Oracle® Fusion Middleware

Integrating Oracle Coherence

12*c* (12.2.1)

E55604-01

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Documentation for developers and administrators that describes how to integrate Oracle Coherence with Coherence*Web, EclipseLink JPA, Hibernate, Spring, memcached adapters, and Coherence GoldenGate HotCache.

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Oracle Fusion Middleware Integrating Oracle Coherence, 12*c* (12.2.1)

E55604-01

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Preface

Oracle Coherence (Coherence) is a JCache-compliant in-memory caching and data management solution for clustered Java Platform Enterprise Edition (Java EE) applications and application servers. Coherence makes sharing and managing data in a cluster as simple as it is on a single server. It accomplishes this by coordinating updates to the data using clusterwide concurrency control, replicating and distributing data modifications across the cluster using the highest performing clustered protocol available, and delivering notifications of data modifications to any servers that request them. Developers can take advantage of Coherence features using the standard Java collections API to access and modify data, and use the standard JavaBeans event model to receive data change notifications.

Audience

This guide is for software developers and architects who will be integrating Coherence with TopLink-Grid, JPA, Hibernate, Spring, memcached adapters, and Coherence GoldenGate HotCache.

Documentation Accessibility

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Related Documents

For more information about Oracle Coherence, see the following:

- *Administering HTTP Session Management with Oracle Coherence*Web*
- *Administering Oracle Coherence*
- *Developing Applications with Oracle Coherence*
- *Developing Remote Clients for Oracle Coherence*
- *Installing Oracle Coherence*

- *Managing Oracle Coherence*
- *Securing Oracle Coherence*
- *Java API Reference for Oracle Coherence*
- *.NET API Reference for Oracle Coherence*
- *C++ API Reference for Oracle Coherence*
- *Release Notes for Oracle Coherence*

Conventions

The following text conventions are used in this guide:

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

What's New in This Guide

The following topics introduce the new and changed features of Oracle Coherence and other significant changes that are described in this guide, and provides pointers to additional information.

New and Changed Features for 12*c* (12.2.1)

Oracle Coherence 12*c* (12.2.1) includes the following new and changed features for this document.

- Support for GoldenGate HotCach has been updated. For details on using the HotCache feature, see "Integrating with Oracle Coherence GoldenGate HotCache" on page 7-1.

Other Significant Changes in this Document for 12*c* (12.2.1)

For 12*c* (12.2.1), this guide has been updated in several ways. Following are the sections that have been added or changed.

- Support for the Toplink cache store and cache loader has been removed.

1

Integrating TopLink Grid with Oracle Coherence

This chapter describes how Oracle TopLink Grid enables you to scale out Java Persistence API (JPA) applications using Oracle Coherence. TopLink Grid provides applications with a number of options on how they can scale, ranging from using Coherence as a distributed shared (L2) cache up to directing JP QL queries to Coherence for parallel execution across the grid to reduce database load. With TopLink Grid, you do not have to rewrite your applications to scale out. You can use your investment in JPA, and still take advantage of the scalability of Coherence.

This chapter contains the following sections:

1.1 What is TopLink Grid?

Oracle TopLink Grid is a feature of Oracle TopLink that provides integration between the EclipseLink JPA and Coherence. Standard JPA applications interact directly with their primary data store, typically a relational database. However, with TopLink Grid you can store some or all of your domain model in the Coherence data grid. This configuration is also known as *JPA on the Grid*.

You can easily configure TopLink Grid to use Coherence as the primary data store, execute queries against the grid, and allow Coherence to manage the persistence of new and modified data. Coherence provides the layer between JPA and the data store, where direct database calls can be offloaded from every application instance. This makes it possible for clustered application deployments to scale beyond the bounds of standard database operations.

The Oracle TopLink Grid page on the Oracle Technology Network provides additional information and code examples for Coherence for TopLink Grid.

`http://www.oracle.com/technetwork/middleware/ias/tl-grid-097210.html`

1.1.1 What are the *JPA on the Grid* Configurations?

These are the typical *JPA on the Grid* configurations that applications can use:

- Grid Cache configuration, which uses Coherence as the TopLink L2 (shared) cache. This configuration applies the Coherence data grid to JPA applications that rely on database-hosted data that cannot be entirely preloaded into a Coherence cache. Some reasons why it might not be able to be preloaded include extremely complex queries that exceed the feature set of Coherence Filters, third-party database updates that create stale caches, reliance on native SQL queries, stored procedures or triggers, and so on.

  In this configuration, you can scale TopLink up into large clusters while avoiding the requirement to coordinate local L2 caches. Updates made to entities are available in all Coherence cluster members immediately, upon committing a transaction. For more information, see "Grid Cache Configuration" on page 1-5.

- Grid Read configuration, which is optimal for entities that require fast access to large amounts of (fairly stable) data and must write changes synchronously to the database. In these entities, cache warming could be used to populate the Coherence cache, but individual queries could also be directed to the database if necessary. For more information, see "Grid Read Configuration" on page 1-9.

- Grid Entity configuration, which is optimal for applications that require fast access to large amounts of (fairly stable) data and perform relatively few updates. This configuration can be combined with a Coherence cache store using write-behind to improve application response time by performing database updates asynchronously. For more information, see "Grid Entity Configuration" on page 1-14.

1.1.2 What are the Benefits of Using TopLink Grid with Oracle Coherence?

TopLink Grid provides the following benefits:

- Simple application configuration using annotations or XML configurations that align with standard JPA.
- The ability to store complex object graphs with relationships in Coherence.
- The ability to selectively choose which entities are stored in the grid and which are stored directly in the backing database.
- Allows you to execute JP QL queries in the Grid or directly against the database.
- Allows you to store entities with both eager and lazy relationships into Coherence.

TopLink Grid integrates the EclipseLink JPA implementation with Oracle Coherence and provides these development approaches:

- You can build applications using JPA and transparently use the power of the data grid for improved scalability and performance. In this *JPA on the Grid* approach, TopLink Grid provides a set of cache and query configuration options that allow you to control how EclipseLink JPA uses Coherence. These implementations reside in the `oracle.eclipselink.coherence.integrated` package. See "JPA on the Grid Configurations" on page 1-3 for more information.
- If you have existing Native ORM applications, then you can use the EclipseLink Native Object Relational Mapping (ORM) framework with them. The Native ORM approach is very similar to *JPA on the Grid*, however, it does not use annotations to configure how the cache is used. Instead, this approach employs an *amendment method* that defines the appropriate cache behavior. See "EclipseLink Native ORM Configurations" on page 1-20 for more information.

- You can use the Coherence API with caches backed by TopLink Grid to access relational data with special cache loader and cache store interfaces which have been implemented for JPA.

  In this traditional Coherence approach, TopLink Grid provides the `CacheLoader` and `CacheStore` implementations in the `oracle.eclipselink.coherence.standalone` package that are optimized for EclipseLink JPA. This technique is described in "Using TopLink Grid with Coherence Client Applications" on page 2-1.

When integrating JPA applications with the Coherence data grid, note the potential benefits and restrictions. You must understand how the grid works and how it relates to your JPA configurations to realize the full potential.

1.2 Required Files

The required files for working with TopLink Grid are the `javax.persistence_2.2.0.0_1-0-2.jar`, the `eclipselink.jar`, and the `toplink-grid.jar`. Assuming that you performed a standard installation of Coherence, these files can be found in the following locations:

- `.../Oracle_Home/oracle_common/modules/javax.persistence_2.2.0.0_1-0-2.jar`
- `.../Oracle_Home/oracle_common/modules/oracle.toplink12.1.3/eclipselink.jar`
- `.../Oracle_Home/oracle_common/modules/oracle.toplink12.1.3/toplink-grid.jar`

1.3 *JPA on the Grid* Configurations

This section describes *JPA on the Grid* and how to read and write objects in the Grid Cache, Grid Read, and Grid Entity configurations. It also describes how to work with queries against the Coherence cache under these configurations.

This section contains the following:

- Understanding JPA on the Grid
- JPA on the Grid API
- Grid Cache Configuration
- Grid Read Configuration
- Grid Entity Configuration
- Handling Grid Read and Grid Entity Failovers
- Wrapping and Unwrapping Entity Relationships
- Working with Queries

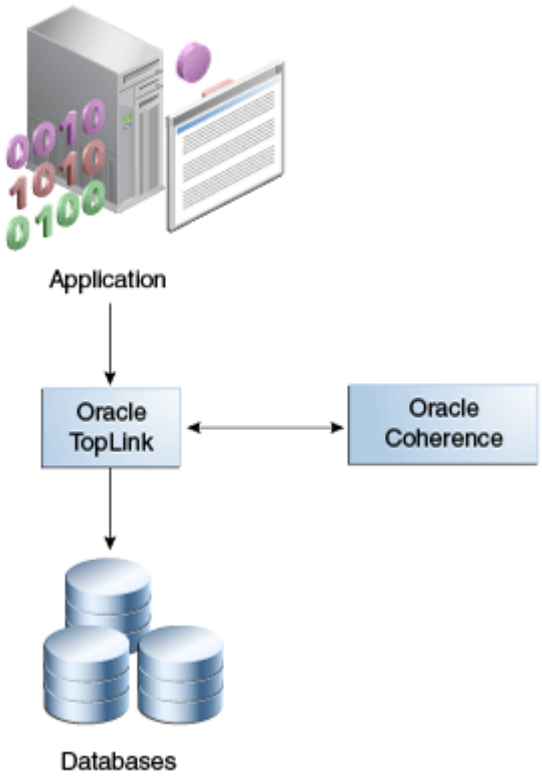
1.3.1 Understanding *JPA on the Grid*

The expression *JPA on the Grid* refers to using JPA and the power of the data grid to build applications with improved scalability and performance. In the *JPA on the Grid* approach, TopLink Grid provides a set of cache and query configuration options that allow you to control how EclipseLink JPA uses Coherence.

You can configure Coherence as a distributed shared (L2) cache or use Coherence as the primary data store. You can also configure entities to execute queries in the Coherence data grid instead of the database. This allows clustered application deployments to scale beyond database-bound operations.

Figure 1–1 illustrates the relationship between an application, TopLink, Coherence, and the database.

Figure 1–1 JPA on the Grid Approach



1.3.2 *JPA on the Grid* API

The API used by *JPA on the Grid* configurations are shipped in the `toplink-grid.jar` file. Table 1–1 lists some of the key classes in the `oracle.eclipselink.coherence.integrated` package that are used in *JPA on the Grid* configurations.

Table 1–1 TopLink Grid Classes to Build JPA on the Grid Applications

Class Name	Description
`oracle.eclipseLink.coherence.integrated.EclipseLinkJPACacheLoader`	Provides JPA-aware versions of the Coherence `CacheLoader` interface.
`oracle.eclipseLink.coherence.integrated.EclipseLinkJPACacheStore`	Provides JPA-aware versions of the Coherence `CacheStore` interface.
`oracle.eclipselink.coherence.integrated.config.CoherenceReadCustomizer`	Enables a Coherence read configuration.
`oracle.eclipselink.coherence.integrated.config.CoherenceReadWriteCustomizer`	Enables a Coherence read/write configuration.

Table 1–1 (Cont.) TopLink Grid Classes to Build JPA on the Grid Applications

Class Name	Description
`oracle.eclipselink.coherence.integrated.config.GridCacheCustomizer`	Enables cache instances to be cached in Coherence instead of in the internal EclipseLink shared cache. All calls to the internal TopLink L2 cache are redirected to Coherence.
`oracle.eclipselink.coherence.integrated.querying.IgnoreDefaultRedirector`	Allows queries to bypass the Coherence cache and be sent directly to the database.

The configuration also uses the standard JPA run-time configuration file `persistence.xml` and the JPA mapping file `orm.xml`. You must also use the Coherence cache configuration file `coherence-cache-config.xml` to override the default Coherence settings and define the cache store caching scheme.

1.3.3 Grid Cache Configuration

The Grid Cache configuration can be considered as the base configuration for TopLink Grid. In this configuration, Coherence acts as the TopLink shared (L2) cache. This brings the power of the Coherence data grid to JPA applications that rely on database-hosted data that cannot be entirely preloaded into a Coherence cache. Some reasons why the data might not be able to be preloaded include extremely complex queries that exceed the abilities of Coherence Filters, third-party database updates that create stale caches, and reliance on native SQL queries, stored procedures, or triggers.

By using Coherence as the TopLink Grid cache, you can scale TopLink up into large clusters while avoiding the need to coordinate local shared caches. Updates made to entities are available in all Coherence cluster members immediately, upon committing a transaction.

In general, read and write operations in a Grid Cache configuration have the following characteristics:

- A primary key query will attempt to get entities first from the Coherence cache. If the attempt is unsuccessful, the database will be queried and the Coherence cache will be updated with the query results. See the following section, "Reading Objects in Grid Cache Configuration".
- A nonprimary key query will be executed against the database and the results will be checked against the Coherence cache. This is to avoid the negative performance impact of constructing entities that are already cached. Newly queried entities are put into the Coherence cache.
- A write operation will update the database and, if successfully committed, will put updated entities into the Coherence cache. See "Writing Objects in Grid Cache Configuration" on page 1-7.

See "Grid Cache Configuration Examples" on page 1-7 for detailed examples.

To use Coherence as a distributed cache for an entity, you must enable shared caching in EclipseLink. Shared caching is enabled by default for all entities, but the default can be explicitly set to `true` or `false` by setting the `eclipselink.cache.shared.default` property in the `persistence.xml` file. Specific entities can override the default using the `@Cache` annotation or by specifying the corresponding XML `<cache>` element in the `eclipselink-orm.xml` file. For more information, see:

```
http://wiki.eclipse.org/Using_EclipseLink_JPA_Extensions_(ELUG)#How_to_
Use_the_.40Cache_Annotation
```

1.3.3.1 Reading Objects in Grid Cache Configuration

In the Grid Cache configuration, all read queries are directed to the database *except* primary key queries, which are directed to the Coherence cache first. Any cache misses will result in a database query.

All entities queried from the database are placed in the Coherence cache. This makes the entities immediately available to all members of the cluster. This is valuable because, by default, TopLink uses the cache to avoid constructing new entities from database results.

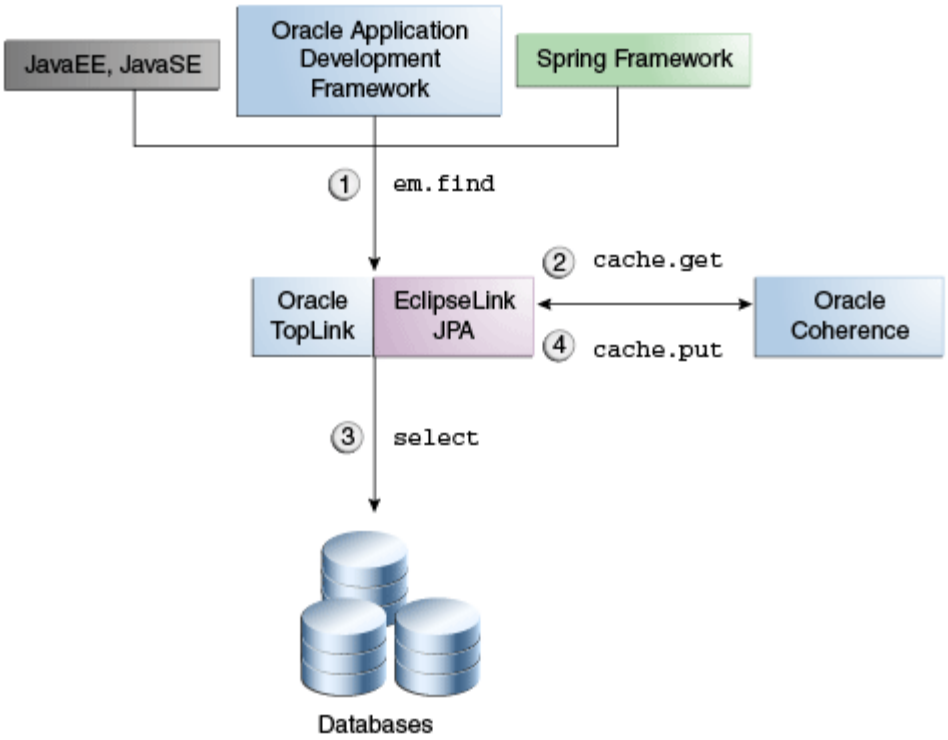
For each row resulting from a query, TopLink uses the primary key of the result row to query the corresponding entity from the cache. If the cache contains the entity then the entity is used and a new entity is not built. This approach can greatly improve application performance, especially with a warmed cache, because it reduces the cost of a query by eliminating the cost associated with object building.

Figure 1–2 illustrates the path of a read query in the Grid Cache configuration:

1. The application issues a `find` query.
2. For primary key queries, TopLink queries the Coherence cache first.
3. If the object does not exist in the Coherence cache, TopLink queries the database.

   For all read queries *except primary key queries*, TopLink queries the database first.
4. Read objects are `put` into the Coherence cache.

Figure 1–2 Reading Objects in Grid Cache Configuration



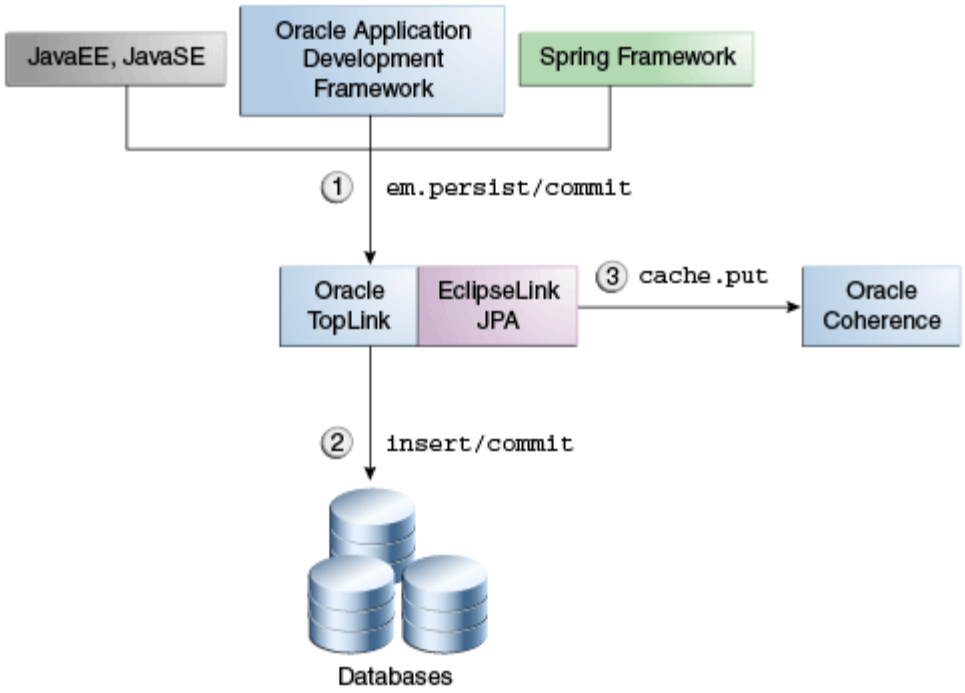
1.3.3.2 Writing Objects in Grid Cache Configuration

In the Grid Cache configuration, TopLink performs all database write operations (insert, update, delete). The Coherence cache is then updated to reflect the changes made to the database. TopLink offers a number of performance features when writing large amounts of data including batch writing, parameter binding, stored procedure support, and statement ordering to ensure that database constraints are satisfied.

Figure 1–3 illustrates the path for writing and persisting objects in the Grid Cache configuration:

1. The application issues a `commit` query.
2. TopLink updates the database.
3. After a successful transaction, TopLink updates the Coherence cache.

Figure 1–3 Writing and Persisting Objects in grid Cache Configuration



1.3.3.3 Grid Cache Configuration Examples

You can obtain the code in these examples at the following URL:

http://www.oracle.com/technetwork/middleware/toplink/examples-325517-en-ca.html

1.3.3.3.1 Configuring the Cache for the Grid Cache Configuration The cache configuration file (`coherence-cache-config.xml`) in Example 1–1 defines the cache and configures a wrapper serializer to support serialization of relationships.

Example 1–1 Configuring the Cache in Grid Cache Configuration

```
<cache-config>
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>*</cache-name>
```

```
      <scheme-name>eclipselink-distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>
  <caching-schemes>
    <distributed-scheme>
      <scheme-name>eclipselink-distributed</scheme-name>
      <service-name>EclipseLinkJPA</service-name>
      <!--
        Configure a wrapper serializer to support serialization of relationships.
      -->
      <serializer>
        <class-name>oracle.eclipselink.coherence.integrated.cache.WrapperSerialize
r</class-name>
      </serializer>
      <backing-map-scheme>
      <!--
        Backing map scheme with no eviction policy.
      -->
        <local-scheme>
          <scheme-name>unlimited-backing-map</scheme-name>
        </local-scheme>
      </backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

1.3.3.3.2 Configuring an Entity for the Grid Cache Configuration

To configure an entity to use Grid Cache, use the `@Customizer` annotation and the `GridCacheCustomizer` class as shown in Example 1–2. This class intercepts all TopLink calls to the internal TopLink Grid cache and redirects them to the Coherence cache.

Example 1–2 Configuring the Entity in Grid Cache Configuration

```
import oracle.eclipselink.coherence.integrated.config.GridCacheCustomizer;
import org.eclipse.persistence.annotations.Customizer;

@Entity
@Customizer(GridCacheCustomizer.class)
public class Employee {
...
```

1.3.3.3.3 Inserting Objects for the Grid Cache Configuration

In Example 1–3, TopLink performs the insert to create a new employee. Entities are persisted through the `EntityManager` and placed in the database. After a successful transaction, the Coherence cache is updated.

Example 1–3 Inserting Objects in Grid Cache Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");

// Create an employee with an address and telephone number.
EntityManager em = emf.createEntityManager();
em.getTransaction().begin();
Employee employee = createEmployee();
em.persist(employee);
em.getTransaction().commit();
em.close();
```

1.3.3.3.4 Querying Objects for the Grid Cache Configuration In Example 1–4, the named JPQL query is directed to the database. Query results are resolved against the Coherence cache to avoid the cost of building objects that have previously been cached.

Example 1–4 Querying Objects in Grid Cache Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");

EntityManager em = emf.createEntityManager();
List<Employee> employees = em.createQuery("select e from Employee e where
e.lastName = :lastName").setParameter("lastName", "Smith").getResultList();

for (Employee employee : employees) {
   System.err.println(employee);
   for (PhoneNumber phone : employee.getPhoneNumbers()) {
      System.err.println("\t" + phone);
   }
}

emf.close();
```

1.3.4 Grid Read Configuration

Use the Grid Read configuration for entities that require fast access to large amounts of (fairly stable) data and write changes synchronously to the database. For these entities, cache warming would typically be used to populate the Coherence cache, but individual queries could be directed to the database if necessary.

In general, read and write operations in a Grid Read configuration have the following characteristics:

- Read operations get objects from the Coherence cache. Configuring a cache loader has no impact on JPQL queries. See the next section, "Reading Objects in Grid Read Configuration".
- Write operations update the database and, if successfully committed, updated entities are put into the Coherence cache. See "Writing Objects in Grid Read Configuration" on page 1-11.

See "Grid Read Configuration Examples" on page 1-12 for detailed examples.

1.3.4.1 Reading Objects in Grid Read Configuration

In the Grid Read configuration, all primary key and non-primary key queries are directed to the Coherence cache. To reduce query processing time, TopLink Grid supports parallel processing of queries across the data grid. Coherence contains data already in object form, avoiding the performance impact of database communication and object construction.

With the Grid Read configuration, if Coherence does not contain the entity requested by the `find(...)` method, then `null` is returned. However, if a cache loader is configured for the entity's cache, Coherence will attempt to load the object from the database. This is true only for primary key queries.

Configuring a cache loader has no impact on JPQL queries translated to Coherence filters. When searching with a filter, Coherence will operate *only* on the set of entities in the caches; the database will not be queried. However, it is possible to direct a query, on a query-by-query basis, to the database instead of to Coherence by using the

`oracle.eclipselink.coherence.integrated.querying.IgnoreDefaultRedirector` class, as shown in following example:

```
query.setHint(QueryHints.QUERY_REDIRECTOR, new IgnoreDefaultRedirector());
```

Any objects retrieved by a database query will be added to the Coherence cache so that they are available for subsequent queries. Because this configuration resolves all queries for an entity through Coherence by default, the Coherence cache should be warmed with all of the data that is to be queried.

In the Grid Read configuration, projection queries (reports) that extract data from a single entity type will also be directed to Coherence. For example, the following JPQL query will return the first and last names of all employees contained in the Coherence cache.

```
select e.firstName, e.lastName from Employee e
```

This type of query is useful when the entire entity is not required, for example when populating a drop-down list in a user interface.

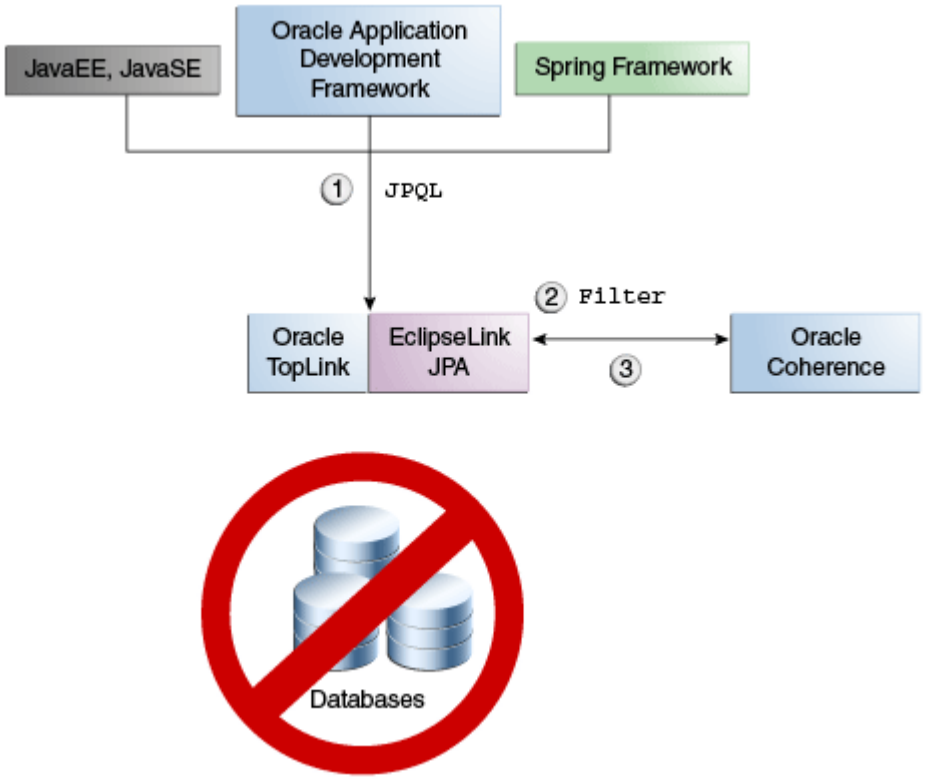
A cache store is not compatible with the Grid Read configuration because the EclipseLink JPA will perform all database updates and then propagate the updated objects into Coherence. If you use a cache store, Coherence will attempt to write the objects again.

For complete information on using EclipseLink JPA query hints, see "JPA Query Customization Extensions" in *Java Persistence API (JPA) Extensions Reference for Oracle TopLink* and "About JPA Query Hints" in *Oracle Fusion Middleware Understanding Oracle TopLink*.

Figure 1–4 illustrates the path for a query in the Grid Read configuration:

1. The application issues a JPQL query.
2. TopLink executes a Filter on the Coherence cache.
3. TopLink returns results from the Coherence cache only; the database is not queried.

Figure 1–4 Reading Objects with a Query



1.3.4.2 Writing Objects in Grid Read Configuration

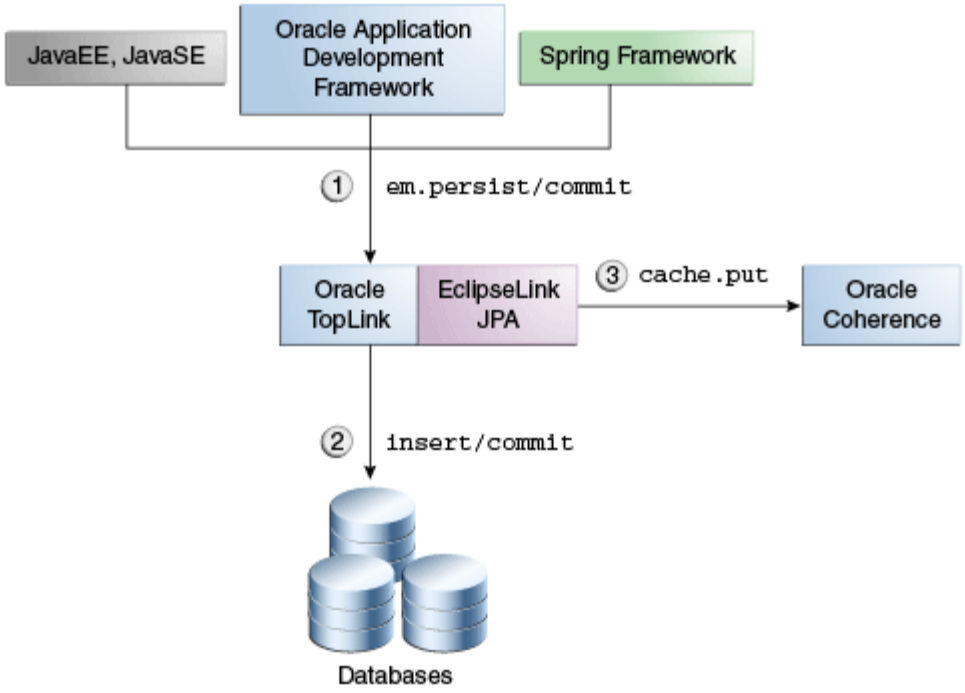
In the Grid Read configuration, TopLink performs all database write operations (insert, update, delete) directly. The Coherence caches are then updated to reflect the changes made to the database. TopLink offers a number of performance features when writing large amounts of data. These include batch writing, parameter binding, stored procedure support, and statement ordering to ensure that database constraints are satisfied.

This approach offers the best possibilities: database updates are performed efficiently *and* queries continue to be executed in parallel across the Coherence data grid, with the option of directing individual queries to the database.

Figure 1–5 illustrates the path for writing and persisting objects in the Grid Read configuration:

1. The application issues a `commit` query.
2. TopLink updates the database.
3. After a successful transaction, TopLink updates the Coherence cache.

Figure 1–5 Writing and Persisting Objects in Grid Read Configuration



1.3.4.3 Grid Read Configuration Examples

You can obtain the code in these examples at the following URL:

http://www.oracle.com/technetwork/middleware/toplink/examples-325517-en-ca.html

1.3.4.3.1 Configuring the Cache in Grid Read Configuration The cache configuration file (`coherence-cache-config.xml`) in Example 1–5 defines the cache and configures a wrapper serializer to support serialization of relationships. The `oracle.eclipselink.coherence.integrated.EclipseLinkJPACacheLoader` class defines the cache store scheme.

Example 1–5 Configuring the Cache in Grid Read Configuration

```
<cache-config>
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>*</cache-name>
      <scheme-name>eclipselink-distributed-readonly</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>
  <caching-schemes>
    <distributed-scheme>
      <scheme-name>eclipselink-distributed-readonly</scheme-name>
      <service-name>EclipseLinkJPAReadOnly</service-name>
      <!--
        Configure a wrapper serializer to support serialization of relationships.
      -->
      <serializer>
        <class-name>oracle.eclipselink.coherence.integrated.cache.WrapperSerializer</class-name>
      </serializer>
```

```
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme />
          </internal-cache-scheme>
          <!--
            Define the cache scheme.
          -->
          <cachestore-scheme>
            <class-scheme>
              <class-name>oracle.eclipselink.coherence.integrated.EclipseLinkJPACa
cheLoader</class-name>
              <init-params>
                <param-type>java.lang.String</param-type>
                <param-value>{cache-name}</param-value>
              </init-param>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>employee-pu</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </cachestore-scheme>
          <read-only>true</readonly>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

1.3.4.3.2 Reading Objects for the Grid Read Configuration

To configure an entity to read through a Coherence cache, use the `@Customizer` annotation and the `CoherenceReadCustomizer` class as shown in Example 1–6:

Example 1–6 Configuring the Entity in Grid Read Configuration

```
import oracle.eclipselink.coherence.integrated.config.CoherenceReadCustomizer;
import org.eclipse.persistence.annotations.Customizer;

@Entity
@Customizer(CoherenceReadCustomizer.class)
public class Employee {
...
}
```

1.3.4.3.3 Inserting Objects for the Grid Read Configuration

In Example 1–7, TopLink performs an insert to create a new employee. If the transaction is successful, the new object is placed into the Coherence cache under its primary key.

Example 1–7 Inserting Objects in Grid Read Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");
// Create an employee with an address and telephone number
EntityManager em = emf.createEntityManager();
em.getTransaction().begin();
Employee employee = createEmployee();
em.persist(employee);
em.getTransaction().commit();
em.close();
```

```
emf.close();
```

1.3.4.3.4 Querying Objects for the Grid Read Configuration

When finding an employee, the read query is directed to the Coherence cache. The JPQL query is translated to Coherence filters, as shown in Example 1–8.

Example 1–8 Querying Objects in Grid Read Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");
EntityManager em = emf.createEntityManager();
List<Employee> employees = em.createQuery("select e from Employee e where
e.lastName = :lastName").setParameter("lastName", "Smith").getResultList();
  for (Employee employee : employees) {
    System.err.println(employee);
      for (PhoneNumber phone : employee.getPhoneNumbers()) {
        System.err.println("\t" + phone);
      }
  }
emf.close();
```

To retrieve an object from the Coherence cache with a specific ID (key), use the `em.find(Entity.class, ID)` method. You can also configure a Coherence cache loader to query the database to find the object, if the cache does not contain the object with the specified ID.

1.3.5 Grid Entity Configuration

The Grid Entity configuration should be used by applications that require fast access to large amounts of (fairly stable) data, but perform relatively few updates. This configuration can be combined with a Coherence cache store using write-behind to improve application response time by performing database updates asynchronously.

In general, read and write operations in a Grid Entity configuration have the following characteristics:

- Read operations get objects from the Coherence cache. See "Reading Objects in Grid Entity Configuration" on page 1-14.
- Write operations put objects into the Coherence cache. If a cache store is configured, TopLink also performs write operations on the database. See "Writing Objects in Grid Entity Configuration" on page 1-14.

See "Grid Entity Configuration Examples" on page 1-15 for detailed examples.

1.3.5.1 Reading Objects in Grid Entity Configuration

In the Grid Entity configuration, querying objects is identical to the Grid Read configuration. See "Reading Objects in Grid Cache Configuration" on page 1-6 for more information.

1.3.5.2 Writing Objects in Grid Entity Configuration

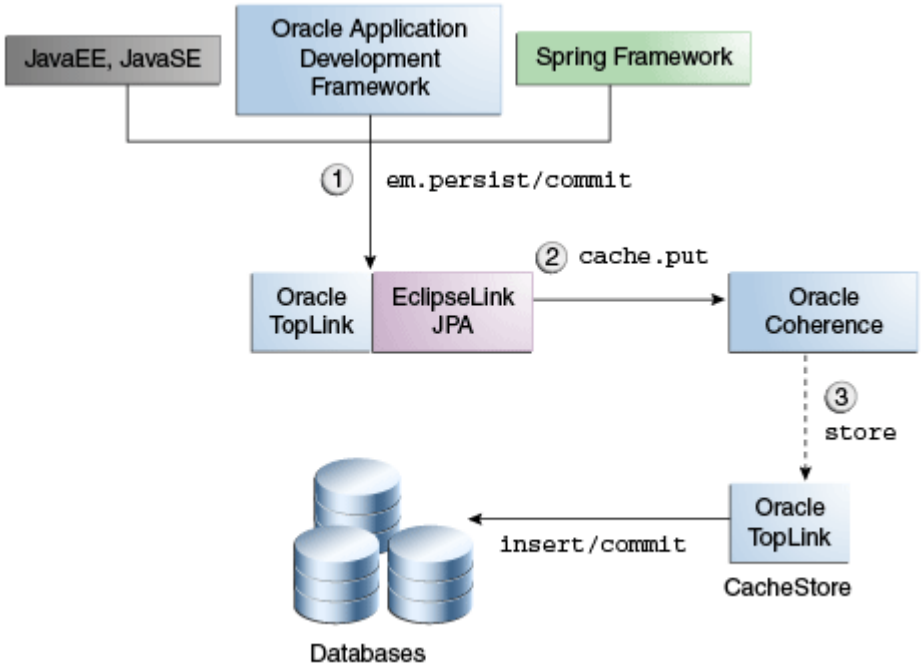
In the Grid Entity configuration, all objects that are persisted, updated, or merged through an `EntityManager` instance will be put in the appropriate Coherence cache. To persist objects in a Coherence cache to the database, an EclipseLink JPA cache store (`oracle.eclipselink.coherence.integrated.EclipseLinkJPACacheStore`) must be configured for each cache.

You can also configure the cache store to use write-behind to asynchronously batch-write updated objects. See *Developing Applications with Oracle Coherence* for more information.

Figure 1–6 illustrates the path for writing and persisting objects in the Grid Entity configuration.

1. The application issues a `commit` call.
2. TopLink directs all queries to update the Coherence cache.
3. By configuring a Coherence cache store (optional), TopLink will also update the database.

Figure 1–6 Writing and Persisting Objects in Grid Entity Configuration



1.3.5.3 Limitations on Writing Objects in Grid Entity Configuration

When using a cache store, Coherence assumes that all write operations succeed and will not inform TopLink of a failure. This could result in the Coherence cache differing from the database. You cannot use optimistic locking to protect against data corruption that may occur if the database is concurrently modified by Coherence and a third-party application.

Because the order in which Coherence cache members write updates to the database is unpredictable, referential integrity cannot be guaranteed. Referential integrity constraints must be removed from the database. If they are not, write operations could fail with the following error:

```
org.eclipse.persistence.exceptions.DatabaseException
Internal Exception: java.sql.BatchUpdateException: ORA-02292: integrity constraint
violated - child record found
Error Code: 2292
```

1.3.5.4 Grid Entity Configuration Examples

You can obtain the code in these examples at the following URL:

http://www.oracle.com/technetwork/middleware/toplink/examples-325517-en-ca.html

1.3.5.4.1 Configuring the Cache for the Grid Entity Configuration

The cache configuration file (`coherence-cache-config.xml`) in Example 1–9 configures a wrapper serializer to support serialization of relationships. The `oracle.eclipselink.coherence.integrated.EclipseLinkJPACacheStore` class defines the cache store scheme.

Example 1–9 Configuring the Cache in Grid Entity Configuration

```
<cache-config>
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>*</cache-name>
      <scheme-name>eclipselink-distributed-readwrite</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>
  <caching-schemes>
    <distributed-scheme>
      <scheme-name>eclipselink-distributed-readwrite</scheme-name>
      <service-name>EclipseLinkJPAReadWrite</service-name>
      <!--
        Configure a wrapper serializer to support serialization of relationships.
      -->
      <serializer>
        <class-name>oracle.eclipselink.coherence.integrated.cache.WrapperSerialize
r</class-name>
      </serializer>
      <backing-map-scheme>
       <read-write-backing-map-scheme>
        <internal-cache-scheme>
          <local-scheme />
          </internal-cache-scheme>
           <!--
             Define the cache scheme
           -->
            <cachestore-scheme>
              <class-scheme>
                <class-name>oracle.eclipselink.coherence.integrated.EclipseLinkJPA
CacheStore</class-name>
                <init-params>
                  <init-param>
                    <param-type>java.lang.String</param-type>
                    <param-value>{cache-name}</param-value>
                  </init-param>
                  <init-param>
                    <param-type>java.lang.String</param-type>
                    <param-value>employee-pu</param-value>
                  </init-param>
                </init-params>
              </class-scheme>
            </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

1.3.5.4.2 Configuring an Entity for the Grid Entity Configuration

To configure an entity to read through Coherence, use the `@Customizer` annotation and the `CoherenceReadWriteCustomizer` class as shown Example 1–10:

Example 1–10 Configuring an Entity in Grid Entity Configuration

```
import
oracle.eclipselink.coherence.integrated.config.CoherenceReadWriteCustomizer;
import org.eclipse.persistence.annotations.Customizer;

@Entity
@Customizer(CoherenceReadWriteCustomizer.class)
public class Employee {
...
}
```

1.3.5.4.3 Persisting Objects for the Grid Entity Configuration

In Example 1–11, TopLink performs the insert to create a new employee. Entities persist through the `EntityManager` instance and are placed in the appropriate Coherence cache.

Example 1–11 Persisting Objects in Grid Entity Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");

// Create an employee with an address and telephone number.
EntityManager em = emf.createEntityManager();
em.getTransaction().begin();
Employee employee = createEmployee();
em.persist(employee);
em.getTransaction().commit();
em.close();
```

1.3.5.4.4 Querying Objects for the Grid Entity Configuration

When finding an employee, the read query is directed to the Coherence cache, as shown in Example 1–12.

Example 1–12 Querying Objects in Grid Entity Configuration

```
EntityManagerFactory emf = Persistence.createEntityManagerFactory("employee-pu");

EntityManager em = emf.createEntityManager();
List<Employee> employees = em.createQuery("select e from Employee e where
e.lastName = :lastName").setParameter("lastName", "Smith").getResultList();

for (Employee employee : employees) {
   System.err.println(employee);
   for (PhoneNumber phone : employee.getPhoneNumbers()) {
      System.err.println("\t" + phone);
   }
}

emf.close();
```

To get an object from the Coherence cache with a specific ID (key), use the `em.find(Entity.class, ID)` method. You can also configure a Coherence cache store to query the database to find the object, if the cache does not contain the object with the specified ID.

1.3.6 Handling Grid Read and Grid Entity Failovers

In the Grid Read and Grid Entity configurations, TopLink Grid will attempt to translate JPQL queries into Coherence Filters and execute the query in the grid. However some queries cannot be translated into filters. When TopLink Grid encounters such a query, it automatically fails over to the database to execute the query. In TopLink, you can specify a user-defined translation failure delegate object that will be called if the JPQL-to-filter translation fails. You configure the translation failure delegate by declaring the `eclipselink.coherence.query.translation-failure-delegate` persistence unit property. For example:

```
<property name="eclipselink.coherence.query.translation-failure-delegate"
value="org.example.ExceptionFailoverPolicy"/>
```

A translation failure delegate must implement `oracle.eclipselink.coherence.integrated.querying.TranslationFailureDelegate` class which defines the single method `translationFailed(DatabaseQuery query, Record arguments, Session session)`.

1.3.7 Wrapping and Unwrapping Entity Relationships

When storing entities with relationships in the Coherence cache, TopLink Grid generates a wrapper class that maintains the relationship information. In this way, when the object is read from the Coherence cache (eager or lazy), the relationships can be resolved.

If you read entities directly from the Coherence cache using the Coherence API, the wrappers are not automatically removed. You can configure automatic unwrapping programatically by calling the `setNotEclipseLink(true)` method on the serializer, as shown in Example 1–13. You can also set the system property as `eclipselink.coherence.not-eclipselink` to automatically unwrap an entity.

When configured properly, a cache `get` operation will return the unwrapped entity.

Example 1–13 Unwrapping an Entity

```
WrapperSerializer wrapperSerializer =
(WrapperSerializer)myCache.getCacheService().getSerializer();
wrapperSerializer.setNotEclipseLink(true); // So the Serializer will unwrap an
Entity when clients use a get() call from the cache.
```

1.3.8 Working with Queries

This section includes information on the following topics:

- Querying Objects by ID
- Querying Objects with Criteria
- Using Indexes in Queries
- Limitations on Queries

1.3.8.1 Querying Objects by ID

To get an entity from the Coherence cache with a specific ID (key), use the `em.find(Entity.class, ID)` method. For example, the following code will get the entity with key `8`, from the Coherence `Employee` cache.

```
em.find(Employee.class, 8)
```

If the entity is not found in the Coherence cache, TopLink executes a `SELECT` statement against the database. If a result is found, then the entity is constructed and placed into the Coherence cache. The query's specific behavior will depend on your Coherence cache configuration:

- calling the `find` method with a Grid Cache Configuration performs a `SELECT` statement against the database on a cache miss and then updates the cache.
- calling the `find` method with a Grid Read Configuration or a Grid Entity Configuration performs a `get` operation on the Coherence cache. A cache miss results in a `SELECT` statement against the database by using a `CacheLoader` instance, if it is configured.

1.3.8.2 Querying Objects with Criteria

To retrieve an entity that matches a specific selection criterion, use the `em.createQuery("...")` method. The query's specific behavior will depend on your Coherence cache configuration:

- For the Grid Cache Configuration, the query will always execute a `SELECT` statement against the database. For example, the following code will execute a `SELECT` statement to find employees named John.

  ```
  em.createQuery("select e from Employee e where e.name='John'")
  ```

- For the Grid Read Configuration and Grid Entity Configuration, the query will be executed against the Coherence cache. If the cache does not contain any entities that match the selection criteria, then nothing will be returned. This is an example of why the cache should be warmed before performing the query.
- For the cache store and cache loader, queries are performed only on primary keys

1.3.8.3 Using Indexes in Queries

Indexes allow values (or attributes of those values) and corresponding keys to be correlated within a cache to improve query performance. TopLink Grid allows you to declare indexes with the `@Property` annotation. The `IntegrationProperties` class provides the `INDEXED` property.

In Example 1–14, the `@Property` annotation declares that the `name` attribute is to be indexed. TopLink Grid will define an index for that attribute in the `Publisher` cache.

Example 1–14 Exposing a Coherence Query Index to TopLink Grid

```
import static oracle.eclipselink.coherence.IntegrationProperties.INDEXED;
import oracle.eclipselink.coherence.integrated.config.CoherenceReadCustomizer;

@Customizer(CoherenceReadCustomizer.class)
public class Publisher implements Serializable {
...
    @Property(name=INDEXED, value="true")
    private String name;
 ...
```

With an index in place, you can issue a JPQL query, such as the following, to return all the `Publishers` in the cache with a name beginning with `S`.

```
SELECT Publisher p WHERE p.name like 'S%'
```

Internally, Coherence will process the query by consulting the `name` index to find matches rather than by deserializing and examining every `Publisher` object stored in the grid. By avoiding deserialization, you achieve a significant positive improvement on query execution time, eliminate garbage collection of the temporarily deserialized objects, and reduce CPU usage.

1.3.8.4 Limitations on Queries

The following are limitations on querying Coherence caches:

- Because the Coherence Filter framework is limited to a single cache, JPQL `join` queries cannot be translated to Filters. All `join` queries will execute on the database.
- This release of TopLink Grid does not provide support for JPQL bulk updates and deletions.

1.4 EclipseLink Native ORM Configurations

This section describes the EclipseLink Native Object Relational Mapping (ORM), an extensible object-relational mapping framework. It also describes how to configure amendment methods with Oracle JDeveloper and how to configure EclipseLink Native ORM cache stores and cache loaders.

This section contains the following:

- Understanding EclipseLink Native ORM
- API for EclipseLink Native ORM
- Configuring an Amendment Method
- Configuring the EclipseLink Native ORM Cache Store and Cache Loader

1.4.1 Understanding EclipseLink Native ORM

EclipseLink Native ORM provides an extensible object-relational mapping framework. It provides high-performance object persistence with extended capabilities configured declaratively through XML. These extended capabilities include caching (including support for clustered caching), advanced database-specific capabilities, and performance tuning and management options.

Like *JPA on the Grid* configurations, applications that employ EclipseLink ORM can access Coherence caches. However, unlike *JPA on the Grid* configurations, EclipseLink ORM applications do not use the `@Customizer` annotation to configure how the cache is used. Instead, they typically call an *amendment method* that defines the appropriate cache behavior.

1.4.2 API for EclipseLink Native ORM

The cache store and cache loader API used in EclipseLink Native ORM configurations are shipped in the `toplink-grid.jar` file. Table 1–2 describes the API for EclipseLink Native ORM. These classes can be found in the `oracle.eclipselink.coherence.integrated` package.

Table 1–2 EclipseLink Classes for Native ORM Configurations

Class Name	Description
`EclipseLinkNativeCacheStore(String cacheName, String sessionName)`	Coherence cache store that should be used with native EclipseLink configuration (`sessions.xml`).
`EclipseLinkNativeCacheLoader(String cacheName, String sessionName)`	Coherence cache loader that should be used with native EclipseLink configuration (`sessions.xml`).
`oracle.eclipselink.coherence.integrated.config.CoherenceReadCustomizer`	Enables a Coherence read configuration.
`oracle.eclipselink.coherence.integrated.config.CoherenceReadWriteCustomizer`	Enables a Coherence read/write configuration.
`oracle.eclipselink.coherence.integrated.config.GridCacheCustomizer`	Enables entity instances to be cached in Coherence instead of in the internal EclipseLink shared cache

Note that the second initialization parameter in the signatures, `sessionName`, represents the name of the mapping project that must be listed in the native EclipseLink configuration file, `META-INF/sessions.xml`.

The `EclipseLinkNativeCacheStore` and `EclipseLinkNativeCacheLoader` classes allow applications that use EclipseLink Native ORM to access Coherence caches. Use these classes when Coherence cache behavior has been configured through an amendment method. These classes can be used to configure a cache store or cache loader for each persistent class in the same way as described in "JPA on the Grid Configurations" on page 1-3.

Use the Coherence cache configuration file `coherence-cache-config.xml` to define the cache store caching scheme and to override any default Coherence settings.

The configuration uses the native EclipseLink `sessions.xml` file and the `project.xml` file. The `sessions.xml` file, and all of the deployment XML files (which have user-defined names) listed in it, must be available on the classpath or packaged within a JAR file within the `META-INF` directory.

You must also configure an amendment method to define the appropriate cache behavior. See "Configuring an Amendment Method" for more information.

1.4.3 Configuring an Amendment Method

An *amendment method* is a method that uses the EclipseLink descriptor API to customize the ORM mapping metadata for a class. The method is called when the descriptor is loaded at runtime. The purpose of the amendment methods provided by TopLink Grid is to define how the Coherence cache is going to be used. Amendment methods are the TopLink native ORM alternative to the `@Customizer` annotation; they produce the same configuration.

The TopLink Grid customizer classes in the `toplink-grid.jar` file (`CoherenceReadCustomizer`, `CoherenceReadWriteCustomizer`, and `GridCacheCustomizer`) provide an `afterLoad` amendment method that can be selected to enable the appropriate Coherence cache behavior.

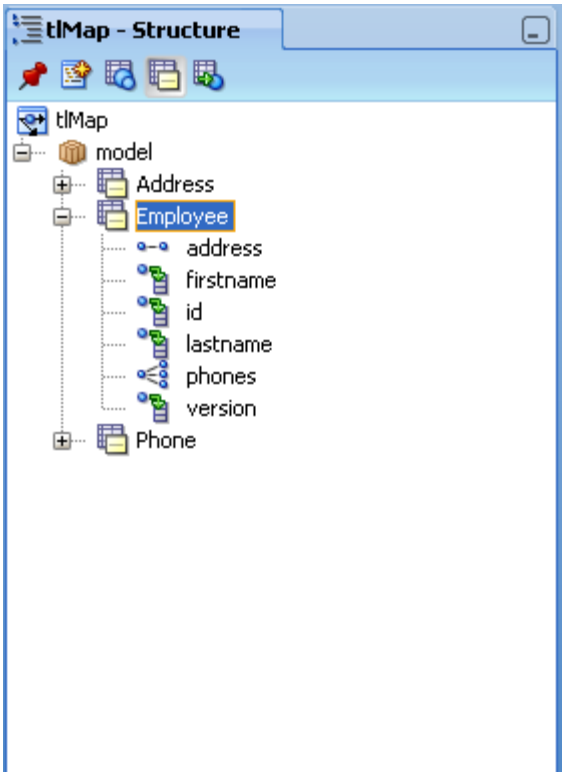
You can select the amendment method using either JDeveloper or EclipseLink Workbench. The following section describes how to configure the amendment method with JDeveloper. A description of EclipseLink Workbench is beyond the scope of this document.

1.4.3.1 Configuring the Amendment Method in JDeveloper

To configure an amendment method:

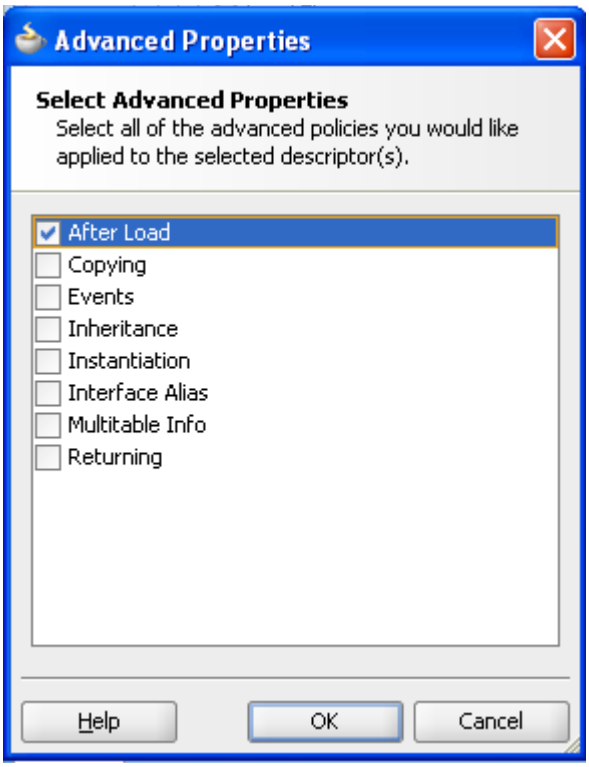
1. In the JDeveloper Structure pane, expand the desired **tlMap** descriptor name.

Figure 1–7 tlMap Descriptors in the JDeveloper Structure Pane



2. Right-click the desired TopLink descriptor element. Select **Advanced Properties** to open the **Advanced Properties** dialog box. Select the **After Loading** check box and click **OK**.

Figure 1–8 Advanced Properties Dialog Box



3. In the **After Load** tab of the **tlMap** configuration window, enter the name of the class containing the `afterLoad` amendment method you want to use for the selected TopLink descriptor. You can also use the class browser to search for the class. Figure 1–9 illustrates the After Load tab of the **tlMap** configuration window.

Figure 1–9 After Load Tab for a TopLink Descriptor

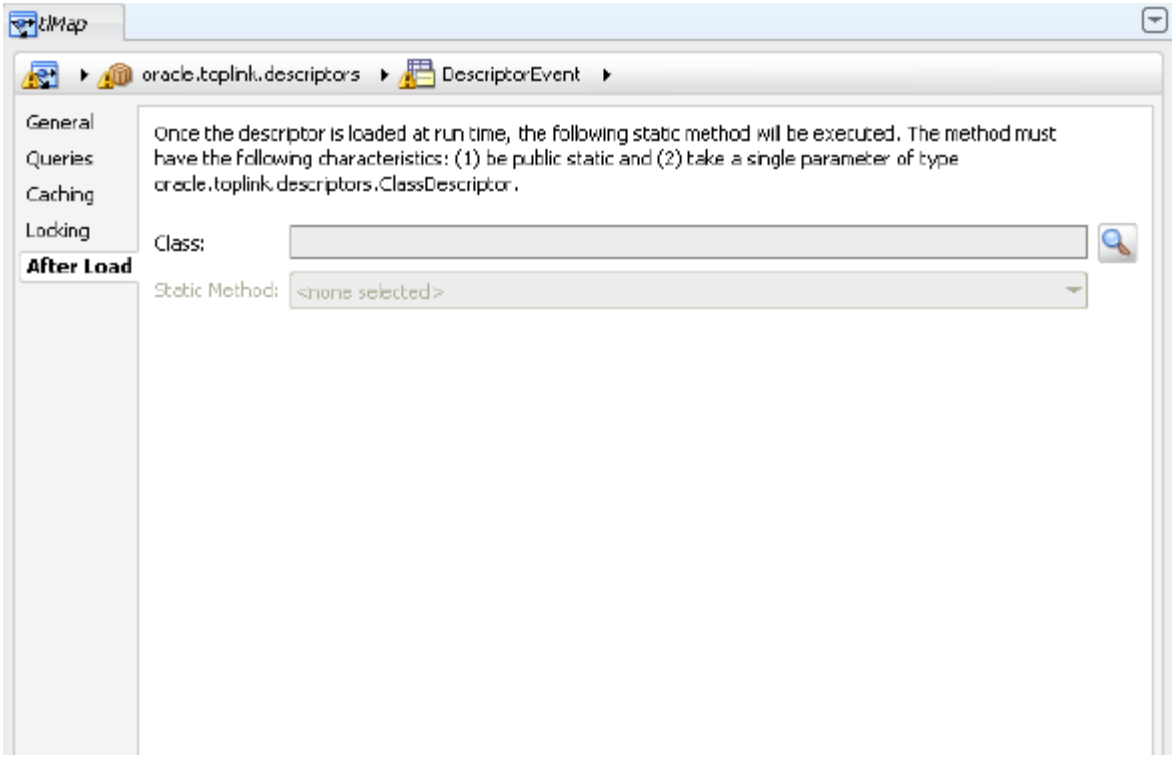
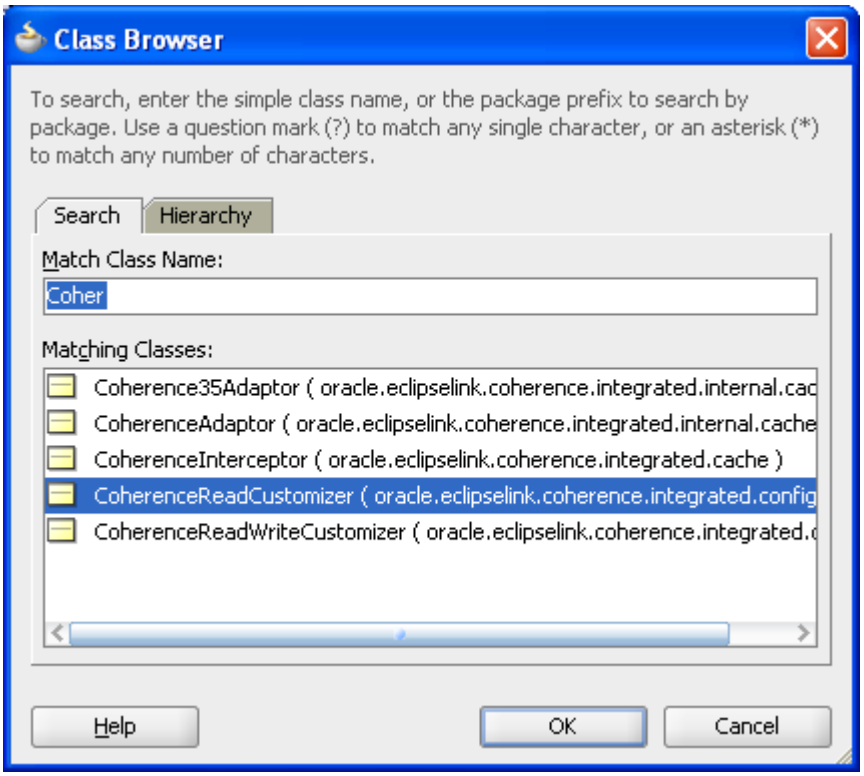


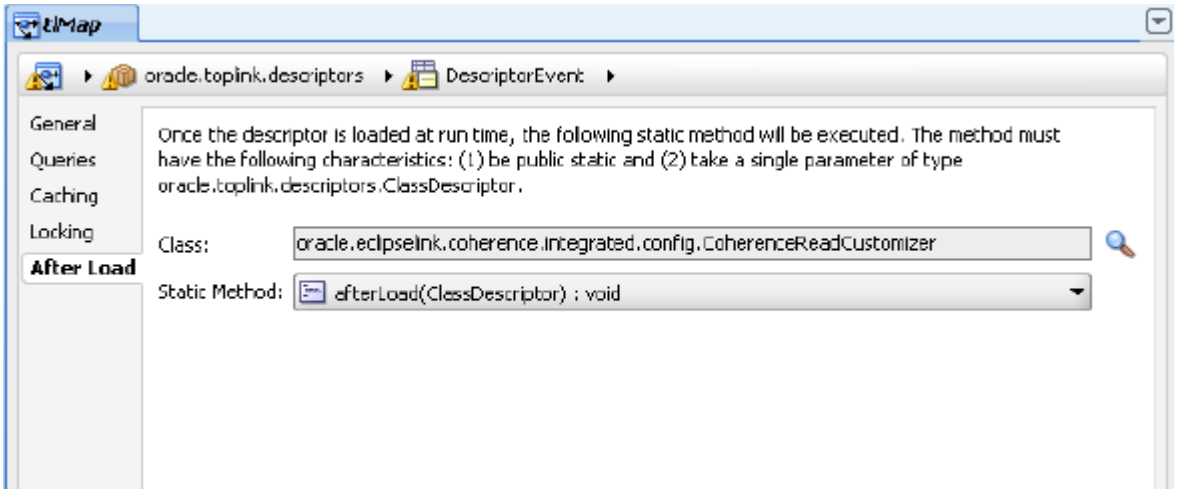
Figure 1–10 illustrates the class browser with the with the `CoherenceReadCustomizer` class selected.

Figure 1–10 Searching for the Class containing the Amendment Method



4. In the **After Load** tab of the **tlMap** configuration window, select the amendment method from the **Static Method** dropdown list. For the Coherence Customizer classes, this will be the `afterLoad` method.

Figure 1–11 Selecting the Amendment Method



1.4.4 Configuring the EclipseLink Native ORM Cache Store and Cache Loader

The `coherence-cache-config.xml` file must specify the cache loader or cache store class and provide parameters for the cache name and session name (that is, *project name*). The following examples illustrate that aside from changing the class name (`EclipseLinkNativeCacheStore` or `EclipseLinkNativeCacheLoader`), you do not have to make any changes to the Coherence cache configuration depending on whether you are using the cache loader or cache store.

Example 1–15 illustrates a configuration in the `coherence-cache-config.xml` file for a cache that can communicate with EclipseLink Native ORM applications. The `class-name` element identifies the `EclipseLinkNativeCacheStore` class as the cache store scheme. The `param-value` elements specify the cache name and the session (project) name that are passed to the class.

Example 1–15 Configuration for an Integrated EclipseLinkNativeCacheStore

```
...
<distributed-scheme>
      <scheme-name>eclipselink-native-distributed-store</scheme-name>
      <service-name>EclipseLinkNative</service-name>
  <serializer>

<class-name>oracle.eclipselink.coherence.integrated.cache.WrapperSerializer</class
-name>
  </serializer>
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme/>
          </internal-cache-scheme>
          <!-- Define the cache scheme -->
          <cachestore-scheme>
            <class-scheme>
```

```
<class-name>oracle.eclipselink.coherence.integrated.EclipseLinkNativeCacheStore</c
lass-name>
              <init-params>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>{cache-name}</param-value>
                </init-param>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>coherence-native-project</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
...
```

Example 1–16 illustrates an integrated `EclipseLinkNativeCacheLoader` instance configuration in the `coherence-cache-config.xml` file. The cache name (`{cache-name}`) and session name (`coherence-native-project`) parameter values are passed to the class.

Example 1–16 Configuration for an Integrated EclipseLinkNativeCacheLoader

```
...
<cachestore-scheme>
   <class-scheme>

<class-name>oracle.eclipselink.coherence.integrated.EclipseLinkNativeCacheLoader</
class-name>
      <init-params>
         <init-param>
            <param-type>java.lang.String</param-type>
            <param-value>{cache-name}</param-value>
         </init-param>
         <init-param>
            <param-type>java.lang.String</param-type>
            <param-value>coherence-native-project</param-value>
         </init-param>
      </init-params>
   </class-scheme>
</cachestore-scheme>
...
```

1.5 Using POF Serialization with TopLink Grid and Coherence

This section describes how to use Portable Object Format (POF) serialization to optimize the performance of applications that use TopLink Grid and Coherence caches.

Serialization is the process of encoding an object into a binary format. It is a critical component when working with Coherence as data must be moved around the network. The Portable Object Format (also referred to as POF) is a language agnostic binary format. POF was designed to be incredibly efficient in both space and time and has become a cornerstone element in working with Coherence. Using POF has many advantages ranging from performance benefits to language independence. It's

recommended that you look closely at POF as your serialization solution when working with Coherence.

This section focuses only on the changes and additions that you need to make to your TopLink application files to make them eligible to participate in POF serialization. For more detailed information on using and configuring POF, see "Using Portable Object Format" in the *Developing Applications with Oracle Coherence*.

This section contains the following:

- Implement a Serialization Routine
- Define a Cache Configuration File
- Define a POF Configuration File

1.5.1 Implement a Serialization Routine

You must implement serialization routines that know how to serialize and deserialize your Entities. You can do this by implementing the `PortableObject` interface or by creating a serializer using the `com.tangosol.io.pof.PofSerializer` interface.

- Implement the `PortableObject` interface in your Entity class files

  The `com.tangosol.io.pof.PortableObject` interface provides classes with the ability to self-serialize and deserialize their state to and from a POF data stream. To use this interface, you must also provide implementations of the required methods `readExternal` and `writeExternal`.

  Example 1–17 illustrates a sample Entity class file that implements the `PortableObject` interface. Note the implementations of the required `readExternal` and `writeExternal` methods.

  Also note that the class includes an `@OneToOne` annotation to define the relationship mapping between the `Trade` object and a `Security` object. TopLink supports all of the relationship mappings defined by the JPA specification: one-to-one, one-to-many, many-to-many, and many-to-many. These relationships can be expressed as annotations.

Example 1–17 Sample Entity Class that Implements PortableObject

```
package oracle.toplinkgrid.codesample.pof.models.trader;

import java.io.IOException;
import java.io.Serializable;

import javax.persistence.Entity;
import javax.persistence.FetchType;
import javax.persistence.GeneratedValue;
import javax.persistence.Id;
import javax.persistence.OneToOne;

import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PofWriter;
import com.tangosol.io.pof.PortableObject;

/**
 * This class will not be stored within Coherence as Trades are not high
 * throughput objects in this model.
 *
 */
@Entity
```

```
public class Trade implements Serializable, PortableObject{
    /**
     *
     */
    private static final long serialVersionUID = -244532585419336780L;
    @Id
    @GeneratedValue
    protected long id;
    @OneToOne(fetch=FetchType.EAGER)
    protected Security security;
    protected int quantity;
    protected double amount;
    public long getId() {
        return id;
    }
    public void setId(long id) {
        this.id = id;
    }
    public Security getSecurity() {
        return security;
    }
    public void setSecurity(Security security) {
        this.security = security;
    }
    public int getQuantity() {
        return quantity;
    }
    public void setQuantity(int quantity) {
        this.quantity = quantity;
    }
    public double getAmount() {
        return amount;
    }
    public void setAmount(double amount) {
        this.amount = amount;
    }
    public void readExternal(PofReader pofreader) throws IOException {
        id = pofreader.readLong(0);
        quantity = pofreader.readInt(2);
        amount = pofreader.readDouble(3);

    }
    public void writeExternal(PofWriter pofwriter) throws IOException {
        pofwriter.writeLong(0, id);
        pofwriter.writeInt(2, quantity);
        pofwriter.writeDouble(3, amount);

    }
}
```

- Create a `POFSerializer` for the Entities

  An alternative to implementing the `PortableObject` interface is to implement the `com.tangosol.io.pof.PofSerializer` interface to create your own serializer and deserializer. This interface provides you with a way to externalize your serialization logic from the Entities you want to serialize. This is particularly useful when you do not want to change the structure of your classes to work with POF and Coherence. The `POFSerializer` interface provides these methods:

  - `public Object deserialize(PofReader in)`

- `public void serialize(PofWriter out, Object o)`

1.5.2 Define a Cache Configuration File

In the cache configuration file, create cache mappings corresponding to the Entities you will be working with. Identify the serializer (such as `com.tangosol.io.pof.ConfigurablePofContext`) and the POF configuration file `pof-config.xml`. Identify the EclipseLink cache store (such as `oracle.eclipselink.coherence.integrated.EclipseLinkJPACacheStore`) in the `<cachestore-scheme>` attribute.

Example 1–18 Sample Cache Configuration File

```
<?xml version="1.0"?>
<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
              xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"

xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
http://xmlns.oracle.com/coherence/coherence-cache-config/1.0/coherence-cache-confi
g.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
        <cache-name>ATTORNEY_JPA_CACHE</cache-name>
        <scheme-name>eclipselink-jpa-distributed</scheme-name>
    </cache-mapping>
    <cache-mapping>
        <cache-name>CONTACT_JPA_CACHE</cache-name>
        <scheme-name>eclipselink-jpa-distributed-load</scheme-name>
    </cache-mapping>
...
additional cache mappings
...
<caching-schemes>
    <distributed-scheme>
      <scheme-name>eclipselink-jpa-distributed-load</scheme-name>
      <service-name>EclipseLinkJPA</service-name>

    <serializer>
      <instance>
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
      <init-params>
        <init-param>
          <param-type>String</param-type>
          <param-value>trader-pof-config.xml</param-value>
        </init-param>
      </init-params>
      </instance>
    </serializer>
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme/>
          </internal-cache-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
    <distributed-scheme>
      <scheme-name>eclipselink-jpa-distributed</scheme-name>
      <service-name>EclipseLinkJPA</service-name>
```

```
    <serializer>
      <instance>
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
      <init-params>
        <init-param>
          <param-type>String</param-type>
          <param-value>trader-pof-config.xml</param-value>
        </init-param>
      </init-params>
      </instance>
    </serializer>

      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme/>
          </internal-cache-scheme>
          <!-- Define the cache scheme -->
          <cachestore-scheme>
            <class-scheme>

<class-name>oracle.eclipselink.coherence.integrated.EclipseLinkJPACacheStore</clas
s-name>
              <init-params>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>{cache-name}</param-value>
                </init-param>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>coherence-pu</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

1.5.3 Define a POF Configuration File

Provide a file that identifies the Entity classes that will participate in POF serialization. Coherence provides a POF configuration file which is named `pof-config.xml` by default. Use the file to assign `type-ids` of TopLink classes to the Entity classes.

TopLink Grid simplifies the assignment of `type-ids` to TopLink-Grid required classes. If the `allow-interfaces` element is set to `true` in the POF configuration file, then only one `type-id` entry is needed for TopLink-Grid classes.

- `oracle.eclipselink.coherence.integrated.cache.TopLinkGridPortableObject`—the TopLink Grid analog of the `PortableObject` interface. TopLink Grid classes that implement the `TopLinkGridPortableObject` interface can be POF serialized by the `TopLinkGridSerializer` class. This allows you to register a single class for all implementors of this interface when the `allow-interfaces` POF configuration element is set to `true`.

- `oracle.eclipselink.coherence.integrated.cache.TopLinkGridSerializer`—the associated serializer for all implementors of the `TopLinkGridPortableObject` interface. This allows you to register a single class for all implementors of this interface in your POF configuration XML file when the `allow-interfaces` POF configuration element is set to true.

Example 1–19 illustrates the assignment of the `TopLinkGridPortableObject` and `TopLinkGridSerializer` serializer class to the `Attorney` Entity.

Example 1–19 Simplified POF Configuration File

```
<?xml version="1.0"?>
<pof-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://xmlns.oracle.com/coherence/coherence-pof-config"
    xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-pof-config
http://xmlns.oracle.com/coherence/coherence-pof-config/1.0/coherence-pof-config.xs
d">
  <user-type-list>
    <!-- include all "standard" Coherence POF user types -->
    <include>coherence-pof-config.xml</include>
     <user-type>
       <type-id>1163</type-id>

<class-name>oracle.toplinkgrid.codesample.pof.models.trader.Attorney</class-name>
     </user-type>
   ...
   additional type IDs for Entity classes
   ...
    <user-type>
       <type-id>1130</type-id>

<class-name>oracle.eclipselink.coherence.integrated.cache.TopLinkGridPortableO
bject</class-name>
       <serializer>

<class-name>oracle.eclipselink.coherence.integrated.cache.TopLinkGridSerialize
r</class-name>
       </serializer>
     </user-type>
...

   <allow-interfaces>true</allow-interfaces>
 </pof-config>
```

> **Note:** the `allow-subclasses` element is not required for a TopLink Grid POF configuration.

If you cannot set `allow-interfaces` to `true`, then you must define individual `type-id` entries for the following classes:

- `oracle.eclipselink.coherence.integrated.internal.cache.ElementCollectionUpdateProcessor`—Entry processor used by TopLink Grid to update an `ElementCollection` object within the cache.
- `oracle.eclipselink.coherence.integrated.internal.cache.RelationshipUpdateProcessor`—An internal file, used to update lazy-loaded relationship data into the grid.

- `oracle.eclipselink.coherence.integrated.internal.cache.VersionPutProcessor`—An internal file, used for optimistic lock-aware updates to the grid.
- `oracle.eclipselink.coherence.integrated.internal.cache.VersionRemoveProcessor`—An internal file, used for optimistic lock-aware removals from the grid.
- `oracle.eclipselink.coherence.integrated.internal.cache.SerializableWrapper` —A generic wrapper class for non POF serialization. It provides for serialization to a node which may not have the correct dynamic wrapper defined which would otherwise result in an exception.
- `oracle.eclipselink.coherence.integrated.internal.cache.LockVersionExtractor`—Used during conditional puts of Optimistically Locked objects. This class is used to extract the version value from the object.
- `oracle.eclipselink.coherence.integrated.internal.querying.FilterExtractor`—used by the filters to extract values from the objects stored in the caches. It supports both attribute access and method access.
- `oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkFilterFactory$SubClassOf`—An inner class. This is a `Filter` extension that filters on the type of Entity, eliminating superclasses from polymorphic queries. A `type-id` is needed for this class needed only if you are using this operation.
- `oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkFilterFactory$$IsNull`—An inner class. `IsNull` is equivalent to the Coherence `IsNullFilter` except that it provides support for a `ValueExtractor` instead of an explicit method name. A `type-id` is needed for this class needed only if you are using this operation.
- `oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkFilterFactory$$IsNotNull`—An inner class. `IsNotNull` is equivalent to the Coherence `IsNotNullFilter` except that it provides support for a `ValueExtractor` instead of an explicit method name. A `type-id` is needed for this class needed only if you are using this operation.

Example 1–20 illustrates a sample POF configuration file that includes definitions for the TopLink Grid support files.

Example 1–20 Sample POF Configuration File with Definitions for TopLink Classes

```
...
additional type IDs for Entity classes
...
  <user-type>
    <type-id>1144</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.ElementCollectionUpdateProcessor</class-name>
  </user-type>
  <user-type>
    <type-id>1143</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.querying.FilterExtractor</class-name>
  </user-type>
  <user-type>
    <type-id>1142</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.LockVersionExtractor</class-name>
```

```
      </user-type>
      <user-type>
        <type-id>1141</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.VersionPutProce
ssor</class-name>
      </user-type>
      <user-type>
        <type-id>1140</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.VersionRemovePr
ocessor</class-name>
      </user-type>
      <user-type>
        <type-id>1139</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.RelationshipUpd
ateProcessor</class-name>
      </user-type>
      <user-type>
        <type-id>1138</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.cache.SerializableWra
pper</class-name>
      </user-type>
      <user-type>
        <type-id>1137</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkF
ilterFactory$SubClassOf</class-name>
      </user-type>
      <user-type>
        <type-id>1136</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkF
ilterFactory$$IsNull</class-name>
      </user-type>
      <user-type>
        <type-id>1135</type-id>

<class-name>oracle.eclipselink.coherence.integrated.internal.querying.EclipseLinkF
ilterFactory$$IsNotNull</class-name>
      </user-type>
    </user-type-list>

    <allow-interfaces>false</allow-interfaces>
 </pof-config>
```

1.6 Best Practices

This section contains best practice recommendations on how to use TopLink Grid with byte code weaving, lazy loading, near caches, and cache configurations.

This section contains the following:

- Changing Compiled Java Classes with Byte Code Weaving
- Deferring Database Queries with Lazy Loading
- Defining Near Caches for Applications Using TopLink Grid

- Ensuring Prefixed Cache Names Use Wildcard in Cache Configuration
- Overriding the Default Cache Name

1.6.1 Changing Compiled Java Classes with Byte Code Weaving

Byte code weaving is a technique for changing the byte code of compiled Java classes. You can configure byte code weaving to enable a number of EclipseLink JPA performance optimizations, including support for the lazy loading of one-to-one and many-to-one relationships, attribute-level change tracking, and fetch groups.

Weaving can be performed either dynamically when entity classes are loaded, or statically as part of the build process. Static byte code weaving can be incorporated into an Ant build using the `weaver` task provided by EclipseLink.

Dynamic byte code weaving is automatically enabled in Java EE 5-compliant application servers such as Oracle WebLogic. However, in Java SE it must be explicitly enabled by using the JRE 1.5 `javaagent` JVM command line argument. See "Using Weaving" in *Solutions Guide for Oracle TopLink*

To enable byte code weaving in a Coherence cache server, the Java VM should be invoked with `-javaagent:<PATH>\eclipselink.jar`. Java SE client applications should be run with the `-javaagent` argument.

See "Using Weaving" in *Solutions Guide for Oracle TopLink* for more information on configuring and disabling static and dynamic byte code weaving.

1.6.2 Deferring Database Queries with Lazy Loading

Lazy loading is a technique used to defer the querying of objects from the database until they are required. This can reduce the amount of data loaded by an application and improve throughput. A TopLink Grid JPA or native ORM application should lazily load all relationships. Lazy loading is the default for one-to-many and many-to-many relationships in JPA, but is eager for one-to-one and many-to-one relationships. You must explicitly select lazy loading on these relationship types. For example, you can specify lazy loading as an attribute for many of the relationship annotations:

```
...
@ManyToOne(fetch=FetchType.LAZY)
private Publisher parent
 ...
```

For maximum efficiency, lazy loading should be specified for all one-to-one and many-to-one entity relationships that TopLink Grid stores in the Coherence cache. Lazy loading is implemented through byte code weaving in EclipseLink and must be enabled explicitly if not running in a Java EE 5-compliant application server. For more information, see "Changing Compiled Java Classes with Byte Code Weaving" on page 1-34.

1.6.3 Defining Near Caches for Applications Using TopLink Grid

Near cache is one of the standard cache configurations offered by Oracle Coherence. The use of near caches can improve throughput by avoiding network access when an object is retrieved repeatedly. For example, in an environment where users are pinned to a particular Web server, near caching may improve performance.

The near cache is a hybrid cache consisting of a front cache, which is of limited size and offers fast data access, and a larger back cache, which can be scalable, can load on demand, and provide failover protection.

For applications using TopLink Grid, you configure the near cache in the same way as any other application using Oracle Coherence. See "Near Cache" and "Defining Near Cache Schemes" in the *Developing Applications with Oracle Coherence* for more information on near caches.

Note: Near caches are used only on a Coherence cache `get` operation, but not when a `Filter` operation is executed. This is because the `Filter` operation is sent to each member, and they return results directly to the caller. In this case, a near cache will not add value.

This can also become an issue if you are using JPQL queries. In the TopLink Grid Grid Read or Grid Entity configurations, JPQL queries are mapped to `Filter` operations. In the case of either of these configurations, if you execute TopLink JPQL queries, you will not see any cache hits.

1.6.4 Ensuring Prefixed Cache Names Use Wildcard in Cache Configuration

When using TopLink Grid with applications that use Coherence caches and Coherence*Web, you might want to apply different configuration properties to the TopLink Grid caches for entities and the Coherence*Web caches. The most efficient way to specify and configure a set of caches is to use a wildcard character ("*"). However, this will match both sets of caches. To separate the Coherence*Web caches from entity caches, you must create a wildcard pattern that will match entities only. One way to do this is to prepend a unique prefix to the entity cache names.

The following steps describe how to create and use a custom session customizer to prepend a specified prefix to TopLink Grid-enabled classes.

1. Create a session customizer class that will prepend TopLink-enabled classes with a specified prefix.

   Example 1–21 illustrates a custom session customizer class, `CacheNamePrefixCustomizer`, which implements the EclipseLink `SessionCustomizer` class. The class defines a `PREFIX_PROPERTY` `myapp.cache-prefix` that represents the prefix that will be added to the TopLink-enabled classes. The value of the property can be either specified in the `persistence.xml` file (described in Step 2) or passed in an optional property map to the `Persistence.createEntityManagerFactory` method.

Example 1–21 Session Customizer to Prepend

```
import java.util.Collection;

import oracle.eclipselink.coherence.IntegrationProperties;
import oracle.eclipselink.coherence.integrated.cache.CoherenceInterceptor;
import
oracle.eclipselink.coherence.integrated.internal.cache.CoherenceCacheHelper;
import org.eclipse.persistence.config.SessionCustomizer;
import org.eclipse.persistence.descriptors.ClassDescriptor;
import org.eclipse.persistence.sessions.Session;

public class CacheNamePrefixCustomizer implements SessionCustomizer {
```

```
   private static final String PREFIX_PROPERTY = "myapp.cache-prefix";

   public void customize(Session session) throws Exception {
      // Look up custom persistence unit cache prefix property
      String prefix = (String) session.getProperty(PREFIX_PROPERTY);
      if (prefix == null) {
         throw new RuntimeException(
            "Cache name prefix customizer configured but prefix property '" +
            PREFIX_PROPERTY + "' not specified");
      }
      // Iterate over all entity descriptors
      Collection<ClassDescriptor> descriptors = session.getDescriptors().values();
      for (ClassDescriptor classDescriptor : descriptors) {
         // If entity is TopLink Grid-enabled, prepend cache name with prefix
         if
(CoherenceInterceptor.class.equals(classDescriptor.getCacheInterceptorClass())) {
            String cacheName = CoherenceCacheHelper.getCacheName(classDescriptor);
            classDescriptor.setProperty(IntegrationProperties.COHERENCE_CACHE_
NAME, prefix + cacheName);
         }
      }
   }
}
```

2. Edit the `persistence.xml` file to declare a value for the prefix property.

   In the following example, `MyApp_` is defined as the value of the prefix property `myapp.cache-prefix` in the `persistence.xml` file. The `myapp.cache-prefix` prefix property is defined in the custom session customizer file.

   ```
   <property name="myapp.cache-prefix" value="MyApp_"/>
   ```

   See http://www.eclipse.org/eclipselink/ for more information on the EclipseLink `SessionCustomizer` class.

3. Edit the `persistence.xml` file to add the name of the custom session customizer class as the value of the `eclipselink.session.customizer` context property.

   ```
   <property name="eclipselink.session.customizer"
   value="CacheNamePrefixCustomizer"/>
   ```

4. Edit the `coherence-cache-config.xml` file to add the name of the prefix with a wildcard character to the cache mapping.

   ```
   <cache-mapping>
       <cache-name>MyApp_*</cache-name>
       <scheme-name>eclipselink-distributed-readonly</scheme-name>
   </cache-mapping>
   ```

1.6.5 Overriding the Default Cache Name

There may be situations where you want to override the default name given to an entity cache. In TopLink Grid, entity cache names default to the entity name. The following list describes how the name of the cache can be determined, and how you can change it explicitly:

Cache Name—the cache name can be set either by default, or set explicitly:

- Default: cache name defaults to entity name. The entity name, in turn can be set either by default, or set explicitly:

  - Default: Entity name defaults to class short name.
  - Explicit: Entity name can be set explicitly by using the `name` property of the `@Entity` annotation.
- Explicit: the cache name can be set explicitly by using the `@Property` annotation.

For example, the following code fragment illustrates the `Employee` class. By default, the entity cache name would be `Employee`. However, you can force the name of the `Employee` entity cache to be `EMP_CACHE` by using the `@Property` annotation.

```
import static oracle.eclipselink.coherence.IntegrationProperties.COHERENCE_CACHE_
NAME;
import org.eclipse.persistence.annotations.Property;

    ...
    @Entity(name="Emp")
    @Property(name=COHERENCE_CACHE_NAME, value="EMP_CACHE")
    public class Employee implements Serializable {
...
```

Notice that the code explicitly specifies the entity name as `Emp`. If the `name="Emp"` value were not present, then the entity name would have defaulted to the short class name `Employee`.

2

Integrating JPA Using the Coherence API

This chapter describes how to use the Coherence API with caches backed by TopLink Grid to access relational data. It also describes how to use the native, entity-based Coherence implementations of the cache store and cache loader to access relational data. These implementations use JPA to load and store objects to the database.

> **Note:** Only resource-local and bootstrapped entity managers can be used with Coherence API and JPA. Container-managed entity managers and those that use Java Transaction Architecture (JTA) transactions are not currently supported.

This chapter contains the following sections:

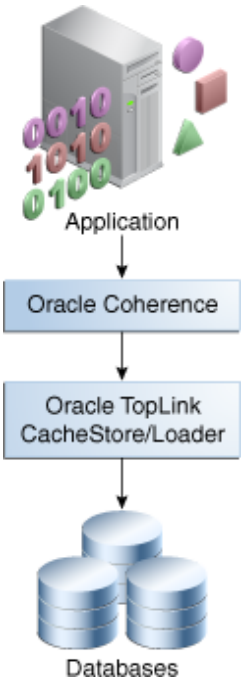
2.1 Using TopLink Grid with Coherence Client Applications

This section describes how to use the Coherence API with caches backed by TopLink Grid to access relational data. Access to the relational data is provided with JPA cache loader and cache store interfaces which have been optimized for EclipseLink JPA.

In this traditional Coherence approach, TopLink Grid provides the `CacheLoader` and `CacheStore` implementations in the `oracle.eclipselink.coherence.standalone` package that are optimized for EclipseLink JPA.

Figure 2–1 illustrates the relationship between the client application (which employs Coherence APIs), the Coherence cache, TopLink Grid, and the database.

Figure 2–1 Coherence with TopLink Grid Approach



2.1.1 API for Coherence with TopLink Grid Configurations

TopLink Grid uses the standard JPA run-time configuration file `persistence.xml` and the JPA mapping file `orm.xml`. The Coherence cache configuration file `coherence-cache-config.xml` must be specified to override the default Coherence settings and to define the cache store caching scheme.

The TopLink Grid cache store and cache loader implementations are shipped in the `toplink-grid.jar` file. The JAR file in installed with the Coherence product in the `...\oracle_common\modules\oracle.toplink_12.1.3` folder.

The TopLink Grid cache store and cache loader classes which are optimized for EclipseLink JPA and designed for use by Coherence applications, are in the `oracle.eclispelink.coherence.standalone` package. Table 2–1 describes these classes.

Table 2–1 TopLink Grid Classes to build Coherence with TopLink Grid Applications

Class Name	Description
`EclipseLinkJPACacheLoader`	Provides JPA-aware versions of the Coherence `CacheLoader` class.
`EclipseLinkJPACacheStore`	Provides JPA-aware versions of the Coherence `CacheStore` class.

2.1.2 Sample Cache Configuration File for Coherence with TopLink Grid

In the cache configuration file (`coherence-cache-config.xml`), define the cache as illustrated in Example 2–1. For TopLink Grid, you have to define only two parameters:

- The *name of the cache for the entity being stored*. Unless explicitly overridden in JPA this is the entity name that, by default, is the unqualified name of the entity class. In Example 2–1, the name of the cache is `Employee`. You can use the built-in Coherence macro `{cache-name}` to supply the name of the cache that is constructing and using the cache store.

- The *name of the persistence unit containing the entity being stored*. In Example 2–1, `employee-pu` is a persistence unit defined in the `META-INF/persistence.xml` file that includes the `Employee` entity.

  To define more entity caches, add additional `<cache-mapping>` elements.

Example 2–1 Configuring the Cache for Coherence with TopLink Grid

```
<cache-config>
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>Employee</cache-name>
      <scheme-name>distributed-eclipselink</scheme-name>
    </caching-scheme-mapping>
  </caching-scheme-mapping>
  <caching-schemes>
    <distributed-scheme>
      <scheme-name>distributed-eclipselink</scheme-name>
      <service-name>EclipseLinkJPA</service-name>
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme />
          </internal-cache-scheme>
          <!--
            Define the cache scheme.
          -->
          <cachestore-scheme>
            <class-scheme>
            <!--
              Because the client code is using Coherence API, use the "standalone"
version of the cache loader.
            -->
              <class-name>oracle.eclipselink.coherence.standalone.EclipseLinkJPACa
cheStore</class-name>
              <init-params>

           <!-- This parameter is the name of the cache containing the entity. -->
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>{cache-name}</param-value>
                </init-param>

            <!-- This parameter is the persistence unit name. -->
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>employee-pu</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

2.1.3 Sample Project for Using Coherence with TopLink Grid

"Using JPA with Coherence" in the *Tutorial for Oracle Coherence* provides a sample project that uses the TopLink Grid cache store and cache loader classes which are optimized for EclipseLink JPA and designed for use by Coherence applications. These classes can be found in the `oracle.eclispelink.coherence.standalone` package.

The project uses the Oracle Express Database and the Eclipse IDE to configure a project for JPA, create the JPA persistence unit and entities, edit the persistence.xml file, create a cache configuration file for JPA, automatically generate JPA objects for a database table, and create a class to interact with the data objects.

2.2 Using Third Party JPA Providers

Oracle Coherence provides its own implementations of the `CacheLoader` and `CacheStore` classes which can be used with JPA. The `JpaCacheLoader` and `JpaCacheStore` classes do not have to use EclipseLink JPA—they can use any JPA implementation to load and store entities to and from a data store. The entities must be mapped to the data store and a JPA persistence unit configuration must exist. A JPA persistence unit is defined as a logical grouping of user-defined entity classes that can be persisted and their settings.

Coherence also provides a default cache configuration file named `coherence-cache-config.xml`. The JPA run-time configuration file, `persistence.xml`, and the default JPA Object-Relational mapping file, `orm.xml`, are typically provided by the JPA implementation.

2.2.1 API for Native Coherence JPA CacheStore and CacheLoader

The `JpaCacheLoader` and `JpaCacheStore` classes can be found in the `coherence-jpa.jar` file, which is installed in the `...\coherence\lib` folder in the Coherence installation. The `CacheLoader` and `CacheStore` interfaces can be found in the `coherence.jar` file, which is also installed in the `...\coherence\lib` folder.

Table 2–2 describes the default JPA implementations provided by Coherence.

Table 2–2 JPA-Related CacheStore and CacheLoader API Included with Coherence

Class Name	Description
`com.tangosol.net.cache.CacheLoader`	A JCache cache loader.
`com.tangosol.net.cache.CacheStore`	A JCache cache store. The `CacheStore` interface extends `CacheLoader`.
`com.tangosol.coherence.jpa.JpaCacheLoader`	The JPA implementation of the Coherence `CacheLoader` interface. Use this class as a load-only implementation. It can use any JPA implementation to load entities from a data store. The entities must be mapped to the data store and a JPA persistence unit configuration must exist. Use the `JpaCacheStore` class for a full load and store implementation.
`com.tangosol.coherence.jpa.JpaCacheStore`	The JPA implementation of the Coherence `CacheStore` interface. Use this class as a full load and store implementation. It can use any JPA implementation to load and store entities to and from a data store. The entities must be mapped to the data store and a JPA persistence unit configuration must exist. **Note:** The persistence unit is assumed to be set to use `RESOURCE_LOCAL` transactions.

2.2.2 Steps to Use a Third Party JPA Provider and Native Coherence JPA API

To use a third party JPA provider and the native Coherence JPA API to load and store objects to the database:

1. Obtain a JPA Provider Implementation. The provider implementation allows you to map, query, and store Java objects to a database.
2. Configure a Coherence JPA Cache Store. The JPA cache store configuration maps database entities to Java objects.

2.2.2.1 Obtain a JPA Provider Implementation

A JPA provider allows you to work directly with Java objects, rather then with SQL statements. You can map, store, update and retrieve data, and the provider will perform the translation between database entities and Java objects.

The Coherence JPA cache store and cache loader work with any JPA-compliant implementation. Oracle recommends using EclipseLink JPA, the reference implementation for the JPA 2.0 specification. Oracle TopLink and TopLink Grid for Coherence integration include EclipseLink as their JPA implementations.

The TopLink Grid and EclipseLink JAR files (`toplink-grid.jar` and `eclipselink.jar`) are included in the Coherence installation and can be found in the `...\oracle_common\modules\oracle.toplink_12.1.3` folder.

2.2.2.2 Configure a Coherence JPA Cache Store

JPA is a standard API for mapping, querying, and storing Java objects to a database. The characteristics of the different JPA implementations can differ, however, when it comes to caching, threading, and overall performance. EclipseLink provides a high-performance JPA implementation with many advanced features.

Coherence provides a default entity-based cache store implementation, `JpaCacheStore`, and a corresponding cache loader, `JpaCacheLoader`. You can find additional information in the Javadoc for these classes.

To configure a Coherence `JpaCacheStore`:

1. Map the Persistent Classes
2. Configure JPA
3. Configure a Coherence Cache for JPA
4. Configure the Persistence Unit

2.2.2.2.1 Map the Persistent Classes Map the entity classes to the database. This will allow you to load and store objects through the JPA cache store. JPA mappings are standard, and can be specified in the same way for all JPA providers.

You can map entities either by annotating the entity classes or by adding an `orm.xml` or other XML mapping file. See the JPA provider documentation for more information about how to map JPA entities.

2.2.2.2.2 Configure JPA Edit the `persistence.xml` file to create the JPA configuration. This file contains the properties that dictate run-time operation.

Set the transaction type to `RESOURCE_LOCAL` and provide the required JDBC properties for your JPA provider (such as `driver`, `url`, `user`, and `password`) with the appropriate values for connecting and logging into your database. List the classes that are mapped using JPA annotations in `<class>` elements. Example 2–2 illustrates a sample `persistence.xml` file with the typical properties that you can set.

Example 2–2 Sample persistence.xml File for JPA

```
<persistence xmlns:xsi="http://www.w3.org/2001/XMLSchemainstance" version="1.0"
xmlns="http://java.sun.com/xml/ns/persistence">
<persistence-unit name="EmpUnit" transaction-type="RESOURCE_LOCAL">
    <provider>
        org.eclipse.persistence.jpa.PersistenceProvider
    </provider>
    <class>com.oracle.coherence.handson.Employee</class>
    <properties>
        <property name="eclipselink.jdbc.driver"
value="oracle.jdbc.OracleDriver"/>
        <property name="eclipselink.jdbc.url"
value="jdbc:oracle:thin:@localhost:1521:XE"/>
        <property name="eclipselink.jdbc.user" value="scott"/>
        <property name="eclipselink.jdbc.password" value="tiger"/>
    </properties>
</persistence-unit>
</persistence>
```

2.2.2.2.3 Configure a Coherence Cache for JPA Create a `coherence-cache-config.xml` file to override the default Coherence settings and define the `JpaCacheStore` caching scheme. The caching scheme should include a `<cachestore-scheme>` element that lists the `JpaCacheStore` class and includes the following parameters.

- The *entity name of the entity being stored*. Unless it is explicitly overridden in JPA, this is the unqualified name of the entity class. Example 2–3 uses the built-in Coherence macro `{cache-name}` that translates to the name of the cache that is constructing and using the cache store. This works because a separate cache must be used for each type of persistent entity and Coherence ensures that the name of each cache is set to the name of the entity that is being stored in it.
- The *fully qualified name of the entity class*. If the classes are all in the same package and use the default JPA entity names, then you can again use the `{cache-name}` macro for the part that is variable across the different entity types. In this way, the same caching scheme can be used for all of the entities that are cached within the same persistence unit.
- The *persistence unit name*. This should be the same as the name specified in the `persistence.xml` file.

The various named caches are then directed to use the JPA caching scheme. Example 2–3 is a sample `coherence-cache-config.xml` file that defines a `NamedCache` class named `Employee` that caches instances of the `Employee` class. To define additional entity caches for more classes, add more `<cache-mapping>` elements to the file.

Example 2–3 Assigning Named Caches to a JPA Caching Scheme

```
<cache-config>
  <caching-scheme-mapping>
    <cache-mapping>
      <!-- Set the name of the cache to be the entity name.  -->
      <cache-name>Employee</cache-name>
      <!-- Configure this cache to use the following defined scheme. -->
      <scheme-name>jpa-distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>
  <caching-schemes>
    <distributed-scheme>
      <scheme-name>jpa-distributed</scheme-name>
      <service-name>JpaDistributedCache</service-name>
```

```
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme/>
          </internal-cache-scheme>
          <!- Define the cache scheme. -->
          <cachestore-scheme>
            <class-scheme>
              <class-name>
                com.tangosol.coherence.jpa.JpaCacheStore
              </class-name>
              <init-params>

                <!-- This param is the entity name. -->
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>{cache-name}</param-value>
                </init-param>

                <!-- This param is the fully qualified entity class. -->
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>com.acme.{cache-name}</param-value>
                </init-param>

                <!-- This param should match the value of the -->
                <!-- persistence unit name in persistence.xml. -->
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>EmpUnit</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

2.2.2.2.4 Configure the Persistence Unit When using the `JpaCacheStore` class, configure the persistence unit to ensure that no changes are made to entities when they are inserted or updated. Any changes made to entities by the JPA provider are not reflected in the Coherence cache. This means that the entity in the cache will not match the database contents. In particular, entities should not use ID generation, for example, `@GeneratedValue`, to obtain an ID. IDs should be assigned in application code before an object is put into Coherence. The ID is typically the key under which the entity is stored in Coherence.

Optimistic locking (for example, `@Version`) should not be used because it might lead to the failure of a database transaction commit transaction. See *Caching Data Sources* and *Sample CacheStore* in *Developing Applications with Oracle Coherence* for more information about how a cache store works, and how to set up your database schema.

When using either the `JpaCacheStore` or `JpaCacheLoader` class, L2 ("shared") caching should be disabled in your persistence unit. See the documentation for your provider. In Oracle TopLink, this can be specified on an individual entity with `@Cache(shared=false)` or as the default in the `persistence.xml` file with the following property:

```
<property name="eclipselink.cache.shared.default" value="false"/>
```

When using EclipseLink with TopLink Grid, the TopLink Grid implementations will automatically disable L2 caching, optimistic lock checking, and versioning. Essentially, TopLink Grid implementations understand the cache store context in which the persistence unit is being deployed and adjust the configuration accordingly.

3

Integrating Coherence Applications with Coherence*Web

This chapter provides more detailed information on how to configure applications running under Coherence*Web so that they can share Coherence cache and session information.

You can find more information on Coherence*Web and how to enable it for applications running on a variety of application servers in *Administering HTTP Session Management with Oracle Coherence*Web*.

3.1 Merging Coherence Cache and Session Information

In Coherence, the cache configuration deployment descriptor provides detailed information about the various caches that can be used by applications within a cluster. Coherence provides a sample cache configuration deployment descriptor, named `coherence-cache-config.xml`, in the root of the `coherence.jar` library.

In Coherence*Web, the session cache configuration deployment descriptor provides detailed information about the caches, services, and attributes used by HTTP session management. Coherence*Web provides a sample session cache configuration deployment descriptor, named `default-session-cache-config.xml`, in the `coherence-web.jar` library. You can use this file as the basis for any custom session cache configuration file you may need to write.

At run time, Coherence uses the first `coherence-cache-config.xml` file that is found in the classpath, and it must precede the `coherence.jar` library; otherwise, the sample `coherence-cache-config.xml` file in the `coherence.jar` file is used.

In the case of Coherence*Web, it first looks for a custom session cache configuration XML file in the classloader that was used to start Coherence*Web. If no custom session cache configuration XML resource is found, then it will use the `default-session-cache-config.xml` file packaged in `coherence-web.jar`.

If your Coherence applications are using Coherence*Web for HTTP session management, the start-up script for the application server and the Coherence cache servers must reference the session cache configuration file—not the cache configuration file. In this case, you must complete these steps:

1. Extract the session cache configuration file from the `coherence-web.jar` library.
2. Merge the cache information from the Coherence cache configuration file into the session cache configuration file.

Note that in the cache scheme mappings in this file, you cannot use wildcards to specify cache names. You must provide, at least, a common prefix for application cache names.

3. Ensure that modified session cache configuration file is used by the Coherence members in the cluster.

   The cache and session configuration must be consistent across WebLogic Servers and Coherence cache servers.

4

Integrating Hibernate and Coherence

This chapter describes where you can find information on integrating Oracle Coherence with Hibernate, an object-relational mapping tool for Java environments. The functionality in Oracle Coherence and Hibernate can be combined such that Hibernate can act as the Coherence cache store or Coherence can act as the Hibernate L2 cache.

You can find information on integrating Coherence with Hibernate in the Coherence Community projects at the following URL:

https://java.net/projects/cohhib

5

Integrating Spring with Coherence

This chapter describes where you can find information on integrating Oracle Coherence with Spring, a platform for building and running Java-based enterprise applications. You can find information on how to configure the Oracle Coherence cache to consume objects provided by the Spring platform in Coherence Community projects. Coherence Community projects provide example implementations for commonly used design patterns based on Oracle Coherence. See the following URL:

https://java.net/projects/cohspr/

6

Enabling ECID in Coherence Logs

This chapter describes how Oracle Coherence can use the Execution Context ID (ECID). This globally unique ID can be attached to requests between Oracle components. The ECID allows you to track log messages pertaining to the same request when multiple requests are processed in parallel.

Coherence logs will include ECID only if the client already has an activated ECID prior to calling Coherence operations. The ECID may be passed from another component or obtained in the client code. To activate the context, use the `get` and `activate` methods on the `oracle.dms.context.ExecutionContext` interface in the Coherence client code. The ECID will be attached to the executing thread. Use the `deactivate` method to release the context, for example:

Example 6–1 Using a DMS Context in Coherence Client Code

```
...
// Get the context associated with this thread
ExecutionContext ctx = ExecutionContext.get();
ctx.activate();
...
set additional execution context values (optional)
perform some cache operations
...
// Release the context
ctx.deactivate();
...
```

ECID logging will occur only on the node where the client is running. If a client request is processed on some other node and an exception is thrown by Coherence, then the remote error will be returned to the originating node and it will be logged on the Coherence client. The log message will contain the ECID of the request. Messages logged on the remote node will not contain the ECID.

For more information on how to include the ECID in a Coherence log message, see "Changing the Log Message Format" in the *Developing Applications with Oracle Coherence*.

7

Integrating with Oracle Coherence GoldenGate HotCache

This chapter describes how to use Oracle Coherence GoldenGate HotCache (HotCache) with applications using Coherence caches. HotCache allows changes to the database to be propagated to objects in the Coherence cache.

A detailed description of Oracle GoldenGate is beyond the scope of this documentation. For more information, see *Installing and Configuring Oracle GoldenGate for Oracle Database* to install GoldenGate on Oracle databases and *Administering Oracle GoldenGate Adapters*.

> **Note:** To use HotCache, you must have licenses for Oracle GoldenGate and Coherence Grid Edition. HotCache can be used with Oracle GoldenGate 11*g*R1, 11*g*R2, and 12*c* releases.

This chapter contains the following sections:

7.1 Overview

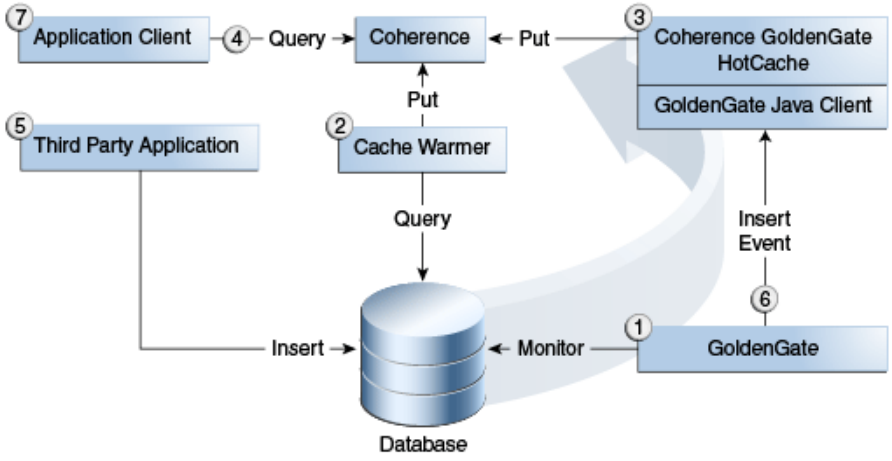
Third-party updates to the database can cause Coherence applications to work with data which could be stale and out-of-date. HotCache solves this problem by monitoring the database and pushing any changes into the Coherence cache. HotCache employs an efficient push model which processes only stale data. Low latency is assured because the data is pushed when the change occurs in the database.

HotCache can be added to any Coherence application. Standard JPA is used to capture the mappings from database data to Java objects. The configuration can be captured in XML exclusively or in XML with annotations.

The following scenario describes how HotCache could be used to work with the database and with applications that use Coherence caches. Figure 7–1 illustrates the scenario.

1. Start GoldenGate—see "Starting the Application" in *Administering Oracle GoldenGate Adapters* for details. GoldenGate monitors the transaction log for changes of interest. These changes will be placed into a "trail file".
2. Start the Coherence cache server and warm the cache, if required.
3. Start HotCache so that it can propagate changes in the trail file into the cache. If changes occur during cache warming, then they will be applied to the cache once HotCache is started so no changes are lost.
4. Start an application client. As part of its operation, assume that the application performs repeated queries on the cache.
5. A third-party application performs a direct database update.
6. GoldenGate detects the database change which is then propagated to the Coherence cache by HotCache.
7. The application client detects the change in cache.

Figure 7–1 How HotCache Propagates Database Changes to the Cache



7.2 How Does HotCache Work?

HotCache processes database change events delivered by GoldenGate and maps those changes onto the affected objects in the Coherence cache. It is able to do this through the use of Java Persistence API (JPA) mapping metadata. JPA is the Java standard for object-relational mapping in Java and it defines a set of annotations (and corresponding XML) that describe how Java objects are mapped to relational tables. As Example 7–1 illustrates, instances of an `Employee` class could be mapped to rows in an `EMPLOYEE` table with the following annotations.

Example 7–1 Mapping Instances of Employee Class to Rows with Java Code

```
@Entity
@Table(name="EMPLOYEE")
Public class Employee {
   @Id
   @Column(name="ID")
```

```
   private int id;
   @Column(name="FIRSTNAME")
   private String firstName;
…
}
```

The `@Entity` annotation marks the `Employee` class as being persistent and the `@Id` annotation identifies the `id` field as containing its primary key. In the case of Coherence cached objects, the `@Id` field must also contain the value of the key under which the object is cached. The `@Table` and `@Column` annotations associate the class with a named table and a field with a named column, respectively.

For simplification, JPA assumes a number of default mappings such as `table name=class name` and `column name=field name` so many mappings need only be specified when the defaults are not correct. In Example 7–1, both the table and field names match the Java names so the `@Table` and `@Column` can be removed to make the code more compact, as illustrated in Example 7–2.

Example 7–2 Simplified Java Code for Mapping Instances of Employee Class to Rows

```
@Entity
Public class Employee {
   @Id
   private int id;
   private String firstName;
…
}
```

Note that the Java code in the previous examples can also be expressed as XML. Example 7–3 illustrates the XML equivalent of the Java code in Example 7–1.

Example 7–3 Mapping Instances of Employee Class to Rows with XML

```
<entity class="Employee">
       <table name="EMPLOYEE"/>
            <attributes>
                <id name="id">
                    <column name="ID"/>
                </id>
                <basic name="firstName"/>
                    <column name="FIRSTNAME"/>
                </basic>
                ...
        </attributes>
</entity>
```

Similarly, Example 7–4 illustrates the XML equivalent for the simplified Java code in Example 7–2.

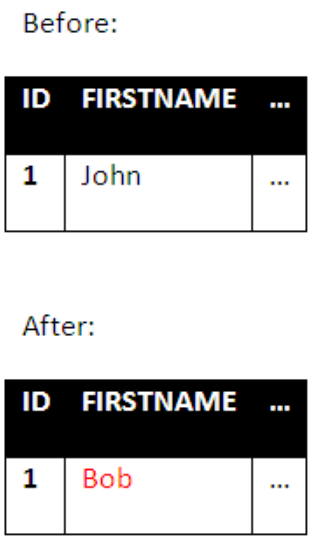
Example 7–4 Simplified XML for Mapping Instances of Employee Class to Rows

```
<entity class="Employee">
       <attributes>
            <id name="id"/>
            <basic name="firstName"/>
             ...
        </attributes>
</entity>
```

7.2.1 How the GoldenGate Java Adapter uses JPA Mapping Metadata

JPA mapping metadata provides mappings from object to relational; however, it also provides the inverse relational to object mappings which HotCache can use. Given the `Employee` example, consider an update to the `FIRSTNAME` column of a row in the `EMPLOYEE` table. Figure 7–2 illustrates the `EMPLOYEE` table before the update, where the first name John is associated with employee ID 1, and the `EMPLOYEE` table after the update where first name Bob is associated with employee ID 1.

Figure 7–2 EMPLOYEE Table Before and After an Update



With GoldenGate monitoring changes to the `EMPLOYEE` table and HotCache configured on the appropriate trail file, the adapter processes an event indicating the `FIRSTNAME` column of the `EMPLOYEE` row with primary key `1` has been changed to `Bob`. The adapter will use the JPA mapping metadata to first identify the class associated with the `EMPLOYEE` table, `Employee`, and then determine the column associated with an `Employee`'s ID field, `ID`. With this information, the adapter can extract the ID column value from the change event and update the `firstName` field (associated with the `FIRSTNAME` column) of the `Employee` cached under the `ID` column value.

7.2.2 Supported Database Operations

Database `INSERT`, `UPDATE`, and `DELETE` operations are supported by the GoldenGate Java Adapter. `INSERT` operations into a mapped table will result in the addition of a new instance of the associated class populated with the data from the newly inserted row. Changes applied through an `UPDATE` operation will be propagated to the corresponding cached object. If the cache does not contain an object corresponding to the updated row, the cache is unchanged. A `DELETE` operation will result in the removal of the corresponding object from the cache, if one exists.

7.3 Prerequisites

The instructions in the following sections assume that you have set up your database to work with GoldenGate. This includes the following tasks:

- creating a database and tables
- granting user permissions

- enabling logging
- provisioning the tables with data

Example 7–5 illustrates a list of sample commands for the Oracle Database that creates a user named `csdemo` and grants user permissions to the database.

Note the `ALTER DATABASE ADD SUPPLEMENTAL LOG DATA` command. When supplemental logging is enabled, all columns are specified for extra logging. At the very least, minimal database-level supplemental logging must be enabled for any change data capture source database.

Example 7–5 Sample Commands to Create a User, Grant Permissions, and Enable Logging

```
CREATE USER csdemo IDENTIFIED BY csdemo;
GRANT DBA TO csdemo;
grant alter session to csdemo;
grant create session to csdemo;
grant flashback any table to csdemo;
grant select any dictionary to csdemo;
grant select any table to csdemo;
grant select any transaction to csdemo;
grant unlimited tablespace to csdemo;
ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;
```

The instructions in the following sections also assume that you have installed Oracle GoldenGate and started the manager. This includes the following tasks:

- downloading and installing Oracle GoldenGate
- running `ggsci` to create the GoldenGate subdirectories
- creating a manager parameter (`mgr.prm`) file, specifying the listener port
- adding JVM libraries to the libraries path
- starting the manager

A detailed description of these tasks is beyond the scope of this documentation. For more information, see *Installing and Configuring Oracle GoldenGate for Oracle Database* to install GoldenGate on Oracle databases and *Administering Oracle GoldenGate Adapters*.

7.4 Configuring GoldenGate

Updating the cache from a GoldenGate trail file requires configuring GoldenGate and HotCache. You then enable HotCache by configuring the GoldenGate Java Adapter.

- Monitor Table Changes
- Filter Changes Made by the Current User

7.4.1 Monitor Table Changes

Indicate the table that you want to monitor for changes by using the `ADD TRANDATA` command. The `ADD TRANDATA` command can be used on the command line or as part of a `ggsci` script. For example, to monitor changes to tables in the `csdemo` schema, use the following command:

```
ADD TRANDATA csdemo.*
```

Example 7–6 illustrates a sample `ggsci` script named `cs-cap.ggsci`.

- The script starts the manager and logs into the database. It stops and deletes any running extract named `cs-cap`.
- The `ADD TRANDATA` command instructs the extract that tables named `csdemo*` should be monitored for changes.
- The `SHELL` command deletes all trail files in the `dirdat` directory to ensure that if the extract is being recreated, there will be no old trail files. Note that the `rm -f` command is platform-specific. An extract named `cs-cap` is created using parameters from the `dirprm/cs-cap.prm` file. A trail is added at `dirdat/cs` from the extract `cs-cap` file.
- The `start` command starts the `cs-cap.ggsci` script.
- The `ADD EXTRACT` command automatically uses the `cs-cap.prm` file as the source of parameters, so a `PARAMS dirprm/cs-cap.prm`, statement is not necessary.

Example 7–6 Sample GoldenGate Java Adapter ggsci Script to Monitor Table Changes

```
start mgr
DBLOGIN USERID csdemo, PASSWORD csdemo
STOP EXTRACT cs-cap
DELETE EXTRACT cs-cap
ADD TRANDATA csdemo.*
ADD EXTRACT cs-cap, tranlog, begin now
SHELL rm -f dirdat/cs*
ADD EXTTRAIL dirdat/cs, EXTRACT cs-cap
start cs-cap
```

7.4.2 Filter Changes Made by the Current User

Configure GoldenGate to ignore changes made by the user that the Coherence CacheStores are logged in as. This avoids GoldenGate processing any changes made to the database by Coherence that are already in the cache.

The `TranLogOptions excludeUSER` command can be used on the command line or in a `ggsci` script. For example, the following command instructs GoldenGate extract process to ignore changes to the database tables made by the Coherence CacheStore user logged in as `csdemo`.

```
TranLogOptions excludeUser csdemo
```

Example 7–7 illustrates a sample extract `.prm` file named `cs-cap.prm`. The user that the Coherence CacheStore is logged in as is `csdemo`. The `recoveryOptions OverwriteMode` line indicates that the extract overwrites the existing transaction data in the trail after the last write-checkpoint position, instead of appending the new data. The `EXTRAIL` parameter identifies the trail as `dirdat/cs`. The `BR BROFF` parameter controls the Bounded Recovery (BR) feature. The `BROFF` value turns off Bounded Recovery for the run and for recovery. The `GETUPDATEBEFORES` parameter indicates that the before images of updated columns are included in the records that are processed by Oracle GoldenGate. The `TABLE` parameter identifies `csdemo.*` as the tables that should be monitored for changes. The `TranLogOptions excludeUSER` parameter indicates that GoldenGate should ignore changes to the tables made by the Coherence CacheStore user logged in as `csdemo`.

Example 7–7 Sample Extract .prm File for the GoldenGate Java Adapter

```
EXTRACT cs-cap
USERID csdemo, PASSWORD csdemo
RecoveryOptions OverwriteMode
```

```
EXTTRAIL dirdat/cs
BR BROFF
getUpdateBefores
TABLE csdemo.*;
TranLogOptions excludeUser csdemo --ignore changes made by csuser
```

7.5 Configuring HotCache

HotCache is configured with system properties, EclipseLink JPA mapping metadata (as described in"How Does HotCache Work?" on page 7-2), and a JPA `persistence.xml` file. The connection from HotCache to the Coherence cluster can be made by using Coherence*Extend (TCP), or the HotCache JVM can join the Coherence cluster as a member.

The following sections describe the properties needed to configure HotCache and provides details about connecting with Coherence*Extend.

- Create a Properties File with GoldenGate for Java Properties
- Add Java Boot Options to the Properties File
- Provide Coherence*Extend Connection Information

7.5.1 Create a Properties File with GoldenGate for Java Properties

Create a text file with the filename extension `.properties`. In the file, enter the configuration for HotCache. A minimal configuration should contain the list of event handlers, the fully-qualified Java class of the event handler, whether the user-exit checkpoint file is being used, and the name of the Java writer.

Note: The path to the `.properties` file must be set as the value of the GoldenGate Java Adapter `GGS_USEREXIT_CONF` variable in a `.prm` file, for example:

```
SetEnv(GGS_USEREXIT_CONF="dirprm/cs-cgga.properties")
```

This is described in "Edit the GoldenGate Java Client Extracts File" on page 7-12.

Example 7–8 illustrates a `.properties` file that contains the minimal configuration for a HotCache project. The following properties are used in the file:

- `gg.handlerlist=cgga`

  The `gg.handlerlist` property specifies a comma-separated list of active handlers. This example defines the logical name `cgga` as database change event handler. The name of a handler can be defined by the user, but it must match the name used in the `gg.handler.{`*name*`}`.type property in the following bullet.

- `gg.handler.cgga.type=oracle.toplink.goldengate.CoherenceAdapter`

  The `gg.handler.{name}.type` property defines handler for HotCache. The `{name}` field should be replaced with the name of an event handler listed in the `gg.handlerlist` property. The only handler that can be set for HotCache is `oracle.toplink.goldengate.CoherenceAdapter`.

- `goldengate.userexit.nochkpt=true`

The `goldengate.userexit.nochkpt` property is used to disable the user-exit checkpoint file. This example defines the user-exit checkpoint file to be disabled.

- `goldengate.userexit.writers=jvm`

  The `goldengate.userexit.writers` property specifies the name of the writer. The value of `goldengate.userexit.writers` must be `jvm` to enable calling out to the GoldenGate Java Adapter.

- `-Dlog4j.configuration=my-log4j.properties`

  The `-Dlog4j.configuration` property specifies a user-defined Log4J properties file, `my-log4j.properties`, in the `dirprm` directory (note that the `dirprm` directory is already on the classpath). This statement is optional, because properties can be loaded from classpath (that is, `log4j.configuration=my-log4j.properties`). For more information on configuring logging properties for HotCache, see "Logging Properties" on page 7-10.

There are many other properties that can be used to control the behavior of the GoldenGate Java Adapter. For more information, see the *Administering Oracle GoldenGate Adapters*.

Example 7–8 .properties File for a HotCache Project

```
# ================================================================
# List of active event handlers. Handlers not in the list are ignored.
# ================================================================
gg.handlerlist=cgga

# ================================================================
# Coherence cache updater
# ================================================================
gg.handler.cgga.type=oracle.toplink.goldengate.CoherenceAdapter

# ================================================================
# Native JNI library properties
# ================================================================
goldengate.userexit.nochkpt=true
goldengate.userexit.writers=jvm

# ====================================
# Java boot options
# ====================================
jvm.bootoptions=-Djava.class.path=dirprm:/home/oracle/app/oracle/product/11.2.0/db
home_
2/jdbc/lib/ojdbc6.jar:ggjava/ggjava.jar:/home/oracle/Oracle/Middleware/coherence/l
ib/coherence.jar:/home/oracle/Oracle/Middleware/coherence/lib/coherence-hotcache.j
ar:/home/oracle/Oracle/Middleware/oracle_common/modules/javax.persistence_2.0.0.0_
2-0.jar:/home/oracle/Oracle/Middleware/oracle_common/modules/oracle.toplink_
12.1.2/eclipselink.jar:/home/oracle/Oracle/Middleware/oracle_
common/modules/oracle.toplink_
12.1.2/toplink-grid.jar:/home/oracle/cgga/workspace/CacheStoreDemo/bin -Xmx32M
-Xms32M -Dtoplink.goldengate.persistence-unit=employee
-Dlog4j.configuration=my-log4j.properties
-Dcoherence.distributed.localstorage=false
-Dcoherence.cacheconfig=/home/oracle/cgga/workspace/CacheStoreDemo/client-cache-co
nfig.xml -Dcoherence.ttl=0
```

The Java boot options are described in the following section.

7.5.2 Add Java Boot Options to the Properties File

This section describes the properties that must appear in the Java boot options section of the `.properties` file. These options are defined by using the `jvm.bootoptions` property.

A sample `jvm.bootoptions` listing is illustrated in `Java boot options` section of Example 7–8.

- Java Classpath Files
- HotCache-related Properties
- Coherence-related Properties
- Logging Properties

7.5.2.1 Java Classpath Files

The following is a list of directories and JAR files that should be included in the Java classpath. The directories and JAR files are defined with the `java.class.path` property.

- `dirprm` – the GoldenGate `dirprm` directory which contains the extract `.prm` files
- `ggjava.jar` – contains the GoldenGate Java adapter libraries
- `coherence.jar` – contains the Oracle Coherence libraries
- `coherence-hotcache.jar` – contains the Oracle Coherence GoldenGate HotCache libraries
- `javax.persistence_2.0.0.0_2-0.jar` – contains the Java persistence libraries
- `eclipselink.jar` – contains the EclipseLink libraries
- `toplink-grid.jar` – contains the Oracle TopLink libraries required by HotCache
- domain classes – the JAR file or directory containing the user classes cached in Coherence that are mapped with JPA for use in HotCache. Also, the Coherence configuration files, `persistence.xml` file, and any `orm.xml` file.

7.5.2.2 HotCache-related Properties

The `toplink.goldengate.persistence-unit` property is required as it identifies the persistence unit defined in `persistence.xml` file that HotCache should load. The persistence unit contains information such as the list of participating domain classes, configuration options, and optionally, database connection information.

The `toplink.goldengate.on-error` property is optional. It controls how the adapter responds to errors while processing a change event. This response applies to both expected optimistic lock exceptions and to unexpected exceptions. This property is optional, as its value defaults to "Refresh". Refresh causes the adapter to attempt to read the latest data for a given row from the database and update the corresponding object in the cache. Refresh requires a database connection to be specified in the `persistence.xml` file. This connection will be established during initialization of HotCache. If a connection cannot be made, then an exception is thrown and HotCache will fail to start.

The other on-error strategies do not require a database connection. They are:

- `Ignore`—Log the exception only. The cache may be left with stale data. Depending on application requirements and cache eviction policies this may be acceptable.

- `Evict`—Log a warning and evict the object corresponding to the change database row from the cache
- `Fail`—Throw an exception and exit HotCache

7.5.2.3 Coherence-related Properties

Any Coherence property can be passed as a system property in the Java boot options. The `coherence.distributed.localstorage` system property with a value of `false` is the only Coherence property that is required to be passed in the Java boot options. Like all Coherence properties, precede the property name with the `-D` prefix in the `jvm.bootoptions` statement, for example:

```
-Dcoherence.distributed.localstorage=false
```

7.5.2.4 Logging Properties

The following logging properties can be defined for HotCache.

The `-Dlog4j.configuration=default-log4j.properties` property specifies the default Log4J configuration file. Example properties are located in `$GOLDEN_GATE_HOME/ggjava/resources/classes/` directory. You can merge these with your existing Log4J configuration.

The Log4J properties file that is bundled with GoldenGate for Java is for demonstration purposes only. The file can be used as-is, or you can merge its contents with the existing Log4J properties.

If the file is used as-is, then it should be copied into the `dirprm` directory, given a new name, and specified with the `-Dlog4j.configuration` property. For example, the following line specifies the user-defined `my-log4j.properties` file in the `dirprm` directory (note the `dirprm` directory is already on the classpath):

```
-Dlog4j.configuration=my-log4j.properties
```

Using the default properties file in its current location can cause problems during upgrades: your changes will lost when a new distribution is installed.

To allow HotCache to log warnings, add the following line to the property file:

```
log4j.logger.oracle.toplink.goldengate=WARN, stdout, rolling
```

To allow HotCache to log errors, add the following line to the property file you use:

```
-Dlog4j.logger.oracle.toplink.goldengate=DEBUG, stdout, rolling
```

> **Note:** A Coherence Log4J configuration can co-exist with the GoldenGate Log4J configuration. Both can be included in the same file that is configured on the `jvm.bootoptions` path.

7.5.3 Provide Coherence*Extend Connection Information

The connection between HotCache and the Coherence cluster can be made with Coherence*Extend. For more information on Coherence*Extend, see *Developing Remote Clients for Oracle Coherence*.

The Coherence configuration files must be in a directory referenced by the `jvm.bootoptions=-Djava.class.path=` ... entry in the `.properties` file. For an example, see the `jvm.bootoptions` entry in Example 7–8.

Example 7–9 illustrates the section of a client cache configuration file that uses Coherence*Extend to connect to the Coherence cluster. In the client cache configuration file, Coherence*Extend is configured in the `<remote-cache-scheme>` section. By default, the connection port for Coherence*Extend is `9099`.

Example 7–9 Coherence*Extend Section of a Client Cache Configuration File

```
<cache-config>
 ...
   <caching-schemes>
      <remote-cache-scheme>
         <scheme-name>CustomRemoteCacheScheme</scheme-name>
         <service-name>CustomExtendTcpCacheService</service-name>
         <initiator-config>
            <tcp-initiator>
               <remote-addresses>
                  <socket-address>
                     <address>localhost</address>
                     <port>9099</port>
                  </socket-address>
               </remote-addresses>
            </tcp-initiator>
            <outgoing-message-handler>
             ...
            </outgoing-message-handler>
         </initiator-config>
      </remote-cache-scheme>
 ...
</cache-config>
```

Example 7–10 illustrates the section of a server cache configuration file that listens for Coherence*Extend connections. In the server cache configuration file, Coherence*Extend is configured in the `<proxy-scheme>` section. By default, the listener port for Coherence*Extend is `9099`.

Example 7–10 Coherence*Extend Section of a Server Cache Configuration File

```
<cache-config>
   ...
   <caching-schemes>
    ...
      <proxy-scheme>
         <scheme-name>CustomProxyScheme</scheme-name>
         <service-name>CustomProxyService</service-name>
         <thread-count>2</thread-count>
         <acceptor-config>
            <tcp-acceptor>
               <local-address>
                  <address>localhost</address>
                  <port>9099</port>
               </local-address>
            </tcp-acceptor>
         </acceptor-config>
         <load-balancer>proxy</load-balancer>
         <autostart>true</autostart>
      </proxy-scheme>

   </caching-schemes>
</cache-config>
```

7.6 Configuring the GoldenGate Java Client

The GoldenGate Java client provides a way to process GoldenGate data change events in Java by configuring an event handler class. The configuration for the GoldenGate Java client allows it to monitor an extract and to pass data change events to HotCache.

This configuration is provided in an extracts `.prm` file and is described in the following section. The extracts `.prm` file also contains a reference to the event handler class. This is the same event handler class that is specified in the properties file described in "Create a Properties File with GoldenGate for Java Properties" on page 7-7.

7.6.1 Edit the GoldenGate Java Client Extracts File

This section describes the parameters that can be defined in the extract `.prm` file for a GoldenGate Java client. The parameters are illustrated in Example 7–11 and constitute a minimal configuration for a HotCache project.

For more information on these parameters and others that can be added to a `.prm` extracts file, see *Reference for Oracle GoldenGate for Windows and UNIX*.

- `SetEnv ( GGS_USEREXIT_CONF = "dirprm/cs-cgga.properties" )`

  The `GGS_USEREXIT_CONF` property provides a reference to the `.properties` file that you created in "Create a Properties File with GoldenGate for Java Properties" on page 7-7. It is assumed that the file is named `cs-cgga.properties` and is stored in the `dirprm` folder.

- `GETUPDATEBEFORES`

  The `GETUPDATEBEFORES` property indicates that the before and after values of columns that have changed are written to the trail if the before values are present and can be compared. If before values are not present only after values are written.

- `CUserExit libggjava_ue.so CUSEREXIT PassThru IncludeUpdateBefores`

  The `CUSEREXIT` parameter includes the following:

  - The location of the user exit library, which will be `libggjava_ue.so` for UNIX or `ggjava_ue.dll` for Windows
  - `CUSEREXIT`—the callback function name that must be uppercase
  - `PASSTHRU`—avoids the need for a dummy target trail
  - `INCLUDEUPDATEBEFORES`—needed for transaction integrity

- `NoTcpSourceTimer`

  Use the `NOTCPSOURCETIMER` parameter to manage the timestamps of replicated operations for reporting purposes within the Oracle GoldenGate environment. `NOTCPSOURCETIMER` retains the original timestamp value. Use `NOTCPSOURCETIMER` when using timestamp-based conflict resolution in a bidirectional configuration.

Example 7–11 illustrates a sample `.prm` file for GoldenGate for Java client.

Example 7–11 Sample .prm Parameter File for GoldenGate for Java Client

```
Extract cs-cgga
USERID csdemo, PASSWORD csdemo

SetEnv ( GGS_USEREXIT_CONF = "dirprm/cs-cgga.properties" )

-- the user-exit library (unix/linux)
CUserExit libggjava_ue.so CUSEREXIT PassThru IncludeUpdateBefores
```

```
-- the user-exit library (windows)
-- CUserExit ggjava_ue.dll CUSEREXIT PassThru IncludeUpdateBefores
--  pass all trail data to user-exit (don't ignore/omit/filter data)
GetUpdateBefores

-- TcpSourceTimer (default=on) adjusts timestamps in replicated records for more
-- accurate lag calculation, if time differences between source/target
NoTcpSourceTimer

-- pass all data in trail to user-exit. Can wildcard tables, but not schema name
Table csdemo.*;
```

7.7 Using Portable Object Format with HotCache

Serialization is the process of encoding an object into a binary format. It is a critical component to working with Coherence as data must be moved around the network. Portable Object Format (also known as POF) is a language-agnostic binary format. POF was designed to be very efficient in both space and time and has become a cornerstone element in working with Coherence.

POF serialization can be used with HotCache but requires a small update to the POF configuration file (`pof-config.xml`) to allow for HotCache and TopLink Grid framework classes to be registered. The `pof-config.xml` file must include the `coherence-hotcache-pof-config.xml` file and must register the `TopLinkGridPortableObject` user type and `TopLinkGridSerializer` as the serializer. The `<type-id>` for each class must be unique and must match across all cluster instances. For more information on configuring a POF file, see "Registering POF Objects" in *Developing Applications with Oracle Coherence*.

The `<allow-interfaces>` element must be set to `true` to allow you to register a single class for all implementors of the `TopLinkGridPortableObject` interface.

Example 7–12 illustrates a sample `pof-config.xml` file for HotCache. The value *`integer_value`* represents a unique integer value greater than `1000`.

Example 7–12 Sample POF Configuration File for HotCache

```
<?xml version='1.0'?><pof-config
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"xmlns="http://xmlns.oracle.co
m/coherence/coherence-pof-config"xsi:schemaLocation="http://xmlns.oracle.com/coher
ence/coherence-pof-configcoherence-pof-config.xsd">
<user-type-list>
<include>coherence-hotcache-pof-config.xml</include>
<!-- User types must be above 1000 -->
...
   <user-type>
      <type-id><integer_value></type-id>

<class-name>oracle.eclipselink.coherence.integrated.cache.TopLinkGridPortableObjec
t</class-name>
       <serializer>

<class-name>oracle.eclipselink.coherence.integrated.cache.TopLinkGridSerializer</c
lass-name>
       </serializer>
   </user-type>
     ...
</user-type-list>
   <allow-interfaces>true</allow-interfaces>
```

```
   ...
</pof-config>
```

7.8 Enabling Wrapper Classes for TopLink Grid Applications

TopLink Grid applications which depend on HotCache to pump changed data to the Coherence cache can use the `toplink.goldengate.enable-toplinkgrid-client` context property set to `true` to generate Java wrapper classes for Coherence cache inserts.

TopLink Grid depends on wrappers to encode relationship information so that eager and lazy JPA relationships can be rebuilt when retrieved from Coherence by TopLink Grid JPA clients. If you are using TopLink Grid with HotCache and the property is not set to `true`, then relationships between objects will be null when retrieved from the Coherence cache.

This context property can be set in the `persistence.xml` file or as a system property in the Java boot options section of the HotCache `.properties` file.

8

Using Memcached Clients with Oracle Coherence

This chapter provides instructions for configuring the Oracle Coherence memcached adapter. The memcached adapter allows Coherence to be used as a distributed cache for memcached-based clients. The instructions in this chapter assume that an existing memcached client is being used to connect to Coherence. A simple hello world client that is written using the spymemcached API is provided for demonstration purposes.

This chapter contains the following sections:

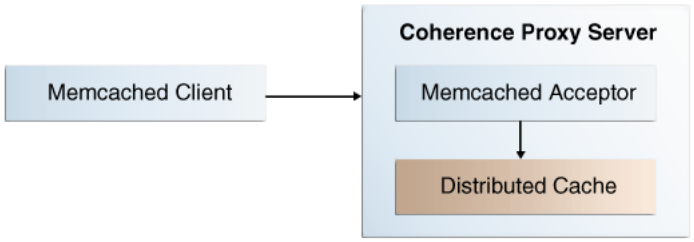
8.1 Overview of the Oracle Coherence Memcached Adapter

The memcached adapter provides access to Coherence caches over the memcached binary protocol and allows Coherence to be used as a drop-in replacement for a memcached server. The adapter supports any memcached client API that supports the memcached binary protocol. This allows memcached clients that are written in many different programming languages to use Coherence.

The memcached adapter is located on a Coherence proxy server and is implemented as a Coherence*Extend-styled acceptor. Memcached clients connect to the acceptor, which manages the distributed cache operations on the cluster. The cache operations are performed as entry processor operations. The acceptor must first be enabled within a proxy service in order to interact with Coherence cached data. Additional features for securing memcached client communication and for sharing data with native Coherence clients are provided and can be configured as required.

Figure 8–1 shows a conceptual view of a memcached client connecting to the memcached acceptor located on a Coherence proxy server in order to use a distributed cache.

Figure 8–1 Conceptual View of a Memcached Client Connection



8.2 Setting Up the Memcached Adapter

Memcached adapters are configured within a proxy service using a specific memcached acceptor. The acceptor configuration defines the socket address and the distributed cache for use by memcached clients.

8.2.1 Define the Memcached Adapter Socket Address

The memcached adapter uses a socket address (IP, or DNS name, and port) for clients to connect to. The socket address is configured in an operational override configuration file using the `<address-provider>` element. The address is then referenced from a proxy service definition using the configured `id` attribute. For details on the `<address-provider>` element, see *Developing Applications with Oracle Coherence*.

The following example configures a socket address and uses `198.168.1.5` for the IP address, `9099` for the port, and `memcached` for the ID.

```
...
<cluster-config>
   <address-providers>
      <address-provider id="memcached">
         <socket-address>
            <address>198.168.1.5</address>
            <port>9099</port>
         </socket-address>
      </address-provider>
   </address-providers>
</cluster-config>
...
```

8.2.2 Define Memcached Adapter Proxy Service

A proxy service allows remote clients to interact with the caching services of a Coherence cluster without becoming cluster members. A proxy service for the memcached adapter includes a specific memcached acceptor that accepts memcached client requests on a defined socket address and then delegates the requests to a distributed cache.

> **Note:** The memcached adapter can only use a distributed cache.

To create a proxy service for memcached clients, edit the cache configuration file and add a `<proxy-scheme>` element and include the `<memcached-acceptor>` element within

the <acceptor-config> element. The <memcached-acceptor> element must include the name of the cache to use and a reference to an address provider definition that defines the socket address to listen to for memcached client communication. For a detailed reference of the <memcached-acceptor> element, see *Developing Applications with Oracle Coherence*.

The following example creates a proxy service and defines a memcached acceptor. The example references the address provider that was defined in Section 8.2.1.

```
...
<caching-schemes>
   <proxy-scheme>
      <service-name>MemcachedProxyService</service-name>
      <acceptor-config>
         <memcached-acceptor>
            <cache-name>hello-example</cache-name>
            <address-provider>memcached</address-provider>
         </memcached-acceptor>
      </acceptor-config>
      <autostart>true</autostart>
   </proxy-scheme>
</caching-schemes>
...
```

The cache name refers to the `hello-example` cache. The cache name must resolve to a distributed cache. The following example shows the definition of the `hello-example` cache and the distributed scheme to which it maps.

```
<?xml version="1.0"?>
<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
              xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
              xsi:schemaLocation=
                "http://xmlns.oracle.com/coherence/coherence-cache-config
                coherence-cache-config.xsd">

   <caching-scheme-mapping>
      <cache-mapping>
         <cache-name>hello-example</cache-name>
         <scheme-name>distributed</scheme-name>
      </cache-mapping>
   </caching-scheme-mapping>

   <caching-schemes>
      <distributed-scheme>
         <scheme-name>distributed</scheme-name>
         <service-name>MemcachedTest</service-name>
         <backing-map-scheme>
           <local-scheme/>
         </backing-map-scheme>
         <autostart>true</autostart>
      </distributed-scheme>

      <proxy-scheme>
         <service-name>MemcachedProxyService</service-name>
         <acceptor-config>
            <memcached-acceptor>
               <cache-name>hello-example</cache-name>
               <address-provider>memcached</address-provider>
            </memcached-acceptor>
         </acceptor-config>
         <autostart>true</autostart>
      </proxy-scheme>
```

```
   </caching-schemes>
</cache-config>
```

8.3 Connecting to the Memcached Adapter

Memcached clients must specify the address and port of a proxy service for the memcached adapter. The proxy service address is used in place of the memcached server address. Refer to your memcached client documentation for details on how to specify the address of a memcached server.

The following example shows a simple hello world client that uses the spymemcached client API to connect to the proxy service for the memcached adapter that was defined in Section 8.2.

```
import net.spy.memcached.AddrUtil;
import net.spy.memcached.BinaryConnectionFactory;
import net.spy.memcached.MemcachedClient;

public class MemcachedExample {
   public static void main(String[] args) throws Exception {
      String key = "k1";
      String value = "Hello World!";

      MemcachedClient c = new MemcachedClient(
         new BinaryConnectionFactory(),
         AddrUtil.getAddresses("198.168.1.5:9099"));

      c.add(key, 0, value);
      System.out.println((String)c.get(key));
      c.shutdown();
   }
}
```

8.4 Securing Memcached Client Communication

The memcached adapter can use both authentication and authorization to restrict access to cluster resources. Authentication support is provided for the SASL (Simple Authentication and Security Layer) plain authentication. Authorization is implemented using Oracle Coherence*Extend-styled authorization, which relies on interceptor classes that provide fine-grained access for cache service operations. The memcached adapter authentication and authorization features reuses much of the existing security capabilities of Oracle Coherence: references are provided to existing content where applicable.

8.4.1 Performing Memcached Client Authentication

Memcached clients can use SASL plain authentication to provide a username and password when connecting to the memcached adapter. To use SASL plain authentication, you must create an `IdentityAsserter` implementation on the proxy. The memcached adapter calls the `IdentityAsserter` implementation and passes the `com.tangosol.net.security.UsernameAndPassword` object as a token. For details on creating and enabling an `IdentityAsserter` implementation, see *Securing Oracle Coherence*. Refer to your memcached client documentation for details on establishing a SASL plain connection.

In addition to an `IdentityAsserter` implementation, authentication must be enabled on a memcached adapter to use SASL plain authentication. To enable authentication,

edit the proxy service definition in the cache configuration file and add a <memcached-auth-method> element, within the <memcached-acceptor> element, and set it to plain.

```
...
<caching-schemes>
   <proxy-scheme>
      <service-name>MemcachedProxyService</service-name>
      <acceptor-config>
         <memcached-acceptor>
            <cache-name>hello-example</cache-name>
            <memcached-auth-method>plain</memcached-auth-method>
            <address-provider>memcached</address-provider>
         </memcached-acceptor>
      </acceptor-config>
      <autostart>true</autostart>
   </proxy-scheme>
</caching-schemes>
...
```

8.4.2 Performing Memcached Client Authorization

The memcached adapter relies on the Oracle Coherence*Extend authorization framework to restrict which operations a memcached client performs on a cluster. For detailed instructions about implementing Oracle Coherence*Extend-style authorization, see *Securing Oracle Coherence*.

8.5 Sharing Data Between Memcached and Coherence Clients

The memcached adapter stores entries in a cache using a binary format. If you intend to share the data with Coherence clients, then memcached clients must use a serialization format that Coherence clients also support. Coherence clients typically use Portable Object Format (POF), which is highlighted in this section. For details about POF, see *Developing Applications with Oracle Coherence*.

To share data between memcached and coherence clients:

1. Edit the proxy service definition in the cache configuration file and add an <interop-enabled> element, within the <memcached-acceptor> element, and set it to true.

   ```
   ...
   <proxy-scheme>
      <service-name>MemcachedProxyService</service-name>
      <acceptor-config>
         <memcached-acceptor>
            <cache-name>hello-example</cache-name>
            <interop-enabled>true</interop-enabled>
            <address-provider>memcached</address-provider>
         </memcached-acceptor>
      </acceptor-config>
      <autostart>true</autostart>
   </proxy-scheme>
   ...
   ```

2. Enable POF on the distributed cache that is used by the memcached acceptor.

   ```
   ...
   <distributed-scheme>
   ```

```
      <scheme-name>distributed</scheme-name>
      <service-name>MemcachedTest</service-name>
      <serializer>
         <instance>
            <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
            <init-params>
               <init-param>
                  <param-type>String</param-type>
                  <param-value>memcached-pof-config.xml</param-value>
               </init-param>
            </init-params>
         </instance>
      </serializer>
      <backing-map-scheme>
         <local-scheme/>
      </backing-map-scheme>
      <autostart>true</autostart>
   </distributed-scheme>
```

3. Register POF types in the defined POF configuration file. For the above example, the POF configuration file is named `memcached-pof-config.xml`. The file must be found on the classpath before the `coherence.jar` file. The following example defines a POF user type for the `PofUser` object:

```
<?xml version='1.0'?>

<pof-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns="http://xmlns.oracle.com/coherence/coherence-pof-config"
   xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-pof-config
   coherence-pof-config.xsd">
   <user-type-list>
      <include>coherence-pof-config.xml</include>

      <!-- User types must be above 1000 -->
      <user-type>
         <type-id>1001</type-id>
         <class-name>memcached.PofUser</class-name>
      </user-type>

   </user-type-list>
</pof-config>
```

Create a Memcached Client that Uses POF

Many memcached client libraries include the ability to plug in custom serializers. Refer to your memcached client documentation for details on how to plug in custom serializers. The following excerpt shows a spymemcached client that adds the `PofUser` object that was registered in step 3 and uses a spymemcached transcoder to plug in the POF serializer.

```
MemcachedClient client = m_client;
String key = "pofKey";
PofUser user = new PofUser("memcached", 1);
PofTranscoder<PofUser> tc = new PofTranscoder("memcached-pof-config.xml");

if (!client.set(key, 0, user, tc).get())
   {
      throw new Exception("failed to set value");
   }
```

The POF transcoder plug-in is defined as follows:

```
import com.tangosol.io.pof.ConfigurablePofContext;
import com.tangosol.util.Binary;
import com.tangosol.util.ExternalizableHelper;

import net.spy.memcached.CachedData;
import net.spy.memcached.compat.SpyObject;
import net.spy.memcached.transcoders.Transcoder;


public class PofTranscoder<T> extends SpyObject implements Transcoder<T>
    {

    public PofTranscoder(String sLocator)
        {
        m_ctx = new ConfigurablePofContext(sLocator);
        }

    @Override
    public boolean asyncDecode(CachedData arg0)
        {
        return Boolean.FALSE;
        }

    @Override
    public T decode(CachedData cachedData)
        {
        int nFlag = cachedData.getFlags();
        Binary bin = new Binary(cachedData.getData());
        return (T) ExternalizableHelper.fromBinary(bin, m_ctx);
        }

    @Override
    public CachedData encode(Object obj)
        {

        byte[] oValue = ExternalizableHelper.toByteArray(obj, m_ctx);
        return new CachedData(FLAG, oValue, CachedData.MAX_SIZE);
        }

    @Override
    public int getMaxSize()
        {
        return CachedData.MAX_SIZE;
        }

    protected ConfigurablePofContext m_ctx;

    protected static final int       FLAG = 4;
```