats:

- POST Requests Using application/sql Content-Type
- POST Requests Using application/json Content-Type

9.5.1 POST Requests Using application/sql Content-Type

For POST requests with `Content-Type` as `application/sql` , the payload is specified using SQL, SQL*Plus, and SQLcl statements. The payload can be a single line statement, multiple line statements, or a file that consists of multiline statements as shown in the following examples:

- Using a Single SQL Statement
- Using Multiple SQL Statements

- Using a File with cURL

> **Note:**
>
> While evaluating your SQL/PLSQL statements, if you see an error message 555 with the following message, then ensure that you have correctly formed your SQL/PLSQL statement:
> " 555 User Defined Resource Error
>
> The request could not be processed because an error occurred whilst attempting to evaluate the SQL statement associated with this resource.Please check the SQL statement is correctly formed and executes without error"

9.5.1.1 Using a Single SQL Statement

The following example uses Schema Authentication to run a single SQL statement against the `demo` Oracle Database schema:

Request:

```
curl -i -X POST --user DEMO:demo --data-binary "select sysdate from dual"
-H "Content-Type: application/sql" -k https://localhost:8088/ords/
demo/_/sql
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked

{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
                "startLine":1,
                "endLine":2
            },
            "statementText":"select sysdate from dual",
            "response":[

            ],
            "result":0,
            "resultSet":{
                "metadata":[
                    {
                        "columnName":"SYSDATE",
                        "jsonColumnName":"sysdate",
```

```
                        "columnTypeName":"DATE",
                        "precision":0,
                        "scale":0,
                        "isNullable":1
                    }
                ],
                "items":[
                    {
                        "sysdate":"2017-07-21T08:06:44Z"
                    }
                ],
                "hasMore":false,
                "limit":1500,
                "offset":0,
                "count":1
            }
        }
    ]
}
```

Where:

- `DEMO` is the Oracle Database schema name.
- `demo` is the Oracle Database schema password.
- `select sysdate from dual` is the SQL statement that will run in the `DEMO` Oracle Database schema.
- `Content-Type: application/sql` is the content type. Only `application/sql` and `application/json` are supported.
- `https://localhost:8088/ords/demo/_/sql` is the location of the REST- Enabled SQL service for the `demo` Oracle Database schema.

9.5.1.2 Using a File with cURL

For multiline SQL statements, using a file as payload data in requests is useful.

File: `simple_query.sql`

```
SELECT 10
FROM dual;
```

Request:

```
curl -i -X POST --user DEMO:demo --data-binary "@simple_query.sql" -H "Content-
Type: application/sql" -k https://localhost:8088/ords/demo/_/sql
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
```

```
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
                "startLine":1,
                "endLine":1
            },
            "statementText":"SELECT 10 FROM dual",
            "response":[

            ],
            "result":0,
            "resultSet":{
                "metadata":[
                    {
                        "columnName":"10",
                        "jsonColumnName":"10",
                        "columnTypeName":"NUMBER",
                        "precision":0,
                        "scale":-127,
                        "isNullable":1
                    }
                ],
                "items":[
                    {
                        "10":10
                    }
                ],
                "hasMore":false,
                "limit":1500,
                "offset":0,
                "count":1
            }
        }
    ]
}
```


9.5.1.3 Using Multiple SQL Statements

You can run one or more statements in each POST request. Statements are separated similar to Oracle Database SQL*Plus script syntax, such as, end of line for SQL*Plus statements, a semi colon for SQL statements, and forward slash for PL/SQL statements.

File: **`script.sql`**:

```
CREATE TABLE T1 (col1 INT);
DESC T1
INSERT INTO T1 VALUES(1);
```

```
SELECT * FROM T1;
BEGIN
INSERT INTO T1 VALUES(2);
END;
/
SELECT * FROM T1;
```

Request:`curl -i -X POST --user DEMO:demo --data-binary "@script.sql" -H "Content-Type: application/sql" -k https://localhost:8088/ords/demo/_/sql`

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
```


```
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"ddl",
            "statementPos":{
                "startLine":1,
                "endLine":1
            },
            "statementText":"CREATE TABLE T_EXAMPLE1 (col1 INT)",
            "response":[
                "\nTable T_EXAMPLE1 created.\n\n"
            ],
            "result":0
        },
        {
            "statementId":2,
            "statementType":"sqlplus",
            "statementPos":{
                "startLine":2,
                "endLine":2
            },
            "statementText":"DESC T_EXAMPLE1",
            "response":[
                "Name Null\n Type \n---- ----- ---------- \nCOL1 NUMBER(38)
\n"
            ],
            "result":0
        },
        {
            "statementId":3,
            "statementType":"dml",
            "statementPos":{
                "startLine":3,
                "endLine":3
```

```
                },
                "statementText":"INSERT INTO T_EXAMPLE1 VALUES(1)",
                "response":[
                    "\n1 row inserted.\n\n"
                ],
                "result":1
            },
            {
                "statementId":4,
                "statementType":"query",
                "statementPos":{
                    "startLine":4,
                    "endLine":4
                },
                "statementText":"SELECT * FROM T_EXAMPLE1",
                "response":[

                ],
                "result":1,
                "resultSet":{
                    "metadata":[
                        {
                            "columnName":"COL1",
                            "jsonColumnName":"col1",
                            "columnTypeName":"NUMBER",
                            "precision":38,
                            "scale":0,
                            "isNullable":1
                        }
                    ],
                    "items":[
                        {
                            "col1":1
                        }
                    ],
                    "hasMore":false,
                    "limit":1500,
                    "offset":0,
                    " count":1
                }
            },
            {
                "statementId":5,
                "statementType":"plsql",
                "statementPos":{
                    "startLine":5,
                    "endLine":8
                },
                "statementText":"BEGIN\n INSERT INTO T_EXAMPLE1
VALUES(2);\nEND;",
                "response":[
                    "\nPL\/SQL procedure successfully completed.\n\n"
                ],
                "result":1
            },
```

```
            {
                "statementId":6,
                "statementType":"query",
                "statementPos":{
                    "startLine":9,
                    "endLine":9
                },
                "statementText":"SELECT * FROM T_EXAMPLE1",
                "response":[

                ],
                "result":1,
                "resultSet":{
                    "metadata":[
                        {
                            "columnName":"COL1",
                            "jsonColumnName":"col1",
                            "columnTypeName":"NUMBER",
                            "precision":38,
                            "scale":0,
                            "isNullable":1
                        }
                    ],
                    "items":[
                        {
                            "col1":1
                        },
                        {
                            "col1":2
                        }
                    ],
                    "hasMore":false,
                    "limit":1500,
                    "offset":0,
                    "count":2
                }
            },
            {
                "statementId":7,
                "statementType":"ddl",
                "statementPos":{
                    "startLine":10,
                    "endLine":10
                },
                "statementText":"DROP TABLE T_EXAMPLE1",
                "response":[
                    "\nTable T_EXAMPLE1 dropped.\n\n"
                ],
                "result":1
            }
        ]
    }
```

9.5.2 POST Requests Using application/json Content-Type

Using a JSON document as the payload enables you to define more complex requests as shown in the following sections:

- Using a File with cURL
- Specifying the Limit Value in a POST Request for Pagination
- Specifying the Offset Value in a POST Request for Pagination
- Defining Binds in a POST Request

9.5.2.1 Using a File with cURL

The following example posts a JSON document (within the `simple_query.json` file) to the REST-Enabled SQL service.

File: `simple_query.json`

```
{ "statementText":"SELECT TO_DATE('01-01-1976','dd-mm-yyyy') FROM dual;"}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@simple_query.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Where:

- The `statementText` holds the SQL statement or statements.
- The `Content-Type` is `application/json`.

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
                "startLine":1,
                "endLine":1
            },
            "statementText":"SELECT TO_DATE('01-01-1976','dd-mm-yyyy')
FROM dual",
            "response":[
             ],
            "result":0,
            "resultSet":{
                "metadata":[
```

```
                    {
                        "columnName":"TO_DATE('01-01-1976','DD-MM-YYYY')",
                        "jsonColumnName":"to_date('01-01-1976','dd-mm-
yyyy')",
                        "columnTypeName":"DATE",
                        "precision":0,
                        "scale":0,
                        "isNullable":1
                    }
                ],
                "items":[
                    {
                        "to_date('01-01-1976','dd-mm-
yyyy')":"1976-01-01T00:00:00Z"
                    }
                ],
                "hasMore":false,
                "limit":1500,
                "offset":0,
                "count":1
            }
        }
    ]
}
```

9.5.2.2 Specifying the Limit Value in a POST Request for Pagination

You can specify the `limit` value in a POST JSON request for the pagination of a large result set returned from a query.

File: `limit.json`

```
{
 "statementText": "
 WITH data(r) AS (
 SELECT 1 r FROM dual
 UNION ALL
 SELECT r+1 FROM data WHERE r < 100
 )
 SELECT r FROM data;",
 "limit": 5
}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@limit.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Where: The `limit` is the maximum number of rows returned from a query.

> **Note:**
>
> The maximum number of rows returned from a query is based on the `misc.pagination.maxRows` value set in `defaults.xml` file.

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
 {
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
                "startLine":1,
                "endLine":1
            },
            "statementText":" WITH data(r) AS ( SELECT 1 r FROM dual
UNION ALL SELECT r+1 FROM data WHERE r < 100 ) SELECT r FROM data",
            "response":[
             ],
            "result":0,
            "resultSet":{
                "metadata":[
                    {
                        "columnName":"R",
                        "jsonColumnName":"r",
                        "columnTypeName":"NUMBER",
                        "precision":0,
                        "scale":-127,
                        "isNullable":1
                    }
                ],
                "items":[
                    {
                        "r":1
                    },
                    {
                        "r":2
                    },
                    {
                        "r":3
                    },
                    {
                        "r":4
                    },
                    {
                        "r":5
                    }
                ],
                "hasMore":true,
                "limit":5,
                "offset":0,
                "count":5
```

```
                }
            }
        ]
    }
```

9.5.2.3 Specifying the Offset Value in a POST Request for Pagination

You can specify the `offset` value in a POST JSON request. This value specifies the first row that must be returned and is used for pagination of the result set returned from a query.

File: `offset_limit.json`

```
{
 "statementText": "
 WITH data(r) AS (
 SELECT 1 r FROM dual
 UNION ALL
 SELECT r+1 FROM data WHERE r < 100
 )
 SELECT r FROM data;",
 "offset": 25,
 "limit": 5
}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@offset_limit.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Where: `offset` is the first row to be returned in the result set. Typically, this is used to provide the pagination for a large result set that returns the **next** page of rows in the result set.

> **Note:**
>
> Each request made to the REST-Enabled SQL service is performed in its own transaction, which means that you cannot ensure that the rows returned will match the previous request. To avoid these risks, queries that need pagination should use the ORDER BY clause on a primary key.

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
 {
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
```

```
                "startLine":1,
                "endLine":1
            },
            "statementText":" WITH data(r) AS ( SELECT 1 r FROM dual
UNION ALL SELECT r+1 FROM data WHERE r < 100 ) SELECT r FROM data",
            "response":[
            ],
            "result":0,
            "resultSet":{
                "metadata":[
                    {
                        "columnName":"R",
                        "jsonColumnName":"r",
                        "columnTypeName":"NUMBER",
                        "precision":0,
                        "scale":-127,
                        "isNullable":1
                    }
                ],
                "items":[
                    {
                        "r":26
                    },
                    {
                        "r":27
                    },
                    {
                        "r":28
                    },
                    {
                        "r":29
                    }
                    {
                        "r":30
                    }
                ],
                "hasMore":true,
                "limit":5,
                "offset":25,
                "count":5
            }
        }
    ]
}
```


9.5.2.4 Defining Binds in a POST Request

You can define binds in JSON format. This functionality is useful when calling procedures and functions that use binds as the parameters.

Example 9-2 Binds in POST Request

File: `binds.json`

```
{
 "statementText": "CREATE PROCEDURE TEST_OUT_PARAMETER (V_PARAM_IN INT IN,
V_PARAM_OUT INT OUT) AS BEGIN V_PARAM_OUT := V_PARAM_IN + 10; END;
/
EXEC TEST_OUT_PARAMETER(:var1, :var2)",
 "binds":[
 {"name":"var1","data_type":"NUMBER","value":10},
 {"name":"var2","data_type":"NUMBER","mode":"out"}
 ]
}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@binds.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
 {
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"plsql",
            "statementPos":{
                "startLine":1,
                "endLine":2
            },
            "statementText":"CREATE PROCEDURE TEST_OUT_PARAMETER (V_PARAM_IN
IN INT, V_PARAM_OUT OUT INT) AS BEGIN V_PARAM_OUT := V_PARAM_IN + 10; END;",
            "response":[
                "\nProcedure TEST_OUT_PARAMETER compiled\n\n"
            ],
            "result":0,
            "binds":[
                {
                    "name":"var1",
                    "data_type":"NUMBER",
                    "value":10
                },
                {
                    "name":"var2",
                    "data_type":"NUMBER",
                    "mode":"out",
                    "result":null
                }
            ]
```

```
        },
        {
            "statementId":2,
            "statementType":"sqlplus",
            "statementPos":{
                "startLine":3,
                "endLine":3
            },
            "statementText":"EXEC TEST_OUT_PARAMETER(:var1, :var2)",
            "response":[
                "\nPL\/SQL procedure successfully completed.\n\n"
            ],
            "result":0,
            "binds":[
                {
                    "name":"var1",
                    "data_type":"NUMBER",
                    "value":10
                },
                {
                    "name":"var2",
                    "data_type":"NUMBER",
                    "mode":"out",
                    "result":20
                }
            ]
        }
    ]
}
```

Example 9-3   Complex Bind in POST Request

File`complex_bind_example.json`

```
{
    "statementText":"
declare
 type t is table of number index by binary_integer;
 l_in  t    := :IN;
 l_out t;
 begin
   for i in 1..l_in.count loop
  l_out(i) := l_in(i) * 2;
   end loop;
   :L_OUT := l_out;
 end;
",
    "binds":[
        {
            "name":"IN",
            "data_type":"PL/SQL TABLE",
            "type_name":"",
            "type_subname":"",
            "type_components":[
                {
```

```
                    "data_type":"NUMBER"
                }
            ],
            "value":[
                2,
                4,
                7
            ]
        },
        {
            "name":"L_OUT",
            "data_type":"PL/SQL TABLE",
            "type_name":"",
            "type_subname":"",
            "type_components":[
                {
                    "data_type":"NUMBER"
                }
            ],
            "mode":"out"
        }
    ]
}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@complex_bind_example.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"plsql",
            "statementPos":{
                "startLine":2,
                "endLine":12
            },
            "statementText":"declare \n type t is table of number index by
binary_integer;   \n l_in  t    := :IN;   \n l_out t;  \n begin   \n   for i
in 1..l_in.count loop   \n  l_out(i) := l_in(i) * 2;  \n   end loop;
\n   :L_OUT := l_out;   \n end;",
            "response":[
            ],
            "result":1,
            "binds":[
                {
```

```
                    "name":"IN",
                    "data_type":"PL/SQL TABLE",
                    "type_components":[
                        {
                            "data_type":"NUMBER"
                        }
                    ],
                    "type_name":"",
                    "type_subname":"",
                    "value":[
                        2,
                        4,
                        7
                    ]
                },
                {
                    "name":"L_OUT",
                    "data_type":"PL/SQL TABLE",
                    "mode":"out",
                    "type_components":[
                        {
                            "data_type":"NUMBER"
                        }
                    ],
                    "type_name":"",
                    "type_subname":"",
                    "result":[
                        4,
                        8,
                        14
                    ]
                }
            ]
        }
    ]
}
```

9.5.2.5 Specifying Batch Statements in a POST Request

This section shows the examples with batch statements and batch bind values in a POST request.

Example 9-4 Batch statements

File: batch_example.json

```
{
    "statementText":[
        "insert into adhoc_table_simple values(1)",
        "insert into adhoc_table_simple values(2)",
        "delete from adhoc_table_simple"
    ]
}
```

Request :`curl -i -X POST --user DEMO:demo --data-binary "@batch_example.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"dml",
            "statementPos":{
                "startLine":0,
                "endLine":0
            },
            "statementText":[
                "insert into adhoc_table_simple values(1)",
                "insert into adhoc_table_simple values(2)",
                "delete from adhoc_table_simple"
            ],
            "response":[
                "\n1 row inserted.\n\n",
                "\n1 row inserted.\n\n",
                "\n2 rows inserted.\n\n"
            ],
            "result":[
                1,
                1,
                2
            ]
        }
    ]
}
```

Example 9-5 Batch bind values

File: batch_bind_example.json

```
{
    "statementText":"INSERT INTO ADHOC_TABLE_DATE VALUES(?,?)",

    "binds":[
        {
            "index":1,
            "data_type":"NUMBER",
            "batch":true,
            "value":[
```

```
                3,
                6,
                9,
                13,
                17
            ]
        },
        {
            "index":2,
            "data_type":"DATE",
            "batch":true,
            "value":[
                "2017-02-21T06:12:20Z",
                "2017-02-21T06:12:20Z",
                "2017-02-21T06:12:20Z",
                "2017-02-21T06:12:20Z",
                "2017-02-21T06:12:20Z"
            ]
        }
    ]
}
```


Request: `curl -i -X POST --user DEMO:demo --data-binary "@batch_bind_example.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Response:


```
HTTP/1.1 200 OK
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"dml",
            "statementPos":{
                "startLine":1,
                "endLine":2
            },
            "statementText":"INSERT INTO ADHOC_TABLE_DATE VALUES(?,?)",
            "response":[
                "\n1 row inserted.\n\n",
                "\n1 row inserted.\n\n",
                "\n1 row inserted.\n\n",
                "\n1 row inserted.\n\n",
                "\n1 row inserted.\n\n"
            ],
            "result":[
                1,
                1,
```

```
                        1,
                        1,
                        1
                    ],
                    "binds":[
                        {
                            "index":1,
                            "data_type":"NUMBER",
                            "batch":true,
                            "value":[
                                3,
                                6,
                                9,
                                13,
                                17
                            ]
                        },
                        {
                            "index":2,
                            "data_type":"DATE",
                            "batch":true,
                            "value":[
                                "2017-02-21T06:12:20Z",
                                "2017-02-21T06:12:20Z",
                                "2017-02-21T06:12:20Z",
                                "2017-02-21T06:12:20Z",
                                "2017-02-21T06:12:20Z"
                            ]
                        }
                    ]
                }
            ]
        }
```

9.5.3 Example POST Request with DATE and TIMESTAMP Format

Example 9-6 Oracle REST Data services Time Zone Set as Europe/London

Oracle Database DATE and TIMESTAMP data types do not have a time zone associated with them. The DATE and TIMESTAMP values are associated with the time zone of the application. Oracle REST Data Services and the REST- Enabled SQL service return values in a JSON format. The standard for JSON is to return date and timestamp values using the UTC Zulu format. Oracle REST Data Services and the REST- Enabled SQL service return Oracle Database DATE and TIMESTAMP values in the Zulu format using the time zone in which Oracle REST Data Services is running.

Oracle recommends running Oracle REST Data Services using the UTC time zone to make this process easier.

File: `date.json`

```
{
    "statementText":"SELECT TO_DATE('2016-01-01 10:00:03','yyyy-mm-dd
```

```
hh24:mi:ss' ) winter, TO_DATE('2016-07-01 10:00:03','yyyy-mm-dd
hh24:mi:ss' ) summer FROM dual;"
}
```

Request: `curl -i -X POST --user DEMO:demo --data-binary "@date.json" -H "Content-Type: application/json" -k https://localhost:8088/ords/demo/_/sql`

Response:

> **Note:**
>
> In this example, both DATE values are specified as 10 a.m. The `"summer"` value is returned as 9 a.m. Zulu time. This is due to British Summer Time.

```
HTTP/1.1 200 OK
Date: Wed, 26 Jul 2017 14:59:27 GMT
Content-Type: application/json
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked
Server: Jetty(9.2.21.v20170120)
{
    "env":{
        "defaultTimeZone":"Europe/London"
    },
    "items":[
        {
            "statementId":1,
            "statementType":"query",
            "statementPos":{
                "startLine":1,
                "endLine":1
            },
            "statementText":"SELECT TO_DATE('2016-01-01
10:00:03','yyyy-mm-dd hh24:mi:ss' ) winter, TO_DATE('2016-07-01
10:00:03','yyyy-mm-dd hh24:mi:ss' ) summer FROM dual",
            "response":[
             ],
            "result":0,
            "resultSet":{
                "metadata":[
                    {
                        "columnName":"WINTER",
                        "jsonColumnName":"winter",
                        "columnTypeName":"DATE",
                        "precision":0,
                        "scale":0,
                        "isNullable":1
                    },
                    {
                        "columnName":"SUMMER",
                        "jsonColumnName":"summer",
                        "columnTypeName":"DATE",
```

```
                    "precision":0,
                    "scale":0,
                    "isNullable":1
                }
            ],
            "items":[
                {
                    "winter":"2016-01-01T10:00:03Z",
                    "summer":"2016-07-01T09:00:03Z"
                }
            ],
            "hasMore":false,
            "limit":1500,
            "offset":0,
            "count":1
        }
    }
  ]
}
```

9.5.4 Data Types and Formats Supported

The following code snippet shows the different data types and the formats supported:

```
{

"statementText":"SELECT ?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?
,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,?,? FROM dual",
    "binds":[
        {
            "index":1,
            "data_type":"NUMBER",
            "value":1233
        },
        {
            "index":2,
            "data_type":"NUMERIC",
            "value":123
        },
        {
            "index":3,
            "data_type":"DECIMAL",
            "value":123
        },
        {
            "index":4,
            "data_type":"DEC",
            "value":123
        },
        {
            "index":5,
            "data_type":"NUMBER",
            "value":123
        },
```

```
{
    "index":6,
    "data_type":"INTEGER",
    "value":123
},
{
    "index":7,
    "data_type":"INT",
    "value":123
},
{
    "index":8,
    "data_type":"SMALLINT",
    "value":123
},
{
    "index":9,
    "data_type":"FLOAT",
    "value":123
},
{
    "index":10,
    "data_type":"DOUBLE PRECISION",
    "value":123
},
{
    "index":11,
    "data_type":"REAL",
    "value":123
},
{
    "index":12,
    "data_type":"BINARY_FLOAT",
    "value":123
},
{
    "index":13,
    "data_type":"BINARY_DOUBLE",
    "value":123
},
{
    "index":14,
    "data_type":"CHAR",
    "value":"abc"
},
{
    "index":15,
    "data_type":"CHARACTER",
    "value":"abc"
},
{
    "index":16,
    "data_type":"VARCHAR",
    "value":"abc"
},
```

```
{
    "index":17,
    "data_type":"VARCHAR2",
    "value":"abc"
},
{
    "index":18,
    "data_type":"CHAR VARYING",
    "value":"abc"
},
{
    "index":19,
    "data_type":"CHARACTER VARYING",
    "value":"abc"
},
{
    "index":20,
    "data_type":"NCHAR",
    "value":"abc"
},
{
    "index":21,
    "data_type":"NATIONAL CHAR",
    "value":"abc"
},
{
    "index":22,
    "data_type":"NATIONAL CHARACTER",
    "value":"abc"
},
{
    "index":23,
    "data_type":"NVARCHAR",
    "value":"abc"
},
{
    "index":24,
    "data_type":"NVARCHAR2",
    "value":"abc"
},
{
    "index":25,
    "data_type":"NCHAR VARYING",
    "value":"abc"
},
{
    "index":26,
    "data_type":"NATIONAL CHAR VARYING",
    "value":"abc"
},
{
    "index":27,
    "data_type":"NATIONAL CHARACTER VARYING",
    "value":"abc"
},
```

```
{
    "index":28,
    "data_type":"DATE",
    "value":"01-Jan-2016"
},
{
    "index":29,
    "data_type":"TIMESTAMP",
    "value":"1976-02-01T00:00:00Z"
},
{
    "index":30,
    "data_type":"TIMESTAMP",
    "value":"1976-02-01T00:00:00Z"
},
{
    "index":31,
    "data_type":"TIMESTAMP WITH LOCAL TIME ZONE",
    "value":"1976-02-01T00:00:00Z"
},
{
    "index":32,
    "data_type":"TIMESTAMP WITH TIME ZONE",
    "value":"1976-02-01T00:00:00Z"
},
{
    "index":33,
    "data_type":"INTERVALYM",
    "value":"P10Y10M"
},
{
    "index":34,
    "data_type":"INTERVAL YEAR TO MONTH",
    "value":"P10Y10M"
},
{
    "index":35,
    "data_type":"INTERVAL YEAR(2) TO MONTH",
    "value":"P10Y10M"
},
{
    "index":36,
    "data_type":"INTERVALDS",
    "value":"P11DT10H10M10S"
},
{
    "index":37,
    "data_type":"INTERVAL DAY TO SECOND",
    "value":"P11DT10H10M10S"
},
{
    "index":38,
    "data_type":"INTERVAL DAY(2) TO SECOND(6)",
    "value":"P11DT10H10M10S"
},
```

```
            {
                "index":39,
                "data_type":"ROWID",
                "value":1
            },
            {
                "index":40,
                "data_type":"RAW",
                "value":"AB"
            },
            {
                "index":41,
                "data_type":"LONG RAW",
                "value":"AB"
            },
            {
                "index":42,
                "data_type":"CLOB",
                "value":"clobvalue"
            },
            {
                "index":43,
                "data_type":"NCLOB",
                "value":"clobvalue"
            },
            {
                "index":45,
                "data_type":"LONG",
                "value":"A"
            }
        ]

}
```

9.6 REST-Enabled SQL Request and Response Specifications

The following sections provide REST-Enabled SQL request and response specifications:

- Request Specification
- Response Specification

9.6.1 Request Specification

Request Specification for application/sql

The body of the request is in plain UTF8 text. Statements can be separated by their usual SQL*Plus terminator.

Specification for application/json

JSONPath	Type	Description	Example	Default Value	Possible Values
`$.statementText`	String	Specifies the SQL statements to execute.	`"select 1 from dual"`	Not applicable	Not applicable
`$.statementText`	Array	Specifies batch DML statements using an array. One DML statement is specified per string in an array.	`[ "insert into test1 values(1)", "update test1 set col1=2" ]`	Not applicable	Not applicable
`$.offset`	Number	Specifies the number of rows to offset the query result. This is used for pagination of the result set returned from a query.	`25`	`0`	Between 0 to `misc.pagination.maxRows`.
`$.limit`	Number	Specifies the maximum number of rows returned from a query. Values greater than the value of the `misc.pagination.maxRows` property, specified in the `defaults.xml`, is ignored.	`500`	`misc.pagination.maxRows`	Between 0 to `misc.pagination.maxRows`.
`$.binds`	Array	Specifies an array of objects specifying the bind information.	`"binds": [ { "name": "mybind1", "data_type":"NUMBER", "mode":"out" }, { "name":"mybind2", "data_type":"NUMBER", "value":7 } ]`	Not applicable	Not applicable
`$.binds[*].name`	String	Specifies the name of the bind, when you are using named notation.	`"mybind"`	Not applicable	Not applicable

JSONPath	Type	Description	Example	Default Value	Possible Values
`$.binds[*].index`	Number	Specifies the index of bind, when you are using positional notation.	`1`	Not applicable	`Between 1 to n`
`$.binds[*].data_type`	String	Specifies Oracle data type of the bind.	`"NUMBER"`	Not applicable	For more information, refer to Oracle Built-in Types
`$.binds[*].value`	Any value	Specifies the value of the bind.	`"value to insert"`	`null`	Can be one of the following data-types: • Number • String • Array For more information, refer to Oracle Built-in Types
`$.binds[*].mode`	String	Specifies the mode in which the bind is used.	`"out"`	`"in"`	`[ "in" , "inout", "out" ]`
`$.binds[*].batch`	Boolean	Specifies whether or not you want to perform a batch bind. If you want to perform a batch bind, then set the value to `true`. If the value is set to `true`, then `$binds[*]` must consist of an array of values.	`true`	`false`	`[ true, false ]`
`$.binds[*].type_name`	String	Required when you are using `$binds[*].data_type = "PL/SQL TABLE"` Currently, only an empty string is accepted as the value.	`""`	Not applicable	Not applicable
`$.binds[*].type_subname`	String	Required when you are using `$binds[*].data_type = "PL/SQL TABLE"` Currently, only an empty string is accepted as the value.	`""`	Not applicable	Not applicable

JSONPath	Type	Description	Example	Default Value	Possible Values
`$.binds[*].type_components`	Array	Specifies an array of data types in the PL/SQL TABLE Required when you are using `$binds[*].data_type = "PL/SQL TABLE"`	`[{"data_type":"NUMBER"}]`	Not applicable	Not applicable
`$.binds[*].type_components[*].data_type`	String	Specifies Oracle data type of a column in the PL/SQL TABLE. Required when you are using `$binds[*].data_type = "PL/SQL TABLE"`	`"NUMBER"`	Not applicable	For more information, refer to Oracle Built-in Types

9.6.2 Response Specification

JSONPath	Data type	Description	Example Values	Possible values
`$.env`	Object	Specifies the information about the Oracle REST Data Services environment.	Not applicable	Not applicable
`$.env.defaultTimeZone`	String	Specifies the timezone in which Oracle REST Data Services server is running on.	`"Europe/London"`	Not applicable
`$.items`	Array	Specifies that there is one item for each statement executed.	Not applicable	Not applicable
`$.items[*].statementId`	Number	Specifies the sequence number of the statement.	`1`	Not applicable
`$.items[*].statementType`	String	Specifies the type of statement.	`"query"`	["query" , "dml", "ddl", "plsql" , "sqlplus" , "ignore", "transaction-control", "session-control", "system-control", "jdbc", "other"]

JSONPath	Data type	Description	Example Values	Possible values
`$.items[*].statementPos`	Object	Specifies information about the position of a specified statement.	Not applicable	Not applicable
`$.items[*].statementPos.startLine`	Number	Specifies start line of the statement.	Not applicable	Not applicable
`$.items[*].statementPos.endLine`	Number	Specifies end line of the statement.	Not applicable	Not applicable
`$items[*].statementText`	String	Specifies the SQL statement to be executed.	`"select 1 from dual"`	Not applicable
`$items[*].statementText`	Array	Specifies batch DML statements can be specified using an array. One DML statement specified per string in an array.	`[ "insert into test1 values(1) ","update test1 set col1=2" ]`	Not applicable
`$.items[*].response`	Array	Specifies array of Strings. The response generated when running the statement.	`[ "\n1 row inserted.\n\n" ]`	Not applicable
`$.items[*].result`	Number	Specifies the result generated when running the statement. For DML statements, this will be the number of rows affected.	`5`	Not applicable
`$.items[*].result`	Array	Specifies the result generated when running each of the batch statements. For DML statements, this will be the number of rows affected.	`[ 1, 1, 2 ]`	Not applicable
`$.items[*].resultSet`	Object	Specifies information about the result set generated from a query.	Not applicable	Not applicable

JSONPath	Data type	Description	Example Values	Possible values
`$.items[*].resultSet.metadata`	Array	Specifies each object in the array provides information about the metadata of a column.	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].columnName`	String	Specifies the name of the column used in the Oracle Database.	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].jsonColumnName`	String	Specifies the name of the column used in `$.items[*].resultSet.items[*].<columnname>`	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].columnTypeName`	String	Specifies the Oracle Database data type of the column.	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].precision`	Number	Specifies the precision of the column.	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].scale`	Number	Specifies the scale of the column.	Not applicable	Not applicable
`$.items[*].resultSet.metadata[*].isNullable`	Number	Specifies whether the column is nullable or not. 0, if the column is not nullable. 1, if the column is nullable.	Not applicable	Not applicable
`$.items[*].resultSet.items`	Array	Specifies the list of all rows returned in the result set.	Not applicable	Not applicable
`$.items[*].resultSet.items[*].<columnname>`	Any type	Specifies the value of a particular column and row in the result set.	Not applicable	Not applicable

JSONPath	Data type	Description	Example Values	Possible values
`$.items[*].resultSet.hasMore`	Boolean	Specifies whether result set has more rows. Value is set to `true` if the result set has more rows, otherwise set to `false`. The rows in the result set depend on `misc.pagination.maxRows` value configured in `defaults.xml` file or as specified in the request.	`false`	[true , false]
`$.items[*].resultSet.count`	Number	Specifies the number of rows returned.	Not applicable	Not applicable
`$.items[*].resultSet.offset`	Number	Specifies the number of rows to offset the query result. This is used for pagination of the result set returned from a query.	`25`	Between 0 to `misc.pagination.maxRows`
`$.items[*].resultSet.limit`	Number	Specifies the maximum number of rows returned from a query. Values greater than `misc.pagination.maxRows` value specified in `defaults.xml` file are ignored.	`500`	Between 0 to `misc.pagination.maxRows`

JSONPath	Data type	Description	Example Values	Possible values
`$.items[*].binds`	Array	Specifies an array of objects specifying the bind information.	`"binds": [ { "name":"mybind1", "data_type":"NUMBER", "mode":"out" }, { "name": "mybind2", "data_type":"NUMBER", "value":7 } ]`	Not applicable
`$.items[*].binds[*].name`	String	Specifies the name of the bind, when you are using named notation.	`"mybind"`	Not applicable
`$.items[*].binds[*].index`	Number	specifies iIndex of bind, when you are using positional notation.	`1`	`1 - n`
`$.items[*].binds[*].data_type`	String	Specifies the Oracle data type of the bind.	`"NUMBER"`	For more information, refer to Oracle Built-in Types
`$.items[*].binds[*].value`	Any type	Specifies the value of the bind.	`"value to insert"`	Can be one of the following data types: • Number • String • Array For more information, refer to Oracle Built-in Types
`$.items[*].binds[*].result`	Any type	Specifies the result of an OUT bind.	Not applicable	Not applicable
`$.items[*].binds[*].mode`	String	Specifies the mode in which the bind is used.	`"out"`	`[ "in" , "inout", "out" ]`

JSONPath	Data type	Description	Example Values	Possible values
`$.items[*].binds[*].batch`	Boolean	Specifies whether or not you want to perform a batch bind. If you want to perform a batch bind, then set the value to `true`. If a batch bind is to be performed, then the value is set to `true`. If the value is set to `true`, then `$binds[*]` value must be an array of values.	`true`	`[ true, false ]`
`$.items[*].binds[*].type_name`	String	Required when using `$binds[*].data_type = "PL/SQL TABLE"`. Currently, only an empty string is accepted as the value.	`""`	Not applicable
`$.items[*].binds[*].type_subname`	String	Required when using `$binds[*].data_type = "PL/SQL TABLE"`. Currently, only an empty string is accepted as the value.	`""`	Not applicable
`$.items[*].binds[*].type_components`	Array	Array of data types in the PL/SQL TABLE Required when using `$binds[*].data_type = "PL/SQL TABLE"`.	`[{"data_type":"NUMBER"}]`	Not applicable
`$.items[*].binds[*].type_components[*].data_type`	String	The Oracle data type of a column in the PL/SQL TABLE. Required when using `$binds[*].data_type = "PL/SQL TABLE"`	`"NUMBER"`	For more information, refer to Oracle Built-in Types

9.7 Supported SQL, SQL*Plus, and SQLcl Statements

This section lists all the supported SQL, SQL*Plus and SQLcl statements for REST-Enabled SQL service.

Topics

- Supported SQL Statements
- Supported PL/SQL Statements
- Supported SQL*Plus Statements
- Supported SQLcl Statements

9.7.1 Supported SQL Statements

This section describes the SQL statements that the REST- Enabled SQL service supports.

REST- Enabled SQL service supports all SQL commands. If the specified Oracle Database schema has the appropriate privileges, then you can run them. Oracle REST Data Services makes all queries into in-line views before execution to provide pagination support. Queries are made in-line irrespective of the format in which you provide the query. All the other nonquery SQL statements are executed as they are.

In-line views have the following limitations:

- All column names in a query must be unique because the views and in-line views cannot have ambiguous column names.
- Cursor expressions are not displayed in view or in-line views.
- WITH FUNCTION clause is not supported in in-line views.

Related Topics

- SQL_statements_ref

9.7.2 Supported PL/SQL Statements

The REST- Enabled SQL service supports PL/SQL statements and blocks.

Example 9-7   PL/SQL Statement

```
DECLARE v_message VARCHAR2(100) := 'Hello World';
BEGIN
  FOR i IN 1..3 LOOP
    DBMS_OUTPUT.PUT_LINE (v_message);
  END LOOP;
END;
/
```

Related Topics

- plsql_block

9.7.3 Supported SQL*Plus Statements

This section lists all the SQL*Plus statements that the REST- Enabled SQL service supports.

REST- Enabled SQL service supports most of the SQL*Plus statements except those statements that are related to formatting. The specific Oracle Database schema must have the appropriate privileges to run the SQL*Plus statemments.

The following is a list of supported SQL*Plus statements:

- `SET system_variable value`

> **Note:**
>
> `system_variable` and `value` represent one of the clauses described in Set System Variables section.

- `/ (slash)`
- `DEF[INE] [variable] | [variable = text]`
- `DESC[RIBE] {[schema.]object[@connect_identifier]}`
- `EXEC[UTE] statement`
- `HELP | ? [topic]`
- `PRINT [variable ...]`
- `PRO[MPT] [text]`
- `REM[ARK]`
- `SHO[W] [option]`
- `TIMI[NG] [START text | SHOW | STOP]`
- `UNDEF[INE] variable ...`
- `VAR[IABLE] [variable [type][=value]]`

Related Topics

- sqlplus_commands

9.7.3.1 Set System Variables

The following is a list of possible values for `system_variable` and `value`:

> **Note:**
>
> The command `SET CMDS[EP] {; | c | ON | OFF}` is obsolete.

- `SET APPI[NFO]{ON | OFF | text}`
- `SET AUTOP[RINT] {ON | OFF}`

- `SET AUTOT[RACE] {ON | OFF | TRACE[ONLY]} [EXP[LAIN]] [STAT[ISTICS]]`
- `SET BLO[CKTERMINATOR] {. | c | ON | OFF}`
- `SET CMDS[EP] {; | c | ON | OFF}`
- `SET COLINVI[SIBLE] [ON | OFF]`
- `SET CON[CAT] {. | c | ON | OFF}`
- `SET COPYC[OMMIT] {0 | n}`
- `SET DEF[INE] {& | c | ON | OFF}`
- `SET DESCRIBE [DEPTH {1 | n | ALL}] [LINENUM {ON | OFF}] [INDENT {ON | OFF}]`
- `SET ECHO {ON | OFF}`
- `SET ERRORL[OGGING] {ON | OFF} [TABLE [schema.]tablename] [TRUNCATE] [IDENTIFIER identifier]`
- `SET ESC[APE] {\ | c | ON | OFF}`
- `SET FEED[BACK] {6 | n | ON | OFF | ONLY}]`
- `SET SERVEROUT[PUT] {ON | OFF} [SIZE {n | UNL[IMITED]}] [FOR[MAT] {WRA[PPED] | WOR[D_WRAPPED] | TRU[NCATED]}]`
- `SET SHOW[MODE] {ON | OFF}`
- `SET SQLBL[ANKLINES] {ON | OFF}`
- `SET SQLP[ROMPT] {SQL> | text}`
- `SET TI[ME] {ON | OFF}`
- `SET TIMI[NG] {ON | OFF}`
- `SET VER[IFY] {ON | OFF}`

Related Topics

- set-system_var_summary

9.7.3.2 Show System Variables

This section lists the possible values for `option` which is either a term or a clause used in the `SHO[W] option` command.

The following is a list of possible values for the `option` variable:

> **Note:**
>
> The commands `SHOW CMDSEP` and `SHOW DESCR[IBE]` are obsolete.

- `SHOW system_variable`
- `SHOW EDITION`

- SHOW ERR[ORS] [{ ANALYTIC VIEW | ATTRIBUTE DIMENSION | HIERARCHY | FUNCTION | PROCEDURE | PACKAGE | PACKAGE BODY | TRIGGER | VIEW | TYPE | TYPE BODY | DIMENSION | JAVA CLASS } [schema.]name]
- SHOW PDBS
- SHOW SGA
- SHOW SQLCODE
- SHOW COLINVI[SIBLE]
- SHOW APPIN[FO]
- SHOW AUTOT[RACE]
- SHOW BINDS
- SHOW BLO[CK TERMINATOR]
- SHOW CMDSEP
- SHOW COPYTYPECHECK
- SHOW COPYCOMMIT
- SHOW DEFINE
- SHOW DEFINES
- SHOW DESCR[IBE]
- SHOW ECHO
- SHOW EDITION
- SHOW ERRORL[OGGING]
- SHOW ESC[APE]
- SHOW FEEDBACK
- SHOW CONCAT
- SHOW SHOW[MODE]
- SHOW RECYC[LEBIN]
- SHOW RELEASE
- SHOW SQLBL[ANKLINES]
- SHOW SCAN
- SHOW SERVEROUT[PUT]
- SHOW SPACE
- SHOW TABLES
- SHOW TIMI[NG]
- SHOW USER
- SHOW VER[IFY]
- SHOW XQUERY

Related Topics

- show_command

9.7.4 Supported SQLcl Statements

This section lists the SQLcl statements that the REST- Enabled SQL service supports.

REST- Enabled SQL service supports some of the SQLcl statements. The specific Oracle Database schema must have the appropriate privileges to run the SQLcl statements.

The following is a list of supported SQLcl statements:

- `CTAS`
- `DDL`
- `SET DDL`

9.8 REST-Enabled SQL Service and MySQL Database

This section describes an ORDS feature that is supported only with MySQL databases running on Oracle Cloud Infrastructure.

You can use the REST-Enabled SQL Service with MySQL database 8.0 or later, hosted in Oracle Cloud infrastructure. For MySQL database, you do not need to install any ORDS-specific software, but must specify the configuration details about how to connect to the database over JDBC through a connection pool. The ORDS distribution includes the MySQL connector/J JDBC driver.

The endpoints for REST-Enabled SQL Service and the corresponding export service end with `/_/sql` and `/_/sql/export` respectively.

ORDS returns data in a well-formed JSON structure. The MySQL data types JSON and GEOMETRY are returned as a JSON object in the response. Any binary data, such as BLOB data types, is returned as a BASE64 encoded string. The supported export format types are CSV, HTML, JSON, and XML.

9.8.1 Examples

This section describes how to configure a sample MySQL database and perform a few common operations.

The examples described in this section refers to the MySQL `sakila` sample database. The connection pool called `mysql` is configured to connect to the MySQL database instance with `db.credentials`. The source is set to `REQUEST` and MySQL database user in this example is `francis` and the password is set as `frank`.

Example 9-8 Script

This example shows how to list the schemas in the database instance.

Request

```
curl --user francis:frank --request POST 'http://localhost:8080/ords/
mysql/_/sql' \
```

```
--header 'Content-Type: application/sql' \
--data 'show databases'
```

Response

```
{
   "env" : {
      "defaultTimeZone" : "UTC"
   },
   "items" : [
      {
         "response" : [

"Database                                                         ",
            "\n",

"---------------------------------------------------------------- ",
            "\n",

"information_schema                                               ",
            "\n",

"mysql                                                            ",
            "\n",

"performance_schema                                               ",
            "\n",

"sakila                                                           ",
            "\n",

"sys                                                              ",
            "\n"
         ],
         "result" : 0,
         "statementId" : 1,
         "statementPos" : {
            "endLine" : 1,
            "startLine" : 1
         },
         "statementText" : "show databases",
         "statementType" : "sqlplus"
      }
   ]
}
```

Example 9-9 Query

This example shows how to query the `film` table in the `sakila` schema, using bind variables and limit in the query.

> **Note:**
>
> All bind variables are `VARCHAR` data type and are mapped to the appropriate data type for the referenced column.

Request

```
curl --user francis:frank --request POST 'http://localhost:8080/ords/
mysql/_/sql' \
--header 'Content-Type: application/json' \
--data-raw '{
    "statementText": "select film.title, film.release_year from
sakila.film film where film.rating = :var1 and film.release_year
between :lowDate and :highDate order by release_year",
    "offset": 0,
    "limit": 5,
    "binds": [
        {
            "name": "var1",
            "data_type": "VARCHAR",
            "value": "G"
        },
        {
            "name": "highDate",
            "data_type": "VARCHAR",
            "value": "2006-01-01T00:00:00Z"
        },
        {
            "name": "lowDate",
            "data_type": "VARCHAR",
            "value": "2005-01-01T00:00:00Z"
        }
    ]
}'
```

Response


```
{
   "env" : {
      "defaultTimeZone" : "Europe/Dublin"
   },
   "items" : [
      {
         "binds" : [
            {
               "data_type" : "VARCHAR",
               "name" : "var1",
               "value" : "G"
            },
            {
               "data_type" : "VARCHAR",
               "name" : "highDate",
```

```
            "value" : "2006-01-01T00:00:00Z"
         },
         {
            "data_type" : "VARCHAR",
            "name" : "lowDate",
            "value" : "2005-01-01T00:00:00Z"
         }
      ],
      "response" : [],
      "result" : 0,
      "resultSet" : {
         "count" : 5,
         "hasMore" : true,
         "items" : [
            {
               "release_year" : "2006-01-01T00:00:00Z",
               "title" : "ACE GOLDFINGER"
            },
            {
               "release_year" : "2006-01-01T00:00:00Z",
               "title" : "AFFAIR PREJUDICE"
            },
            {
               "release_year" : "2006-01-01T00:00:00Z",
               "title" : "AFRICAN EGG"
            },
            {
               "release_year" : "2006-01-01T00:00:00Z",
               "title" : "ALAMO VIDEOTAPE"
            },
            {
               "release_year" : "2006-01-01T00:00:00Z",
               "title" : "AMISTAD MIDSUMMER"
            }
         ],
         "limit" : 5,
         "metadata" : [
            {
               "columnClassName" : "java.lang.String",
               "columnName" : "title",
               "columnTypeName" : "VARCHAR",
               "isNullable" : 0,
               "jsonColumnName" : "title",
               "precision" : 128,
               "scale" : 0
            },
            {
               "columnClassName" : "java.sql.Date",
               "columnName" : "release_year",
               "columnTypeName" : "YEAR",
               "isNullable" : 1,
               "jsonColumnName" : "release_year",
               "precision" : 4,
               "scale" : 0
            }
```

```
            ],
            "offset" : 0
         },
         "statementId" : 1,
         "statementPos" : {
            "endLine" : 2,
            "startLine" : 1
         },
         "statementText" : "select film.title, film.release_year from
sakila.film film where film.rating = :var1 and film.release_year
between :lowDate and :highDate order by release_year",
         "statementType" : "query"
      }
   ]
}
```

Example 9-10 Export

This example shows how to export the rows from the `film` table in CSV format to a file `film.csv`.

Request

```
curl --user francis:frank --location --output film.csv --request
        POST 'http://localhost:8080/ords/mysql/_/sql/export' \--header
'Content-Type: application/x-www-form-urlencoded' \--data-urlencode
'data={"statementText":"select * from sakila.film",
        "formatDetails":{"format":"CSV", "header": true,
"lineTerminator":
        "\n"}}'
```

10 GraphQL in Oracle REST Data Services

This section introduces GraphQL functionality in Oracle REST Data Services.

The GraphQL feature in Oracle REST Data Services enables you to fetch the data from an Oracle REST Data Services enabled schema using GraphQL queries.

Topics:

- GraphQL Terminology
- Enabling GraphQL in Oracle REST Data Services
- Enabling Objects for GraphQL
- Accessing Objects Using GraphQL queries
- Examples of Filtering in Queries
- Sorting the Data
- Keyset Pagination
- Using Dynamic Arguments in Queries: Variables
- GraphiQL

10.1 GraphQL Terminology

This section describes the common terms used in this section.

Following are the common terms used in this section:

- **GraphQL Schema Definition Language (SDL):** Sometimes it is simply referred to as GraphQL schema language. It is a language with a simple syntax that allows to define a schema.
- **Schema:** A schema in the GraphQL context refers to a collection of GraphQL types.
- **Type:** Represents a kind of object that you can fetch from your service. Each REST-Enabled table or view object in Oracle REST Data Services represents a GraphQL type.
- **Field**: A GraphQL type contains a set of fields that you can fetch in a query. Every column of a table or view object in Oracle REST Data Services represents a field.

10.2 Enabling GraphQL in Oracle REST Data Services

This section describes how to enable GraphQL.

To enable GraphQL, Oracle REST Data Services is required to run in a GraalVM runtime environment with the Java Script component enabled.

> **See Also:**
>
> System Requirements

10.3 Enabling Objects for GraphQL

This section explains how to enable the objects for GraphQL.

Any REST-Enabled table or view of an Oracle REST Data Services enabled schema can be accessed through GraphQL queries. For a REST-Enabled object to be mapped into a GraphQL type, it is necessary that it has one or multiple primary keys associated to the object. If this condition is not satisfied, then the ROWID pseudo column is used to guarantee that the objects obtained in a query are unique and are not a duplicate derived from a join.

> **Note:**
>
> The use of ROWID as an identifier has some limitations.

GraphQL endpoint syntax:

```
http://<HOST>:<PORT>/ords/<Schema>/_/graphql
```

> **Note:**
>
> This feature is available only for Oracle REST Data Services enabled schemas.

10.3.1 Accessing Protected REST-Enabled Objects

The following roles protect the REST-enabled objects that require authorization:

- `oracle.dbtools.autorest.any.schema`
- `oracle.dbtools.role.autorest.<SCHEMANAME>.<OBJECTNAME>`

This means that, GraphQL request must have proper authorization in order to have access to the protected objects.

> **See Also:**
>
> About Oracle REST Data Services User Roles

10.4 Accessing Objects Using GraphQL queries

This section provides examples for using GraphQL queries against tables and views after REST-enabling the tables and views.

Following examples are discueed in this section:

- Getting GraphQL Schema
- Simple Query
- Join Query

10.4.1 Getting GraphQL Schema

The GraphQL schema is auto generated and it contains the REST-enabled objects (tables and views) of the rest enabled user database schema.

The generated schema includes the following:

- Each REST-enabled object represented as a GraphQL type with its columns represented as fields and the relationships between the objects.
- The resolvers for all the REST-enabled objects
- Supported data types

To get the GraphQL schema, run the following query:

Syntax:

```
GET 'http://<HOST>:<PORT>/ords/<Schema>/_/graphql'
```

Example query:

```
GET 'http://localhost:8080/ords/hr/_/graphql'
```

Response:

```
{"schemaName":"HR","description":"the SDL representation of the 'HR' GraphQL
Schema","SDL":"type Query {  \"\"\"Generic resolver for EMPLOYEES
type.\"\"\"\n
      employees(primaryKey: JSON, where: JSON, sort: JSON, limit: Int,
offset: Int):
      [EMPLOYEES]\n\n  \"\"\"Generic resolver for COUNTRIES type.\"\"\"\n
      countries(primaryKey: JSON, where: JSON, sort: JSON, limit: Int,
offset: Int):
      [COUNTRIES]\n}\n\n\"\"\"\nThe 'Date' scalar type represents date
values as specified by the
      ISO 8601 format in UTC time zone (YYYY-MM-
DDThh:mm:ssZ).\n\"\"\"\nscalar
      Date\n\n\"\"\"\nThe `Float` scalar type represents signed double-
precision fractional
      values as specified by [IEEE 754](https://en.wikipedia.org/wiki/
IEEE_floating_point).\n\"\"\"\nscalar
```

```
      Float\n\n\"\"\"\nThe `Int` scalar type represents non-fractional
signed whole numeric
      values. Int can represent values between -(2^31) and 2^31 -
1.\n\"\"\"\nscalar
      Int\n\n\"\"\"\nThe `JSON` scalar type represents JSON values as
specified by [ECMA-404](http://www.ecma-international.org/publications/files/ECMA-ST/
ECMA-404.pdf).\n\"\"\"\nscalar
      JSON\n\n\"\"\"\nThe `String` scalar type represents textual
data, represented as UTF-8
      character sequences. The String type is most often used by
GraphQL to represent free-form
      human-readable text.\n\"\"\"\nscalar String\n\ntype COUNTRIES
{\n  country_id: String!\n
      country_name: String\n  region_id: Int\n}\n\ntype EMPLOYEES {\n
employee_id: Int!\n
      manager_id: Int\n  phone_number: String\n  commission_pct:
Float\n  department_id: Int\n
      salary: Float\n  first_name: String\n  email: String!\n  job_id:
String!\n  hire_date:
      Date!\n  last_name: String!\n\n  \"\"\"\n  The relationship
between the EMPLOYEES type
      and the EMPLOYEES type on EMPLOYEES.MANAGER_ID =
EMPLOYEES.EMPLOYEE_ID\n  \"\"\"\n
      manager_id_employees(primaryKey: JSON, where: JSON, sort: JSON,
limit: Int, offset: Int):
      [EMPLOYEES]\n\n  \"\"\"\n  The relationship between the
EMPLOYEES type and the EMPLOYEES
      type on EMPLOYEES.EMPLOYEE_ID = EMPLOYEES.MANAGER_ID\n  \"\"\"\n
      employees_manager_id(primaryKey: JSON, where: JSON, sort: JSON,
limit: Int, offset: Int):
      [EMPLOYEES]\n}"}
```

10.4.2 Simple Query

A simple query retrieves the data in a type present in the GraphQL Schema.

This example query fetches the `employee_id`, `first_name`, `last_name`, `job_id`, and `salary` in the employees type from the HR schema.

```
query Employees {
  employees {
    employee_id
    first_name
    last_name
    job_id
    salary
  }
}
```

Example cURL command:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
```

```
--data '{
    "query": "{employees { employee_id first_name last_name job_id salary }}"
}'
```

Response:

```
{
  "data": {
    "employees": [
      {
        "employee_id": 100,
        "first_name": "Steven",
        "last_name": "King",
        "job_id": "AD_PRES",
        "salary": 24000
      },
      {
        "employee_id": 101,
        "first_name": "Neena",
        "last_name": "Kochhar",
        "job_id": "AD_VP",
        "salary": 17000
      },
      {
        "employee_id": 103,
        "first_name": "Alexander",
        "last_name": "Hunold",
        "job_id": "IT_PROG",
        "salary": 9000
      },
      {
        "employee_id": 104,
        "first_name": "Bruce",
        "last_name": "Ernst",
        "job_id": "IT_PROG",
        "salary": 6000
      },
      {
        "employee_id": 105,
        "first_name": "David",
        "last_name": "Austin",
        "job_id": "IT_PROG",
        "salary": 4800
      },
    ...
}
```

10.4.3 Join Query

A join query retrieves the data from one or more relationships between existing types present in the GraphQL Schema.

Example 1:

The following query fetches all the cities associated with a location as well as the departments in each city and the employees who work in each one of the departments.

```
query Locations{
  locations{
    city
    departments_location_id{
      department_name
      employees_department_id{
        first_name
        last_name
        salary
      }
    }
  }
}
```

Example cURL Command:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query Locations{ locations{ city
departments_location_id{ department_name
employees_department_id{first_name last_name salary} } } }"
}'
```

Response:

```
{
  "data": {
    "locations": [
      {
        "city": "Seattle",
        "departments_location_id": [
          {
            "department_name": "Executive",
            "employees_department_id": [
              {
                "first_name": "Steven",
                "last_name": "King",
                "salary": 24000
              },
              {
                "first_name": "Neena",
                "last_name": "Kochhar",
                "salary": 17000
              },
              {
                "first_name": "Lex",
                "last_name": "De Haan",
                "salary": 17000
              }
```

```
      ]
    },
    {
      "department_name": "Finance",
      "employees_department_id": [
        {
          "first_name": "Nancy",
          "last_name": "Greenberg",
          "salary": 12000
        },
        {
          "first_name": "Daniel",
          "last_name": "Faviet",
          "salary": 9000
        },
        {
          "first_name": "John",
          "last_name": "Chen",
          "salary": 8200
        },
        {
          "first_name": "Ismael",
          "last_name": "Sciarra",
          "salary": 7700
        },
        {
          "first_name": "Jose Manuel",
          "last_name": "Urman",
          "salary": 7800
        },
        {
          "first_name": "Luis",
          "last_name": "Popp",
          "salary": 6900
        }
      ]
    },
    {
      "department_name": "Purchasing",
      "employees_department_id": [
        {
          "first_name": "Den",
          "last_name": "Raphaely",
          "salary": 11000
        },
        {
          "first_name": "Alexander",
          "last_name": "Khoo",
          "salary": 3100
        },
        {
          "first_name": "Shelli",
          "last_name": "Baida",
          "salary": 2900
        },
```

```
        {
          "first_name": "Sigal",
          "last_name": "Tobias",
          "salary": 2800
        },
        {
          "first_name": "Guy",
          "last_name": "Himuro",
          "salary": 2600
        },
        {
          "first_name": "Karen",
          "last_name": "Colmenares",
          "salary": 2500
        }
      ]
    },
    {
      "department_name": "Administration",
      "employees_department_id": [
        {
          "first_name": "Jennifer",
          "last_name": "Whalen",
          "salary": 4400
        }
      ]
    },
    {
      "department_name": "Accounting",
      "employees_department_id": [
        {
          "first_name": "Shelley",
          "last_name": "Higgins",
          "salary": 12000
        },
        {
          "first_name": "William",
          "last_name": "Gietz",
          "salary": 8300
        }
      ]
    },
    {
      "department_name": "IT Support",
      "employees_department_id": []
    },
    {
      "department_name": "Operations",
      "employees_department_id": []
    },
    {
      "department_name": "Payroll",
      "employees_department_id": []
    },
    {
```

```
          "department_name": "Construction",
          "employees_department_id": []
        },
        {
          "department_name": "Government Sales",
          "employees_department_id": []
        },
        {
          "department_name": "Retail Sales",
          "employees_department_id": []
        },
        {
          "department_name": "Contracting",
          "employees_department_id": []
        },
        {
          "department_name": "Recruiting",
          "employees_department_id": []
        },
        {
          "department_name": "Control And Credit",
          "employees_department_id": []
        },
        {
          "department_name": "NOC",
          "employees_department_id": []
        },
        {
          "department_name": "Treasury",
          "employees_department_id": []
        },
        {
          "department_name": "Manufacturing",
          "employees_department_id": []
        },
        {
          "department_name": "Corporate Tax",
          "employees_department_id": []
        },
        {
          "department_name": "IT Helpdesk",
          "employees_department_id": []
        },
        {
          "department_name": "Shareholder Services",
          "employees_department_id": []
        },
        {
          "department_name": "Benefits",
          "employees_department_id": []
        }
      ]
    }
  ]
```

```
  }
}
```

Example 2:

The following example query fetches all the employees from the HR schema and the department in which they work:

```
query Employees {
    employees {
        employee_id
        first_name
        last_name
        departments_department_id {
            department_id
            department_name
        }
    }
}
```

Example cURL command:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "{employees { employee_id first_name last_name 
departments_department_id{ department_id department_name } }}"
}'
```

Response:

```
{
    "data": {
        "employees": [
            {
                "employee_id": 200,
                "first_name": "Jennifer",
                "last_name": "Whalen",
                "departments_department_id": [
                    {
                        "department_id": 10,
                        "department_name": "Administration"
                    }
                ]
            },
            {
                "employee_id": 201,
                "first_name": "Michael",
                "last_name": "Hartstein",
                "departments_department_id": [
                    {
                        "department_id": 20,
                        "department_name": "Marketing"
```

```
                    }
                ]
            },
            {
                "employee_id": 202,
                "first_name": "Pat",
                "last_name": "Fay",
                "departments_department_id": [
                    {
                        "department_id": 20,
                        "department_name": "Marketing"
                    }
                ]
            },...
        ]
    }
}
```

Note:

GraphQL nesting depth is limited to a maximum of five levels. Any query with more than five nested joins returns an error.

See Also:

Understanding Configurable Settings

10.4.3.1 Circular Relationships Between Objects

This section explains with an example a circular relationship.

A table or view can have a circular relationship and GraphQL can be used to query the data.

Following is an example showing a circular relationship in the HR schema.

The `employees` table has a constraint defined between `manager_id` and `employee_id` columns.

The following example query fetches all the employees from the HR schema along with their respective managers:

```
query Employees {
    employees {
        employee_id
        first_name
        last_name
        manager_id
        manager_id_employees {
            first_name
            last_name
```

```
            employee_id
        }
    }
}
```

Example cURL Command:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "{ employees { employee_id first_name last_name
manager_id employees_manager_id{ first_name last_name
employee_id } } }"
}'
```

Response:

```
{
  "data": {
    "employees": [
      {
        "employee_id": 101,
        "first_name": "Neena",
        "last_name": "Kochhar",
        "manager_id": 100,
        "employees_manager_id": [
          {
            "first_name": "Steven",
            "last_name": "King",
            "employee_id": 100
          }
        ]
      },
      {
        "employee_id": 114,
        "first_name": "Den",
        "last_name": "Raphaely",
        "manager_id": 100,
        "employees_manager_id": [
          {
            "first_name": "Steven",
            "last_name": "King",
            "employee_id": 100
          },
          {
            "first_name": "Eleni",
            "last_name": "Zlotkey",
            "employee_id": 149
          }
        ]
      },
      {
        "employee_id": 120,
        "first_name": "Matthew",
```

```
          "last_name": "Weiss",
          "manager_id": 100,
          "employees_manager_id": [
            {
              "first_name": "Steven",
              "last_name": "King",
              "employee_id": 100
            },
            {
              "first_name": "John",
              "last_name": "Russell",
              "employee_id": 145
            },
            {
              "first_name": "Karen",
              "last_name": "Partners",
              "employee_id": 146
            }
          ]
        }
    }
  }
```

10.5 Examples of Filtering in Queries

This section provides examples of filtering in queries against REST-enabled tables and views.

To filter in a query, include the parameter `<filterName>: GraphQLJSON`, where `GraphQLJSON` is a JSON like object that represents the custom selection to be applied to the resource. Each filter has its own predefined `GraphQLJSON` syntax.

10.5.1 Supported Data Types

This section lists the supported data types for filters.

Data Type	Description
`String`	The `string` scalar type represents a textual data, represented as UTF-8 character sequences. The string type is most often used by GraphQL to represent free-form human-readable text.
`Int`	The `int` scalar type represents non-fractional signed whole numeric values. Int can represent values between -(2^31) and 2^31 - 1.
`Float`	The `float` scalar type represents signed double-precision fractional values as specified by IEEE 754.
`Date`	The `date` scalar type represents date values as specified by the ISO 8601 format in UTC time zone (`YYYY-MM-DDThh:mm:ssZ`).

Data Type	Description
`Timestamp`	The `timestamp` scalar type represents timestamp values as specified by the ISO 8601 format in UTC time zone (`YYYY-MM-DDThh:mm:ss.sssZ`).
`Boolean`	The `boolean` scalar type represents `true` or `false`.

10.5.2 Filtering by Primary Key

Filtering by primary key enables you to retrieve the data by specifying its identifying key value or key values.

Primary Key Syntax:

```
value = String | Int | Float | Date | Timestamp
primaryKeyPair = <fieldName> : <value>
primaryKeyExp = { primaryKeyPair1, ... , primaryKeyPairN }
```

The following query includes a filter that restricts the `employee_id` field to `100`:

```
query {
  employees(primaryKey: {employee_id: 100}){
    employee_id
    first_name
    last_name
    job_id
    salary
  }
}
```

`Example cURL command`:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "{ employees(primaryKey : {employee_id :100})
{ first_name last_name department_id job_id } } "
}'
```

Response:

```
{
  "data": {
    "employees": [
      {
        "first_name": "Steven",
        "last_name": "King",
        "department_id": 90,
        "job_id": "AD_PRES"
      }
```

```
    ]
  }
}
```

10.5.2.1 Filtering by Composite Primary Key

Filtering by primary key enables you to retrieve the data from the tables that have a composite primary key by adding a list of primary keys to the filter.

```
query {
  compositeTable(primaryKey: { <fieldName> : <value>, <fieldName> : <value>})
{
    data
  }
}
```

10.5.3 Where Filter

Filtering using a `where` condition enables you to query the data and specify a valid condition or conditions that the fields present in the requested types should satisfy.

Where Filter Syntax:

```
fieldName = stringvalue = String | Int | Float | Date | Timestamp  operator
= eq | neq | gt | lt | gte | lte | like | nlike | in | nin | btwn | nbtwn
          | nullbooleanOperator = and | orvalidFilter = { <fieldName> :
{ <operator> : <value> }booleanExp = { <booleanOperator> : [ <ValidFilter1
| BoleanExp1>, ..., <ValidFilterN |
        BoleanExpN> ] }whereExp = { where : <validFilter | booleanExp> }
```

Table 10-1 Supported Operators

Operator	GraphQLJSON Syntax	Description	Supported Data Types
`=`	`{ column : { eq : value } }`	Equality	String | Int | Float | Date | Timestamp
`!=, <>`	`{ column : { neq : value } }`	Inequality	String | Int | Float | Date | Timestamp
`>`	`{ column : { gt : value } }`	Greater than	String | Int | Float | Date | Timestamp
`<`	`{ column : { lt : value } }`	Less than	String | Int | Float | Date | Timestamp
`>=`	`{ column : { gte : value } }`	Greater than or equal to	String | Int | Float | Date | Timestamp
`<=`	`{ column : { lte : value } }`	Less than or equal to	String | Int | Float | Date | Timestamp
`LIKE`	`{ column : { like : pattern } }`	Operator used for pattern matching	String
`NOT LIKE`	`{ column : { nlike : pattern } }`	Operator used for pattern matching	String

Table 10-1 (Cont.) Supported Operators

Operator	GraphQLJSON Syntax	Description	Supported Data Types
`IN`	`{ column : { in : [value1_, ... , value_n ] } }`	Equal to any value in a list of values	String | Int | Float | Date | Timestamp
`NOT IN`	`{ column : { nin : [value_1, ... ,value_n] } }`	Not equal to any value in a list of values	String | Int | Float | Date | Timestamp
`BETWEEN`	`{ column : { btwn : [value_1, value_2] } }`	Equivalent to >= n and <= y	String | Int | Float | Date | Timestamp
`NOT BETWEEN`	`{ column : { nbtwn : [value_1, value_2] } }`	Equivalent to NOT >= n and <= y	String | Int | Float | Date | Timestamp
`IS NULL`	`{ column : { null: [ Boolean ] } }`	NULL test	Boolean
`OR`	`{ or : [ { GraphQL expression 1 } ..., { GraphQL expression n } ] }`	Logical operator, returns `true` if any expression is true.	Not Applicable
AND	`{ and : [ { GraphQL expression 1 }, ...., { GraphQL expression n } ] }`	Logical operator, returns `true` if both expressions are true.	Not Applicable

10.5.3.1 Example: EQUALS (eq) operator

The following query includes a filter that restricts the the `job_id` field to `IT_PROG`.

```
query {
  employees(where : {job_id: {eq : "IT_PROG"}}){
    employee_id
    first_name
    last_name
    job_id
    salary
   }
}
```

Example cURL command:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "{ employees(where : {job_id : {eq :\"IT_PROG\"}})
{ employee_id first_name last_name job_id salary } } "
}'
```

Response:

```
{
    "data": {
        "employees": [
            {
                "employee_id": 103,
                "first_name": "Alexander",
                "last_name": "Hunold",
                "job_id": "IT_PROG",
                "salary": 9000
            },
            {
                "employee_id": 104,
                "first_name": "Bruce",
                "last_name": "Ernst",
                "job_id": "IT_PROG",
                "salary": 6000
            },
            {
                "employee_id": 105,
                "first_name": "David",
                "last_name": "Austin",
                "job_id": "IT_PROG",
                "salary": 4800
            },
            {
                "employee_id": 106,
                "first_name": "Valli",
                "last_name": "Pataballa",
                "job_id": "IT_PROG",
                "salary": 4800
            },
            {
                "employee_id": 107,
                "first_name": "Diana",
                "last_name": "Lorentz",
                "job_id": "IT_PROG",
                "salary": 4200
            }
        ]
    }
}
```

10.5.3.2 Example: Greater than (>) Operator and Date Data Type

The following query includes a filter that restricts the `hire_date` field to be greater than `01 Jan 2006`.

```
query {
  employees(where : { hire_date : { gt : "2006-01-01T00:00:00Z" } } ){
    employee_id
    first_name
    last_name
    hire_date
  }
}
```

10.5.3.3 Example: LIKE (like) operator

The following query includes a filter that restrics the `first_name` field to match the pattern `S%`:

```
query {
  employees(where : { first_name : { like : "S%" } }){
    employee_id
    first_name
    last_name
  }
}
```

10.5.3.4 Example: IN (in) operator

The following query includes a filter that restricts the the `job_id field` to `IT_PROG` or `FI_ACCOUNT` using the `in` operator:

```
query  {
  employees(where : { job_id : { in : ["IT_PROG", "FI_ACCOUNT"] } } ){
   employee_id
   first_name
   last_name
   job_id
   salary
  }
}
```

10.5.3.5 Example: AND (and) operator

The following query includes a filter that restricts the the `job_id` field to `IT_PROG` and the `salary` field to be between 4000 and 6000:

```
query Employees {
  employees(where : { and : [
   {job_id : { eq : "IT_PROG" }},
```

```
   {salary : { btwn : [4000, 6000] }}
    ]}){
   employee_id
   first_name
   last_name
   job_id
   salary
  }
}
```

```
Request:

query Employees {
  employees(where : { and : [
   {job_id : { eq : "IT_PROG" }},
   {salary : { btwn : [4000, 6000] }}
    ]}){
   employee_id
   first_name
   last_namecurl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "{employees(where : { and : [  {job_id : { eq : \"IT_PROG\" }},
{salary : { btwn : [4000, 6000] }} ] }){
               employee_id first_name last_name job_id salary } } "
}'
   job_id
   salary
  }
}
```

```
Response:

{
    "data": {
        "employees": [
            {
                "employee_id": 104,
                "first_name": "Bruce",
                "last_name": "Ernst",
                "job_id": "IT_PROG",
                "salary": 6000
            },
            {
                "employee_id": 105,
                "first_name": "David",
                "last_name": "Austin",
                "job_id": "IT_PROG",
                "salary": 4800
            },
            {
                "employee_id": 106,
                "first_name": "Valli",
                "last_name": "Pataballa",
```

```
                    "job_id": "IT_PROG",
                    "salary": 4800
                },
                {
                    "employee_id": 107,
                    "first_name": "Diana",
                    "last_name": "Lorentz",
                    "job_id": "IT_PROG",
                    "salary": 4200
                }
            ]
        }
}
```

10.5.3.6 Example: OR (or) operator

The following query includes a filter that restricts the the `job_id` field to `IT_PROG` or `FI_ACCOUNT` using `or` operator:

```
query Employees {
  employees(where : { or : [
   {job_id : { eq : "IT_PROG" }},
   {job_id : { eq : "FI_ACCOUNT" }}
    ]}){
   employee_id
   first_name
   last_name
   job_id
   salary
  }
}
```

10.5.3.7 Example: Where Filter in Children Types

All the filters described in the preceding sections can be applied to nested types in a query, that enables you to widen the range of fields that can be filtered in a single query.

The following query retrieves all employees that are managers of employees whose `job_id` is equal to `IT_PROG`:

```
query{
  employees{
    employee_id
    first_name
    last_name
    job_id
    salary
    employees_manager_id(where : {job_id : {eq : "IT_PROG"}}){
      employee_id
    first_name
    last_name
    job_id
```

```
    salary
    }
  }
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query{ employees{ employee_id first_name last_name job_id
salary employees_manager_id( where : { job_id :
    { eq :          \"IT_PROG\" } } ){employee_id first_name last_name
job_id salary} } }"
}'
```

Response:


```
{
  "data": {
    "employees": [
      {
        "employee_id": 102,
        "first_name": "Lex",
        "last_name": "De Haan",
        "job_id": "AD_VP",
        "salary": 17000,
        "employees_manager_id": [
          {
            "employee_id": 103,
            "first_name": "Alexander",
            "last_name": "Hunold",
            "job_id": "IT_PROG",
            "salary": 9000
          }
        ]
      },
      {
        "employee_id": 103,
        "first_name": "Alexander",
        "last_name": "Hunold",
        "job_id": "IT_PROG",
        "salary": 9000,
        "employees_manager_id": [
          {
            "employee_id": 104,
            "first_name": "Bruce",
            "last_name": "Ernst",
            "job_id": "IT_PROG",
            "salary": 6000
          },
          {
            "employee_id": 105,
            "first_name": "David",
```

```
            "last_name": "Austin",
            "job_id": "IT_PROG",
            "salary": 4800
          },
          {
            "employee_id": 106,
            "first_name": "Valli",
            "last_name": "Pataballa",
            "job_id": "IT_PROG",
            "salary": 4800
          },
          {
            "employee_id": 107,
            "first_name": "Diana",
            "last_name": "Lorentz",
            "job_id": "IT_PROG",
            "salary": 4200
          }
        ]
      }
    ]
  }
}
```


10.5.3.8 Working with Dates/Timestamps Using Filters

Most of the filters described in the previous sections, can be applied on fields whose type is `Date` or `Timestamp`. To apply these filters on fields whose type is `Date`, you must use the format: `YYYY-MM-DDThh:mm:ssZ`. For the date fields, `YYYY-MM-DD` format can also be used. To apply these filters on fields whose type is `Timestamp`, you must use the format: `YYYY-MM-DDThh:mm:ss.sssZ`. The following query includes a filter that restricts the `hire_date` field to be inbetween the range `01 Jan 2006 and 01 Jun 2006`:

```
query{
  employees(where : {hire_date : {btwn : ["2006-01-01",
"2006-06-01"]}}){
    employee_id
    first_name
    last_name
    job_id
    salary
    hire_date
  }
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \--header 'Content-Type:
application/json' \--data '{    "query": "query{ employees(where :
{hire_date : {btwn : [\"2006-01-01\",
        \"2006-06-01\"]}}){employee_id first_name last_name job_id
```

```
salary hire_date}
      }"}'
```

Response:


```
{
  "data": {
    "employees": [
      {
        "employee_id": 103,
        "first_name": "Alexander",
        "last_name": "Hunold",
        "job_id": "IT_PROG",
        "salary": 9000,
        "hire_date": "2006-01-03T00:00:00Z"
      },
      {
        "employee_id": 106,
        "first_name": "Valli",
        "last_name": "Pataballa",
        "job_id": "IT_PROG",
        "salary": 4800,
        "hire_date": "2006-02-05T00:00:00Z"
      },
      {
        "employee_id": 112,
        "first_name": "Jose Manuel",
        "last_name": "Urman",
        "job_id": "FI_ACCOUNT",
        "salary": 7800,
        "hire_date": "2006-03-07T00:00:00Z"
      },
      {
        "employee_id": 139,
        "first_name": "John",
        "last_name": "Seo",
        "job_id": "ST_CLERK",
        "salary": 2700,
        "hire_date": "2006-02-12T00:00:00Z"
      },
      {
        "employee_id": 140,
        "first_name": "Joshua",
        "last_name": "Patel",
        "job_id": "ST_CLERK",
        "salary": 2500,
        "hire_date": "2006-04-06T00:00:00Z"
      },
      {
        "employee_id": 143,
        "first_name": "Randall",
        "last_name": "Matos",
        "job_id": "ST_CLERK",
        "salary": 2600,
```

```
    "hire_date": "2006-03-15T00:00:00Z"
  },
  {
    "employee_id": 153,
    "first_name": "Christopher",
    "last_name": "Olsen",
    "job_id": "SA_REP",
    "salary": 8000,
    "hire_date": "2006-03-30T00:00:00Z"
  },
  {
    "employee_id": 169,
    "first_name": "Harrison",
    "last_name": "Bloom",
    "job_id": "SA_REP",
    "salary": 10000,
    "hire_date": "2006-03-23T00:00:00Z"
  },
  {
    "employee_id": 170,
    "first_name": "Tayler",
    "last_name": "Fox",
    "job_id": "SA_REP",
    "salary": 9600,
    "hire_date": "2006-01-24T00:00:00Z"
  },
  {
    "employee_id": 176,
    "first_name": "Jonathon",
    "last_name": "Taylor",
    "job_id": "SA_REP",
    "salary": 8600,
    "hire_date": "2006-03-24T00:00:00Z"
  },
  {
    "employee_id": 177,
    "first_name": "Jack",
    "last_name": "Livingston",
    "job_id": "SA_REP",
    "salary": 8400,
    "hire_date": "2006-04-23T00:00:00Z"
  },
  {
    "employee_id": 180,
    "first_name": "Winston",
    "last_name": "Taylor",
    "job_id": "SH_CLERK",
    "salary": 3200,
    "hire_date": "2006-01-24T00:00:00Z"
  },
  {
    "employee_id": 181,
    "first_name": "Jean",
    "last_name": "Fleaur",
    "job_id": "SH_CLERK",
```

```
          "salary": 3100,
          "hire_date": "2006-02-23T00:00:00Z"
        },
        {
          "employee_id": 196,
          "first_name": "Alana",
          "last_name": "Walsh",
          "job_id": "SH_CLERK",
          "salary": 3100,
          "hire_date": "2006-04-24T00:00:00Z"
        },
        {
          "employee_id": 197,
          "first_name": "Kevin",
          "last_name": "Feeney",
          "job_id": "SH_CLERK",
          "salary": 3000,
          "hire_date": "2006-05-23T00:00:00Z"
        }
      ]
    }
  }
```

10.6 Sorting the Data

Sorting enables you to sort the data in a ascending or descending order by one or more fields.

Sort Query Syntax:

```
sortValue = "asc" | "desc" | "ASC" | "DESC"
sortExp = [{<fieldName1> : sortValue}, ... ,{<fieldNameN> : sortValue} ]
sort : <sortExp>
```

The following query specifies `sort` filter to order the `employee_id` field in a descending order:

```
query {
  employees(sort : [ { employee_id : "desc" } ] ){
    employee_id
    first_name
    last_name
    salary
  }
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query {  employees(sort : [ { employee_id : \"desc\" } ] )
```

```
    {    employee_id    first_name    last_name    salary  } }"
}'
```

Response:


```
{
  "data": {
    "employees": [
      {
        "employee_id": 206,
        "first_name": "William",
        "last_name": "Gietz",
        "salary": 8300
      },
      {
        "employee_id": 205,
        "first_name": "Shelley",
        "last_name": "Higgins",
        "salary": 12008
      },
      {
        "employee_id": 204,
        "first_name": "Hermann",
        "last_name": "Baer",
        "salary": 10000
      },
      {
        "employee_id": 203,
        "first_name": "Susan",
        "last_name": "Mavris",
        "salary": 6500
      },
      {
        "employee_id": 202,
        "first_name": "Pat",
        "last_name": "Fay",
        "salary": 6000
      },
      {
        "employee_id": 201,
        "first_name": "Michael",
        "last_name": "Hartstein",
        "salary": 13000
      },
      {
        "employee_id": 200,
        "first_name": "Jennifer",
        "last_name": "Whalen",
        "salary": 4400
      },
     ...
    ]
  }
}
```

10.6.1 Example: Sorting by Multiple Columns

The following query includes a sort filter that orders the data in a descending order by `department_id` field and in an ascending order by `salary` field:

```
query {
  employees(sort : [ { department_id : "desc" } , { salary : "asc" }] ){
    employee_id
    first_name
    last_name
    salary
    department_id
  }
}
```

10.7 Keyset Pagination

Keyset pagination enables you to specify a `limit` and `offset` to paginate the data received from any given query. If sorting expression is not specified, then `ROWID` is used by default as a sort argument to uniquely address the rows.

The following query specifies the `offset` and `limit` parameters:

```
query Employees {
  employees(limit: 3, offset: 5) {
    employee_id
    first_name
    last_name
    email
  }
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query {  employees( limit: 3, offset: 5 ){  employee_id
first_name    last_name    email   } }"
}'
```

Response:

```
{
    "data": {
        "employees": [
            {
                "employee_id": 105,
                "first_name": "David",
                "last_name": "Austin",
                "email": "DAUSTIN"
```

```
            },
            {
                "employee_id": 106,
                "first_name": "Valli",
                "last_name": "Pataballa",
                "email": "VPATABAL"
            },
            {
                "employee_id": 107,
                "first_name": "Diana",
                "last_name": "Lorentz",
                "email": "DLORENTZ"
            }
        ]
    }
}
```

10.7.1 Example: Pagination with Other Filters

The following query specifies the `offset` and `limit` parameters and orders the results in a descending order by `employee_id` field:

```
query {
  employees(sort : [ { employee_id : "DESC" } ], limit: 3, offset: 2){
    employee_id
    first_name
    last_name
    salary
    department_id
  }
}
```

10.7.2 Example: Pagination in Nested Types

The following query specifies the `limit` parameter both in `employees` and in the nested type `employees_manager_id` and limits the number of employees returned in the nested object to two:

```
query{
  employees(limit : 1){
    employee_id
    first_name
    last_name
    job_id
    salary
    employees_manager_id(limit : 2){
      employee_id
      first_name
    }
  }
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query {employees(limit : 1){employee_id first_name last_name
job_id salary employees_manager_id(limit : 2){employee_id first_name}}}"
}'
```

Response:

```
{
  "data": {
    "employees": [
      {
        "employee_id": 100,
        "first_name": "Steven",
        "last_name": "King",
        "job_id": "AD_PRES",
        "salary": 24000,
        "employees_manager_id": [
          {
            "employee_id": 101,
            "first_name": "Neena"
          },
          {
            "employee_id": 102,
            "first_name": "Lex"
          }
        ]
      }
    ]
  }
}
```

10.8 Using Dynamic Arguments in Queries: Variables

To replace variables with static values in GraphQL queries, perform the following steps:

1. Replace the static value with `$variableName`
2. Declare `$variableName` as one of the variables accepted by the query and then specify the data type
3. Pass variables dictionary separately

The following query uses variables to use dynamic values in the filters:

```
query Employees($job_id : String, $min_salary : Int, $max_salary : Int){
    employees (where : { and : [
   {job_id : { eq : $job_id }},
   {salary : { btwn : [$min_salary, $max_salary] }} ]}){
        employee_id
        manager_id
```

```
            phone_number
            commission_pct
            department_id
            salary
            first_name
            email
            job_id
            hire_date
            last_name
        }
}
```

Variables Dictionary:

```
{
    "job_id" : "IT_PROG",
    "min_salary" : 4000,
    "max_salary" : 6000
}
```

Request:

```
curl --location 'http://localhost:8080/ords/hr/_/graphql' \
--header 'Content-Type: application/json' \
--data '{
    "query": "query Employees($job_id : String, $min_salary :
Int, $max_salary : Int){ employees (where : { and : [\n   {job_id :
{ eq : $job_id }}, {salary : { btwn : [$min_salary, $max_salary] }} ]})
{ employee_id  manager_id  phone_number commission_pct department_id
salary first_name email job_id hire_date last_name }}",
    "operationName": "Employees",
    "variables": {
        "job_id": "IT_PROG",
        "min_salary": 4000,
        "max_salary": 6000
    }
}'
```

10.9 GraphiQL

Oracle REST Data Services includes GraphiQL, an in-browser IDE for exploring GraphQL. Use the following endpoint and login with the Rest-enabled user database schema credentials:

```
http://<HOST>:<PORT>/ords/<SCHEMANAME>/_/graphiql
```

11 Extending ORDS Functionality with Plugins

This chapter explains and provides examples on using ORDS plugin framework.

ORDS has a plugin framework that allows you to add your own custom functionality into the ORDS web application. Plugins can be added to the ORDS runtime by placing the jar files in the `lib/ext` directory. The ORDS distribution contains the source for example plugins. The plugin examples can be built using Apache `ant`, a software tool used for automating the build processes.

11.1 Plugin Demonstration Example

This section shows how you can locate and build a plugin demonstration example..

The plugin-demonstraion example is at `examples/plugins/plugin-demo` location and contains the source for a `HttpServlet` that gets a database connection injected at runtime. The servlet uses that JDBC database connection to run a query in the database and return a response at runtime.

Perform the following steps to build and use the demonstration example:

1. Change the directory to `examples/plugins/plugin-demo`
2. Run `ant` to build the `examples/plugins/plugin-demo/built/plugin-demo.jar` file
3. Copy the `plugin-demo.jar` to the ORDS distribution `lib/ext` directory and start an ORDS instance.
4. Invoke the servlet using the following URL pattern: `http://server/ords/schema/demos/plugin?who=somebody`
    a. For example: `http://localhost:8080/ords/hr/demos/plugin?who=scott` where ORDS is configured with a default pool and `HR` is an alias for a REST Enabled Schema in that database.

The details of developing and deploying Java based plugins is available in the *Oracle REST Data Services Java API Reference* book.

See Also:

- Getting Started Guide
- Developer Guide
- Route Patterns Specification

11.2 Plugin Javascript

ORDS provides a JavaScript as a service framework for customers to define a JavaScript that can be executed in the ORDS instance on request. This is similar to the conventional RESTful services concept used to develop the applications. The framework is based on the module, template, and handler architecture. See Developing Oracle REST Data Services Applications. Rather than defining the modules, templates, and handlers in the database, they are specified in an XML representation that is read from `lib/ext/` directory as a plugin.

The ORDS examples directory contains a `plugin-javascript` example and the source can be found in the `examples/plugins/plugin-javascript` directory. This section describes the key elements of the plugin.

> **Note:**
>
> GraalVM with JS component is required for JavaScript plugin ORDS feature to work.

GraalVM with JS component is required for this ORDS feature to work. See GraalVM Configuration for more information.

The example contains a number of inline and external definitions for JavaScript source. References to external JavaScript source are to the files that are found in the classpath.

File	Description
`build.xml`	The `ant` build project.
`src/js/example.js`	An example external JavaScript file. External here means, not defined in, but referred to from, the XML Resource Module file.
`src/META-INF/manifest.json`	A plugin configuration metadata file that ORDS reads at startup to register XML Resource Modules.
`src/META-ING/modules/javascript.xml`	An XML Resource Module file that defines an example module with a number of templates and handlers.

Perform the following steps to build and use the example:

1. Change the directory to `examples/plugins/plugin-javascript`.
2. Run `ant` to build `examples/plugins/plugin-javascript/built/plugin-javascript.jar` file.
3. Copy the `plugin-javascript.jar` file to the ORDS distribution `lib/ext` directory and start the ORDS instance using a supported GraalVM with JS component.
4. Invoke the defined handlers using the URL pattern: `http://server/ords/javascript-examples/{template pattern}`.
   a. For example: `http://localhost:8080/ords/javascript-examples/now` where the current time is returned.

> **Note:**
>
> Unlike the ORDS REST Services, the JavaScript as a service implementation does not require or use a database connection.

11.2.1 Example Services Purpose and Use

This section provides the information on the purpose and use of the example services.

Purpose	Request	Action	Response
An example of inline Javascript that returns the current UTC time as `application/json`.	`/ords/javascript-examples/now`	`GET`	`{ "now":"2023-08-31T16:08:55.471Z" }`
An example of inline Javascript that accepts a parameter.	`/ords/javascript-examples/future?days=7`	`GET`	`{ "now":"2023-08-31T16:08:55.471Z", "future":"2023-09-07T16:08:55.471Z", "days":7 }`

An example of inline Javascript that accepts various parameters from different sources.	`/ords/javascript-examples/hello?name=Ted`
	
	`curl --location 'ords/javascript-examples/hello' \ --header 'Agent: Test'`
		`GET`	`Hello Ted`
			`Hello Test`

An example of external Javascript file that accepts a parameter.	`/ords/javascript-examples/fibonacci?length=50`	GET	`{fib: 12586269025}`
An example of inline Javascript that uses implicit parameters `content_type` and `body_text` for getting the request values as well as using `ords_response` to invoke `setStatus` and `setContentType` on `HttpServletResponse`.	`curl --location '/ords/hr/javascript-examples/countwords' \ --header 'Content-Type: application/json' \ --data '{"text": "How many words are here?"}'`	`POST`	`{"text": "How many words are here?","count": 5}`

12 Migrating from mod_plsql to ORDS

This chapter demonstrates how a mod_plsql application is migrated to Oracle REST Data Services (ORDS).

Oracle REST Data Services is a Java EE-based alternative for Oracle HTTP Server and mod_plsql. An Oracle HTTP Server mod_plsql application can be migrated to ORDS by defining new ORDS configuration files. The mod_plsql database resources such as before procedures, after procedures, request validation functions, owa_custom packages, doc upload procedures and doc tables require no change when you are migrating to ORDS.

Topics:

- Oracle HTTP Server mod_plsql Authentication
- Example Oracle HTTP Server DAD file
- Mapping mod_plsql Settings to ORDS
- Example ORDS Configuration Files
- Example ORDS URL Mapping
- Example ORDS Default Configuration
- Oracle REST Data Services Functionality
- ORDS Features
- Modifying Synonyms

12.1 Oracle HTTP Server mod_plsql Authentication

Oracle HTTP Server mod_plsql applications are configured in a database access descriptor (DAD) file.

The following example mod_plsql application provides the methods to authenticate the requests against the Oracle Database:

- **Basic authentication**: The username and password are stored in the DAD file and so the end user is not required to log in. This method is useful for web pages that provide public information.
- **Basic dynamic authentication**: The users provide credentials in a browser HTTP basic authentication dialog box. The only way to log out is to close all the instances of the browser.
- **Custom authentication**: Enables applications to invoke a user-written authentication function to authenticate the users within the application and not at the database level.

12.2 Example Oracle HTTP Server DAD file

This section provides an example Oracle HTTP Server DAD file.

The following `dads.conf` file includes three locations demonstrating the basic, basic dynamic and custom authentications and the following directives:

- `PlsqlBeforeProcedure`
- `PlsqlAfterProcedure`
- `PlsqlRequestValidationFunction`
- `PlsqlDocumentTablename`
- `PlsqlDocumentProcedure`

Example 12-1   dads.conf file

```
#
========================================================================
=====
#                     mod_plsql DAD Configuration File
#
========================================================================
=====
<Location /pls/basic_auth>
  SetHandler pls_handler
  Order deny,allow
  Allow from all
  AllowOverride                       None
  PlsqlDatabaseUsername               PRIVILEGED_USER
  PlsqlDatabasePassword               passwordF0R$0RD5Example
  PlsqlDatabaseConnectString          oracle-ee:1521:ORCLPDB1
ServiceNameFormat
  PlsqlAuthenticationMode             Basic
  PlsqlBeforeProcedure
sample_plsql_app_metadata.beforeProc
  PlsqlAfterProcedure                 sample_plsql_app_metadata.afterProc
  PlsqlRequestValidationFunction
sample_plsql_app_metadata.validationFunc
  PlsqlDocumentTablename              privileged_user.doc_table
  PlsqlDocumentProcedure              privileged_user.upload
</Location>
<Location /pls/basic_dynamic_auth>
  SetHandler pls_handler
  Order deny,allow
  Allow from all
  AllowOverride                       None
  PlsqlDatabaseConnectString          oracle-ee:1521:ORCLPDB1
ServiceNameFormat
  PlsqlAuthenticationMode             Basic
  PlsqlBeforeProcedure
sample_plsql_app_metadata.beforeProc
  PlsqlAfterProcedure                 sample_plsql_app_metadata.afterProc
  PlsqlRequestValidationFunction
sample_plsql_app_metadata.validationFunc
</location>
<Location /pls/custom_auth>
  SetHandler pls_handler
```

```
  Order deny,allow
  Allow from all
  AllowOverride                     None
  PlsqlDatabaseUsername             PRIVILEGED_USER
  PlsqlDatabasePassword             passwordF0R$0RD5Example
  PlsqlDatabaseConnectString        oracle-ee:1521:ORCLPDB1 ServiceNameFormat
  PlsqlAuthenticationMode           CustomOwa
  PlsqlBeforeProcedure              sample_plsql_app_metadata.beforeProc
  PlsqlAfterProcedure               sample_plsql_app_metadata.afterProc
  PlsqlRequestValidationFunction    sample_plsql_app_metadata.validationFunc
</location>
```

12.3 Mapping mod_plsql Settings to ORDS

This section shows the mappings of mod_plsql settings to ORDS.

ORDS allows you to specify configuration files that are similar to a location defined in an Oracle HTTP Server mod_plsql DAD file. Each configuration file is defined in `ords_conf/ords/conf` directory and the configuration file is then mapped to a particular URL using the `ords_conf/ords/url-mapping.xml` file. ORDS provides the following configurable parameters that can be used when migrating mod_plsql directives:

Table 12-1 Mappings of mod_plsql Directives to ORDS Settings

mod_plsql Setting	ORDS Setting	Description
`PlsqlDatabaseUserName`	`db.username`	Specifies the username to use to log in to the database. ORDS and mod_plsql are equivalent.
`PlsqlDatabasePassword`	`db.password`	Specifies the password to use to log in to the database. ORDS and mod_plsql are equivalent.
`PlsqlDatabaseConnectString`	Multiple Settings such as: • `db.hostname` • `db.port` • `db.servicename` • `db.sid`	Specifies the connection to an Oracle database. ORDS and mod_plsql are equivalent.

Table 12-1 (Cont.) Mappings of mod_plsql Directives to ORDS Settings

mod_plsql Setting	ORDS Setting	Description
`PlsqlAuthenticationMode`	`security.requestAuthenticationFunction`	Specifies the authentication mode to use to allow access. When `security.requestAuthenticationFunction` is not specified, ORDS behavior is same as `Basic` mode of mod_plsql. When `security.requestAuthenticationFunction` is specified, ORDS can perform the same action as example dad directive `PlsqlAuthenticationMode CustomOwa`of mod_plsql. Example ORDS equivalent configuration parameter: `<entry key="security.requestAuthenticationFunction">privileged_user.owa_custom.authorize</entry>` ORDS and mod_plsql are equivalent.
`PlsqlBeforeProcedure`	`procedure.preProcess`	Specifies the procedure to be invoked before calling the requested procedure. ORDS and mod_plsql are equivalent.
`PlsqlAfterProcedure`	`procedure.postProcess`	Specifies the procedure to be invoked after calling the requested procedure. ORDS and mod_plsql are equivalent.
`PlsqlRequestValidationFunction`	`security.requestValidationFunction`	Specifies an application-defined PL/SQL function that can allow or disallow further processing of the requested procedure. ORDS and mod_plsql are equivalent.
`PlsqlDocumentTablename`	`owa.docTable`	Specifies the table in the database to which all documents are uploaded. ORDS and mod_plsql are equivalent.

Table 12-1 (Cont.) Mappings of mod_plsql Directives to ORDS Settings

mod_plsql Setting	ORDS Setting	Description
`PlsqlDocumentProcedure`	N/A	Specifies the procedure to call when a document download is initiated. In ORDS the document procedure is the requested resource. It is not defined in the configuration file. ORDS and mod_plsql are equivalent.
`PlsqlDocumentPath`	N/A	ORDS has no equivalent.
`PlsqlDefaultPage`	`misc.defaultPage`	Specifies the default procedure to call if none is specified in the URL. ORDS and mod_plsql are equivalent.
`PlsqlErrorStyle`	`debug.printDebugToScreen`	Specifies the error reporting mode for mod_plsql errors. `debug.printDebugToScreen` is equivalent to `PlsqlErrorStyle DebugStyle`, otherwise there is no equivalent. ORDS and mod_plsql are equivalent.
`PlsqlExclusionList`	`security.exclusionList`	Specifies a pattern for procedures, packages, or schema names which are forbidden to be directly run from a browser. ORDS and mod_plsql are equivalent. See Understanding Configurable Parameters.
`PlsqlIdleSessionCleanupInterval`	`jdbc.InactivityTimeout`	Specifies the time (in minutes) in which the idle database sessions should be closed and cleaned. Value can be 0 to N seconds. Where, 0 (default) means that the idle connections are not removed from pool. ORDS and mod_plsql are equivalent.
`PlsqlMaxRequestsPerSession`	`jdbc.MaxConnectionReuseCount`	Specifies the maximum number of requests a pooled database connection should service before it is closed and re-opened. Default value is 1000. ORDS and mod_plsql are equivalent.

Table 12-1 (Cont.) Mappings of mod_plsql Directives to ORDS Settings

mod_plsql Setting	ORDS Setting	Description
`PlsqlInfoLogging`	N/A	See Understanding Configurable Parameters.
`PlsqlLogDirectory`	N/A	See Understanding Configurable Parameters.
`PlsqlLogEnable`	N/A	See Understanding Configurable Parameters.
`PlsqlSessionStateManagement`	N/A	Specifies how package and session state should be cleaned up at the end of each request. ORDS always performs: `dbms_session.modify_package_state`(`dbms_session.reinitialize`) at the end of each request.
`PlsqlAlwaysDescribeProcedure`	N/A	Specifies whether the mod_plsql application should describe a procedure before trying to run it. ORDS always describes procedure on first access, and then the definition is cached. Changes in signature are detected and recached.
`PlsqlConnectionValidation`	N/A	Specifies the mechanism the mod_plsql module should use to detect terminated connections in its connection pool. ORDS always validates connections on borrow.
`PlsqlFetchBufferSize`	N/A	Specifies the number of rows of content to fetch from the database for each trip, using either `owa_util.get_page` or `owa_util.get_page_raw`. ORDS materializes results as a 32K VARCHAR or CLOB if results are greater than 32K, so not applicable.
`PlsqlNLSLanguage`	N/A	Specifies the NLS_LANG variable. ORDS, Java, and JDBC use unicode.
`PlsqlTransferMode`	N/A	`PlsqlTransferMode` specifies the transfer mode for data from the database back to the mod_plsql application. ORDS always uses unicode.

Table 12-1 (Cont.) Mappings of mod_plsql Directives to ORDS Settings

mod_plsql Setting	ORDS Setting	Description
`PlsqlBindBucketLengths`	N/A	Specifies the rounding size to use while binding the number of elements in a collection bind. Rarely used in mod_plsql, and JDBC has no equivalent concept.
`PlsqlBindBucketWidths`	N/A	Specifies the rounding size to use while binding the number of elements in a collection bind. Rarely used in mod_plsql and JDBC has no equivalent concept.
`PlsqlCacheCleanupTime`	N/A	ORDS has no equivalent.
`PlsqlDMSEnable`	N/A	ORDS does not support DMS.
`PlsqlSessionCookieName`	N/A	ORDS does not offer session management for PL/SQL Gateway calls.
`PlsqlCacheDirectory`	N/A	ORDS has no equivalent.
`PlsqlCacheEnable`	N/A	ORDS has no equivalent.
`PlsqlCacheMaxAge`	N/A	ORDS has no equivalent.
`PlsqlCacheMaxSize`	N/A	ORDS has no equivalent.
`PlsqlCacheTotalSize`	N/A	ORDS has no equivalent.
`PlsqlCGIEnvironmentList`	N/A	ORDS has no equivalent.
`PlsqlConnectionTimeout`	N/A	ORDS has no equivalent.
`PlsqlPathAlias`	N/A	ORDS has no equivalent.
`PlsqlPathAliasProcedure`	N/A	ORDS has no equivalent.
`PlsqlUploadAsLongRaw`	N/A	ORDS has no equivalent.

12.4 Example ORDS Configuration Files

The following sections show how the example mod_plsql application can be migrated to ORDS.

Topics:

- Example Configuration File for Basic Authentication
- Example Configuration File for Basic Dynamic Authentication
- Example Configuration file for Custom Authentication

12.4.1 Example Configuration File for Basic Authentication

Example 12-2 ords_conf/ords/conf/basic_auth.xml

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
```

```
    <comment>Saved on Wed Jul 25 10:22:37 UTC 2018</comment>
    <entry key="db.username">PRIVILEGED_USER</entry>
    <entry key="db.password">!passwordF0R$0RD5Example</entry>
    <!-- Example url -->
    <!-- See url-mapping.xml -->
    <!-- http://localhost:8086/ords/pls/basic_auth/
sample_plsql_app.sample_public_proc-->
    <!-- http://localhost:8086/ords/pls/basic_auth/
sample_plsql_app.privileged_public_proc-->
    <entry
key="procedure.postProcess">sample_plsql_app_metadata.afterProc</entry>
    <entry
key="procedure.preProcess">sample_plsql_app_metadata.beforeProc</entry>
    <entry
key="security.requestValidationFunction">sample_plsql_app_metadata.vali
dationFunc</entry>
    <entry key="owa.docTable">sample_plsql_app.doc_table</entry>
</properties>
```

12.4.2 Example Configuration File for Basic Dynamic Authentication

Example 12-3 ords_conf/ords/conf/basic_dynamic_auth.xml

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
    <comment>Saved on Wed Jul 25 10:22:37 UTC 2018</comment>
    <!--  NOTE THAT IF THIS USER HAS EXECUTE PRIVILEGE ON THE RESOURCE
THEN jdbc.auth.enabled IS IGNORED -->
    <!--  IF THIS USER DOES NOT HAVE EXECUTE PRIVILEGE ON THE RESOURCE
THEN jdbc.auth.enabled IS INVOKED AND THE CREDENTIALS OF A PRIVILEGED
USER HAS TO BE PROVIDED-->
    <entry key="db.username">NON_PRIVILEGED_USER</entry>
    <entry key="db.password">!passwordF0R$0RD5Example</entry>
    <entry key="jdbc.auth.enabled">true</entry>
    <!-- Example url -->
    <!-- See url-mapping.xml -->
    <!-- INVOKE jdbc.auth.enabled :   http://localhost:8086/ords/pls/
basic_dynamic_auth/sample_plsql_app.sample_privileged_proc -->
    <!-- IGNORE jdbc.auth.enabled :   http://localhost:8086/ords/pls/
basic_dynamic_auth/sample_plsql_app.sample_public_proc   -->
    <!-- Because jdbc.auth.enabled is ignored when referencing the
sample_public_app, the beforeProc,afterProc and validationFunc must be
accessible by NON_PRIVILEGED_USER -->
    <!-- The following objects are executed by the same credentials
used to access the resource -->
    <!-- If the resource can be accessed by the db.username then that
connection is used to access these methods -->
    <!-- If the resource cannot be accessed by the db.username then
jdbc.auth.enabled is invoked and those credentials as used to access
these methods -->
    <entry
key="procedure.postProcess">sample_plsql_app_metadata.afterProc</entry>
```

```
    <entry key="procedure.preProcess">sample_plsql_app_metadata.beforeProc</
entry>
    <entry
key="security.requestValidationFunction">sample_plsql_app_metadata.validation
Func</entry>
</properties>
```

12.4.3 Example Configuration file for Custom Authentication

Example 12-4 ords_confs/ords/conf/custom_auth.xml

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
    <comment>Saved on Wed Jul 25 10:22:37 UTC 2018</comment>
    <entry key="db.username">PRIVILEGED_USER</entry>
    <entry key="db.password">!passwordF0R$0RD5Example</entry>
    <!-- Example url -->
    <!-- See url-mapping.xml -->
    <!-- http://localhost:8086/ords/pls/custom_auth/
sample_plsql_app.sample_proc -->
    <!-- privileged_user.owa_custom.authorize requires the following as the
custom login -->
    <entry key="procedure.postProcess">sample_plsql_app_metadata.afterProc</
entry>
    <entry key="procedure.preProcess">sample_plsql_app_metadata.beforeProc</
entry>
    <entry
key="security.requestValidationFunction">sample_plsql_app_metadata.validation
Func</entry>
    <entry
key="security.requestAuthenticationFunction">privileged_user.owa_custom.autho
rize</entry>
</properties>
```

12.5 Example ORDS URL Mapping

This section shows the example mapping between base-path url and the configuration files.

Example 12-5 ords_conf/ords/url-mapping.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<pool-config xmlns="http://xmlns.oracle.com/apex/pool-config">
    <pool name="basic_auth" base-path="/pls/basic_auth"
updated="2018-07-17T20:52:29.045Z" />
    <pool name="basic_dynamic_auth" base-path="/pls/basic_dynamic_auth"
updated="2018-07-17T20:52:29.045Z" />
    <pool name="custom_auth" base-path="/pls/custom_auth"
updated="2018-07-17T20:52:29.045Z" />
</pool-config>
```

12.6 Example ORDS Default Configuration

This section shows the example default configuration setting for ORDS.

The `defaults.xml` file provides the database connection details used by all configurations.

> **Note:**
>
> To turn off procedure validation caching, set `security.maxEntries` value to 0. This is necessary to emulate Oracle HTTP Server mod_plsql.

Example 12-6 ords_conf/ords/defaults.xml

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<!DOCTYPE properties SYSTEM "http://java.sun.com/dtd/properties.dtd">
<properties>
   <!-- by default security.maxEntries = 2000 which means 2000
procedures validity will be cached-->
   <!-- this is fine for applications like apex where the validation
of a procedure does not change  -->
   <!-- for applications migrating from mod_plsql the cache should be
disabled so that procedures validity is determined for each request -->
   <!-- this is done by setting security.maxentries to 0 -->
   <entry key="security.maxEntries">0</entry>
   <entry key="db.hostname">oracle-ee</entry>
   <entry key="db.port">1521</entry>
   <entry key="db.servicename">orclpdb1</entry>
</properties>
```

12.7 Oracle REST Data Services Functionality

Oracle REST Data Services is a J2EE-based servlet which offers increased functionality including a web-based configuration, enhanced security, and file caching.

The following sections explains the different functionalities equivalent to mod_plsql module.

12.7.1 Basic Authentication

This section describes the basic authentication implemented using ORDS.

The database credentials are specified in the ORDS configuration file. The `db.username` must have the required privileges to access the resources.

> **Note:**
>
> The entry `security.requestAuthenticationFunction` is not specified.

12.7.2 Basic Dynamic Authentication

This section describes how basic dynamic authentication is implemented using ORDS.

A default `db.username` and `db.password` must be specified in ORDS configuration file when providing basic dynamic authentication for accessing the resources.

The resources that cannot be accessed using this type of authentication can be accessed if the following conditions are satisfied:

- The value for `<entry key="jdbc.auth.enabled">true</entry>` entry must be `true`..
- The `security.requestAuthenticationFunction` entry must not be specified.
- When ORDS response prompts a Basic HTTP Authentication dialog box in a browser, the credentials provided by the user must have the required privileges, then the resource is made available.

> **Note:**
>
> If the credentials are provided through the browser HTTP authentication dialog box, then the only way to log out is to close all the instances of the browser.

12.7.3 Custom Authentication

This section describes how custom authentication is implemented using ORDS.

A function is specified to perform the custom authentication. This function has access to the owa variables. Resources are only available if the following function returns a `TRUE` value:

```
<entry
key="security.requestAuthenticationFunction">privileged_user.owa_custom.authoriz
e</entry>
```

The authentication function must have signature as shown in the following code snippet:

```
/**
* OWA_CUSTOM used in mod_plsql when the following is used in the dad
configuration file
  PlsqlAuthenticationMode       Custom
  In ORDS environment this can reside in any schema as long as the
connection has execute privileges
  In mod_plsql this has to reside in the connections schema as you cannot
specify the name of the schema,package or function
  ex: PlsqlAuthenticationMode           CustomOwa
*/
CREATE OR REPLACE PACKAGE OWA_CUSTOM  AS
/**
```

```
 * Response:
  >IF Failed
   WWW-Authenticate in response header
   Authorization Required
   You are not authorized to access the requested resource. Check the
supplied credentials (e.g., username and password).
 */
FUNCTION authorize RETURN BOOLEAN;
END OWA_CUSTOM ;
/
```

12.8 ORDS Features

This section describes the ORDS features that are useful when you are migrating from a mod_plsql application to ORDS.

Topics:

- Request Validation Function
- Pre Process Feature
- Post Process Feature
- File Upload Feature
- Cross-Origin Resource Sharing Feature
- Procedure Allow List

12.8.1 Request Validation Function

This section explains the use of request validation function.

The request validation function restricts the access to resources. The request validation function is provided with the name of the resource being requested and returns `TRUE` or `FALSE` value in response.

If the request validation function returns a `FALSE` value, then ORDS terminates the request.

Example 12-7 security.requestValidationFunction

```
<entry
key="security.requestValidationFunction">sample_plsql_app_metadata.vali
dationFunc</entry>
```

You can choose any name for the validation function. However, the signature must be in the following format:

```
CREATE OR REPLACE FUNCTION validationfunc(procedure_name VARCHAR2) RETURN
BOOLEAN IS.
```

12.8.2 Pre Process Feature

This section describes the `procedure.preProcess` ORDS configuration parameter.

The `procedure.preProcess` ORDS configuration parameter allows a comma delimited list of procedures that are executed before the requested resource.

Example 12-8 procedure.preProcess

Following example code snippet shows a use case for logging in:

```
<entry key="procedure.preProcess">sample_plsql_app_metadata.beforeProc</
entry>
```

12.8.3 Post Process Feature

This section describes the `procedure.postProcess` ORDS configuration parameter.

The `procedure.postProcess` ORDS configuration parameter allows a comma delimited list of procedures that are executed after the requested resource.

Example 12-9 procedure.postProcess

Following example code snippet shows a use case for logging out:

```
<entry key="procedure.postProcess">sample_plsql_app_metadata.afterProc</
entry>
```

12.8.4 File Upload Feature

This section describes the ORDS file upload feature.

The ORDS configuration parameter `owa.docTable`, defines the table name where the uploaded files persist.

Example 12-10 Table upload

```
CREATE TABLE DOC_TABLE (
     NAME               VARCHAR(256)   UNIQUE NOT NULL,
     MIME_TYPE          VARCHAR(128),
     DOC_SIZE           NUMBER,
     DAD_CHARSET        VARCHAR(128),
     LAST_UPDATED       DATE,
     CONTENT_TYPE       VARCHAR(128),
     CONTENT            LONG RAW,
     BLOB_CONTENT       BLOB );
```

Example 12-11 Procedure upload

You can choose to have any name for the upload function. However, the signature must match the following POST request:

```
--The parameters of the procedure should match the parameters of the request
--The procedure is called after ORDS performs the file upload/insert.
--This procedure can rollback the file INSERT as it is in the same
transaction as the INSERT
CREATE OR REPLACE PROCEDURE upload (filename VARCHAR2 DEFAULT NULL)
```

Example 12-12 Curl command for file upload

```
curl -i -X POST -F 'filename=@helloworld.txt' "http://localhost:8086/
ords/pls/basic_auth/example_user1.upload
```

12.8.5 Cross-Origin Resource Sharing Feature

This section describes the Cross-Origin Resource Sharing (CORS) feature.

By default ORDS does not allow cross-origin calls to its PL/SQL gateway.

Trusted origins can be configured through the `security.externalSessionTrustedOrigins` configuration parameter that defines a comma separated list of origins that are trusted to make CORS request. If this parameter is empty or not configured, then no CORS requests are allowed for the PL/SQL gateway and results in a 403 Unauthorized status.

```
<entry key="security.externalSessionTrustedOrigins">http://example.com,
https://example.com:8443</entry>
```

12.8.6 Procedure Allow List

This section describes the Allow List feature for PL/SQL Gateway procedures.

Oracle REST Data Services (ORDS) provides an Allow List feature for PL/SQL Gateway procedures.You can authorize execution of custom procedures by adding them to the Allow List.

12.8.6.1 Configuring ORDS PL/SQL Gateway Allow List

This section describes how to configure the ORDS PL/SQL Gateway Allow List.

Ensure that your PL/SQL Gateway pool is configured to use the ORDS validation function named `ords_util.authorize_plsql_gateway`.

```
./ords config --db-pool <plsql_pool> get
security.requestValidationFunction
```

If PL/SQL Gateway pool is empty, then it is setup using the following command:

```
./ords config --db-pool <plsql_pool> set
security.requestValidationFunction ords_util.authorize_plsql_gateway
```

> **Note:**
>
> To use the feature ORDS PL/SQL Gateway Allow list with APEX, the APEX must be installed in a Pluggable Database.

12.8.6.1.1 Authorizing Procedures

This section describes how to authorize the stored procedures.

To authorize the stored procedures you must add them to the PL/SQL Gateway Allow List using the `ords_admin.add_plsql_gateway_procedure` procedure. You are required to have `ORDS_ADMINISTRATOR_ROLE` role to execute the procedure.

```
BEGIN
        ords_admin.add_plsql_gateway_procedure(
                    p_owner => 'MY_SCHEMA',
                    p_package_name => 'MY_PACKAGE', /* Can be null if not a 
package procedure*/
                    p_procedure_name => 'MY_STORED_PROCEDURE',
                    p_comments => 'Enabling access to Project 1'); /* 
Optional comments*/
END;
```

The Allow List stores resolved procedure names. Procedures are resolved before adding them to the list.

12.8.6.1.2 Removing Stored Procedures

This section describes how to remove the stored procedures from the PL/SQL Gateway Allow List.

To remove the stored procedures from the PL/SQL Gateway Allow List use `ords_admin.remove_plsql_gateway_procedure` procedure. You are required to have `ORDS_ADMINISTRATOR_ROLE` role to execute the procedure.

```
BEGIN
        ords_admin.remove_plsql_gateway_procedure(
                    p_owner => 'MY_SCHEMA',            /* Schema owning the 
stored procedure */
                    p_package_name => 'MY_PACKAGE',    /* Can be null if not 
a package procedure*/
                    p_procedure_name => 'MY_STORED_PROCEDURE');
END;
```

12.8.6.1.3 Removing Stored Procedures in Bulk

This section describes how to remove the stored procedures in bulk from the PL/SQL Gateway Allow List.

To remove the stored procedures from the PL/SQL Gateway Allow List use `ords_admin.clear_plsql_gateway_procedures` procedure. You are required to have `ORDS_ADMINISTRATOR_ROLE` role to execute the procedure.

```
BEGIN
        ords_admin.clear_plsql_gateway_procedures(
                                p_owner => 'MY_SCHEMA'); /* Remove all 
procedures owned by this schema. */
END;
```

12.9 Modifying Synonyms

When you are invoking synonyms through PL/SQL Gateway, ORDS executes the procedure they point to. If an existing synonym is redefined to point to a second procedure, then revoke the EXECUTE privilege from the first procedure to force the synonym to reload and ensure that ORDS executes the second procedure.

A

Setting-up a PL/SQL Gateway User

This section explains how to set-up a PL/SQL gateway user.

To set-up a PL/SQL gateway user, perform the following steps:

1. Unzip the ords*.zip file.
2. Execute the script that provides the password:
   Example:

```
SQL> @install <password>

install.sql
set define '^'
set termout on

define PWD       = '^1'

-- Create the schema to hold the stored proc. This account is not
directly accessible
create user sample_plsql_app identified by L0ck3dAcc0unt password expire
account lock;

-- create the application users
create user example_user1 identified by ^PWD;
create user example_user2 identified by ^PWD;
grant connect to example_user1;
grant connect to example_user2;

alter session set current_schema=sample_plsql_app;

-- define the stored procedure
create or replace procedure sample_proc as
 l_user varchar(255) := owa_util.get_cgi_env('REMOTE_USER');
begin
 htp.prn('<h1>Hello ' || l_user || '!</h1>');
end;
/

-- authorize users to access stored proc
grant execute on sample_plsql_app.sample_proc to example_user1;
grant execute on sample_plsql_app.sample_proc to example_user2;

quit
```

   Preceding sample creates three database users:

   - `SAMPLE_PLSQL_APP` - A database schema where the protected `SAMPLE_PROC` is installed

- `EXAMPLE_USER1` - A database user granted with execute privilege on `SAMPLE_PLSQL_APP.SAMPLE_PROC`
- `EXAMPLE_USER2` - A second database user granted with execute privilege on `SAMPLE_PLSQL_APP.SAMPLE_PROC`

Use the non-interactive install command and include the options `--gateway-user <database user>` and `--gateway-mode` proxied to indicate that the PL/SQL gateway user is a proxied user.

Configuring a PL/SQL Gateway User

Non-Interactive Example:

```
./bin/ords --config /path/to/test/config install-cli --db-pool pdb2 --
admin-user SYS --proxy-user --db-hostname localhost --db-port 1521 --db-
servicename pdb1 --feature-sdw true --gateway-user EXAMPLE_USER1 --
gateway-mode proxied --log-folder /path/to/logs < password.txt
```

Assuming ORDS is running in a standalone mode on localhost on port 8080, access the following URL in your web browser: http://localhost:8080/ords/pdb2/sample_plsql_app.sample_proc. The browser displays the following text

Hello EXAMPLE_USER1!

B

Oracle REST Data Services Database Type Mappings

This appendix describes the REST Data Services database type mappings along with the structural database types.

B.1 Oracle Built-in Types

Data Type	JSON Data Type	REST Version	Value Example	Description
NUMBER	number	v1	`"big" : 1234567890` `"bigger" : 1.2345678901e10`	Represented with all significant digits. An exponent is used when the number exceeds 10 digits.
RAW	string	Custom	`"code" : "SEVMTE8gV09STEQh"`	Base64 bit encoding is used
DATE	string	v1.2	`"start" : "1995-06-02T04:29:11Z"`	Represented using ISO 8601 format in UTC time zone
TIMESTAMP	string	v1.2	`when : "1995-06-02T04:29:11.002Z"`	Represented using ISO 8601 format in UTC time zone
TIMESTAMP WITH LOCAL TIME ZONE	string	v1.2	`"at" : "1995-06-02T04:29:11.002Z"`	Represented using ISO 8601 format. The local time zone is converted to UTC time zone as the local time zone specification does not apply for a transfer encoding.
CHAR	string	v1	`"message" : "Hello World! "`	Represented with trailing spaces. This may be required as padding for PUT or POST methods. For example, "`abc` ".
ROWID	string	Custom	`"id" : "AAAGq9AAEAAAA0bAAA"`	Output as the native Oracle textual representation. For example, equivalent to the following conversion: `SELECT ROWIDTOCHAR(id) id FROM DUAL`.
UROWID	string	Custom	`"uid" : "AAAGq9AAEAAAA0bAAA"`	Output as the native Oracle textual representation. For example, equivalent to the following conversion: `SELECT CAST(uid as VARCHAR(4000)) id FROM DUAL`.
FLOAT	number	v1	`*as NUMBER`	

Data Type	JSON Data Type	REST Version	Value Example	Description
NCHAR	string	v1	`"message" : "Hello World! "`	Represented using unicode character where the character is not supported by the body character set.
NVARCHAR2	string	v1	`"message" : "Hello World!"`	Represented using unicode character where the character is not supported by the body character set.
VARCHAR2	string	v1	`"message" : "Hello World!"`	
BINARY_FLOAT	number	v1	`*as NUMBER`	
BINARY_DOUBLE	number	v1	`*as NUMBER`	
TIMESTAMP WITH TIME ZONE	object	v1.2	`"event" : "1995-06-02T04:29:11.002Z"` `"when" : "1995-06-02T04:29:11.002Z"`	Represented using ISO 8601 format in UTC time zone. The value represents the same point in time but the original time zone is lost.
INTERVAL YEAR TO MONTH	object	Custom	`"until" : "P-123Y3M"` `"until" : "P3M"`	Represented using ISO 8601 "Duration" format. Zero duration components are considered optional.
INTERVAL DAY TO SECOND	object	Custom	`"until" : "P-5DT3H55M"` `"until" : "PT3H55M"`	Represented using ISO 8601 "Duration" format. Zero duration components are considered optional
LONG	string	v1	`*as VARCHAR`	
LONG RAW	string	Custom	`"long_code" : { "SEVMTE8gV09STEQh"`	
BLOB	string	Custom	`"bin" : { "base64_value" : "bGVhc3VyZS4=" }`	

Data Type	JSON Data Type	REST Version	Value Example	Description
CLOB	string	Custom	`"text" : { "value" : "Hello World!" }`	
BFILE	Object	Custom	`"file" : { "locator" : "TARGET_DIR", "filename" : "myfile" }`	
BOOLEAN	true|false	v1	`"right" : true "wrong" : false`	

B.2 Handling Structural Database Types

This section explains how structural database types are handled.

Object Types

An exception to this is where ORDS has adopted an accepted encoding for an Industry Standard type such as GeoJSON.

Following is a sample code snippet:

```
"address" : {

"number" : 42,

"street" : "Wallaby Way",

"city" : "Sydney"

}
```

Inheritance

Object type inheritance is not supported. For marshalling purposes, all object types are treated as if they are left concrete types.

PL/SQL Records

PL/SQL Records are not supported.

VARRAYS

VARRAYS are mapped directly to the JSON array type.

Following is a sample code snippet:

```
"addresses" : [

{

"__db_type" : "MY_SCHEMA.AUS_ADDRESS",

"number" : 42,

"street" : "Wallaby Way",

"city" : "Sydney"

},

{

"__db_type" : "MY_SCHEMA.UK_ADDRESS"

"number : 1,

"street" : "Oracle Parkway"

"city" : "Reading"

"postcode" : "RG6 1RA"

}

]
```

Element Inheritance

If the type of a VARRAY element instance is a sub-type of the defined type, then it becomes mandatory to add the `__db_type` named value, as explained in the object types section.

Associative Arrays

Associative arrays (formally known as PL/SQL table or index-by table) fall into following two categories:

- **Indexed by an integer value**: A sparsely populated indexed array. This type of array may not yield a value for a given index. When this type of array is converted to and from JSON, the index is ignored, removing the indexable value gaps. This will have the side-effect that a sparsely populated indexed array that is passed as an IN/OUT parameter through a PL/SQL procedure without any changes, could still appear to have been changed, as the indexable value gaps would have been removed.

Following is a sample code snippet:

```
"avg_values" : [

34,

57,

86,

3235

]
```

:

- **Not indexed by an integer value**: For example, VARCHAR. This category is rarely used and not supported by the Oracle JDBC API.

B.3 Oracle Geospacial Encoding

Oracle Geospacial types comprises of more than the predefined Oracle Object types. However, recognized JSON encoding call, GeoJSON is used to encode the instance data.

Related Topics

- GeoJSON standard documentation

B.4 Enabling Database Mapping Support

This section shows how to enable the extended database mapping support.

To enable the extended database mapping support, the following code snippet must be added to the Oracle REST Data Services `defaults.xml` file, which is located in the Oracle REST Data Services configuration `ords` directory:

```
<entry key="misc.datatypes.enable">true</entry>
```

C

Troubleshooting Oracle REST Data Services

This appendix contains information on troubleshooting Oracle REST Data Services.

Topics:

- Enabling Detailed Request Error Messages
- Configuring Oracle APEX Static Resources with Oracle REST Data Services

C.1 Enabling Detailed Request Error Messages

To enable detailed request error messages, add the following setting to the Oracle REST Data Services configuration file named: `defaults.xml`:

```
<entry key="debug.printDebugToScreen">true</entry>
```

When this setting is present in `defaults.xml`, any request that produces an error response includes a detailed message, including a stack trace. This setting must not be enabled on productions systems due to the risk of sensitive information being revealed to an attacker.

C.2 ORDS User Defined Service

The following table lists the ORDS user defined services:

Table C-1 List of ORDS user defined service

Service	Response

--HTTP 200
BEGIN
ORDS.define_service(
p_module_name => 'test1',
p_base_path => 'test1/',
p_pattern => 'ok/',
p_method => 'GET',
p_source_type => ORDS.source_type_collection_feed,
p_source => 'SELECT * FROM dual',
p_items_per_page => 0);
	>curl -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test1/ok/
	HTTP/1.1 200 OK
	Date: Thu, 19 Mar 2020 17:18:05 GMT
	Content-Type: application/json
	ETag: "BLNTmyd/ZM889Q0GlgJ1t7lkSYo2kpAVIv4CY5dvtp9NI/Em1DJRzpmE5Bg/4GiKifewtzuJA6i+YCgdxETWWQ=="
	Transfer-Encoding: chunked

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`COMMIT;`
`END;`
`/`	

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`--HTTP 200 , p_source_type => ORDS.source_type_collection_feed , BEGIN`
`ORDS.define_service(`
`p_module_name => 'test2',`
`p_base_path => 'test2/' ,`
`p_pattern => 'norows/',`
`p_method => 'GET',`
`p_source_type => ORDS.source_type_collection_feed ,`
`p_source => 'SELECT`
	`>curl --head -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test2/norows/`
	`HTTP/1.1 200 OK`
	`Date: Thu, 19 Mar 2020 17:18:28 GMT`
	`Content-Type: application/json`
	`ETag: "aZVsHTwewrbbkl6wHNcTa3RFFdEsbdtDRBTSlR93r/vBmDvVsgud2rFqLDI65UKxzSElnAAMQdlBj/sB9ywWqQ=="`
	`Transfer-Encoding: chunked`

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`* FROM dual where 1 = 2', p_items_per_page => 0);`
 	
`COMMIT;`
`END;`
`/`	

Table C-1 (Cont.) List of ORDS user defined service

Service	Response
create table no_rows (col1 int); --HTTP 200 , p_source_type => ORDS.source_type_collection_feed , BEGIN ORDS.define_service(p_module_name => 'test2b' , p_base_path => 'test2b/', p_pattern => 'norows/', p_method => 'GET', p_source_type => ORDS.source_type_collect	>curl --head -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test2b/norows/ HTTP/1.1 200 OK Date: Thu, 19 Mar 2020 17:18:34 GMT Content-Type: application/json ETag: "Ns/g/hFxVWYPHUyZT53HNl6EMVlQUXD5wmz3eoO15dlY6nSVkk2FX3sNw3Yvq87SdLYAlCLeuqb4N4DQrcy+0Q==" Transfer-Encoding: chunked

Table C-1 (Cont.) List of ORDS user defined service

Service	Response
ion_feed , p_source => 'SELECT * FROM no_rows' , p_items_ per_page => 0); COMMIT; END; /	

Table C-1 (Cont.) List of ORDS user defined service

Service	Response
--HTTP 404 , p_source_type => ORDS.source_type_collection_item , BEGIN ORDS.define_service(p_module_name => 'test2c' , p_base_path => 'test2c/', p_pattern => 'norows/', p_method => 'GET', p_source_type => ORDS.source_type_collection_item , p_source => 'SELECT	>curl --head -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test2c/norows/ HTTP/1.1 404 Not Found Content-Type: text/html Content-Length: 16127

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`* FROM dual where 1 = 2',`
 	
`p_items_per_page => 0);`
 	
`COMMIT;`
`END;`
`/`	

Table C-1 (Cont.) List of ORDS user defined service

Service	Response
--HTTP 404 BEGIN ORDS.define_service(p_module_name => 'test3', p_base_path => 'test3/', p_pattern => 'doesnotexist/', p_method => 'GET', p_source_type => ORDS.source_type_collection_feed, p_source => 'SELECT 10 as A FROM doesnotexist', p_items_per_page	>curl --head -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test3/doesnotexist/ HTTP/1.1 403 Forbidden Content-Type: text/html Error-Reason: error="missing.object"; error_description*=UTF-8''The request could not be processed because a table or view referenced 0by the SQL statement being evaluate

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`=> 0);`
 	
`COMMIT;`
`END;`
`/`
	`d is not accessible or does not exist Content-Length: 16327`

Table C-1 (Cont.) List of ORDS user defined service

Service	Response

`--HTTP 555`
`BEGIN`
`ORDS.define_service(`
`p_module_name => 'test4',`
`p_base_path => 'test4/',`
`p_pattern => 'badsyntax/',`
`p_method => 'GET',`
`p_source_type => ORDS.source_type_collection_feed,`
`p_source => 'SELECT 10',`
`p_items_per_page => 0);`
`COMMIT;`
	`>curl --head -i -X GET --user DEMO:demo -k http://localhost:8082/ords/demo/test4/badsyntax/`
	`HTTP/1.1 500 Server Error`
	`Content-Type: text/html`
	`Error-Reason: error="resource.generator.evaluation"; error_description*=UTF-8''The request could not be processed because an error occurred whilst attempting to`

Table C-1 (Cont.) List of ORDS user defined service

Service	Response
`END;` `/`	`evaluate the SQL statement associated with this resource. Please check the SQL statement is correctly formed and executes without error. SQL Error Code ORA-00923 FROM keyword not found where expected Error Message. Content-Length: 16514`

C.3 Configuring Oracle APEX Static Resources with Oracle REST Data Services

When using Oracle REST Data Services, a blank page might be displayed when attempting to access an Oracle APEX page, for example, when attempting to display `https://example/ords/`. This problem is caused by an improper configuration of Oracle APEX Express static resources, which causes the JavaScript and CSS resources required by APEX not to be found and the APEX page not to render correctly.

The specific cause can be any of the following:

- Forgetting to ensure that the APEX static images are located on the same server as the Oracle REST Data Services instance
- Forgetting to deploy a web application for the static APEX images to Apache Tomcat or WebLogic Server.
- When running in Standalone mode, entering an incorrect path (or not specifying a path) when prompted on the first run of Standalone mode
- When running in Standalone mode, entering an incorrect path with the `--apex-images` option
- Upgrading to a new version of APEX in Standalone mode forgetting to update the location by using the `--apex-images` option

To help in diagnosing the problem, you can try to access the `apex_version.txt` file. For example, if your APEX deployment is located at `https://example.com/ords/` and your static resources have been deployed at `https://example.com/i/`, use a browser to access the following URL:

```
https://example.com/i/apex_version.txt
```

If you get a `404 Not Found` error, then check the preceding list of possible specific causes.

If a plain text file is displayed, it should contain text like the following:

```
Application Express Version:  4.2.1
```

Check that the version number matches the version of APEX that is deployed on the database. If the numbers do not match, check if you have made an error mentioned in the last item in the preceding list of possible specific causes, because Oracle REST Data Services is not configured to use the correct version of the APEX static resources to match the APEX version in the database.

If you need help in solving the problem, check the information in this book about creating and deploying `i.war` for your environment, such as WebLogic Server.

See Also:

Configuring Oracle Application Express Images

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```
{RSA seal within a prominent location (e.g., "read me" files, "help" files
and/or other similar locations),
as well as in user documentation, printed product collateral and product
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D.2 Join Monster 3.3.2

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```

==
==
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==
==
Fourth Party Dependency #3 - deprecate
author Brian M. Carlson

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Fourth Party Dependency #4 - generatorics
 author Andrew Carlson <acarl005@g.ucla.edu>
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=========================================================================
=========================================================================
Fourth Party Dependency #5 - graphql-relay
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D.3 graphql-compose 9.0.10

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D.4 graphql-js 16.8.0

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D.6 JavaScript Extension Toolkit (JET) 14.0.0

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D.8 gridstack.js 8.3.0

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D.16 jackson-jr 2.13.4

```
Notice (https://github.com/FasterXML/jackson-jr/blob/master/jr-
objects/src/main/resources/META-INF/NOTICE)
# Jackson JSON processor

Jackson is a high-performance, Free/Open Source JSON processing
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It was originally written by Tatu Saloranta (tatu.saloranta@iki.fi),
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It is currently developed by a community of developers, as well as
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D.17 Jakarta Json Processing API (JSON-P) 2.1.1

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* https://github.com/eclipse-ee4j/jsonp

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D.18 MongoDB bson 4.10.2

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D.24 swagger-ui 5.1.1

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//                 Frank Tan <https://github.com/tansongyang>
//                 Nicholas Boll <https://github.com/nicholasboll>
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//                 Lenz Weber <https://github.com/phryneas>
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 * java.sun.security.ssl

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 * org.ow2.asm:asm-commons
 * org.ow2.asm:asm

The following dependencies are ASL2 licensed.

 * org.apache.taglibs:taglibs-standard-spec
 * org.apache.taglibs:taglibs-standard-impl
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 * org.apache.tomcat:tomcat-jasper
 * org.apache.tomcat:tomcat-juli
 * org.apache.tomcat:tomcat-jsp-api
 * org.apache.tomcat:tomcat-el-api
 * org.apache.tomcat:tomcat-jasper-el
 * org.apache.tomcat:tomcat-api
 * org.apache.tomcat:tomcat-util-scan
 * org.apache.tomcat:tomcat-util
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 * org.apache.tomcat:tomcat-jasper-el
 * org.apache.tomcat:tomcat-el-api

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D.27 avsc 5.7.7

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D.28 babel-polyfill 7.20.15

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D.29 Dexie 3.2.4

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Dexie.js

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D.30 d3-flame-graph

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sax 1.2.4

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D.39 vscode-jsonrpc-ww 0.2.4

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D.46 VSCode Language Server - Node 8.1.0

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