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Documentation for developers and architects that provides step-by-step examples of creating, configuring, and deploying Oracle Coherence-based Java applications.
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Oracle Coherence (Coherence) is an in-memory data grid solution that enables organizations to predictably scale mission-critical applications by providing fast access to frequently used data. Data grid software is a middleware that reliably manages data objects in memory across many servers. By automatically and dynamically partitioning data, Coherence enables continuous data availability and transactional integrity, even in the event of a server failure.

Developers can easily take advantage of the features of Coherence 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 tutorial is intended for software developers, architects, and administrators. It describes how to develop applications for the Oracle Coherence data grid.

**Documentation Accessibility**

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**Related Documents**

For more information, see the following in the Oracle Coherence documentation set:

- Oracle Fusion Middleware Developing Applications with Oracle Coherence
- Oracle Fusion Middleware Developing Remote Clients for Oracle Coherence
- Oracle Fusion Middleware Integrating Oracle Coherence
- Oracle Fusion Middleware Administering HTTP Session Management with Oracle Coherence*Web
- Oracle Fusion Middleware Managing Oracle Coherence
Oracle Fusion Middleware Administering Oracle Coherence
Oracle Fusion Middleware Securing Oracle Coherence
Oracle Fusion Middleware Developing Oracle Coherence Applications for Oracle WebLogic Server
Oracle Fusion Middleware Java API Reference for Oracle Coherence
Oracle Fusion Middleware .NET API Reference for Oracle Coherence
Oracle Fusion Middleware C++ API Reference for Oracle Coherence

Conventions

The following text conventions are used in this tutorial:

<table>
<thead>
<tr>
<th>Convention</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>boldface</strong></td>
<td>Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.</td>
</tr>
<tr>
<td><em>italic</em></td>
<td>Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.</td>
</tr>
<tr>
<td><strong>monospace</strong></td>
<td>Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.</td>
</tr>
</tbody>
</table>
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 12c (12.1.3)

Oracle Coherence 12c (12.1.3) includes the following new and changed features for this document.

- Tutorial for JCache, which shows you how to use Coherence with JCache, the Java standard APIs for caching on the Java platform. The key Coherence files which support JCache are cache-api.jar and coherence-jcache.jar. The cache-api.jar file contains the JCache libraries. The coherence-jcache.jar file contains the Coherence implementation which is built on top of the JCache library. See Chapter 12, "Working with JCache."

- An appendix has been added describing the basic features, security, and events examples that are delivered with the Coherence distribution in the examples.zip file. These examples (in the Java, C++, and .NET languages) are designed to be built and run on the command line. See Appendix A, "Coherence Examples in the examples.zip File."

Other Significant Changes in this Document for 12c (12.1.3)

For 12c (12.1.3), this guide has been updated in several ways. Following are the sections that have been added or changed.

- Revised all of the tutorials in the tutorial to use Coherence 12c (12.1.3).

- Revised the Coherence and JPA tutorial to use the Oracle 12c database instead of the Oracle XE database. It has also been revised to use EclipseLink 2.5.x, TopLink Grid 12c (12.1.3), and the Java Persistence 2.2.0.0 files. See Chapter 8, "Using JPA with Coherence."

- Revised the tutorial to use the Oracle 12c database instead of the Oracle XE database. It has also been revised to create and configure an Oracle Coherence cache in Eclipse to use EclipseLink 2.5.x, TopLink Grid 12c (12.1.3), and the Java Persistence 2.2.0.0 files. See Chapter 9, "Interacting with the Cache and the Database."

- Revised the session caching and managed WebLogic Servers tutorial to use WebLogic Server 12c (12.1.3). See Chapter 13, "Caching Sessions with Managed Coherence Servers."
This chapter describes how to install and set up your environment for running Oracle Coherence 12c (12.1.3) (Coherence).

**Note:** This tutorial uses the Eclipse Kepler 4.3.1 release with Oracle Enterprise Pack for Eclipse (OEPE) 12.1.3.0.0. For information about configuring Eclipse and OEPE for Coherence-based projects, see Chapter 2, "Installing and Configuring Eclipse and OEPE with Coherence".

This chapter contains the following sections:

- **Prerequisites**
- **Installing Coherence**
- **Testing a Coherence Installation**
- **Introducing the Coherence examples.zip File**

### Prerequisites

- You must have the privileges to install software and set system environment variables as the `oracle` user, an understanding of how to use a terminal window, including setting environment variables, and creating and moving between directories.
- You must have a working installation of the Oracle JDK or JRE (version 7 or higher). This tutorial uses the Oracle JDK 1.7.0_25.
- You must also be running one of the following Microsoft Windows operating systems: XP, Vista, 2000, 2003, 2008 or Windows 7.

### Installing Coherence

For information on installing Oracle Coherence, see "Installing Oracle Coherence for Java" in *Oracle Fusion Middleware Developing Applications with Oracle Coherence*. This chapter provides instructions for installing Oracle Coherence by using the Oracle Universal Installer. The installer supports both a graphical mode and a silent mode. You can also choose to use the Coherence Quick Installer to perform a silent installation with no options.
Note: This tutorial assumes that you have used the Oracle Universal Installer graphical interface to install Oracle Coherence at C:\Oracle\Middleware\Oracle_Home.

The coherence folder which appears under Oracle_Home contains these subfolders:

- bin, which contains command scripts
- doc, which contains the product documentation
- examples, which contains code examples for the Java, .NET, and C++ platforms
- lib, which contains the required library files
- plugins, which contains Maven plugins that are used to integrate Coherence as part of a Maven build process

Testing a Coherence Installation

In this exercise, you test whether your Coherence installation can cluster Java processes. This ensures that Coherence-based applications that ship with Coherence will run as expected. If Coherence is not capable of clustering on a single machine, then you must reconfigure your network and firewall settings.

To complete this exercise, you must have Coherence (Java Edition) 12c (12.1.3) installed. See “Installing Coherence” on page 1-1 for more information.

Coherence uses a variety of network addresses and ports to enable communication between clustered processes. If these addresses and ports are unavailable due to other applications using them, or because of a firewall, then Coherence may be unreliable, may fail to cluster, or may not work at all. By default, Coherence assumes that the network addresses and ports listed in Table 1–1 are available:

<table>
<thead>
<tr>
<th>Address / Port / Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>224.version / version / Multicast</td>
<td>Cluster member discovery and broadcast. The variable version represents the release version of Coherence. For example, the multicast address for the 12.1.3 release is 224.12.1.0. The port number also reflects the release version. For example, for the 12.1.3 release, the port number is 12100. Designing the address in this way ensures that different versions of Coherence do not cluster with each other by default.</td>
</tr>
<tr>
<td>localhost / 8088+ / Unicast</td>
<td>Interprocess communication between cluster members. (localhost is the local IP address and not the loop back address.)</td>
</tr>
<tr>
<td>localhost / 8089 / Unicast</td>
<td>An additional port that is used for unicast communication. By default, the port is assigned as the next available port after the first unicast port.</td>
</tr>
<tr>
<td>localhost / 7 / Unicast</td>
<td>The default port of the IpMonitor component that is used for detecting hardware failure of cluster members is “7”.</td>
</tr>
</tbody>
</table>

Coherence ships with two simple command-line (shell-based) applications that can be used to determine whether Coherence operates correctly.
- The cache server is a simple application that hosts and manages data on behalf of other applications in a cluster.

- The cache client is a simple application that enables a developer to access, process, and update cached data within a cluster. It also provides information about the cluster. By executing these applications either on a single host or on several hosts, you can determine whether Coherence is operating correctly locally or across a network.

When an application uses Coherence as shipped, objects placed into Coherence caches are typically stored and managed in-process within the application. However, to increase object availability, Coherence can manage objects in memory but out of the application process. This enables objects to survive possible application outages (either deliberate or accidental). To manage objects in this way, Coherence uses cache servers. The purpose of a Coherence cache server is to manage the application state in a cluster outside the application process. It is similar to a database server, but without the requirement for storage.

To Test a Coherence Installation—Main Steps

Follow these steps to test a Coherence Installation. The steps are described in detail in the following sections.

1. Configure and Run the Sample Cache Server Application
2. Configure and Run the Sample Cache Client Application
3. Exercise the Sample Cache Client Application
4. Troubleshooting Cache Server Clustering

Configure and Run the Sample Cache Server Application

To set up and run the sample cache server application:

1. Open a terminal window and verify that the PATH environment variable is set to include the Java JDK or JRE (for example, C:\Oracle\Middleware\Oracle_Home\jdk1.7.0_25\bin). If the PATH environment variable does not include the JDK or JRE \bin folder, then set it as follows:
   a. Set the JAVA_HOME environment variable to the base of the JDK or JRE installation.
      
      set JAVA_HOME=C:\Oracle\Middleware\Oracle_Home\jdk1.7.0_25

   b. Include JAVA_HOME\bin in the PATH environment variable.
      
      set PATH=%JAVA_HOME%\bin;%PATH%

2. Navigate to the folder where Coherence is installed.

   cd C:\oracle\Middleware\Oracle_Home\coherence\bin

   Edit the cache-server.cmd file to set the COHERENCE_HOME environment variable to point to the Coherence installation folder:

   coherence_home=C:\oracle\Middleware\Oracle_Home\coherence

   Example 1–1 illustrates the cache-server.cmd file with the edited value of the COHERENCE_HOME environment variable.
Example 1–1  cache-server.cmd File with an Edited COHERENCE_HOME

@echo off
@
@rem This will start a cache server
@setlocal

:config
@rem specify the Coherence installation directory
set coherence_home=c:\oracle\product\coherence

@rem specify the JVM heap size
set memory=512m

:start
if not exist "%coherence_home%\lib\coherence.jar" goto instructions
if "%java_home%"=="" (set java_exec=java) else (set java_exec=%java_home%\bin\java)

:launch
if "%1"=="-jmx" {
    set jmxproperties=-Dtangosol.coherence.management=all -Dtangosol.coherence.
    management.remote=true
    shift
}
set java_opts=-Xms%memory% -Xmx%memory% %jmxproperties%

%java_exec% -server -showversion %java_opts% -cp "%coherence_home%\lib\coherence.
jar" -Dtangosol.coherence.clusterport=3155 com.tangosol.net.DefaultCacheServer %1
goto exit

:instructions

echo Usage:
echo ^<coherence_home^>\bin\cache-server.cmd
goto exit

:exit
endlocal
@echo on

3. Execute the cache server application that is located in the coherence\bin folder.

C:\oracle\product\coherence\bin>cache-server.cmd

When you start the first cache server, there is a slight delay because the cache
server looks for an existing cluster. When the cache server determines that there
are no clusters to join, it starts one. On start-up, the cache server produces output
similar to the text in Example 1–2.

Several important features are highlighted in the example:

■ The Java JDK version number.
- Information about how configuration files are loaded. The default is to load from the coherence.jar file:
  
  Loaded operational configuration from 
  "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"

- The Coherence release number: Oracle Coherence 12.1.3.0.0...

- The Coherence edition: Grid Edition: Development mode

- The multicast address. This address changes with each major Coherence version. Note the 12.1.0 in the address for Coherence 12c (12.1.3):
  Group{Address=224.12.1.0, Port=12100, TTL=4}

- The Member ID indicates the number of members in your cluster. For the purpose of this exercise, the value should be 1. ThisMember=Member (Id=1).

---

**Example 1–2  Output from Starting a Coherence Cache Server**

C:\Oracle\Middleware\Oracle_Home\coherence\bin\cache-server.cmd

```cmd
java version "1.7.0_25"
Java(TM) SE Runtime Environment (build 1.7.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)
```

2013-11-13 13:34:39.298/1.062 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"

2013-11-13 13:34:39.298/1.062 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"

2013-11-13 13:34:39.398/1.162 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/tangosol-coherence-override.xml" is not specified

2013-11-13 13:34:40.155/1.919 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/coherence-cache-config.xml"

2013-11-13 13:34:40.900/2.664 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory

---

**Oracle Coherence Version 12.1.3.0.0 Build 48392**

**Grid Edition: Development mode**

Copyright (c) 2000, 2013, Oracle and/or its affiliates. All rights reserved.
MasterMemberSet{
    ThisMember=Member(Id=1, Timestamp=2013-11-13 13:34:42.73, Address=130.35.99.13:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3224, Role=CoherenceServer)
    OldestMember=Member(Id=1, Timestamp=2013-11-13 13:34:42.73, Address=130.35.99.13:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3224, Role=CoherenceServer)
    ActualMemberSet=MemberSet(Size=1)
        Member(Id=1, Timestamp=2013-11-13 13:34:42.73, Address=130.35.99.13:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3224, Role=CoherenceServer)
}

MemberId|ServiceVersion|ServiceJoined|MemberState
1|12.1.3|2013-11-13 13:34:42.73|JOINED
RecycleMillis=1200000
RecycleSet=MemberSet(Size=0)

TcpRing{Connections=[]}
IpMonitor{Addresses=0}

2013-11-13 13:34:46.420/8.184 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Service Management joined the cluster with senior service member 1
2013-11-13 13:34:46.520/8.284 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=1): Loaded Reporter configuration from "jar:file:/C:/Oracle/Middleware/Oracle_HOME/coherence/lib/coherence.jar!/reports/report-group.xml"
2013-11-13 13:34:47.052/8.816 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=1): TcpAcceptor now listening for connections on 130.35.99.13:8088.3
2013-11-13 13:34:47.572/9.336 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=1): Service DistributedCache joined the cluster with senior service member 1
2013-11-13 13:34:47.612/9.376 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=1): This member has become the distribution coordinator for MemberSet(Size=1)
    Member(Id=1, Timestamp=2013-11-13 13:34:42.73, Address=130.35.99.13:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3224, Role=CoherenceServer)
2013-11-13 13:34:47.652/9.416 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=ReplicatedCache, member=1): Service ReplicatedCache joined the cluster with senior service member 1
2013-11-13 13:34:47.662/9.426 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=OptimisticCache, member=1): Service OptimisticCache joined the cluster with senior service member 1
2013-11-13 13:34:47.672/9.436 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:InvocationService, member=1): Service InvocationService joined the cluster with senior service member 1
2013-11-13 13:34:47.672/9.436 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=1): Services
    ClusterService{Name=Cluster, State={SERVICE_STARTED, STATE_JOINED}, Id=0, Version=12.1.3, OldestMemberId=1}
    InvocationService{Name=Management, State={SERVICE_STARTED}, Id=2, Version=12.1.3, OldestMemberId=1}
    PartitionedCache{Name=DistributedCache, State={SERVICE_STARTED}, LocalStorage=enabled, PartitionCount=257, BackupCount=1, AssignedPartitions=257, BackupPartitions=0}
    ReplicatedCache{Name=ReplicatedCache, State={SERVICE_STARTED}, Id=4, Version=12.1.3, OldestMemberId=1}
    Optimistic{Name=OptimisticCache, State={SERVICE_STARTED}, Id=5, Version=12.1.3, OldestMemberId=1}
    InvocationService{Name=InvocationService, State={SERVICE_STARTED}, Id=6, Version=12.1.3, OldestMemberId=1}
}

Started DefaultCacheServer...
Note: By default, Coherence is configured to use multicast to join a cluster and to distribute cluster events. Multicast can also be used to distribute a message efficiently to multiple nodes in the cluster. You can configure Coherence to disable multicast.

The output of the cache-server.cmd file indicates whether you have one or more members in your cluster. The value of Member Id should be equal to 1:

... In MasterMemberSet
ThisMember=Member(Id should be equal to 1)
...

If ThisMember has an Id greater than one, it means that your cache server has joined a pre-existing cluster in your network. For the purposes of these exercises, the cluster should contain only one member. Follow the steps in "Restricting Coherence to Your Own Host" on page 1-15 to restrict Coherence to your own host.

Configure and Run the Sample Cache Client Application

To set up and run the sample cache client application:

1. Open another terminal window to start the cache client.
   Verify that the PATH environment variable is set to include the %JAVA_HOME%\bin folder. If the PATH environment variable does not include the %JAVA_HOME%\bin folder, then set the variable as described in "Configure and Run the Sample Cache Server Application" on page 1-3.

2. Navigate to the \Oracle\Middleware\Oracle_Home\coherence\bin folder. Edit the query.cmd file to set the COHERENCE_HOME variable to point to the Coherence installation folder.

   The query.cmd file includes a reference to the JLine JAR file (jline.jar). JLine is a Java library that simplifies working with console commands. The jline.jar file is included in the coherence\lib folder.

   Example 1–3 illustrates the query.cmd file, with COHERENCE_HOME = \oracle\product\coherence. JLINE_HOME is set to %jline_home%\lib.

   **Example 1–3  query.cmd File with an Edited COHERENCE_HOME**

   @echo off
   @
   @rem This will start a console application
   @rem demonstrating the functionality of the Coherence(tm) API
   @
   @setlocal
   :config
   @rem specify the Coherence installation directory
   set coherence_home=C:\oracle\Middleware\Oracle_Home\coherence
   @rem specify the jline installation directory
   set jline_home=%coherence_home%\lib
   @rem specify if the console will also act as a server
set storage_enabled=false

@rem specify the JVM heap size
set memory=64m

:start
if not exist "%coherence_home%\lib\coherence.jar" goto instructions
if "%java_home%"=="" (set java_exec=java) else (set java_exec=%java_home%\bin\java)

:launch
if "%storage_enabled%"=='true' (echo ** Starting storage enabled console **) else (echo **
Starting storage disabled console **) 

set java_opts="-Xms%memory% -Xmx%memory% 
-Dtangosol.coherence.distributed.localstorage=%storage_enabled%"

"%java_exec%" -server -showversion "%java_opts%" -cp 
"%coherence_home%\lib\coherence.jar;%jline_home%\jline.jar" 
com.tangosol.coherence.dslquery.QueryPlus %*

go to exit

:instructions

echo Usage:
echo   ^<coherence_home^>\bin\query.cmd

go to exit

:exit
endlocal
@echo on

3. Execute the query.cmd file to start the cache client.

query.cmd

The output of starting the cache client, illustrated in Example 1–4, displays the basic distributed cache functionality that is built into Coherence. At the end of the output, the CohQL> prompt is displayed.

Example 1–4   Output from Starting the Coherence Cache Client

C:\Oracle\Middleware\Oracle_Home\coherence\bin>query.cmd
** Starting storage disabled console **
java version "1.7.0_25"
Java(TM) SE Runtime Environment (build 1.7.0.25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)

Coherence Command Line Tool

CohQL>
Exercise the Sample Cache Client Application

Exercise the cache client application by entering various commands and examining the output.

1. Execute the following Coherence commands in the cache client:
   - Enter `help` to see the list of commands that are available.
   - Enter `create cache "products"` to create a cache named `products`.

   The cache `products` implements the `com.tangosol.net.NamedCache` interface. A cluster can have many named caches.

   **Example 1–5** illustrates that by using the default configuration file (`coherence-cache-config.xml`) within the supplied coherence.jar file, a NamedCache called `products` is created using the distributed scheme.

   **Example 1–5  Output from Starting a Coherence Cache Client**

   ```
   CchQL> create cache "products"
   2013-11-13 14:00:40.286/219.229 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Loaded operational configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"
   2013-11-13 14:00:40.348/219.291 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Loaded operational overrides from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
   2013-11-13 14:00:40.348/219.291 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a):
   Optional configuration override "/tangosol-coherence-override.xml" is not specified
   2013-11-13 14:00:40.364/219.307 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a):
   Optional configuration override "cache-factory-config.xml" is not specified
   2013-11-13 14:00:40.364/219.307 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a):
   Optional configuration override "cache-factory-builder-config.xml" is not specified
   2013-11-13 14:00:40.364/219.307 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a):
   Optional configuration override "/custom-mbeans.xml" is not specified
   2013-11-13 14:00:40.723/219.666 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Loaded cache configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/coherence-cache-config.xml"
   2013-11-13 14:00:41.050/219.993 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Loaded cache configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/internal-txn-cache-config.xml"
   2013-11-13 14:00:43.063/222.006 Oracle Coherence GE 12.1.3.0.0 <D4> (thread=main, member=n/a):
   Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
   2013-11-13 14:00:43.063/222.006 Oracle Coherence GE 12.1.3.0.0 <D4> (thread=main, member=n/a):
   TCMP bound to /130.35.99.13:8090 using SystemDatagramSocketProvider
   2013-11-13 14:00:43.671/222.614 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Failed to satisfy the variance: allowed=16, actual=31
   2013-11-13 14:00:43.671/222.614 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
   Increasing allowable variance to 17
   2013-11-13 14:00:44.014/222.957 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=n/a):
   Member(Id=1, Timestamp=2013-11-13 13:34:42.73, Address=130.35.99.13:8088, MachineId=47251,
   Location=site:,machine:TPPAEFFL-LAP,process:3224, Role=CoherenceServer) joined Cluster with senior member 1
   2013-11-13 14:00:44.030/222.989 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=Cluster, member=n/a):
   This Member (Id=2, Timestamp=2013-11-13 14:00:41.812, Address=130.35.99.13:8090, MachineId=47251,
   ```
2. Execute the following commands at the CohQL> prompt in the cache client. For definitions of these commands, see "Using Coherence Query Language" in Oracle Fusion Middleware Developing Applications with Oracle Coherence.

- Insert an entry (key-value pair) into the products cache:
  
  insert into "products" key "television" value "ID-5070"

- Change the value of the key:
  update "products" set value() = "ID-5080" where key() like "television"

- Retrieve the values in the cache:
  select * from "products"

- Retrieve the value of a key that does not exist. An empty result set will be returned:
select key(), value() from "products" where key() is 'radio'

- Delete an existing key in the cache. An empty result set will be returned:
  delete from "products" where key() = 'television'

- Delete the contents of the products cache. An empty result set will be returned:
  delete from "products"

- Destroy the products cache:
  drop cache "products"

- Re-create the products cache:
  create cache "products"

- Insert more entries into the cache:
  insert into "products" key "television" value "ID-5080"
  insert into "products" key "radio" value "ID-5090"
  insert into "products" key "MP3 Player" value "ID-5100"
  insert into "products" key "laptop" value "ID-5110"

- Retrieve the keys and values in the products cache:
  select key(), value() from "products"

- Save a serialized representation of the cache in a file:
  backup cache "products" to "products.bkup"

- Delete a key from the cache:
  delete from "products" where key() = "television"

- Retrieve the cache contents again, notice that the deleted key and value will not be present:
  select key(), value() from "products"

- Delete the contents of the cache:
  delete from "products"

- Retrieve the contents of the cache. An empty result set will be returned:
  select * from "products"

- Restore the cache contents from the backup file:
  restore cache "products" from file "products.bkup"

- Retrieve the cache contents. Note that all of the entries will be restored and returned:
  select key(), value() from "products"

- Destroy the products cache:
  drop cache "products"

- Exit the command-line tool:
Example 1–6 illustrates the output of each of these commands.

**Example 1–6  Exercising Coherence Commands**

CohQL> create cache 'products'

CohQL> insert into 'products' key 'television' value 'ID-5070'

CohQL> update 'products' set value() = 'ID-5080' where key() like 'television'
Results
television: true

CohQL> select * from 'products'
Results
ID-5080

CohQL> select key(), value() from 'products' where key() is "radio"
Results

CohQL> delete from 'products' where key() = "television"
Results

CohQL> delete from 'products'
Results

CohQL> drop cache "products"

CohQL> create cache 'products'

CohQL> insert into 'products' key 'television' value 'ID-5080'

CohQL> insert into 'products' key 'radio' value 'ID-5090'

CohQL> insert into 'products' key 'MP3 Player' value 'ID-5100'

CohQL> insert into 'products' key 'laptop' value 'ID-5110'

CohQL> select key(), value() from 'products'
Results
"television", "ID-5080"
"radio", "ID-5090"
"MP3 Player", "ID-5100"
"laptop", "ID-5110"

CohQL> backup cache 'products' to 'products.bkup'
WARNING: The backup command should not be used on active data set, as it makes no provisions that ensure data consistency during the backup. Please see the documentation for more detailed information.

CohQL> delete from 'products' where key() = "television"
Results

CohQL> select key(), value() from 'products'
Results
"radio", "ID-5090"
"MP3 Player", "ID-5100"
"laptop", "ID-5110"
In the cache server window, you should see a response similar to the following, indicating that the client (Member 2) has left the cluster:

```
...
2013-11-13 14:08:50.545/2052.309 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Cluster, member=1): TcpRing disconnected from Member(Id=2,
Timestamp=2013-11-13 14:00:43.812, Address=130.35.99.13:8090, MachineId=47251,
Location=site:,machine:TPFAEFFL-LAP,process:3896,
Role=TangosolCoherenceQueryPlus) due to a peer departure; removing the member.
2013-11-13 14:08:50.545/2052.309 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Cluster, member=1): Member(Id=2, Timestamp=2013-11-13 14:08:50.545,
Address=130.35.99.13:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-
LAP,process:3896, Role=TangosolCoherenceQueryPlus) left Cluster with senior
member 1
2013-11-13 14:08:50.545/2052.309 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Invocation:Management, member=3): Member 2 left service Management with
senior member 1
2013-11-13 14:08:50.545/2052.309 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=DistributedCache, member=1): Member 2 left service DistributedCache
with senior member 1
```

3. Open another terminal window and set the PATH environment variable to include %JAVA_HOME% and %JAVA_HOME%\bin. Enter the `query.cmd` command in the new terminal window to start an instance of the cache client.

4. Restart the first client with the `query.cmd` command. Enter the `create cache "products"` command. The cache server terminal window displays a message similar to the following that describes where the first client is running. member 1 is the cache server and member 3 is the restarted first client.

```
2013-11-13 14:15:24.217/27.307 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Invocation:Management, member=3): Service Management joined the cluster
with senior service member 1
2013-11-13 14:15:24.248/27.338 Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=3): Loaded Reporter configuration from
"jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.
jar!/reports/report-group.xml"
2013-11-13 14:15:24.654/27.744 Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=NameService:TcpAcceptor, member=3): TcpAcceptor now listening for
connections on 130.35.99.13:8090.3
```
(thread=DistributedCache, member=3): Service DistributedCache joined the cluster with senior service member 1

CohQL>

5. Enter the create cache "products" command in the new terminal window to connect to the products cache. It enters the cluster as Member 4. Try to get and put values in different sessions. Notice that each client can observe changes made by the other client.

6. Terminate one of the query.cmd client shells (bye). Note that the other shell displays a message indicating that the member has left the cluster, for example:

2013-11-13 14:23:54.085/537.175 Oracle Coherence GE 12.1.3.0.0 <D5>
2013-11-13 14:23:54.085/537.175 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Cluster, member=3): Member(Id=4, Timestamp=2013-11-13 14:23:54.085, Address=130.35.99.13:8092, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:5540, Role=TangosolCoherenceQueryPlus) left Cluster with senior member 1

7. If you terminate each of the cache clients (bye), and then restart them, note that data from the previous session is still available. This is because the data is held in the cache server.

8. If you start another Coherence cache server, and then terminate the initial one that was started (using Ctrl+C or by closing the command window), note that the data is still available.

9. Terminate both the query.cmd shells and cache-server.cmd shell. Restart query.cmd. Create a cache called test using the command create cache "test". Try to put a value into the cache, as before. Because the cache client is configured to start in storage-disabled mode, you will receive a response similar to the following:

com.tangosol.net.RequestPolicyException: No storage-enabled nodes exist for service DistributedCache

10. Start a cache server by running the cache-server.cmd file. Try to insert a value again. This time, the value will be accepted.

11. Terminate all cache servers.

Troubleshooting Cache Server Clustering

If the value of Member ID in the cache-server.cmd output is anything other than 1, then this indicates that the cache server has clustered with one or more other cache servers or processes running Coherence. These servers or processes can be running on the network or running locally on your host. Though this is the default behavior for Coherence—to cluster with other processes running Coherence locally or on a
network—it is strongly advised that while you perform this tutorial, you restrict Coherence to your own host.

Note: To restrict Coherence to a single host, the cache server and cache client executable files used in this tutorial use the tangosol.coherence.clusterport command line property set to 3155.

Restricting Coherence to Your Own Host

The value of the Member ID in the output of the cache-server.cmd cache server command indicates whether you have one or more members in your cluster. For the purpose of this tutorial, the value of Member ID must be equal to 1:

```
... In MasterMemberSet
ThisMember=Member(Ids should be equal to 1)
...```

If the value of Member ID is greater than 1, it means that multiple clusters are being formed in your subnet.

There are several ways to restrict Coherence to your own host. The easiest way is to use the tangosol.coherence.clusterport system property to declare a unique cluster port value in your cache server startup file. For example, add the following Java option to your cache-server.cmd file. The value assigned to the system property can be any unique value, such as the last four digits of your telephone number.

```
-Dtangosol.coherence.clusterport=3155
```

Advanced Steps to Restrict Coherence to Your Own Host

If you follow the steps in “Restricting Coherence to Your Own Host” on page 1-15 and the cache-server.cmd command still fails to return a Member Id value of 1, then there might be additional problems to resolve.

Disconnect from the network or disable networking on your host. If errors or exceptions occur when starting the cache server, your network settings might need to be modified. Try each of the following one at a time, restarting the cache server after each attempt:

- If connected to a Virtual Private Network (VPN), then disconnect from it. By default, most VPN are not configured to permit multicast and some unicast traffic. In this environment, Coherence might not work, if left in the configuration in which it was shipped. Coherence can be configured to run across a VPN, but this requires some advanced settings.
- If you run a firewall, configure it to enable the specified addresses and ports.
- If you still experience problems, disconnect from all networks. This includes wireless and wired networks.
- If all the preceding options fail, set up Coherence to run on a single host.

Introducing the Coherence examples.zip File

The Coherence distribution provides an examples.zip file that contains many of the examples found in this tutorial. They demonstrate many of the cache access, processing, and security features in Coherence. The examples are designed to be built
and run from the command line. The output of the examples is directed to standard output (stdout).

Appendix A, "Coherence Examples in the examples.zip File" provides information on building and running the examples. It also provides minimal documentation on the code in the examples.zip file. More detailed information about the code is embedded as comments in the individual code files.

There are a number of differences between the examples in the examples.zip file and the examples in this tutorial:

- The examples in the examples.zip must be built and run from the command line. This tutorial uses an IDE to compile and run the code.
- The examples in the examples.zip file demonstrate how to use basic Coherence functionality and security features in all supported languages (Java, .NET, and C++). The tutorial covers only Java implementations.
- The Java examples in the examples.zip file are only a subset of the Java examples presented in the tutorial.
- The Java files in the examples.zip file are similar to the files used in this tutorial. In many instances, the code in the tutorial has been simplified for demonstration purposes.

You can obtain the examples.zip file by performing a full Coherence installation with the coherence_version.jar or wls_version.jar file.

If you have already installed Coherence but without the examples, you can obtain the examples.zip file by running the coherence_quick_supp_version.jar supplemental installer file. The supplemental installer contains only API documentation and examples.

Note that the coherence_quick_version.jar quick installer does not install the examples.
This chapter describes how to set up the Kepler release of the Eclipse IDE for Java EE Developers (Eclipse) and Oracle Enterprise Pack for Eclipse 12.1.3.0.0 (OEPE) to build and run Coherence-based Java applications.

This chapter contains the following sections:

- Installing Eclipse and OEPE
- Configuring Eclipse and OEPE for Coherence
- Creating a New Project in the Eclipse IDE
- Launching a Cache Server in the Eclipse IDE
- Learning Eclipse IDE Basics

### Installing Eclipse and OEPE

You can download an "all-in-one" version of OEPE (12.1.3.0.0) that bundles a preconfigured version of Eclipse Kepler and the OEPE plugins. Oracle recommends installing the “all-in-one” version.

As an alternative, you can download the OEPE distribution by itself and install it into an existing Eclipse Kepler installation. The OEPE installer includes Oracle WebLogic Server, Oracle Coherence, and the Oracle ADF Runtime.

To download either version, select the Downloads tab on the Oracle Enterprise Pack for Eclipse page:


Follow the instructions in the installer. You can also find installation instructions at this URL:


This tutorial assumes that you will be installing Eclipse into an eclipse folder that you have created at the file system root, for example:

C:\eclipse\*

### Configuring Eclipse and OEPE for Coherence

To start and configure Eclipse for use with Coherence:
1. Open a terminal window and verify that the `PATH` environment variable is set to include the Java JDK or JRE, for example: `C:\Oracle\Middleware\Oracle_Home\jdk1.7.0_25\bin`. Note that you must have a working installation of Java JDK or JRE version 7 or higher.

If the `PATH` environment variable does not include the Java JDK or JRE `\bin` folder, then set the variable as follows:

   a. Set the `JAVA_HOME` environment variable to the base of the JDK or JRE installation, for example:
      ```
      set JAVA_HOME=\Oracle\Middleware\Oracle_Home\jdk1.7.0_25
      ```

   b. Include `%JAVA_HOME%\bin` in the `PATH` environment variable, for example:
      ```
      set PATH=%JAVA_HOME%\bin;%PATH%
      ```

2. Start Eclipse.

   The eclipse executable is `eclipse.exe`. If you extracted Eclipse into a directory called `eclipse`, you will find `eclipse.exe` here:

   `C:\eclipse\eclipse.exe`

3. If Eclipse prompts you to set or select a workspace in the **Workspace Launcher** dialog box, enter `C:\home\oracle\workspace`.

   *Figure 2–1* illustrates the **Workspace Launcher** dialog box with the path `C:\home\oracle\workspace` selected.

   **Figure 2–1  Workspace Launcher Dialog Box**

   ![Workspace Launcher](image)

4. After Eclipse starts, select the Java EE perspective:

   - Select **Window** then **Open Perspective**, then **Java EE**, or
   - Select the Java EE perspective icon in the menu bar

   *Figure 2–2* illustrates the location of the Java EE perspective icon.
Creating a New Project in the Eclipse IDE

To create a new project in the Eclipse IDE:

1. Select File then New then Application Client Project.

2. In the New Application Client Project dialog box, enter a value, Coherence for example, as the Project name.

3. In the Configuration section, click Modify. In the Project Facets dialog box, select the Oracle Coherence check box. Select version 12.1.3 from the drop-down list if it is not already displayed.
Adding the Oracle Coherence facet automatically adds the `coherence.jar` to your project class path. It also makes these commonly used configuration files available in the Project Explorer:

- `coherence-cache-config.xml`, the default cache configuration file.
- `pof-config.xml`, the configuration file for Portable Object Format serialization.
- `tangosol-coherence-override.xml`, the override file for operational and runtime settings used by Coherence.

**Figure 2–4  Selecting Oracle Coherence in the Project Facets Dialog Box**

4. Click **Save As** to enter a name for the configuration in the **Save Preset** dialog box. For example, enter `CoherenceConfig` in the **Name** field and `Includes Coherence Facet` in the **Description** field.

**Figure 2–5  Specifying a Configuration Name in the Save Preset Dialog Box**
Click **OK** to close the **Save Preset** dialog box. Click **OK** to close the **Project Facets** dialog box.

5. Click **Next** in the **Java** page of the **New Application Client Project** dialog box to accept the defaults.

6. Deselect the **Create a default Main class** in the **Application Client Module** page. Click **Next**.

7. In the **Coherence** page, illustrated in **Figure 2–6**, add the Coherence 12.1.3 library as a User Library to the project.

**Figure 2–6  Creating a Coherence User Library**

![Image of Coherence User Library](image)

a. Click the **Manage Libraries...** icon, then click **New** in the **Preferences** dialog box.

b. Enter **Coherence12.1.3** in the **New User Library** dialog box, as illustrated in **Figure 2–7**. Select the **System library (added to the boot class path)** check box. Click **OK** to close the **New User Library** dialog box.
Launching a Cache Server in the Eclipse IDE

1. Right click the project in the Eclipse IDE. Select Run As then Run Configurations. In the Run Configurations dialog box, select Oracle Coherence then the New launch configuration icon. Enter DefaultCacheServer as the name for the cache server configuration.
2. Under Project, click Browse and select the name of the project from the Project Selection dialog box.

3. Under Main class, select the Include system libraries when searching for a main class checkbox. Click the Search button and enter DefaultCacheServer in the Select Main Type dialog box. Select com.tangosol.net.DefaultCacheServer and click OK. Click Apply. The Main tab should look similar to Figure 2–9.

![Figure 2–9 Main Tab in the Run Configurations Dialog Box](image)

4. In the Coherence tab, select the General tab. Click the Browse icon to navigate to the cache configuration file if it is not already selected. Select local storage to be enabled (cache server). Enter a unique value, such as 3155 for the Cluster port. Click Apply. The Coherence tab should look similar to Figure 2–10.
5. Open the **Arguments** tab. Enter `-showversion` in the **VM Arguments** field. Click **Apply**.

6. Open the **Common** tab of the dialog box. Click the **Shared file** radio button and click **Browse** to navigate to the project. Click **Apply**. The **Common** tab should look similar to Figure 2–11.
Click Run to start the cache server. The cache server should start and display output similar to Example 2–1.

**Example 2–1 Cache Server Output in the Eclipse Console Window**

```
java version "1.7.0_25"
Java(TM) SE Runtime Environment (build 1.7.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)

2013-11-14 11:47:51.241/0.562 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2013-11-14 11:47:51.366/0.687 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
2013-11-14 11:47:51.444/0.765 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "file:/C:/home/oracle/workspace/Coherence/build/classes/tangosol-coherence-override.xml"
2013-11-14 11:47:51.459/0.780 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override 'cache-factory-config.xml' is not specified
2013-11-14 11:47:51.459/0.780 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override 'cache-factory-builder-config.xml' is not specified
2013-11-14 11:47:51.459/0.780 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override '/custom-mbeans.xml' is not specified

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
Copyright (c) 2000, 2013, Oracle and/or its affiliates. All rights reserved.

2013-11-14 11:47:52.418/1.568 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/coherence-cache-config.xml'
2013-11-14 11:47:52.589/1.738 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/internal-txn-cache-config.xml'
2013-11-14 11:47:53.145/2.466 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
```
Launching a Cache Server in the Eclipse IDE

2013-11-14 11:47:54.128/3.449 Oracle Coherence GE 12.1.3.0.0 <D4> (thread=main, member=n/a): TCMP bound to /10.159.162.203:8088 using SystemDatagramSocketProvider

2013-11-14 11:47:58.107/7.428 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=Cluster, member=n/a):
2013-11-14 11:47:58.107/7.428 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
Started cluster Name=cluster:0x47DB

Group(Address=224.12.1.0, Port=3155, TTL=4)

MasterMemberSet{
  ThisMember=Member(Id=1, Timestamp=2013-11-14 11:47:54.535, Address=10.159.162.203:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7096, Role=CoherenceServer)
  OldestMember=Member(Id=1, Timestamp=2013-11-14 11:47:54.535, Address=10.159.162.203:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7096, Role=CoherenceServer)
  ActualMemberSet=MemberSet(Size=1
    Member(Id=1, Timestamp=2013-11-14 11:47:54.535, Address=10.159.162.203:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7096, Role=CoherenceServer)
  )

  MemberId|ServiceVersion|ServiceJoined|MemberState
  1|12.1.3|2013-11-14 11:47:54.535|JOINED

RecycleMillis=1200000
RecycleSet=MemberSet(Size=0)

TcpRing{Connections=[]}
IpMonitor{Addresses=0}

2013-11-14 11:47:58.138/7.459 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Service Management joined the cluster with senior service member 1
2013-11-14 11:47:58.139/7.460 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=1): Loaded Reporter configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/reports/report-group.xml"
2013-11-14 11:47:59.107/8.428 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=1): Service DistributedCache joined the cluster with senior service member 1
2013-11-14 11:47:59.153/8.474 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=OptimisticCache, member=1): Service OptimisticCache joined the cluster with senior service member 1
2013-11-14 11:47:59.154/8.475 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:InvocationService, member=1): Service InvocationService joined the cluster with senior service member 1
2013-11-14 11:47:59.154/8.475 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=1):
Services
{
  ClusterService(Name=Cluster, State=(SERVICE_STARTED, STATE_JOINED), Id=0, Version=12.1.3, OldestMemberId=1)
  InvocationService(Name=Management, State=(SERVICE_STARTED), Id=2, Version=12.1.3, OldestMemberId=1)
PartitionedCache(Name=DistributedCache, State=(SERVICE_STARTED), LocalStorage=enabled, PartitionCount=257, BackupCount=1, AssignedPartitions=220, BackupPartitions=0)
ReplicatedCache(Name=ReplicatedCache, State=(SERVICE_STARTED), Id=4, Version=12.1.3, OldestMemberId=1)
Optimistic(Name=OptimisticCache, State=(SERVICE_STARTED), Id=5, Version=12.1.3, OldestMemberId=1)
InvocationService(Name=InvocationService, State=(SERVICE_STARTED), Id=6, Version=12.1.3, OldestMemberId=1)

Started DefaultCacheServer...

Learning Eclipse IDE Basics

This section describes common tasks that are a part of building projects in the Eclipse IDE.

- Creating a Java Class
- Creating a Runtime Configuration
- Stopping Cache Servers

Creating a Java Class

To create a new Java class in the Eclipse IDE:

1. Right-click the project entry in the Project Explorer window. Select New then Class.
2. In the New Java Class dialog box, enter a package name. In this tutorial, the value will typically be com.oracle.handson.
3. Enter the name of the class in the Name field.
4. Under Which method stubs would you like to create?:
   - Select the public static void main(String[]args) if you want the file to be runnable.
   - Select Constructors from superclass check box if you want stubs of the constructors from the new class's superclass to be added.
   - Inherited abstract methods should be selected by default. This option adds stubs of any abstract methods from superclasses or methods of interfaces that need to be implemented.
5. Click OK to create the Java class.

Figure 2–12 illustrates the New Java Class dialog box.
Creating a Runtime Configuration

To create a runtime configuration for a runnable file:

1. Right click the name of the runnable file in the Project Explorer window. Select Run As then Run Configurations.

2. Click Oracle Coherence, then the New Launch Configuration icon. Select the Java Application node. Click the New Launch Configuration button.

3. Enter a name for the new configuration. Under Project in the Main tab, click the Browse button to navigate to the name of the current project. Click the Search button to navigate to the name of the runnable file for which you are creating the runtime configuration. Click Apply.

This figure illustrates the Main tab of the Run Configurations dialog box.
4. Click the Coherence tab. Under the General tab, you can set many of the more commonly used VM runtime arguments for the configuration. Examples of runtime arguments include the path to the cache configuration descriptor, and the local storage, log level, and cluster port values.

Figure 2–14 illustrates the General tab of the Coherence tab in the Run Configurations dialog box.
Stopping Cache Servers

In the Eclipse IDE, you can stop any running cache server or client by clicking the Terminate and Remove all terminated launches icons in the Eclipse Console.

However, if you look in the Windows Task Manager window, you might notice that the Java process (java.exe) associated with the server or client is still running. To prevent any errors being thrown when the server or client is restarted, you must delete its associated Java process. Select the Java process in the Windows Task Manager window and click End Process.

Figure 2–15 illustrates the Windows Task Manager window with the Java process selected.

Figure 2–15  Java Process in the Windows Task Manager
Accessing the Data Grid from Java

In this exercise, you develop a simple, Java console-based application to access, update, and remove simple types of information from a Coherence clustered cache. You also are introduced to the Coherence NamedCache and CacheFactory Java APIs.

Using the Eclipse IDE, you will perform the following tasks:

- Create a new project
- Create a new named cache (NamedCache object)
- Put information into the cache and then retrieve it
- Retrieve information about the cache

This chapter contains the following sections:

- Introduction
- Creating Your First Coherence-Based Java Program
- Creating Your First Coherence-Based Java Application

Introduction

All Coherence caches are named, have a lifetime scoped by the cluster instance in which they exist, and implement the com.tangosol.net.NamedCache interface. The NamedCache interface is an extension of the java.util.Map interface and holds data and resources that are shared among the cluster members. Each NamedCache object holds data as key/value pairs. Keys and values can be both simple and complex object types. The NamedCache interface provides extensions to the Map interface, such as locking and synchronization, storage integration, queries, event aggregations, and transactions. Table 3–1 describes some of the commonly used methods within the NamedCache interface.

<table>
<thead>
<tr>
<th>Method Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>void clear()</td>
<td>Removes all entries from the NamedCache object.</td>
</tr>
<tr>
<td>boolean containsKey(Object key)</td>
<td>Returns true if the NamedCache object contains an entry for the key.</td>
</tr>
<tr>
<td>boolean containsValue(Object value)</td>
<td>Returns true if there is at least one entry with this value in the NamedCache object.</td>
</tr>
<tr>
<td>Object get(Object key)</td>
<td>Gets the entry from the NamedCache object for that key.</td>
</tr>
</tbody>
</table>
Creating Your First Coherence-Based Java Program

This section describes how to create a Java program that enables you to access, update, and remove simple types of information from a Coherence clustered cache.

1. Create a Program to Put Values in the Cache
2. Create a Program to Get Values from the Cache

Create a Program to Put Values in the Cache

To create a Coherence Java-based application:

1. Create a new Application Client Project in Eclipse. Name the project InsertValue. Ensure that the folder is C:\home\oracle\workspace\InsertValue.

   In the Configuration section of the New Application Client Project dialog box, click Modify. In the Project Facets dialog box, select CoherenceConfig from the Configuration drop down list.

   See "Creating a New Project in the Eclipse IDE" on page 2-3 for detailed instructions.

2. Create your first Coherence Java program. Name the class MyFirstSample and select the public static void main(String[] args) check box in the New Java Class dialog box.
See "Creating a Java Class" on page 2-11 for detailed information.

3. In the Eclipse editor, write the code to create a NamedCache object, enter a value in the cache, and then verify the value that you entered. Example 3–1 illustrates a sample program.

Example 3–1  Creating a NamedCache Object: Inserting and Verifying Values

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

public class MyFirstSample {
    public MyFirstSample() {
    }

    public static void main(String[] args) {
        // create or get a named cache called mycache
        NamedCache myCache = CacheFactory.getCache("mycache");

        // put key, value pair into the cache.
        myCache.put("Name","Gene Smith");

        System.out.println("Value in cache is " + myCache.get("Name"));
    }
}
```


5. Run the program in the Eclipse IDE: right-click the MyFirstSample.java class in the editor and select Run As then Run Configuration. Double-click Oracle Coherence to create a Coherence configuration. Enter MyFirstSample in the Name field of the Run Configuration dialog box.

   In the Main tab, enter InsertValue in the Project field and com.oracle.handson.MyFirstSample in the Main class field.

   In the Coherence tab, enter a unique value, such as 3155, in the Cluster port field to ensure that Coherence is limited to your own host. Select Enabled (cache server) under Local storage.

   Note that in the Classpath tab, the coherence.jar file should be present in the Bootstrap Entries list. Click Apply, then Run.

   Messages similar to Example 3–2 are displayed:

Example 3–2  Output of MyFirstSample Program

```
2013-11-14 14:46:52.652/0.343 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2013-11-14 14:46:52.746/0.437 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "file:/C:/home/oracle/workspace/InsertValue/build/classes/tangosol-coherence-override.xml"
```
Creating Your First Coherence-Based Java Program

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
Copyright (c) 2000, 2013, Oracle and/or its affiliates. All rights reserved.

2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
Copyright (c) 2000, 2013, Oracle and/or its affiliates. All rights reserved.

2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
Copyright (c) 2000, 2013, Oracle and/or its affiliates. All rights reserved.

2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2013-11-14 14:46:52.855/0.546 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
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Creating Your First Coherence-Based Java Program

Accessing the Data Grid from Java

Create a Program to Get Values from the Cache

To create a Java class that gets the value from your cache, instead of using a put and then a get method:

1. Create another Java class with a main method named MyFirstSampleReader. See "Creating a Java Class" on page 2-11 for detailed information. Example 3–3 illustrates a sample program.

Example 3–3  Getting a Value from the Cache

```
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

public class MyFirstSampleReader {
    public MyFirstSampleReader() {
    }

    public static void main(String[] args) {
        // ensure we are in a cluser
        CacheFactory.ensureCluster();

        // create or get a named cache called mycache
        NamedCache myCache = CacheFactory.getCache("mycache");

        System.out.println("Value in cache is " + myCache.get("Name"));
    }
}
```

2. Run the MyFirstSampleReader class in the Eclipse IDE: right-click the MyFirstSampleReader.java class in the editor and select Run As then Run Configuration.

Enter MyFirstSampleReader in the Name field of the Run Configuration dialog box. Ensure that InsertValue appears in the Project field in the Main tab and com.oracle.handson.MyFirstSampleReader appears in the Main class field. In the Coherence tab, ensure that local storage is enabled and Cluster port is set to 3155 to limit Coherence to your own host. Click Apply, then Run.

Example 3–4 illustrates the output from the program. Note that a null value is returned. Although the MyFirstSample program successfully created and populated the NamedCache cache, it only existed within the MyFirstSample process memory. When the MyFirstSample program terminated so did the cache.

Example 3–4  Output of the MyFirstSampleReader Program

```
2013-11-14 14:55:44.990/0.327 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml'
```

2013-11-14 14:47:00.190/7.881 Oracle Coherence GE 12.1.3.0.0 <DS> (thread=DistributedCache, member=1): This member has become the distribution coordinator for MemberSet(Size=1 Member(Id=1, Timestamp=2013-11-14 14:46:55.665, Address=10.159.162.203:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:8184, Role=OracleHandsonMyFirstSample)

Value in cache is Gene Smith

```
Creating Your First Coherence-Based Java Program

Start the DefaultCacheServer that you created in "Launching a Cache Server in the Eclipse IDE" on page 2-6. Ensure that InsertValue appears in the Project field in the Main tab and that local storage is enabled in the Coherence tab. Click Apply, then Run.

Run MyFirstSample to put the value in the NamedCache, and then run MyFirstSampleReader to read the value from the cache. Note the output illustrated in Example 3–5. The Gene Smith value stored by MyFirstSample is returned by MyFirstSampleReader.

Example 3–5 Output of MyFirstSampleReader Program with a Running Cache Server

Value in cache is null

3. Start the DefaultCacheServer that you created in "Launching a Cache Server in the Eclipse IDE" on page 2-6. Ensure that InsertValue appears in the Project field in the Main tab and that local storage is enabled in the Coherence tab. Click Apply, then Run.

4. Run MyFirstSample to put the value in the NamedCache, and then run MyFirstSampleReader to read the value from the cache. Note the output illustrated in Example 3–5. The Gene Smith value stored by MyFirstSample is returned by MyFirstSampleReader.

Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2013-11-14 15:07:25.112/0.546 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
2013-11-14 15:07:25.112/0.546 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2013-11-14 15:07:25.112/0.546 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2013-11-14 15:07:25.112/0.546 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified
Creating Your First Coherence-Based Java Program

MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:6980, Role=CoherenceServer,
2013-11-14 15:07:28.422/3.856 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
Started cluster Name=cluster:0x47DB

Group(Address=224.12.1.0, Port=3155, TTL=4)

MasterMemberSet(
  ThisMember=Member(Id=3, Timestamp=2013-11-14 15:07:28.156, Address=10.159.162.203:8090,
  MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:8096,
  Role=OracleHandsonMyFirstSampleReader)
  OldestMember=Member(Id=1, Timestamp=2013-11-14 15:06:21.971, Address=10.159.162.203:8088,
  MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:6980, Role=CoherenceServer)
  ActualMemberSet=MemberSet(Size=2
    Member(Id=1, Timestamp=2013-11-14 15:06:21.971, Address=10.159.162.203:8088, MachineId=47251,
    Location=site:,machine:TPFAEFFL-LAP,process:6980, Role=CoherenceServer)
    Member(Id=3, Timestamp=2013-11-14 15:07:28.156, Address=10.159.162.203:8090, MachineId=47251,
    Location=site:,machine:TPFAEFFL-LAP,process:8096, Role=OracleHandsonMyFirstSampleReader)
  )
MemberId|ServiceVersion|ServiceJoined|MemberState
1|12.1.3|2013-11-14 15:06:21.971|JOINED,
3|12.1.3|2013-11-14 15:07:28.156|JOINED
RecycleMillis=1200000
RecycleSet=MemberSet(Size=1
  Member(Id=2, Timestamp=2013-11-14 15:06:53.752, Address=10.159.162.203:8090, MachineId=47251)
)

TcpRing{Connections=[1]}
IpMonitor{Addresses=0}

2013-11-14 15:07:28.453/3.887 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=3): Service Management joined the cluster with senior service member 1
2013-11-14 15:07:28.469/3.903 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded Reporter configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/reports/report-group.xml"
2013-11-14 15:07:28.906/4.340 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=3): TcpAcceptor now listening for connections on 10.159.162.203:8090.3
2013-11-14 15:07:29.280/4.714 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded cache configuration from "jar:/file:C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/coherence-cache-config.xml"
2013-11-14 15:07:29.389/4.823 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded cache configuration from "jar:/file:C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/internal-txn-cache-config.xml"
2013-11-14 15:07:29.593/5.027 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2013-11-14 15:07:29.671/5.105 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=3): Service DistributedCache joined the cluster with senior service member 1

**Value in cache is Gene Smith**


This should not be the case for a process that joins the cluster only to perform an operation, such as entering a value and then terminating, like MyFirstSample. By default, all processes start as storage-enabled. The process can store data as part of the cluster. Modify the process so that it is not storage-enabled.
Creating Your First Coherence-Based Java Application

In this exercise, you develop a simple Java console-based application to access, update, and remove simple types of information from a Coherence clustered cache.

To perform this exercise, you must complete "Testing a Coherence Installation" on page 1-2.

Example 3–6  Output of the MyFirstSample Class with Cache Storage Disabled

...  
TcpRing{Connections=[]}
IpMonitor{Addresses=0}

2013-11-14 15:11:40.253/7.019 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Service Management joined the cluster with senior service member 1
2013-11-14 15:11:40.284/7.070 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=1): Loaded Reporter configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/reports/report-group.xml"
2013-11-14 15:11:40.721/7.507 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=1): TcpAcceptor now listening for connections on 10.159.162.203:8088.3
2013-11-14 15:11:41.080/7.866 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=1): Service DistributedCache joined the cluster with senior service member 1

Exception in thread "main" com.tangosol.net.RequestPolicyException: No storage-enabled nodes exist for service DistributedCache

at com.tangosol.coherence.component.util.daemon.queueProcessor.service.grid.
partitionedService.PartitionedCache$BinaryMap.onMissingStorage(PartitionedCache.CDB:27)
at com.tangosol.coherence.component.util.daemon.queueProcessor.service.grid.
partitionedService.PartitionedCache$BinaryMap.ensureRequestTarget(PartitionedCache.CDB:43)
at com.tangosol.coherence.component.util.daemon.queueProcessor.service.grid.
partitionedService.PartitionedCache$BinaryMap.put(PartitionedCache.CDB:23)
at com.tangosol.coherence.component.util.daemon.queueProcessor.service.grid.
partitionedService.PartitionedCache$BinaryMap.put(PartitionedCache.CDB:1)
at com.oracle.common.collections.ConverterCollections$ConverterMap.
put(ConverterCollections.java:1531)
at com.tangosol.coherence.component.util.daemon.queueProcessor.service.grid.
partitionedService.PartitionedCache$ViewMap.put(PartitionedCache.CDB:1)
at com.tangosol.coherence.component.util.SafeNamedCache.put(SafeNamedCache.CDB:1)
at com.oracle.handson.MyFirstSample.main(MyFirstSample.java:16)

6. Restart the DefaultCacheServer cache server and run MyFirstSample and MyFirstSampleReader again. You should now see that the data is persisted between running the two Java examples.
Unlike client/server applications, in which client applications typically connect and disconnect from a server application, Coherence-based clustered applications simply ensure they are in a cluster, after which they can use the services of the cluster. Coherence-based applications typically do not connect to a cluster of applications; they become part of the cluster.

1. **Create the Console Application**
2. **Run the Console Application**

**Create the Console Application**

To create a Java console-based application to access, update, and remove simple types of information from a Coherence clustered cache:

1. Examine the methods in the `CacheFactory` class using the Coherence Java documentation (Javadoc) that is shipped in the `.\coherence\doc` folder.
2. Write a simple Java console application (Java class) called `YourFirstCoherenceApplication` that uses the `CacheFactory` class to join a cluster (using the `ensureCluster` method), and then leave the cluster (using the `shutdown` method). See "Creating a Java Class" on page 2-11 for detailed information on creating a Java class.
   a. Examine the methods that are available in the `NamedCache` interface using the Javadoc.
   b. Extend your application to use the `CacheFactory` method `getCache` to acquire a `NamedCache` for the cache called `mycache` (the same cache name used in the exercise "Testing a Coherence Installation" on page 1-2).
   c. With the `NamedCache` instance, use the `get` method to retrieve the value for the key `message` (the same key used in the exercise "Testing a Coherence Installation" on page 1-2).
   d. Write the value to standard output using the `System.out.println(...)` method.

Example 3–7 illustrates a sample Coherence-based Java application:

**Example 3–7  A Coherence-Based Java Application**

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

public class YourFirstCoherenceApplication {
    public YourFirstCoherenceApplication() {
    }

    public static void main(String[] args) {
        CacheFactory.ensureCluster();

        NamedCache myCache = CacheFactory.getCache("mycache");

        String message = (String)myCache.get("message");

        System.out.println(message);

        CacheFactory.shutdown();
    }
}
```
Run the Console Application

To run the Coherence application.


2. Create a run configuration for a cache client that uses Coherence Query Language and the QueryHelper API. Right-click the project and select Run As then Run Configurations.

   a. In the Run Configurations dialog box click Oracle Coherence then the New launch configuration icon. Enter QueryPlus as the Name of the configuration.

   b. In the Main tab, under Project click the Browse button and select the InsertValue project. Under Main class, select Include system libraries when searching for a main class and click the Search button. In the Select Main Type dialog box, enter QueryPlus and select QueryPlus - com.tangosol.coherence.dslquery. Click OK. The Main tab should look similar to Figure 3–1.

   c. In the Coherence tab, select Disabled (cache client) under Local storage. Enter a unique value for the Cluster port (the value must be the same as the value defined for the cache server you defined in the previous section).

   d. In the Arguments tab, enter -showversion in the VM arguments field.

   e. In the Common tab, select Shared file and click the Browse button to navigate to the \InsertValue project name. Ensure that the Allocate console checkbox is selected. Click Apply.
3. Click **Run** to start the QueryPlus client. You should see output similar to **Example 3–8** in the Eclipse Console.

**Example 3–8  Output for the QueryPlus Cache Client**

```
java version "1.7.0_25"
Java(TM) SE Runtime Environment (build 1.7.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)

Coherence Command Line Tool
jline library cannot be loaded, so you cannot use the arrow keys for line editing and history.

CohQL>
```

4. At the **CohQL>** prompt, enter the following command to create a cache named `mycache` and to connect to it.

```
CohQL> create cache "mycache"
```

5. Create a run configuration for **YourFirstCoherenceApplication**. In the **Run Configurations** dialog box, enter **YourFirstCoherenceApplication** in the **Name** field. In the **Main** tab, enter **InsertValue** in the **Project** field and **com.oracle.handson.YourFirstCoherenceApplication** as the **Main class**.

In the Coherence tab, select **Enabled (cache server)** under **Local storage**, and enter a unique value for the **Cluster port** (this must be the same value that you used for the cache server and cache client).

6. Execute **YourFirstCoherenceApplication** from the Eclipse IDE and view the result.

**Example 3–9** illustrates the output from **YourFirstCoherenceApplication**. The output indicates that there is no data in the cache for the `message` key.

**Example 3–9  Output of the YourFirstCoherenceApplication Class**

```
... 
TcpRing{Connections=[2]}
IpMonitor{Addresses=0}

2013-11-14 15:41:33.008/3.793 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=3): Service Management joined the cluster with senior service member 1
2013-11-14 15:41:33.039/3.824 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded Reporter configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/reports/report-group.xml"
2013-11-14 15:41:33.570/4.355 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=3): TcpAcceptor now listening for connections on 10.159.162.203:8092.3
2013-11-14 15:41:33.975/4.760 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded cache configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/coherence-cache-config.xml"
2013-11-14 15:41:34.132/4.917 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Loaded cache configuration from "jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/internal-txn-cache-config.xml"
2013-11-14 15:41:34.475/5.260 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=3): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2013-11-14 15:41:34.538/5.323 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=3): Service DistributedCache joined the cluster with senior service member 1
null
```
Creating Your First Coherence-Based Java Application

Accessing the Data Grid from Java

7. Using the running QueryPlus cache client in the Eclipse Console, change the key message. For example, enter the following at the CohQL> prompt:

   CohQL> insert into 'mycache' key 'message' value 'hello'

Rerun YourFirstCoherenceApplication from the Eclipse IDE to see the changed values. Example 3–10 illustrates that the cache now holds the value hello for the key message.

Example 3–10 Output of the YourFirstCoherenceApplication Class with a New Key Value

...  
TcpRing{Connections=[2]}
IpMonitor{Addresses=0}

8. In the run configuration for YourFirstCoherenceApplication, change the value of the Local storage from Enabled to Disabled. Notice that the output is the same as the previous run.

9. Shut down your cache server and cache client instances. Restart the cache server and then rerun YourFirstCoherenceApplication (with the new value for Local storage). Note the output is now null.

10. If you change the value of the message key in your application (using the put method), verify that the new value available through the cache client.

   a. For example, comment out the get method and add the put method.
//String message = (String)myCache.get("message");
String message = (String)myCache.put("message", "bye");

b. Run YourFirstCoherenceApplication.

c. Run the get command in the QueryPlus cache client.

```
select key(), value() from "mycache" where key() is "message"
```

The output bye is displayed.
In this exercise, you work with complex objects located in the cache. It highlights the use of the Coherence PofReader, PofWriter, and PortableObject API. Using Eclipse, you create a new Contact class, and then store and retrieve Contact objects in the cache using Portable Object Format (POF) serialization.

This chapter contains the following sections:

- Introduction
- Creating and Caching Complex Objects

**Introduction**

Until now, you have been putting and getting String objects as the value in a NamedCache cache. Many of the implementations of the get and put methods in the Coherence Java API define the values and keys to be of type Object, for example:

```java
public java.lang.Object get(java.lang.Object oKey)
public void put(java.lang.Object oKey, java.lang.Object oValue)
```

Any object can be used as a value or key. This enables you to store complex objects as values in the cache.

Because Coherence might send the object across the wire, the object must be serializable. Object serialization is the process of saving an object’s state into a sequence of bytes, and then rebuilding (deserializing) the bytes into an active object at a future time. For example, objects that implement the java.io.Serializable interface are serializable.

As an alternative to using the Java java.io.Serializable interface, you can improve performance by using Coherence’s own class for high-performance serialization, com.tangosol.io.pof.PortableObject. PortableObject format is up to six times faster than the standard Serializable and the serialized result set is smaller.

The PortableObject interface provides two simple methods, readExternal and writeExternal, that permit you to explicitly read and write serialized object attributes from the provided PofReader and PofWriter streams respectively. By taking control over the serialization format, Coherence provides a way to improve the performance of the process. Using POF reduces the size of the resulting binary file. The size of the binary file is often 5 to 10 times smaller, and the conversion to or from the binary file can be between 5 and 20 times faster, depending on the size of the object.
Creating and Caching Complex Objects

In this exercise, you create a Contact object that contains names, addresses, dates of birth, and telephone numbers for employees. You also use POF serialization to put the objects in the cache and retrieve them by implementing the PortableObject interface.

1. Create the Data Objects
2. Create the Complex Object
3. Create the Driver Class
4. Create the POF and Cache Configuration Files
5. Run the Sample Project

Create the Data Objects

This section describes how to create two data objects that will later be incorporated into another data object. An Address object will provide employee address information and a PhoneNumber object will provide telephone contact information.

1. Create an Address object to store address information for an employee.
   a. Create a new Application Client Project in Eclipse called Contacts. Ensure that the CoherenceConfig is selected in the Configuration field on the opening page and the Create a default main is not selected on the Application Client module page.
      See "Creating a New Project in the Eclipse IDE" on page 2-3 for detailed information.
   b. Create a new Java class called Address. Ensure that the Default Package is com.oracle.handson. Do not select the Main Method check box. See "Creating a Java Class" on page 2-11 for detailed information.
   c. Write the class to use the PortableObject interface for data serialization. In the Eclipse code editor, change your generated Address class to implement com.tangosol.io.pof.PortableObject. Add an import statement for the PortableObject interface.
   e. Add the default public constructor for Address that is required by the PortableObject interface.
   f. Enter the following private attributes for your Address class. You can add others if you like.
      — String Street1
      — String Street2
      — String City
      — String State
      — String Country
      At this point, the Address class should look similar to the following:

package com.oracle.handson;
import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.io.pof.PofWriter;

import java.io.IOException;

public class Address implements PortableObject {
    private String Street1;
    private String Street2;
    private String City;
    private String State;
    private String Zip;
    private String Country;

    /**
     * Default constructor (necessary for PortableObject implementation).
     */
    public Address() {
    }
}

g. Eclipse can generate the default get and set methods for your attributes. From the Source menu, select Generate Getters and Setters. Click Select All to select all of the attributes in the class. All of the attributes are now automatically selected. Click OK to continue.

Figure 4–1 illustrates the Generate Getters and Setters dialog box with the generated accessors for the Address class.
You can also generate the default constructor and equals methods automatically. From the Source menu, select Generate Constructor using Fields, click Select All, and then click OK.

Figure 4–2 illustrates the Generate Constructor using Fields dialog box with the Street1, Street2, City, State, Zip, and Country fields selected.
Add "this" to the members of the generated constructor. The generated constructor should then look similar to the following:

```java
public Address(String Street1, String Street2, String City, String State, String Zip, String Country) {
    super();
    this.Street1 = Street1;
    this.Street2 = Street2;
    this.City = City;
    this.State = State;
    this.Zip = Zip;
    this.Country = Country;
}
```

i. Implement the `readExternal` and `writeExternal` methods as required by the `PortableObject` interface. For example, the following implementation of the `readExternal` method enables the values for the street, city, state, and country to be read as POF objects.

```java
public void readExternal(PofReader reader) throws IOException {
    setStreet1(reader.readString(0));
    setStreet2(reader.readString(1));
    setCity(reader.readString(2));
    setState(reader.readString(3));
    setZip(reader.readString(4));
    setCountry(reader.readString(5));
}
```

j. Implement the `equals`, `hashCode`, and `toString` object methods.
Note: Cache keys and values must be serializable (for example, java.io.Serializable). Cache keys must also provide an implementation of the hashCode() and equals() methods, and those methods must return consistent results across cluster nodes. This implies that the implementation of hashCode() and equals() must be based solely on the object’s serializable state (that is, the object’s nontransient fields); most built-in Java types, such as String, Integer and Date, meet this requirement. Some cache implementations (specifically the partitioned cache) use the serialized form of the key objects for equality testing, which means that keys for which the equals() method returns true must serialize identically; most built-in Java types meet this requirement.

To support these methods, import the com.tangosol.util.Base and com.tangosol.util.HashHelper classes. The Base class provides support for the equals method. The HashHelper class contains helper functions for calculating hash code values for any group of Java intrinsics.

The following code illustrates a sample implementation of the equals() method:

```java
public boolean equals(Object oThat)
{
    if (this == oThat)
    {
        return true;
    }
    if (oThat == null)
    {
        return false;
    }
    Address that = (Address) oThat;
    return Base.equals(getStreet1(), that.getStreet1()) &&
           Base.equals(getStreet2(), that.getStreet2()) &&
           Base.equals(getCity(), that.getCity()) &&
           Base.equals(getState(), that.getState()) &&
           Base.equals(getZip(), that.getZip()) &&
           Base.equals(getCountry(), that.getCountry());
}
```

The following code illustrates a sample implementation of the hashCode() method:

```java
public int hashCode()
{
    return HashHelper.hash(getStreet1(),
                            HashHelper.hash(getStreet2(),
                                            HashHelper.hash(getZip(), 0)));
}
```

The following code illustrates a sample implementation of the toString() method:

```java
public String toString()
{
    return getStreet1() + "\n" +
           getStreet2() + "\n" +
           getCity() + "\n" +
           getState() + "\n" +
           getZip() + "\n" +
           getCountry() + "\n";
}
```
Creating and Caching Complex Objects

Working with Complex Objects

getCity() + " , " + getState() + " " + getZip() + " \n" + getCountry();
}

k. The resulting class should look similar to Example 4–1.

Example 4–1 Implementation of an Address Class

package com.oracle.handson;
import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.io.pof.PofWriter;
import com.tangosol.util.Base;
import com.tangosol.util.HashHelper;
import java.io.IOException;
public class Address implements PortableObject
{
    private String Street1;
    private String Street2;
    private String City;
    private String State;
    private String Zip;
    private String Country;
    /**
     * Default constructor (necessary for PortableObject implementation).
     */
    public Address()
    {
    }
    public Address(String Street1, String Street2, String City, String State,
    String Zip, String Country)
    {
        super();
        this.Street1 = Street1;
        this.Street2 = Street2;
        this.City = City;
        this.State = State;
        this.Zip = Zip;
        this.Country = Country;
    }
    //------------ accessors--------------------------------
    public void setStreet1(String Street1)
    {
        this.Street1 = Street1;
    }
    public String getStreet1()
    {
        return Street1;
    }
    public void setStreet2(String Street2)
    {
        this.Street2 = Street2;
public String getStreet2()
{
    return Street2;
}

public void setCity(String City)
{
    this.City = City;
}

public String getCity()
{
    return City;
}

public void setState(String State)
{
    this.State = State;
}

public String getState()
{
    return State;
}

public void setZip(String Zip)
{
    this.Zip = Zip;
}

public String getZip()
{
    return Zip;
}

public void setCountry(String Country)
{
    this.Country = Country;
}

public String getCountry()
{
    return Country;
}

// -------- PortableObject Interface----------------------------

public void readExternal(PofReader reader)
    throws IOException
{
    setStreet1(reader.readString(0));
    setStreet2(reader.readString(1));
    setCity(reader.readString(2));
    setState(reader.readString(3));
    setZip(reader.readString(4));
    setCountry(reader.readString(5));
}

public void writeExternal(PofWriter writer)
throws IOException
{
  writer.writeString(0, getStreet1());
  writer.writeString(1, getStreet2());
  writer.writeString(2, getCity());
  writer.writeString(3, getState());
  writer.writeString(4, getZip());
  writer.writeString(5, getCountry());
}

// ----- Object methods -----------------------------------------------

public boolean equals(Object oThat)
{
  if (this == oThat)
  {
    return true;
  }
  if (oThat == null)
  {
    return false;
  }
  Address that = (Address) oThat;
  return Base.equals(getStreet1(), that.getStreet1()) &&
         Base.equals(getStreet2(), that.getStreet2()) &&
         Base.equals(getCity(), that.getCity()) &&
         Base.equals(getState(), that.getState()) &&
         Base.equals(getZip(), that.getZip()) &&
         Base.equals(getCountry(), that.getCountry());
}

public int hashCode()
{
  return HashHelper.hash(getStreet1(),
             HashHelper.hash(getStreet2(),
                             HashHelper.hash(getZip(), 0)));
}

public String toString()
{
  return getStreet1() + "\n" +
         getStreet2() + "\n" +
         getCity() + "," + getState() + "" + getZip() + "\n" +
         getCountry();
}

2. Create a PhoneNumber class to store telephone contact data.
   a. Create a new Java class called PhoneNumber. Do not include a main method.
      See "Creating a Java Class" on page 2-11 for detailed information.
   b. Use the PortableObject interface for data serialization. In the Eclipse code
      editor, change your generated PhoneNumber class to implement PortableObject. Add an import statement for the com.tangosol.io.
pof.PortableObject interface.

d. Add the default public constructor for the `PhoneNumber` class that is required by the `PortableObject` interface.

e. Enter the following private attributes for your `PhoneNumber` class. You can add others.

   — `short AccessCode`
   — `short CountryCode`
   — `short AreaCode`
   — `int LocalNumber`

f. Eclipse can generate the default `get` and `set` methods for your attributes. From the `Source` menu, select `Generate Getters and Setters`. Click `Select All` to select all of the attributes in the class. All of the attributes are now automatically selected. Click `OK` to continue.

g. You can also generate the default constructor and `equals` methods automatically. From the `Source` menu, select `Generate Constructor using Fields`, click `Select All`, and then click `OK`.

   Add "this" to the members of the generated constructor. The generated constructor then looks similar to the following:

   ```java
   public PhoneNumber(short AccessCode, short CountryCode, short AreaCode, int LocalNumber) {
       super();
       this.AccessCode = AccessCode;
       this.CountryCode = CountryCode;
       this.AreaCode = AreaCode;
       this.LocalNumber = LocalNumber;
   }
   ```

h. Implement the `readExternal` and `writeExternal` methods as required by the `PortableObject` interface.

i. Implement the `equals`, `hashCode` and `toString` object methods.

j. The resulting class looks similar to Example 4–2.

---

**Example 4–2 Implementation of a PhoneNumber Class**

```java
package com.oracle.handson;

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

import com.tangosol.util.HashHelper;

import java.io.IOException;

public class PhoneNumber implements PortableObject {
    private short AccessCode;
    private short CountryCode;
    private short AreaCode;
```
private int LocalNumber;

//------------ constructors --------------------------------

/**
 * Default constructor (necessary for PortableObject implementation).
 */
public PhoneNumber() {
}

public PhoneNumber(short AccessCode, short CountryCode, short AreaCode,
    int LocalNumber)
{
    super();
    this.AccessCode = AccessCode;
    this.CountryCode = CountryCode;
    this.AreaCode = AreaCode;
    this.LocalNumber = LocalNumber;
}

//------------ accessors--------------------------------

public void setAccessCode(short AccessCode)
{
    this.AccessCode = AccessCode;
}

public short getAccessCode()
{
    return AccessCode;
}

public void setCountryCode(short CountryCode)
{
    this.CountryCode = CountryCode;
}

public short getCountryCode()
{
    return CountryCode;
}

public void setAreaCode(short AreaCode)
{
    this.AreaCode = AreaCode;
}

public short getAreaCode()
{
    return AreaCode;
}

public void setLocalNumber(int LocalNumber)
{
    this.LocalNumber = LocalNumber;
}

public int getLocalNumber()
return LocalNumber;
}

// -------- PortableObject Interface-----------------------------------

public void readExternal(PofReader reader)
   throws IOException
{
   setAccessCode(reader.readShort(0));
   setCountryCode(reader.readShort(1));
   setAreaCode(reader.readShort(2));
   setLocalNumber(reader.readInt(3));
}

public void writeExternal(PofWriter writer)
   throws IOException
{
   writer.writeShort(0, getAccessCode());
   writer.writeShort(1, getCountryCode());
   writer.writeShort(2, getAreaCode());
   writer.writeInt(3, getLocalNumber());
}

// ----- Object methods -------------------------------------------------

/**
   * {@inheritDoc}
   */
public boolean equals(Object oThat)
{
   if (this == oThat)
   {
      return true;
   }
   if (oThat == null)
   {
      return false;
   }
   PhoneNumber that = (PhoneNumber) oThat;
   return getAccessCode() == that.getAccessCode() 
   && getCountryCode() == that.getCountryCode() 
   && getAreaCode() == that.getAreaCode() 
   && getLocalNumber() == that.getLocalNumber();
}

/**
   * {@inheritDoc}
   */
public int hashCode()
{
   return HashHelper.hash(getAreaCode(),
            HashHelper.hash(getLocalNumber(), 0));
}

/**
   * {@inheritDoc}
   */
public String toString()
{
   return "+" + getAccessCode() + " " + getCountryCode() + " " + getAreaCode() + " " + getLocalNumber();
}
Create the Complex Object

The Contact object provides the name, address, and telephone information of employees by incorporating the Address and PhoneNumber data objects.

1. Create a new Java class called Contact. Do not include a main method. See "Creating a Java Class" on page 2-11 for more information.

2. Because the class uses the PortableObject interface for data serialization, change your generated Contact class to implement PortableObject in the Eclipse code editor. Add an import statement for the com.tangosol.io.pof.PortableObject interface.


4. Add the default public constructor for Contact that is required by PortableObject.

5. Enter the following private attributes for your Contact class. You can add others.
   - String FirstName
   - String LastName
   - Address HomeAddress
   - Address WorkAddress
   - Map TelephoneNumbers
   - java.sql.Date BirthDate

6. Eclipse can generate the default get and set methods for your attributes. From the Source menu, select Generate Getters and Setters. Click Select All to select all of the attributes in the class. Click OK to continue.

7. Create an accessor, getAge, to calculate the age of an employee:
   
   ```java
   public int getAge()
   {
       return (int) ((System.currentTimeMillis() - BirthDate.getTime()) / MILLIS_IN_YEAR);
   }
   ```

8. Add a definition for MILLIS_IN_YEAR.

   ```java
   public static final long MILLIS_IN_YEAR = 1000L * 60L * 60L * 24L * 365L;
   ```

9. You can generate the default constructor automatically. From the Source menu, select Generate Constructor using Fields, click Select All, and then click OK. The generated constructor looks similar to the following:

   ```java
   public Contact(String FirstName, String LastName, Address HomeAddress,
                Address WorkAddress, Map TelephoneNumbers, Date BirthDate) {
       super();
       this.FirstName = FirstName;
       this.LastName = LastName;
       this.HomeAddress = HomeAddress;
       this.WorkAddress = WorkAddress;
   }
   ```
10. Implement the `readExternal` and `writeExternal` methods as required by the `PortableObject` interface.

11. Implement the `equals`, `hashCode`, and `toString` object methods.

12. The resulting class looks similar to Example 4–3.

**Example 4–3  Sample Contact Class**

```java
package com.oracle.handson;

import com.tangosol.io.pof.PortableObject;

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

import java.io.IOException;
import java.sql.Date;
import java.util.Iterator;
import java.util.Map;

public class Contact implements PortableObject {
    private String FirstName;
    private String LastName;
    private Address HomeAddress;
    private Address WorkAddress;
    private Map TelephoneNumbers;
    private java.sql.Date BirthDate;

    // ----- constructors ---------------------------------------------------

    /**
     * Default constructor (necessary for PortableObject implementation).
     */
    public Contact() {
    }

    public Contact(String FirstName, String LastName, Address HomeAddress,
        Address WorkAddress, Map TelephoneNumbers, Date BirthDate) {
        super();
        this.FirstName = FirstName;
        this.LastName = LastName;
        this.HomeAddress = HomeAddress;
        this.WorkAddress = WorkAddress;
        this.TelephoneNumbers = TelephoneNumbers;
        this.BirthDate = BirthDate;
    }

    // -------- accessors --------------------------------------------

    public void setFirstName(String FirstName) {
    }
```
this.FirstName = FirstName;
}

public String getFirstName()
{  
    return FirstName;
}

public void setLastName(String LastName)
{  
    this.LastName = LastName;
}

public String getLastName()
{  
    return LastName;
}

public void setHomeAddress(Address HomeAddress)
{  
    this.HomeAddress = HomeAddress;
}

public Address getHomeAddress()
{  
    return HomeAddress;
}

public void setWorkAddress(Address WorkAddress)
{  
    this.WorkAddress = WorkAddress;
}

public Address getWorkAddress()
{  
    return WorkAddress;
}

public void setTelephoneNumbers(Map TelephoneNumbers)
{  
    this.TelephoneNumbers = TelephoneNumbers;
}

public Map getTelephoneNumbers()
{  
    return TelephoneNumbers;
}

public void setBirthDate(Date BirthDate)
{  
    this.BirthDate = BirthDate;
}

public Date getBirthDate()
{  
    return BirthDate;
}

/**
 * Get age.
 */
* @return age
*/
public int getAge()
{
    return (int) ((System.currentTimeMillis() - BirthDate.getTime()) /
                  MILLIS_IN_YEAR);
}

// ----- PortableObject interface ----------------------------------------
/**
 * {@inheritDoc}
 */
public void readExternal(PofReader reader)
    throws IOException
{
    setFirstName(reader.readString(0));
    setLastName(reader.readString(1));
    setHomeAddress((Address) reader.readObject(2));
    setWorkAddress((Address) reader.readObject(3));
    setTelephoneNumbers(reader.readMap(4, null));
    setBirthDate(new Date(reader.readLong(5)));
}

/**
 * {@inheritDoc}
 */
public void writeExternal(PofWriter writer)
    throws IOException
{
    writer.writeString(0, getFirstName());
    writer.writeString(1, getLastName());
    writer.writeObject(2, getHomeAddress());
    writer.writeObject(3, getWorkAddress());
    writer.writeMap(4, getTelephoneNumbers());
    writer.writeLong(5, getBirthDate().getTime());
}

// ----- Object methods ---------------------------------------------------
/**
 * {@inheritDoc}
 */
public String toString()
{
    StringBuffer sb = new StringBuffer(getFirstName()).append(' ').
        append(getLastName()).append('
Addresses').
        append('
Home: ').append(getHomeAddress()).
        append('
Work: ').append(getWorkAddress()).
        append('
Telephone Numbers');
    for (Iterator iter = TelephoneNumbers.entrySet().iterator();
        iter.hasNext(); )
    {
        Map.Entry entry = (Map.Entry) iter.next();
        sb.append('
');
        }
Create the Driver Class

Create a driver class called `ContactDriver` to put `Contact` entries into the cache and retrieve them.

1. Create a new Java class called `ContactDriver` in the `Contacts` project. Ensure that it includes a `main` method.

   See "Creating a Java Class" on page 2-11 for detailed information.

2. In the `ContactDriver` class, create a new `NamedCache` called `contact` and put a new instance of the `Contact` object in it. Get the `Contact` object from the cache and ensure that the two objects are identical. Example 4-4 illustrates a sample implementation of this class.

Example 4-4  Sample ContactDriver Class

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import java.sql.Date;
import java.util.GregorianCalendar;
import java.util.Map;
import java.util.HashMap;

public class ContactDriver {

    public ContactDriver() {
    }

    public static void main(String[] args) {
        NamedCache contact = CacheFactory.getCache("contact");
        Address homeAddress = new Address("4157 Wash Ave", "Suite 4", "Burlingame", "CA", "94407", "USA");
        Address workAddress = new Address("500 Oracle Pkwy", "MS989", "Redwood Shores", "CA", "94065", "USA");
        Date date = new java.sql.Date(new GregorianCalendar(2011, 05, 01).getTime().getTime());
        PhoneNumber phonenumber = new PhoneNumber((short)11, (short)650, (short)506, 7000);
        Map map = new HashMap();
        map.put("home", phonenumber);

        Contact con1 = new Contact("Tom", "Dunn", homeAddress, workAddress,
```
```
map, date);

contact.put(con1.getFirstName(), con1);

Contact con2 = (Contact) contact.get(con1.getFirstName());

if (con2.getFirstName().equals(con1.getFirstName()))
{
    System.out.println("They are the same!!");
}
}
}

Create the POF and Cache Configuration Files

To use POF serialization, you must register your user-defined objects in a POF configuration file. The configuration associates the class of a user-defined object with a numeric value. You must also specify POF serialization and the name of the POF configuration file in the cache configuration file.

1. Create a POF configuration file for the Contact, Address, and PhoneNumber objects.
   a. To create a POF configuration file for your data types, use the pof-config.xml file that was created with your project.
   b. Define <user-type> elements for the Contact, Address, and PhoneNumber objects, assign type IDs 1001, 1002, and 1003 to them and provide their full class names. The file must include the coherence-pof-config.xml file which reserves the first 1000 IDs for Coherence data types.
   c. Rename the file and save it as contacts-pof-config.xml (it will be saved to the C:\home\oracle\workspace\Contacts\appClientModule folder). Example 4–5 illustrates a sample contacts-pof-config.xml file.

Example 4–5  POF Configuration File

```xml
<?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/1.2/coherence-pof-config.xsd">

    <user-type-list>

        <!-- coherence POF user types -->
        <include>coherence-pof-config.xml</include>

        <!-- com.tangosol.examples package -->
        <user-type>
            <type-id>1001</type-id>
            <class-name>com.oracle.handson.Contact</class-name>
        </user-type>
        <user-type>
            <type-id>1002</type-id>
            <class-name>com.oracle.handson.Address</class-name>
        </user-type>
        <user-type>
            <type-id>1003</type-id>
            <class-name>com.oracle.handson.PhoneNumber</class-name>
    </user-type-list>
```
2. Create a cache configuration file. You can use the coherence-cache-config.xml file in the Project Explorer, which is based on the coherence-cache-config.xsd file. You can also find a copy of coherence-cache-config.xml file in the coherence.jar file.

a. Use ExamplesPartitionedPofScheme as the scheme-name and PartitionedPofCache as the service-name.

b. The serializer section is responsible for mapping a POF serialized object to an appropriate serialization routine. You will declare the location of the POF configuration file in the next section.

c. Rename the file in the Project Explorer and save it as contacts-cache-config.xml (it will be saved to the C:|home|oracle|workspace\Contacts\appClientModule folder). Example 4–6 illustrates a sample contacts-cache-config.xml file.

Example 4–6  Cache Configuration File

```xml
<?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">
<defaults>
    <serializer>pof</serializer>
</defaults>

<caching-scheme-mapping>
    <cache-mapping>
        <cache-name>*</cache-name>
        <scheme-name>ExamplesPartitionedPofScheme</scheme-name>
    </cache-mapping>
</caching-scheme-mapping>

<caching-schemes>
    <distributed-scheme>
        <scheme-name>ExamplesPartitionedPofScheme</scheme-name>
        <service-name>PartitionedPofCache</service-name>
        <thread-count>5</thread-count>
        <backing-map-scheme>
            <local-scheme>
                <!-- each node will be limited to 32MB -->
                <high-units>250MB</high-units>
                <unit-calculator>binary</unit-calculator>
            </local-scheme>
        </backing-map-scheme>
        <autostart>true</autostart>
    </distributed-scheme>
</caching-schemes>
</cache-config>
```
Run the Sample Project

The contacts project requires a cache server to be running. The cache server and the application must reference the same POF and cache configuration files. This section describes how to create run configurations for the cache server and the application.

1. Stop any cache servers that are running. See "Stopping Cache Servers" on page 2-14 for detailed information.

2. Create an executable file to start the cache server.
   a. Right click the project and select Run As then Run Configurations. In the Run Configurations dialog box, enter ContactsCacheServer in the Name field.
   b. In the Main tab, ensure that Contacts appears in the Project field. Select the Include system libraries when searching for a main class checkbox and click the Search button. In the Select Main Type dialog box, enter DefaultCacheServer and select the DefaultCacheServer - com.tangosol.net class. Click OK in the Select Main Type dialog box, then Apply in the Run Configurations dialog box.
   c. In the General tab of the Coherence tab, select Absolute File Path in the Topology field and browse to the contacts-cache-config.xml file in the C:\home\oracle\workspace\Contacts\appClientModule directory. Ensure that Enabled (cache server) is selected. Enter a unique value for the Cluster port. Click Apply. The General tab should look similar to Figure 4–3.

Figure 4–3 Coherence Tab for the Contacts Cache Server Executable
In the **Other** tab of the **Coherence** tab, scroll down to the tangosol.pof.config item. Enter the path to the POF configuration file: C:\home\oracle\workspace\Contacts\appClientModule\contacts-pof-config.xml.

In the **Arguments** tab, enter `-showversion` under VM Arguments.

In the **Classpath** tab, ensure that the **Contacts** project appears under User Entries. If it does not, click the **Add Projects** button to add the **Contacts** project.

In the **Common** tab, select **Shared file** and browse for the \Contacts project.

Click **Run** to start the **Contacts** cache server. The output should be similar to Example 4–7.

### Example 4–7  Output from the Contacts Cache Server

```
java version '1.7.0_25'
Java(TM) SE Runtime Environment (build 1.7.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)

2013-11-21 11:04:21.818/0.312 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml'
2013-11-21 11:04:21.912/0.406 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml'
2013-11-21 11:04:22.006/0.500 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'file:/C:/home/oracle/workspace/Contacts/build/classes/tangosol-coherence-override.xml'
2013-11-21 11:04:22.006/0.500 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2013-11-21 11:04:22.006/0.500 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2013-11-21 11:04:22.006/0.500 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified

Oracle Coherence Version 12.1.3.0.0 Build 48392
Grid Edition: Development mode
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2013-11-21 11:04:22.631/1.125 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from "file:/C:/home/oracle/workspace/Contacts/appClientModule/contacts-cache-config.xml"
2013-11-21 11:04:23.691/2.185 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2013-11-21 11:04:24.457/2.951 Oracle Coherence GE 12.1.3.0.0 <D4> (thread=main, member=n/a): TCMP bound to /130.35.99.28:8088 using SystemDatagramSocketProvider
2013-11-21 11:04:28.294/6.788 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Started cluster Name=cluster:0x47DB

Group[Address=224.12.1.0, Port=3155, TTL=4]

MasterMemberSet{
  ThisMember=Member(Id=1, Timestamp=2013-11-21 11:04:24.769, Address=130.35.99.28:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:1344, Role=CoherenceServer)
```
3. Create a run configuration for the ContactDriver executable.
   - Right click the ContactDriver.java file in the Project Explorer and select Run As then Run Configurations.
   - In the Run Configurations dialog box, double-click the Oracle Coherence node. Enter ContactsDriver in the Name field. In the Main tab, browse for Contacts in the Project field, and com.oracle.handson>ContactDriver in the Main class field. Click Apply.
   - In the General tab of the Coherence tab, browse for the absolute path to the contacts-cache-config.xml file in the Cache configuration descriptor field. Select the Disable (cache client) radio button. In the Cluster port field, enter 3155
In the Other tab of the Coherence tab, scroll down to the tangosol.pof.config field and replace the value with the absolute path to the contacts-pof-config.xml POF configuration file.

In the Classpath tab, ensure that Contacts (default classpath) appears under User Entries.

4. Click Run to run the ContactDriver configuration. The output of the Contacts example should look similar to Example 4–8.

In this example, the Contact object is converted to POF at run time. Using POF provides significant performance improvements in CPU time and the size of the generated binary file.

Example 4–8  Output of the Contacts Example in the Eclipse IDE

2013-11-21 11:26:44.085/0.312 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence.xml'
2013-11-21 11:26:44.163/0.390 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'jar:file:/C:/Oracle/Middleware/Oracle_Home/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml'
2013-11-21 11:26:44.256/0.483 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'file:/C:/home/oracle/workspace/Contacts/build/classes/tangosol-coherence-override.xml'
2013-11-21 11:26:44.256/0.483 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override 'cache-factory-config.xml' is not specified
2013-11-21 11:26:44.256/0.483 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override 'cache-factory-builder-config.xml' is not specified
2013-11-21 11:26:44.256/0.483 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override '/custom-mbeans.xml' is not specified

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2013-11-21 11:26:44.897/1.124 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from 'file:/C:/home/oracle/workspace/Contacts/appClientModule/contacts-cache-config.xml'
2013-11-21 11:26:45.942/2.169 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2013-11-21 11:26:47.004/3.231 Oracle Coherence GE 12.1.3.0.0 <D4> (thread=main, member=n/a): TCMP bound to /130.35.99.28:8090 using SystemDatagramSocketProvider
2013-11-21 11:26:47.816/4.043 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=n/a): Member(Id=1, Timestamp=2013-11-21 11:26:21.557, Address=130.35.99.28:8088, MachineId=47251, Location=site, machine=TPPAEFFL-LAP, process:7096, Role=CoherenceServer) joined cluster with senior member 1
2013-11-21 11:26:48.067/4.294 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Started cluster Name=cluster:0x47DB

Group{Address=224.12.1.0, Port=3155, TTL=4}

MasterMemberSet{
Creating and Caching Complex Objects

ThisMember=Member(Id=2, Timestamp=2013-11-21 11:26:47.66, Address=130.35.99.28:8090, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:6432, Role=OracleHandsonContactDriver)
OldestMember=Member(Id=1, Timestamp=2013-11-21 11:26:21.557, Address=130.35.99.28:8088, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:7096, Role=CoherenceServer)
ActualMemberSet=MemberSet(Size=2)
  Member(Id=1, Timestamp=2013-11-21 11:26:21.557, Address=130.35.99.28:8088, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:7096, Role=CoherenceServer)
  Member(Id=2, Timestamp=2013-11-21 11:26:47.66, Address=130.35.99.28:8090, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:6432, Role=OracleHandsonContactDriver)
)
MemberId|ServiceVersion|ServiceJoined|MemberState
1|12.1.3|2013-11-21 11:26:21.557|JOINED,
2|12.1.3|2013-11-21 11:26:47.66|JOINED
RecycleMillis=1200000
RecycleSet=MemberSet(Size=0)
)

TcpRing{Connections=[1]}
IpMonitor{Addresses=0}

2013-11-21 11:26:48.068/4.295 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=2): Service Management joined the cluster with senior service member 1
2013-11-21 11:26:48.505/4.732 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=2): TcpAcceptor now listening for connections on 130.35.99.28:8090.3
2013-11-21 11:26:48.910/5.137 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=DistributedCache:PartitionedPofCache, member=2): Service PartitionedPofCache joined the cluster with senior service member 1
They are the same!!

5. If you go back and look at the cache server output, you can see messages reporting the Contacts cache client joining the cluster, completing its work, then leaving the cluster. See Example 4–9.

Example 4–9 Contacts Cache Server Displaying the Arrival and Departure of the Contacts Client

... Started DefaultCacheServer...

2013-11-21 11:26:25.942/7.726 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): This member has become the distribution coordinator for MemberSet(Size=1)
  Member(Id=1, Timestamp=2013-11-21 11:26:21.557, Address=130.35.99.28:8088, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:7096, Role=CoherenceServer)
)
2013-11-21 11:26:47.816/29.600 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): Member(Id=2, Timestamp=2013-11-21 11:26:47.66, Address=130.35.99.28:8090, MachineId=47251, Location=site:, machine:TPFAEFFL-LAP, process:6432, Role=OracleHandsonContactDriver) joined Cluster with senior member 1

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2013-11-21 11:26:48.099/29.883 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 joined Service Management with senior member 1
2013-11-21 11:26:48.941/30.725 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): Member 2 joined Service PartitionedPofCache with senior member 1
2013-11-21 11:26:49.114/30.898 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): TcpRing disconnected from Member(Id=2, Timestamp=2013-11-21 11:26:47.66, Address=130.35.99.28:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:6432, Role=OracleHandsonContactDriver) due to a peer departure; removing the member.
2013-11-21 11:26:49.114/30.898 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): Member(Id=2, Timestamp=2013-11-21 11:26:49.114, Address=130.35.99.28:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:6432, Role=OracleHandsonContactDriver) left Cluster with senior member 1
2013-11-21 11:26:49.114/30.898 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 left service Management with senior member 1
2013-11-21 11:26:49.114/30.898 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): Member 2 left service PartitionedPofCache with senior member 1

Creating and Caching Complex Objects

Working with Complex Objects  4-25
In this exercise, you learn how to populate a Coherence cache with domain objects that are read from text files. It highlights the use of APIs from the Coherence aggregator, extractor, and filter packages.

This chapter contains the following sections:

- Introduction
- Populating a Cache with Domain Objects
- Querying and Aggregating Data in the Cache

**Introduction**

Until now, you put objects into the cache and retrieved them individually. Each call to the `put` method can result in increased network traffic, especially for partitioned and replicated caches. Additionally, each call to a `put` method returns the object it just replaced in the cache, which adds more unnecessary overhead. By using the `putAll` method, loading the cache can be made much more efficient.

To perform the tasks in this chapter, you must first complete the project described in Chapter 4, “Working with Complex Objects.” You must also be familiar with using `java.io.BufferedReader` to read text files, `java.lang.String.split` method to parse text files, and `java.text.SimpleDateFormat` to parse dates.

**Populating a Cache with Domain Objects**

This exercise shows you how to create a console application that populates a Coherence cache with domain objects. The application will use the Coherence `com.tangosol.io.pof.PortableObject` implementation to serialize the objects into Portable Object format (POF).

In the exercise, you create a key that helps to get the `Contact` object, a generator to provide data for the cache, and a loader to load the cache.

1. Create a Class with the Key for the Domain Objects
2. Edit the POF Configuration File
3. Create the Data Generator
4. Create a Console Application to Load the Cache
5. Run the Cache Loading Example
Create a Class with the Key for the Domain Objects

To create a class that contains the key for a domain object:

1. Create a new Application Client Project called Loading. Select CoherenceConfig from the Configuration drop-down list. In the Application Client Module page of the New Application Client Project wizard, deselect the Create a default Main class checkbox.

See "Creating and Caching Complex Objects" on page 4-2 for information on creating a new project.

2. Add the classes and files related to the Address, PhoneNumber, and Contact classes that you created in an earlier exercise (Contacts). These files can be found in c:\home\oracle\workspace\Contacts\appClientModule and c:\home\oracle\workspace\Contacts\build\classes directories.

Right click the Loading project in the Project Explorer and select Properties. In the Properties for Loading dialog box, select Java Build Path. In the Projects tab, click Add. Select the Contacts project from the Required Project Selection dialog box, as illustrated in Figure 5–1.

![Figure 5–1 Adding Folders to the Project Build Path](image)

In the Order and Export tab, use the Up and Down buttons to move Contacts to the top of the list. The contents of the tab should look similar to Figure 5–2.
3. Create a `ContactId` class that provides a key to the employee for whom information is tracked. See "Creating a Java Class" on page 2-11 for detailed information on creating a Java class.

Create the contact ID based on the employee’s first name and last name. This object acts as the key to get the `Contact` object.

Because this class uses POF serialization, it must implement the `PortableObject` interface, the `writeExternal` and `readExternal` `PortableObject` methods, and the `equals`, `hashCode`, and `toString` object methods.

**Note:** Cache keys and values must be serializable (for example, `java.io.Serializable`). Cache keys must also provide an implementation of the `hashCode` and `equals` methods, and those methods must return consistent results across cluster nodes. This implies that the implementation of the `hashCode` and `equals` object methods must be based solely on the object’s serializable state (that is, the object’s non-transient fields). Most built-in Java types, such as `String`, `Integer` and `Date`, meet this requirement. Some cache implementations (specifically the partitioned cache) use the serialized form of the key objects for equality testing, which means that keys for which the `equals` method returns true must serialize identically; most built-in Java types meet this requirement.

Example 5–1 illustrates a possible implementation of the `ContactId` class.

**Example 5–1 Simple Contact ID Class**

```java
package com.oracle.handson;

import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PofWriter;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.util.Base;
import com.tangosol.util.HashHelper;
import java.io.IOException;

/**
 * ContactId is a key to the person for whom information is tracked.
 */
```
public class ContactId implements PortableObject
{
    // ----- constructors ------------------------------------------
    /**
    * Default constructor (necessary for PortableObject implementation).
    */
    public ContactId()
    {
    }

    /**
    * Construct a contact person.
    *
    */
    public ContactId(String FirstName, String LastName)
    {
        super();
        this.FirstName = FirstName;
        this.LastName  = LastName;
    }

    // ----- accessors -------------------------------------------
    /**
    * Return the first name.
    *
    */
    public String getFirstName()
    {
        return FirstName;
    }

    /**
    * Return the last name.
    *
    */
    public String getLastName()
    {
        return LastName;
    }

    // ----- PortableObject interface ---------------------------
    public void readExternal(PofReader reader)
    throws IOException
    {
        FirstName = reader.readString(0);
        LastName = reader.readString(1);
    }

    public void writeExternal(PofWriter writer)
    throws IOException
    {
        writer.writeString(0, FirstName);
        writer.writeString(1, LastName);
    }

    // ----- Object methods -------------------------------------
public boolean equals(Object oThat)
{
    if (this == oThat)
    {
        return true;
    }
    if (oThat == null)
    {
        return false;
    }

    ContactId that = (ContactId) oThat;
    return Base.equals(getFirstName(), that.getFirstName()) &&
            Base.equals(getLastName(), that.getLastName());
}

public int hashCode()
{
    return HashHelper.hash(getFirstName(),
                           HashHelper.hash(getLastName(), 0));
}

public String toString()
{
    return getFirstName() + " " + getLastName();
}

// ---- data members ---------------------------------------------------

/**
 * First name.
 */
private String FirstName;

/**
 * Last name.
 */
private String LastName;

---

**Edit the POF Configuration File**

Edit the POF configuration file. Add a `<user-type>` entry for the ContactId class to the contacts-pof-config.xml file. The file looks similar to Example 5–2.

**Example 5–2 POF Configuration File with the ContactId Entry**

```xml
<user-type-list>
    <include>coherence-pof-config.xml</include>
</user-type-list>
```
Create the Data Generator

Create a Java class named DataGenerator to generate random employee contact names and addresses. See "Creating a Java Class" on page 2-11 for detailed information.

Use the Address, PhoneNumber, and Contact classes that you created in an earlier exercise. Use java.util.Random to generate some random names, addresses, telephone numbers, and ages.

Example 5–3 illustrates a possible implementation of the data generator. This implementation creates a text file, contacts.csv, that contains the employee contact information.

Example 5–3  Sample Data Generation Class

```java
package com.oracle.handson;

import com.oracle.handson.Address;
import com.oracle.handson.Contact;
import com.oracle.handson.PhoneNumber;
import com.tangosol.util.Base;
import java.io.BufferedWriter;
import java.io.FileOutputStream;
import java.io.IOException;
import java.io.OutputStream;
import java.io.OutputStreamWriter;
import java.io.PrintWriter;
import java.sql.Date;
import java.util.Collections;
import java.util.Random;

/**
 * DataGenerator is a generator of sample contacts.
 */
```
public class DataGenerator
{
  // ----- static methods -----------------------------------------------

  /**
   * Generate contacts.
   */
  public static void main(String[] asArg)
    throws IOException
  {
    String sFile = asArg.length > 0 ? asArg[0] : FILENAME;
    int cCon = asArg.length > 1 ? Integer.parseInt(asArg[1]) : 1000;
    OutputStream out = new FileOutputStream(sFile);
    generate(out, cCon);
    out.close();
  }

  /**
   * Generate the contacts and write them to a file.
   */
  public static void generate(OutputStream out, int cContacts)
    throws IOException
  {
    PrintWriter writer = new PrintWriter(new BufferedWriter(
      new OutputStreamWriter(out)));
    for (int i = 0; i < cContacts; ++i)
    {
      StringBuffer sb = new StringBuffer(256);
      // contact person
      sb.append("John, ")
        .append(getRandomName())
        .append( ",");
      // home and work addresses
      sb.append(Integer.toString(Base.getRandom().nextInt(999)))
        .append(" Beacon St.,, ")
        .append(getRandomName())
        .append( ",")
        .append(getRandomState())
        .append( ",")
        .append(getRandomZip())
        .append( ",", US, Yoyodyne Propulsion Systems, ")
        .append("330 Lectroid Rd., Grover's Mill, ")
        .append(getRandomState())
        .append( ",")
        .append(getRandomZip())
        .append( ",", US, ");
      // home and work telephone numbers
      sb.append("home, ")
        .append(Base.toDelimitedString(getRandomPhoneDigits(), ",,"))
        .append( ",", work, "")
        .append(Base.toDelimitedString(getRandomPhoneDigits(), ",,"))
        .append( ",");
      // random birth date in millis before or after the epoch
      sb.append(getRandomDateInMillis());
    }
  }
}
writer.println(sb);
}
writer.flush();
}

/**
 * Return a random name.
 */
private static String getRandomName()
{
    Random rand = Base.getRandom();
    int cCh = 4 + rand.nextInt(7);
    char[] ach = new char[cCh];

    ach[0] = (char) ('A' + rand.nextInt(26));
    for (int of = 1; of < cCh; ++of)
    {
        ach[of] = (char) ('a' + rand.nextInt(26));
    }
    return new String(ach);
}

/**
 * Return a random phone number.
 * The phone number includes access, country, area code, and local number.
 */
private static int[] getRandomPhoneDigits()
{
    Random rand = Base.getRandom();
    return new int[]
    {
        11,                     // access code
        rand.nextInt(99),      // country code
        rand.nextInt(999),     // area code
        rand.nextInt(9999999)  // local number
    };
}

/**
 * Return a random phone.
 */
private static PhoneNumber getRandomPhone()
{
    int[] anPhone = getRandomPhoneDigits();

    return new PhoneNumber((short)anPhone[0], (short)anPhone[1],
                              (short)anPhone[2], anPhone[3]);
}

/**
 * Return a random Zip code.
 */
private static String getRandomZip()
The `DataGenerator` class generates, at random, information about an employee. The information includes the employee’s name, home address, work address, home telephone number, work telephone number, and the employee’s age. The information includes the employee’s name, home address, work address, home telephone number, work telephone number, and the employee’s age.
is stored in a CSV-formatted file named contacts.csv. This file follows the standard rules for a CSV-formatted file, where there is one record per line, and individual fields within the record are separated by commas.

Example 5-4 illustrates the first few entries of the contacts.csv file.

Example 5-4  Contents of the contacts.csv File

...

Create a Console Application to Load the Cache

Create a Java class called LoaderExample. See "Creating a Java Class" on page 2-11 for detailed information.

Implement the class to load the cache with employee data generated by the program described in "Create the Data Generator" on page 5-6. Use input streams and buffered readers to load the employee information in the contacts.csv file into a single Coherence cache.

Add code to parse the employee information in the data file. After you have this information, create the individual contacts to put into the cache. To conserve processing effort and minimize network traffic, use the putAll method to load the cache.

Example 5-5 illustrates a possible implementation of the LoaderExample class.

Example 5-5  Sample Cache Loading Program

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.oracle.handson.ContactId;
import com.oracle.handson.Address;
import com.oracle.handson.PhoneNumber;
import com.oracle.handson.Contact;
import java.io.BufferedReader;
import java.io.FileInputStream;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.sql.Date;
import java.util.HashMap;
import java.util.Map;

/**
 * LoaderExample loads contacts into the cache from a file.
 */
```
Populating a Cache with Domain Objects

Loading Data Into a Cache

```java
public class LoaderExample {
    // ----- static methods ---------------------------------------------

    /**
     * Load contacts.
     */
    public static void main(String[] asArg)
        throws IOException
    {
        String sFile = asArg.length > 0 ? asArg[0] : DataGenerator.FILENAME;
        String sCache = asArg.length > 1 ? asArg[1] : CACHENAME;

        System.out.println("input file: " + sFile);
        System.out.println("cache name: " + sCache);

        new LoaderExample().load(CacheFactory.getCache(sCache),
            new FileInputStream(sFile));
        CacheFactory.shutdown();
    }

    /**
     * Load cache from stream.
     */
    public void load(NamedCache cache, InputStream in)
        throws IOException
    {
        BufferedReader reader = new BufferedReader(new InputStreamReader(in));
        Map mapBatch = new HashMap(1024);
        String sRecord;
        int cRecord = 0;
        while ((sRecord = reader.readLine()) != null)
        {
            // parse record
            String[] asPart = sRecord.split(",");
            int ofPart = 0;
            String sFirstName = asPart[ofPart++];
            String sLastName = asPart[ofPart++];
            ContactId id = new ContactId(sFirstName, sLastName);
            Address addrHome = new Address(
                /*streetline1*/ asPart[ofPart++],
                /*streetline2*/ asPart[ofPart++],
                /*city*/ asPart[ofPart++],
                /*state*/ asPart[ofPart++],
                /*zip*/ asPart[ofPart++],
                /*country*/ asPart[ofPart++]);
            Address addrWork = new Address(
                /*streetline1*/ asPart[ofPart++],
                /*streetline2*/ asPart[ofPart++],
                /*city*/ asPart[ofPart++],
                /*state*/ asPart[ofPart++],
                /*zip*/ asPart[ofPart++],
                /*country*/ asPart[ofPart++]);
            Map mapTelNum = new HashMap();
            for (int c = asPart.length - 1; ofPart < c; )
```
Populating a Cache with Domain Objects

```java
{  
  mapTelNum.put("/*type*/ asPart[ofPart++], new PhoneNumber(
    /*access code*/ Short.parseShort(asPart[ofPart++]),
    /*country code*/ Short.parseShort(asPart[ofPart++]),
    /*area code*/ Short.parseShort(asPart[ofPart++]),
    /*local num*/ Integer.parseInt(asPart[ofPart++]));
}
Date dtBirth = new Date(Long.parseLong(asPart[ofPart]));

// Construct Contact and add to batch
Contact con1 = new Contact(sFirstName, sLastName, addrHome,
    addrWork, mapTelNum, dtBirth);
System.out.println(con1);
mapBatch.put(id, con1);
++cRecord;
if  (cRecord % 1024 == 0)
{
  // load batch
  cache.putAll(mapBatch);
  mapBatch.clear();
  System.out.print('.');
  System.out.flush();
}
if (!mapBatch.isEmpty())
{
  // load final batch
  cache.putAll(mapBatch);
}
System.out.println("Added " + cRecord + " entries to cache");
}

// ----- constants ------------------------------------------------------
/**
 * Default cache name.
 */
public static final String CACHENAME = "ContactsCache";
}

Run the Cache Loading Example

To run the cache loading example:

1. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for detailed information.

2. Start a cache server with the ContactsCacheServer file.
   a. Right click the project and select Run As then Run Configurations to edit the ContactsCacheServer configuration. In the Main tab, click Browse and select the Loading project.
   b. In the Classpath tab, select User Entries and click Add Projects. In the Project Selection dialog box, select the Loading project. Click OK.
c. In the **Common** tab, click **Shared file** and browse for the **Loading** project.

d. Click **Apply**, then **Run**.

3. Create a run configuration for **DataGenerator**. Right click **DataGenerator** in the **Project Explorer** and select **Run As**. In the **Run Configurations** dialog box select **Oracle Coherence** and click the **New Configuration** icon.

   a. In the **Name** field, enter **DataGenerator**.

   b. In the **Project** field in the **Main** tab, enter **Loading**. In the **Main class** field, enter `com.oracle.handson.DataGenerator`.

   c. In the **General** tab of the **Coherence** tab, browse to the `c:\home\oracle\workspace\Contacts\appClientModule\contacts-cache-config.xml` file in the **Cache configuration descriptor** field. Select the **Disabled (cache client)** button. Enter `3155` in the **Cluster port** field. Click **Apply**.

   In the **Other** tab, scroll down to the **tangosol.pof.config** field. Enter the absolute path to the POF configuration file `contacts-pof-config.xml`. Click **Apply**.

   d. In the **Common** tab, select **Shared file** and browse for the **Loading** directory.

   e. Examine the contents of **Loading** in the **Classpath** tab. **Contacts** should appear as one of the entries under **Loading**, as in **Figure 5–3**.

**Figure 5–3 Classpath for the DataGenerator Program**

![Classpath](image)

4. Create a run configuration for **LoaderExample**.

   - In the **Name** field, enter **LoaderGenerator**

   - In the **Project** field in the **Main** tab, enter **Loading**. In the **Main class** field, enter `com.oracle.handson.LoaderExample`.

   - In the **General** tab of the **Coherence** tab, browse to the `c:\home\oracle\workspace\Contacts\appClientModule\contacts-cache-config.xml` file in the **Cache configuration descriptor** field. Select the **Disabled (cache client)** button. Enter `3155` in the **Cluster port** field. Click **Apply**.

   In the **Other** tab, scroll down to the **tangosol.pof.config** field. Enter the absolute path to the POF configuration file `contacts-pof-config.xml`. Click **Apply**.

   - Examine the contents of the **Classpath** tab. **Contacts** should appear as one of the entries under **Loading**, as in **Figure 5–4**. If it does not appear, click **Use Entries**, then add the project with the **Add Project** button.
5. Run the DataGenerator configuration from the Run Configurations dialog box. Then run the LoaderExample configuration.

The DataGenerator run configuration generates a data file; you should not see any output or response in the Eclipse console window. The LoaderGenerator run configuration sends a stream of employee contact information, similar to Example 5–6, to the Eclipse console window.

Example 5–6  Output from theSample Cache Loading Program

... 

John Itqx
Addresses
Home: 58 Beacon St.

Fcfs, NY 84297
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, RI 29443
US
Telephone Numbers
work: +11 93 148 8101744
home: +11 70 29 5079314
Birth Date: 1975-12-30

John Ysxydw
Addresses
Home: 623 Beacon St.

Ohirim, PR 93378
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, FL 82251
US
Telephone Numbers
work: +11 5 799 6030449
home: +11 14 213 7774277
Birth Date: 1957-01-03

John Htmzlvoig
Addresses
Home: 700 Beacon St.

Ogkgqwbnj, SC 45698
US
Querying and Aggregating Data in the Cache

This exercise introduces querying and aggregating data in a cache. This exercise shows you how to:

- Query the cache for specific data
- Aggregate information within the cache

After putting complex objects in the named caches, you can query and aggregate information within the grid. The `com.tangosol.util.QueryMap` interface provides methods for managing the values or keys within a cache. You can use filters to restrict your results. You can also define indexes to optimize your queries.

Because Coherence serializes information when storing it, you also have the overhead of deserializing when querying information. When indexes are added, the values kept in the index itself are deserialized and, therefore, are quicker to access. The objects that are indexed are always kept serialized.

Some of the often-used methods in the `QueryMap` interface are:

- `Set entrySet(Filter filter)`, which returns a set of entries that are contained in the map that satisfy the filter
- `addIndex(ValueExtractor extractor, boolean fOrdered, Comparator comparator)`, which adds an index
- `Set keySet(Filter filter)`, which is similar to `entrySet`, but returns keys, not values

It is important to note that filtering occurs at Cache Entry Owner level. In a partitioned topology, filtering can be performed in parallel because it is the primary partitions that do the filtering. The `QueryMap` interface uses the `Filter` classes. You can find more information on these classes in the API for the `com.tangosol.util.filter` package.

All Coherence `NamedCache` objects implement the `com.tangosol.util.QueryMap` interface. This enables `NamedCache` objects to support searching for keys or entries in a cache that satisfy a specified condition. The condition can be represented as an object that implements the `com.tangosol.util.Filter` interface.

The `com.tangosol.util.filter` package contains several predefined classes that provide implementations of standard query expressions. Examples of these classes include `GreaterFilter`, `GreaterEquals`, `LikeFilter`, `NotEqualsFilter`, `InFilter`, and so on. You can use these filters to construct object-based equivalents of most SQL `WHERE` clause expressions.
The Filter classes use standard Java method reflection to represent test conditions. For example, the following filter represents the condition where the value returned from the getHomeAddress.getState method on an object in a cache is for Massachusetts (MA): 

\( \text{(new EqualsFilter(}'\text{getHomeAddress.getState}', 'MA')}; \)

If the object tested with this filter does not have a get method, then the test fails.

Here are additional examples of using the Filter classes:

- Return a set of people who live in a city whose name begins with the letter S:
  
  Set sPeople = cache.entrySet(new LikeFilter('getHomeAddress.getCity', 'S%'));

- Return a set containing people over the age of 42:
  
  final int nAge = 42;
  // Find all contacts who are older than nAge
  Set sSeniors = cache.entrySet(new GreaterFilter('getAge', nAge));

In addition to the entrySet and keySet methods defined by the QueryMap interface, Coherence lets you define indexes to improve query performance by using the addIndex method. Unlike relational database systems, where indexes are defined according to well-known and strictly enforced collections of named columns (that is, a schema), Coherence does not have a schema. Because there is no schema, you define indexes differently from a traditional database.

To define the values that are to be indexed for each object placed in a cache, Coherence introduces the concept of a value extractor. The com.tangosol.util.ValueExtractor interface defines an extract method. If given an object parameter, a ValueExtractor implementation returns a value based on the parameter.

A simple example of a ValueExtractor implementation is the com.tangosol.util.extractor.ReflectionExtractor interface, which uses reflection to return the result of a method call on an object, for example:

new ReflectionExtractor('getCity')

You can use value extractors throughout the Coherence API. Typically, however, they are used to define indexes.

An especially useful type of extractor is the ChainedExtractor. This is a composite ValueExtractor implementation based on an array of extractors. Extractors in the array are applied sequentially, from left to right. The result of a previous extractor becomes the target object for a next extractor, for example:

new ChainedExtractor(new ReflectionExtractor('getHomeAddress'), new ReflectionExtractor('getState'))

This example assumes that the HomeAddress and State objects belong to a complex Contact object. ChainedExtractor first uses reflection to call the
getHomeAddress method on each cached Contact object, and then uses reflection to call the getState method on the set of returned HomeAddress objects.

1. Create the Class to Query Cache Data
2. Run the Query Example
3. Edit the Query Example to Perform Aggregations
4. Run the Query and Aggregation Example

Create the Class to Query Cache Data

Create a new Java class called QueryExample to perform your queries. Ensure that the class has a main method. See ‘Creating a Java Class’ on page 2-11 for detailed information.

Use the entrySet method to get the employee contact information for:

- All employees who live in Massachusetts:
  ```java
cache.entrySet(new EqualsFilter("getHomeAddress.getState", "MA"));
```

- All employees who live in Massachusetts and work elsewhere:
  ```java
cache.entrySet(new AndFilter(
      new EqualsFilter("getHomeAddress.getState", "MA"),
      new NotEqualsFilter("getWorkAddress.getState", "MA")));
```

- All employees whose city name begins with an S:
  ```java
cache.entrySet(new LikeFilter("getHomeAddress.getCity", "S%"));
```

- All employees whose last name begins with an S and live in Massachusetts. Use both the key and value in the query. Note that the cache entries use ContactId objects as the keys. You can use the KeyExtractor to get these values. KeyExtractor is a specialized value extractor that indicates that a query be run against the key objects, rather than the values:
  ```java
cache.entrySet(new AndFilter(
      new LikeFilter(new KeyExtractor("getLastName"), "S%", (char) 0, false),
      new EqualsFilter("getHomeAddress.getState", "MA")));
```

- All employees who are older than a specified age. Hint:
  ```java
  final int nAge = 42;
  setResults = cache.entrySet(new GreaterFilter("getAge", nAge));
  ```

Use indexes to improve performance. Hint: Find the addIndex method in the Javadoc for the QueryMap interface.

Example 5–7 illustrates a possible implementation of the QueryExample class.

Example 5–7  Sample QueryExample Class

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

import com.tangosol.util.extractor.ChainedExtractor;
import com.tangosol.util.extractor.KeyExtractor;
```
import com.tangosol.util.extractor.ReflectionExtractor;
import com.tangosol.util.filter.AlwaysFilter;
import com.tangosol.util.filter.AndFilter;
import com.tangosol.util.filter.EqualsFilter;
import com.tangosol.util.filter.GreaterFilter;
import com.tangosol.util.filter.LikeFilter;
import com.tangosol.util.filter.NotEqualsFilter;
import java.util.Iterator;
import java.util.Set;

/**
 * QueryExample runs sample queries for contacts.
 *
 */
public class QueryExample{

    // ----- QueryExample methods ---------------------------------------

    public static void main(String[] args) {
        NamedCache cache = CacheFactory.getCache("ContactsCache");
        query(cache);
    }

    /**
     * Perform the example queries
     *
     */
    public static void query(NamedCache cache) {

        // Add indexes to make queries more efficient
        ReflectionExtractor reflectAddrHome =
            new ReflectionExtractor("getHomeAddress");

        // Add an index for the age
        cache.addIndex(new ReflectionExtractor("getAge"), true, null);

        // Add index for state within home address
        cache.addIndex(new ChainedExtractor(reflectAddrHome,
            new ReflectionExtractor("getState")), true, null);

        // Add index for state within work address
        cache.addIndex(new ChainedExtractor(
            new ReflectionExtractor("getWorkAddress"),
            new ReflectionExtractor("getState")), true, null);

        // Add index for city within home address
        cache.addIndex(new ChainedExtractor(reflectAddrHome,
            new ReflectionExtractor("getCity")), true, null);

        // Find all contacts who live in Massachusetts
        Set setResults = cache.entrySet(new EqualsFilter("getHomeAddress.getState", "MA"));
        printResults("MA Residents", setResults);

        // Find all contacts who live in Massachusetts and work elsewhere
        setResults = cache.entrySet(new AndFilter(
            new EqualsFilter("getHomeAddress.getState", "MA"),
            new NotEqualsFilter("getWorkAddress.getState", "MA")));
    }

}
printResults("MA Residents, Work Elsewhere", setResults);

// Find all contacts whose city name begins with 'S'
setResults = cache.entrySet(new LikeFilter("getHomeAddress.getCity", 'S%'));
printResults("City Begins with S", setResults);

final int nAge = 42;
// Find all contacts who are older than nAge
setResults = cache.entrySet(new GreaterFilter("getAge", nAge));
printResults("Age > " + nAge, setResults);

// Find all contacts with last name beginning with 'S' that live
// in Massachusetts. Uses both key and value in the query.
setResults = cache.entrySet(new AndFilter(
    new LikeFilter(new KeyExtractor("getLastName"), "S%", (char) 0, false),
    new EqualsFilter("getHomeAddress.getState", "MA")))
printResults("Last Name Begins with S and State Is MA", setResults);
}

/**
 * Print results of the query
 *
 * @param sTitle      the title that describes the results
 * @param setResults  a set of query results
 */
private static void printResults(String sTitle, Set setResults)
{
    System.out.println(sTitle);
    for (Iterator iter = setResults.iterator(); iter.hasNext(); )
    {
        System.out.println(iter.next());
    }
}

Run the Query Example

To run the query example:

1. Stop all running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.

2. Create a run configuration for the QueryExample class.
   a. Right click QueryExample in the Project Navigator and select Run As then Run Configurations. Select Oracle Coherence and click the New launch configuration icon.
   b. In the Name field, enter QueryExample.
   c. In the Project field in the Main tab, enter Loading. In the Main class field, enter com.oracle.handson.QueryExample.
   d. In the General tab of the Coherence tab, browse to the c:\home\oracle\workspace\Contacts\appClientModule\contacts-cache-config.xml file in the Cache configuration descriptor field. Select the Disabled (cache client) button. Enter 3155 in the Cluster port field. Click Apply.
In the **Other** tab, scroll down to the **tangosol.pof.config** field. Enter the absolute path to the POF configuration file contacts-pof-config.xml. Click **Apply**.

e. Examine the contents of the **Classpath** tab. The **Contacts** project should appear under the **Loading** project in **User Entries**.

3. Restart the **ContactsCacheServer**.

4. Run the **DataGenerator** class, the **LoaderExample** class, then the **QueryExample** class.

After printing all of the contact information in the cache, the **QueryExample** file displays the results of the queries. The results should look similar to **Example 5–8**.

**Example 5–8  Results of the QueryExample Program**

```plaintext
...  
**MA Residents**  
ConverterEntry(Key='John Ueccc', Value='John Ueccc
Addresses
Home: 285 Beacon St.

Oxtqwisgti, MA 41063
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, VA 28107
US
Telephone Numbers
work: +11 48 835 1876678
home: +11 78 482 1247744
Birth Date: 1972-12-30')

...  
**MA Residents, Work Elsewhere**  
ConverterEntry(Key='John Ueccc', Value='John Ueccc
Addresses
Home: 285 Beacon St.

Oxtqwisgti, MA 41063
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, VA 28107
US
Telephone Numbers
work: +11 48 835 1876678
home: +11 78 482 1247744
Birth Date: 1972-12-30')

...  
**City Begins with S**  
ConverterEntry(Key='John Prepojf', Value='John Prepojf
Addresses
Home: 851 Beacon St.

Swnsfng, PR 00734
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, AR 97794
US
```
Edit the Query Example to Perform Aggregations

Add code to the QueryExample.java file to perform aggregations on the cache data. An entry aggregator (com.tangosol.util.InvocableMap.EntryAggregator) enables you to perform operations on all or a specific set of objects and return an aggregation. EntryAggregator instances are agents that execute services in parallel against the data within the cluster. Aggregations are performed in parallel and can benefit from the addition of cluster members.

There are two ways of aggregating: aggregate over a collection of keys or by specifying a filter. Example 5–9 illustrates the EntryAggregator methods that perform these tasks.

Example 5–9 Methods to Aggregate Over Keys or by Specifying Filters

```
Object aggregate(Collection keys, InvocableMap.entryAggregator agg)
Object aggregate(Filter filter, InvocableMap.entryAggregator agg)
```

To add aggregations to return data for filtering:
1. Using aggregations, write code in the QueryExample class to calculate the following:

   - The number of employees that are older than a specified age. Use the GreaterFilter and the Count class:
     ```java
cache.aggregate(new GreaterFilter("getAge", nAge), new Count())
```

   - Lowest age in the set of employees. Use the AlwaysFilter and the LongMin class:
     ```java
cache.aggregate(AlwaysFilter.INSTANCE, new LongMin("getAge"))
```

   - Highest age in the set of employees. Use the AlwaysFilter and the LongMax class:
     ```java
cache.aggregate(AlwaysFilter.INSTANCE, new LongMax("getAge"))
```

   - Average age of employees. Use the AlwaysFilter and the DoubleAverage class:
     ```java
cache.aggregate(AlwaysFilter.INSTANCE, new DoubleAverage("getAge")
```

2. Import the Count, DoubleAverage, LongMax, and LongMin aggregator classes.

   ```java
   import com.tangosol.util.aggregator.Count;
   import com.tangosol.util.aggregator.DoubleAverage;
   import com.tangosol.util.aggregator.LongMax;
   import com.tangosol.util.aggregator.LongMin;
   ``

   The QueryExample.java file looks similar to Example 5–10.

---

**Example 5–10  QueryExample with Aggregation**

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.util.aggregator.Count;
import com.tangosol.util.aggregator.DoubleAverage;
import com.tangosol.util.aggregator.LongMax;
import com.tangosol.util.aggregator.LongMin;
import com.tangosol.util.extractor.ChainedExtractor;
import com.tangosol.util.extractor.KeyExtractor;
import com.tangosol.util.extractor.ReflectionExtractor;
import com.tangosol.util.filter.AlwaysFilter;
import com.tangosol.util.filter.AndFilter;
import com.tangosol.util.filter.EqualsFilter;
import com.tangosol.util.filter.GreaterFilter;
import com.tangosol.util.filter.LikeFilter;
import com.tangosol.util.filter.NotEqualsFilter;
import java.util.Iterator;
import java.util.Set;

/**
 * QueryExample runs sample queries for contacts.
 */
public class QueryExample{
```
public static void main(String[] args) {
    NamedCache cache = CacheFactory.getCache("ContactsCache");
    query(cache);
}

/**
* Perform the example queries
*
*/
public static void query(NamedCache cache)
{
    // Add indexes to make queries more efficient
    ReflectionExtractor reflectAddrHome =
        new ReflectionExtractor("getHomeAddress");
    cache.addIndex(new ReflectionExtractor("getAge"), true, null);
    cache.addIndex(new ChainedExtractor(reflectAddrHome,
        new ReflectionExtractor("getState")), true, null);
    cache.addIndex(new ChainedExtractor(
        new ReflectionExtractor("getWorkAddress"),
        new ReflectionExtractor("getState")), true, null);
    cache.addIndex(new ChainedExtractor(reflectAddrHome,
        new ReflectionExtractor("getCity")), true, null);

    // Find all contacts who live in Massachusetts
    Set setResults = cache.entrySet(new EqualsFilter(
        "getHomeAddress.getState", "MA");
    printResults("MA Residents", setResults);

    // Find all contacts who live in Massachusetts and work elsewhere
    setResults = cache.entrySet(new AndFilter(
        new EqualsFilter("getHomeAddress.getState", "MA"),
        new NotEqualsFilter("getWorkAddress.getState", "MA"));
    printResults("MA Residents, Work Elsewhere", setResults);

    // Find all contacts whose city name begins with 'S'
    setResults = cache.entrySet(new LikeFilter("getHomeAddress.getCity", 
        "S\%"));
    printResults("City Begins with S", setResults);

    final int nAge = 42;
    // Find all contacts who are older than nAge
    setResults = cache.entrySet(new GreaterFilter("getAge", nAge));
    printResults("Age > " + nAge, setResults);

    // Find all contacts with last name beginning with 'S' that live
    // in Massachusetts. Uses both key and value in the query.
    setResults = cache.entrySet(new AndFilter(
        new LikeFilter(new KeyExtractor("getLastName"), "S\%", 
            (char) 0, false),
        new EqualsFilter("getHomeAddress.getState", "MA"));
    printResults("Last Name Begins with S and State Is MA", setResults);

    // Count contacts who are older than nAge
    System.out.println("count > " + nAge + ": "+ cache.aggregate(
        new GreaterFilter("getAge", nAge), new Count()));

    // Find minimum age
}
System.out.println("min age: " + cache.aggregate(AlwaysFilter.INSTANCE,
    new LongMin("getAge")));

// Calculate average age
System.out.println("avg age: " + cache.aggregate(AlwaysFilter.INSTANCE,
    new DoubleAverage("getAge")));

// Find maximum age
System.out.println("max age: " + cache.aggregate(AlwaysFilter.INSTANCE,
    new LongMax("getAge"));
}

/**
 * Print results of the query
 *
 */
private static void printResults(String sTitle, Set setResults)
{
    System.out.println(sTitle);
    for (Iterator iter = setResults.iterator(); iter.hasNext(); )
    {
        System.out.println(iter.next());
    }
}

Run the Query and Aggregation Example

To query the cache and aggregate the results:

1. Stop the Contacts cache server, ContactsCacheServer. See "Stopping Cache Servers" on page 2-14 for more information.
2. Restart ContactsCacheServer.
3. Run the DataGenerator, LoaderExample, and QueryExample applications.

The output should look similar to Example 5–11 in the Eclipse Console.

Example 5–11  Output from the Aggregators

... 
Last Name Begins with S and State Is MA
ConverterEntry{Key='John Sqmys', Value='John Sqmys
Addresses
Home: 594 Beacon St.
Jxaxt, MA 10081
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, NJ 95236
US
Telephone Numbers
work: +11 70 837 4723938
home: +11 2 227 6816592
Birth Date: 1977-12-29'
count > 42: 482
min age: 22
avg age: 41.627
max age: 61
This exercise illustrates how you can simplify Java expressions that use aggregations and filters by using the Coherence `createFilter` and `createExtractor` factory methods in the `QueryHelper` class.

In Chapter 5, "Loading Data Into a Cache," you created a file, `QueryExample.java`, that used a variety of filters, such as `AlwaysFilter`, `LikeFilter`, and `EqualsFilter`, to pull and aggregate information from the cache. The file also created indexes on the data by using a variety of specialized `ValueExtractors`: `ChainedExtractors`, `KeyExtractors`, and `ReflectionExtractors`. This created some verbose Java statements. These statements can be simplified by using the `QueryHelper` API.

This chapter contains the following sections:

- Introduction
- Simplifying the Query Example
- Rerunning the Query Example

**Introduction**

To simplify filter and extractor statements, and the way in which you interact with the Coherence caches, Coherence provides the `QueryHelper` API. `QueryHelper` (`com.tangosol.util.QueryHelper`) is a utility class that provides a set of `createFilter` and `createExtractor` factory methods that can build instances of `Filter` and `ValueExtractor`. The methods in the class accept a String data type that specifies the creation of rich Filters in a format that is familiar to anyone who understands SQL `WHERE` clauses.

For example, the following statement uses `createFilter(String s)` to construct a filter for employees who live in Massachusetts but work in another state.

```java
QueryHelper.createFilter("homeAddress.state = 'MA' and workAddress.state != 'MA'")
```

This statement is more simple and easier to read than the equivalent filter and extractor statement using the Coherence API:

```java
new AndFilter(new EqualsFilter("getHomeAddress.getState", "MA"),
              new NotEqualsFilter("getWorkAddress.getState", "MA"))
```
For more information, see the Javadoc for the QueryHelper API. For information on the syntax of the WHERE clause within the Coherence Query Language, see "Using Coherence Query Language" in Oracle Fusion Middleware Developing Applications with Oracle Coherence.

Simplifying the Query Example

This section describes how you can simplify the indexes, cache calls, and aggregations in the QueryExample.java file that you created in the previous chapter.

1. Import the QueryHelper API into the QueryExample.java file as a static class.
   ```java
   import static com.tangosol.util.QueryHelper.*;
   ```

2. Comment out the imports for the ChainedExtractor, KeyExtractor, and ReflectionExtractor classes.

3. Comment out the imports for the AlwaysFilter, AndFilter, EqualsFilter, GreaterFilter, LikeFilter, and NotEqualsFilter classes.

4. In the cache.addIndex statements, replace instances of ReflectionExtractor with createExtractor from the QueryHelper API.
   
   Table 6–1 lists the ReflectionExtractors and their createExtractor equivalents.

<table>
<thead>
<tr>
<th>Replace This ReflectionExtractor Statement ...</th>
<th>With the Equivalent createExtractor Statement ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>cache.addIndex(new ReflectionExtractor(&quot;getAge&quot;), true, null);</td>
<td>cache.addIndex(createExtractor(&quot;age&quot;), true, null);</td>
</tr>
<tr>
<td>cache.addIndex(new ChainedExtractor(reflectAddrHome, new ReflectionExtractor(&quot;getState&quot;)), true, null);</td>
<td>cache.addIndex(createExtractor(&quot;homeAddress.state&quot;), false, null);</td>
</tr>
<tr>
<td>cache.addIndex(new ChainedExtractor(new ReflectionExtractor(&quot;getWorkAddress&quot;), new ReflectionExtractor(&quot;getState&quot;)), true, null);</td>
<td>cache.addIndex(createExtractor(&quot;workAddress.state&quot;), false, null);</td>
</tr>
<tr>
<td>cache.addIndex(new ChainedExtractor(reflectAddrHome, new ReflectionExtractor(&quot;getCity&quot;)), true, null);</td>
<td>cache.addIndex(createExtractor(&quot;homeAddress.city&quot;), true, null);</td>
</tr>
</tbody>
</table>

5. Replace the calls to the *Filter methods in the setResults statements with calls to createFilter with the appropriate Coherence Query Language.
   
   Table 6–2 lists the *Filter instances and their createFilter equivalents.
Table 6–2 *Filter Statements and Their Equivalent createFilter Statements in Queries

<table>
<thead>
<tr>
<th>Replace This *Filter Statement ...</th>
<th>With the Equivalent createFilter Statement ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set setResults = cache.entrySet(new EqualsFilter(&quot;getHomeAddress.getState&quot;, &quot;MA&quot;));</td>
<td>Set setResults = cache.entrySet(createFilter(&quot;homeAddress.state = 'MA'&quot;));</td>
</tr>
<tr>
<td>Set setResults = cache.entrySet(new AndFilter(new EqualsFilter(&quot;getHomeAddress.getState&quot;, &quot;MA&quot;), new NotEqualsFilter(&quot;getWorkAddress.getState&quot;, &quot;MA&quot;)));</td>
<td>Set setResults = cache.entrySet(createFilter(&quot;homeAddress.state is 'MA' and workAddress is not 'MA'&quot;));</td>
</tr>
<tr>
<td>Set setResults = cache.entrySet(new AndFilter(new EqualsFilter(&quot;getHomeAddress.getCity&quot;, &quot;S%&quot;)));</td>
<td>Set setResults = cache.entrySet(createFilter(&quot;homeAddress.city like 'S%'&quot;));</td>
</tr>
<tr>
<td>Set setResults = cache.entrySet(new GreaterFilter(&quot;getAge&quot;, nAge));</td>
<td>System.out.println(&quot;count &gt; &quot; + nAge + &quot;: &quot; + cache.aggregate(createFilter(&quot;age &gt; ?1&quot;, aEnv), new Count()));</td>
</tr>
<tr>
<td>Set setResults = cache.entrySet(new AndFilter(new LikeFilter(&quot;getLastName&quot;, &quot;S%&quot;, (char) 0, false), new EqualsFilter(&quot;getHomeAddress.getState&quot;, &quot;MA&quot;)));</td>
<td>System.out.println(&quot;min age: &quot; + cache.aggregate(always, new LongMin(&quot;getAge&quot;)));</td>
</tr>
</tbody>
</table>

6. Replace the calls to the *Filter methods in the aggregate statements with calls to createFilter with the appropriate Coherence Query Language.

Table 6–3 lists the *Filter instances and their createFilter equivalents.

Table 6–3 Filter Statements and Their Equivalent createFilter Statements in Aggregations

<table>
<thead>
<tr>
<th>Replace This *Filter Statement ...</th>
<th>With the Equivalent createFilter Statement ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>System.out.println(&quot;count &gt; &quot; + nAge + &quot;: &quot; + cache.aggregate(new GreaterFilter(&quot;getAge&quot;, nAge), new Count()));</td>
<td>System.out.println(&quot;count &gt; &quot; + nAge + &quot;: &quot; + cache.aggregate(createFilter(&quot;age &gt; ?1&quot;, aEnv), new Count()));</td>
</tr>
<tr>
<td>System.out.println(&quot;min age: &quot; + cache.aggregate(AlwaysFilter.INSTANCE, new LongMin(&quot;getAge&quot;)));</td>
<td>Filter always = createFilter(&quot;true&quot;); System.out.println(&quot;min age: &quot; + cache.aggregate(always, new LongMin(&quot;getAge&quot;)));</td>
</tr>
<tr>
<td>System.out.println(&quot;avg age: &quot; + cache.aggregate(AlwaysFilter.INSTANCE, new DoubleAverage(&quot;getAge&quot;)));</td>
<td>System.out.println(&quot;avg age: &quot; + cache.aggregate(always, new DoubleAverage(&quot;getAge&quot;)));</td>
</tr>
<tr>
<td>System.out.println(&quot;max age: &quot; + cache.aggregate(AlwaysFilter.INSTANCE, new LongMax(&quot;getAge&quot;)));</td>
<td>System.out.println(&quot;max age: &quot; + cache.aggregate(always, new LongMax(&quot;getAge&quot;)));</td>
</tr>
</tbody>
</table>

When you are finished with the code replacements, QueryExample.java looks similar to Example 6–1.
Example 6–1   Edited QueryExample File

package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

import com.tangosol.util.Filter;
import static com.tangosol.util.QueryHelper.*;

import com.tangosol.util.aggregator.Count;
import com.tangosol.util.aggregator.DoubleAverage;
import com.tangosol.util.aggregator.LongMax;
import com.tangosol.util.aggregator.LongMin;

import java.util.Iterator;
import java.util.Set;

/**
 * QueryExample runs sample queries for contacts.
 */
public class QueryExample{

    // ----- QueryExample methods ---------------------------------------
    public static void main(String[] args) {
        NamedCache cache = CacheFactory.getCache("ContactsCache");
        query(cache);
    }

    /**
     * Perform the example queries
     *
     */
    public static void query(NamedCache cache)
    {
        // Add indexes to make queries more efficient
        // ReflectionExtractor reflectAddrHome =
        //     new ReflectionExtractor("getHomeAddress");
        // Add an index for the age
        // cache.addIndex(new ReflectionExtractor("getAge"), true, null);
        // Add index for state within home address
        // cache.addIndex(new ChainedExtractor(reflectAddrHome,
        //     new ReflectionExtractor("getState")), true, null);
    }

*/

}
Simplifying the Query Example

```java
Simplifying Cache Calls and Aggregations

```cache.addIndex(createExtractor("homeAddress.state"), false, null);

// Add index for state within work address
// cache.addIndex(new ChainedExtractor(
//    new ReflectionExtractor("getWorkAddress"),
//    new ReflectionExtractor("getState")), true, null);
cache.addIndex(createExtractor("workAddress.state"), false, null);

// Add index for city within home address
// cache.addIndex(new ChainedExtractor(reflectAddrHome,
//    new ReflectionExtractor("getCity")), true, null);
cache.addIndex(createExtractor("homeAddress.city"), true, null);

// Find all contacts who live in Massachusetts
// Set setResults = cache.entrySet(new EqualsFilter(
//    'getHomeAddress.getState', "MA"));
Set setResults = cache.entrySet(createFilter("homeAddress.state = 'MA'"));
printResults("MA Residents", setResults);

// Find all contacts who live in Massachusetts and work elsewhere
// setResults = cache.entrySet(new AndFilter(
//    new EqualsFilter("getHomeAddress.getState", "MA"),
//    new NotEqualsFilter("getWorkAddress.getState", "MA")));
setResults = cache.entrySet(createFilter("homeAddress.state = 'MA' and
workAddress is not 'MA'"));
printResults("MA Residents, Work Elsewhere", setResults);

// Find all contacts whose city name begins with 'S'
// setResults = cache.entrySet(new LikeFilter("getHomeAddress.getCity", 
//    "S%"));
setResults = cache.entrySet(createFilter("homeAddress.city like 'S%'"));
printResults("City Begins with S", setResults);

final int nAge = 42;
Object[] aEnv = new Object[] {new Integer(nAge)};
// Find all contacts who are older than nAge
// setResults = cache.entrySet(new GreaterFilter("getAge", nAge));
setResults = cache.entrySet(createFilter("age > ?1", aEnv));
printResults("Age > " + nAge, setResults);

// Find all contacts with last name beginning with 'S' that live
// in Massachusetts. Uses both key and value in the query.
// setResults = cache.entrySet(new AndFilter(
//    new LikeFilter(new KeyExtractor("getLastName"), "S%",
//    (char) 0, false),
//    new EqualsFilter("getHomeAddress.getState", "MA")));
setResults = cache.entrySet(createFilter("key(lastName) like 'S%' and
homeAddress.state = 'MA'"));
setResults = cache.entrySet(createFilter("key().lastName like 'S%' and
homeAddress.state = 'MA'"));
printResults("Last Name Begins with S and State Is MA", setResults);

// Count contacts who are older than nAge
// System.out.println("count > " + nAge + ": "+
//    cache.aggregate(new GreaterFilter("getAge", nAge), new Count()));
System.out.println("count > " + nAge + ": " + cache.aggregate(
    createFilter("age > ?1", aEnv), new Count()));

// Find minimum age
// System.out.println("min age: " + cache.aggregate(AlwaysFilter.INSTANCE,
Rerunning the Query Example

To rerun the query example:

1. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.
2. Restart the ContactsCacheServer.
3. Run the DataGenerator, LoaderExample, and QueryExample files.
4. After printing all of the contact information in the cache, it displays the results of the queries. The results should look similar to the following examples.

---

**Note:** The DataGenerator program produces random names, cities and birthdates. Your output may be different.

---

Example 6–2 illustrates the output of the MA Residents filter.

*Example 6–2  Output of the MA Residents Filter*
MA Residents
ConverterEntry{Key="John Hwdrrls", Value="John Hwdrrls
Addresses
Home: 369 Beacon St.

Fetggv, MA 24372
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, NE 84499
US
Telephone Numbers
work: +11 88 331 2307913
home: +11 64 86 2489621
Birth Date: 1976-12-29"}
...

Example 6–3 illustrates the output of the MA Residents, Work Elsewhere filter.

Example 6–3  Output of the MA Residents, Work Elsewhere Filter
...

MA Residents, Work Elsewhere
ConverterEntry{Key="John Hwdrrls", Value="John Hwdrrls
Addresses
Home: 369 Beacon St.

Fetggv, MA 24372
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, NE 84499
US
Telephone Numbers
work: +11 88 331 2307913
home: +11 64 86 2489621
Birth Date: 1976-12-29"}
...

Example 6–4 illustrates the output of the City Begins with S filter.

Example 6–4  Output of the City Begins with S Filter
...

City Begins with S
ConverterEntry{Key="John Pzek", Value="John Pzek
Addresses
Home: 309 Beacon St.

Saqrgy, OH 81353
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, CT 78117
US
Telephone Numbers
work: +11 28 790 2035988
home: +11 61 470 7634708
Birth Date: 1971-12-31"}
...
Example 6–5 illustrates the output of the age greater than 42 filter.

**Example 6–5  Output of the Age Greater than 42 Filter**

...  
**Age > 42**  
ConverterEntry(Key='John Gddurqqziy', Value='John Gddurqqziy  
Addresses  
Home: 613 Beacon St.  
Cxyskdo, DE 28968  
US  
Work: Yoyodyne Propulsion Systems  
330 Lectroid Rd.  
Grover's Mill, SD 07959  
US  
Telephone Numbers  
work: +11 31 768 5136041  
home: +11 87 22 3851589  
Birth Date: 1958-01-03')  
...

Example 6–6 illustrates the output of the Last Name Begins with S and State is MA filter and the output of the aggregators.

**Example 6–6  Output of the State and Age Aggregators**

**Last Name Begins with S and State Is MA**  
ConverterEntry(Key='John Syaqlojl', Value='John Syaqlojl  
Addresses  
Home: 810 Beacon St.  
Rgtaljwph, MA 07471  
US  
Work: 200 Newbury St.  
Yoyodyne, Ltd.  
Boston, MA 02116  
US  
Telephone Numbers  
work: +11 37 18 1767648  
home: +11 98 155 1073866  
Birth Date: 1974-12-30')  
...

count > 42: 446  
min age: 22  
avg age: 41.126  
max age: 61
In this exercise, you set up listeners to observe data changes within a Coherence cache. It highlights the use of the Coherence `ObservableMap`, `MapEvent`, `EventListener`, `EntryProcessor`, and `AbstractMapListener` APIs. You also learn how entry processors can be used to modify and process entries in the Coherence cache.

This chapter contains the following sections:
- Introduction
- Creating a Cache Listener
- Responding to Changes in the Cache

**Introduction**

The `com.tangosol.util.ObservableMap` interface enables you to observe and act on the changes made to cache entries. It extends `java.util.EventListener` and uses the standard JavaBeans event model. All types of `NamedCache` instances implement this interface. To listen for an event, you register a `MapListener` (`com.tangosol.util.MapListener`) instance on the cache. `MapListener` instances are called on the client; that is, the listener code is executed in your client process.

There are multiple ways to listen for events:
- Listen for all events
- Listen for all events that satisfy a filter
- Listen for events on a particular object key

These listener tasks can be performed on a `NamedCache` by the `addMapListener` methods listed in Example 7–1.

**Example 7–1  Listener Methods on a NamedCache**

```java
void addMapListener(MapListener listener)

void addMapListener(MapListener listener, Filter filter, boolean fLite)

void addMapListener(MapListener listener, Object oKey, boolean fLite)
```

The `com.tangosol.util.MapEvent` class captures the object key, and the old and new values. You can specify a `Lite` event, in which the new and old values might not be present. Example 7–2 describes a pattern for registering these methods against a `NamedCache`. This has been done as an anonymous class. You can use the `getOldValue` or `getNewValue` methods in the `MapEvent` class to get the entry for which the event gets fired.
Creating a Cache Listener

This section describes how to create a Java class that listens on a NamedCache and responds to any changes it detects.

1. Create a Class to Listen for Changes in the Cache
2. Run the Cache Listener Example

Create a Class to Listen for Changes in the Cache

In the Loading project, create the class that will listen for a new Contact object entry. Name the class ObserverExample and ensure that it has a main method. See "Creating a Java Class" on page 2-11 for detailed information.

Within this class, add a listener to display a message whenever a new Contact is updated to the cache. For example, use the following code to keep the Java process running until you read from the console. Otherwise, your program will immediately exit.

```java
BufferedReader console = new BufferedReader(new InputStreamReader(System.in));
String text = console.readLine();
```

Within the class, create an inner class to extend AbstractMapListener. Implement the methods to insert, update, and delete the cache values. In this case, most of the work should be done in the entryUpdated method, based on the old and new values contained in a MapEvent.

Example 7–3 illustrates a possible implementation of a listener class.

Example 7–3 Sample Listener Class

```java
package com.oracle.handson;

import com.tangosol.net.NamedCache;
import com.tangosol.util.AbstractMapListener;
import com.tangosol.util.MapEvent;
import com.oracle.handson.Contact;
import com.tangosol.net.CacheFactory;
import java.io.IOException;
```
/**
 * ObserverExample observes changes to contacts.
 */
public class ObserverExample
{

    public ObserverExample()
    {
    }

    // ----- ObserverExample methods -------------------------------------

    public static void main(String[] args)
    {    
        NamedCache cache = CacheFactory.getCache("ContactsCache");
        new ObserverExample().observe(cache);
            try {
                System.in.read();
            } catch (IOException e) {
            }
        }

    /**
     * Observe changes to the contacts.
     * 
     * @param cache  target cache
     */
    public void observe(NamedCache cache)
    {    
        cache.addMapListener(new ContactChangeListener());
    }

    // ----- inner class: ContactChangeListener -------------------------

    public class ContactChangeListener
        extends AbstractMapListener
    {
        // ----- MapListener interface ------------------------------------------

        public void entryInserted(MapEvent event)
        {    
            System.out.println(event);
        }

        public void entryUpdated(MapEvent event)
        {    
            Contact contactOld = (Contact)event.getOldValue();
            Contact contactNew = (Contact)event.getNewValue();
            StringBuffer sb  = new StringBuffer();
            if (!contactOld.getHomeAddress().equals(
            contactNew.getHomeAddress()))
            {
                sb.append("Home address ");
            }
            if (!contactOld.getWorkAddress().equals(
            contactNew.getWorkAddress()))
            {
                sb.append("Work address ");
            }
            if (!contactOld.getTelephoneNumbers().equals(
            contactNew.getTelephoneNumbers()))
            {
Creating a Cache Listener

```java
{  
    sb.append('Telephone ');
}
if (contactOld.getAge() != contactNew.getAge())
{
    sb.append('Birthdate ');
}
sb.append('was updated for ').append(event.getKey());
System.out.println(sb);
}

public void entryDeleted(MapEvent event)
{
    System.out.println(event.getKey());
}
}
```

Run the Cache Listener Example

To run the Cache Listener example:

1. Create a run configuration for ObserverExample. Right click ObserverExample in the Project Explorer and select Run As. In the Run Configurations dialog box select Oracle Coherence and click the New Configuration icon.
   a. In the Name field, enter ObserverExample.
   b. In the Project field in the Main tab, enter Loading. In the Main class field, enter com.oracle.handson.ObserverExample.
   c. In the General tab of the Coherence tab, browse to the c:\home\oracle\workspace\Contacts\appClientModule\contacts-cache-config.xml file in the Cache configuration descriptor field. Select the Disabled (cache client) button. Enter 3155 in the Cluster port field. Click Apply.
   In the Other tab, scroll down to the tangosol.pof.config field. Enter the absolute path to the POF configuration file contacts-pof-config.xml. Click Apply.
   d. In the Common tab, select Shared file and browse for the Loading directory.

2. Stop any running cache servers. See “Stopping Cache Servers” on page 2-14 for more information.


4. Load the cache by running the LoaderExample program from Eclipse. If you now run the ObserverExample, the program waits for input, as illustrated in Example 7-4.

   In "Responding to Changes in the Cache" on page 7-5, you create a program that modifies entries in the cache and returns the changed records.

Example 7-4  Listener Program Waiting for Events

```java
...  
MasterMemberSet(  
    ThisMember=Member(Id=3, Timestamp=2013-11-21 11:29:45.272, Address=130.35.99.6:8090,  
    MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:4752,  
    Role=OracleHandsonObserverExample)
```
Responding to Changes in the Cache

In this section, you will create a Java class to modify entries in the cache and return the changed records.

Until now, to perform actions on the entries in a cache, you used the `put` and `get` operations. However, there is a better way to perform operations on data that ensure consistent behavior when concurrent data access is required. Entry processors (`com.tangosol.util.InvocableMap.EntryProcessor`) are agents that perform processing against entries. The entries are processed directly where the data is being held. The processing you perform can change the data: it can create, update, remove data, or only perform calculations. The processing can occur in parallel in a partitioned cache with multiple nodes, so it is scalable. Processing in the cache also saves I/O expense because data is not pulled to the client for processing.

Entry processors that work on the same key are logically queued. This allows lock-free (high performance) processing. The `com.tangosol.util.InvocableMap` interface (which the `NamedCache` implements) has the following methods for operating on data:
Object invoke(Object oKey, InvocableMap.EntryProcessor processor), which invokes the passed EntryProcessor against an individual object and returns the result of the invocation.

Map invokeAll(Collection keys, InvocableMap.EntryProcessor processor), which invokes the EntryProcessor against the collection of keys and returns the result for each invocation.

Map invokeAll(Filter filter, InvocableMap.EntryProcessor processor), which invokes the EntryProcessor against the entries that match the filter and returns the result for each invocation.

---

Note: EntryProcessor classes must be available in the class path for each cluster node.

---

To create an entry process, you can extend com.tangosol.util.processes.AbstractProcessor and implement the process() method. For example, the following code creates an EntryProcessor instance to change the work address of employees in the Contacts data set:

```java
public static class OfficeUpdater extends AbstractProcessor
    implements PortableObject
...
    public Object process(InvocableMap.Entry entry)
    {
        Contact contact = (Contact) entry.getValue();
        contact.setWorkAddress(m_addrWork);
        entry.setValue(contact);
        return null;
    }
```

To invoke the OfficeUpdater class, you can use the invokeAll method with the name of the OfficeUpdater class as one of its arguments.

```java
cache.invokeAll(new EqualsFilter("getHomeAddress.getState", "MA"),
               new OfficeUpdater(addrWork));
```

In this exercise, you create a Java class with EntryProcessor instances that update entries in the cache. The ObserverExample class created in "Create a Class to Listen for Changes in the Cache" on page 7-2 will detect these changes and display the changed records.

1. Create a Class to Update Entries in the Cache
2. Edit the POF Configuration File
3. Run the Cache Update Example

**Create a Class to Update Entries in the Cache**

To create a file to update entries in the cache:

1. Create a class that updates entries in the cache.
   - In the Loading project, create a class called ProcessorExample with a main method that updates the address of a Contact object in the cache. See "Creating a Java Class" on page 2-11 for detailed information.
2. Write code to find the records of the Contacts object that live in Massachusetts and update their work addresses to an in-state office.
Include an inner class that implements the PortableObject interface (for serializing and deserializing data from the cache) and contains an EntryProcessor instance to set the work addresses. Use methods from the Filter class to isolate the Contacts members whose home addresses are in Massachusetts.

Example 7–5 illustrates a possible implementation of the ProcessorExample class.

Example 7–5  Sample Program to Update an Object in the Cache

```java
package com.oracle.handson;

import com.tangosol.net.NamedCache;
import com.tangosol.util.filter.EqualsFilter;
import com.tangosol.util.processor.AbstractProcessor;
import com.tangosol.util.InvocableMap;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PofWriter;
import com.oracle.handson.Address;
import com.oracle.handson.Contact;
import com.tangosol.net.CacheFactory;
import java.io.IOException;

/**
 * ProcessorExample executes an example EntryProcessor.
 *
 */
public class ProcessorExample
{
    public ProcessorExample()
    {
    }
    public static void main(String[] args)
    {
        NamedCache cache = CacheFactory.getCache("ContactsCache");
        new ProcessorExample().execute(cache);
    }
    // ----- ProcessorExample methods -----------------------------------
    public void execute(NamedCache cache)
    {
        // People who live in Massachusetts moved to an in-state office
        Address addrWork = new Address("200 Newbury St.", "Yoyodyne, Ltd.",
            "Boston", "MA", "02116", "US");
        cache.invokeAll(new EqualsFilter("getHomeAddress.getState", "MA"),
            new OfficeUpdater(addrWork));
    }
    // ----- nested class: OfficeUpdater ------------------------------------

    /**
     * OfficeUpdater updates a contact's office address.
     */
```
public static class OfficeUpdater
    extends AbstractProcessor
    implements PortableObject
{
    // ----- constructors -------------------------------------------

    /**
     * Default constructor (necessary for PortableObject implementation).
     */
    public OfficeUpdater()
    {
    }

    public OfficeUpdater(Address addrWork)
    {
        m_addrWork = addrWork;
    }

    // ----- InvocableMap.EntryProcessor interface ------------------

    public Object process(InvocableMap.Entry entry)
    {
        Contact contact = (Contact) entry.getValue();
        contact.setWorkAddress(m_addrWork);
        entry.setValue(contact);
        System.out.println("Work address was updated for " + contact.
            getFirstName() + " " + contact.getLastName());
        return null;
    }

    // ----- PortableObject interface -------------------------------

    public void readExternal(PofReader reader)
        throws IOException
    {
        m_addrWork = (Address) reader.readObject(0);
    }

    public void writeExternal(PofWriter writer)
        throws IOException
    {
        writer.writeObject(0, m_addrWork);
    }

    // ----- data members -------------------------------------------

    private Address m_addrWork;
}

Edit the POF Configuration File

Edit the contacts-pof-config.xml file to add a user type ID for the
OfficeUpdater entries. In this case, add the type ID 106 for the
ProcessorExample$OfficeUpdater class.

...<user-type>
    <type-id>1006</type-id>
Run the Cache Update Example

To run the cache update example.

1. Create a run configuration for ProcessorExample. Right click ProcessorExample in the Project Explorer and select Run As. In the Run Configurations dialog box select Oracle Coherence and click the New Configuration icon
   - In the Name field, enter ProcessorExample.
   - In the Project field in the Main tab, enter Loading. In the Main class field, enter com.oracle.handson.ProcessorExample.
   - In the General tab of the Coherence tab, browse to the c:\home\oracle\workspace\Contacts\appClientModule\contacts-cache-config.xml file in the Cache configuration descriptor field. Select the Disabled (cache client) button. Enter 3155 in the Cluster port field. Click Apply.
     In the Other tab, scroll down to the tangosol.pof.config field. Enter the absolute path to the POF configuration file contacts-pof-config.xml. Click Apply.
   - In the Common tab, select Shared file and browse for the Loading directory.

2. Perform the following steps to test the ObserverExample and ProcessorExample classes.
   a. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.
   b. Restart the ContactsCacheServer.
   c. Run the LoaderExample class to load the cache.
   d. Run the ObserverExample class.
   e. Run the ProcessorExample to update records in the cache.

You should see messages in the cache server console window, that are similar to Example 7–6, indicating that the work addresses for the specified employees were updated.

Example 7–6 Output from the ObserverExample and ProcessorExample Classes

... Started DefaultCacheServer... ...

2013-11-21 15:44:33.425/69.017 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): Member 4 joined Service PartitionedPofCache with senior member 1
Work address was updated for John Lfyovf
Work address was updated for John Jptrpajked
Work address was updated for John Mtqdln
Work address was updated for John Mstaugiw
Work address was updated for John Olfezqse
Work address was updated for John Qjefjgtgj
Work address was updated for John Kuhgkzn
Work address was updated for John Jpby
Work address was updated for John Cekuea
Work address was updated for John Guhkam
Work address was updated for John Ijwj
Work address was updated for John Trlb
Work address was updated for John Hnfcwxjq
Work address was updated for John Kizifh
Work address was updated for John Rqlhgboi
Work address was updated for John Ipphab

2013-11-21 15:44:33.547/69.139 Oracle Coherence GE 12.1.3.0.0 <D5> {thread=Cluster, member=1}:
TcpRing disconnected from Member (Id=4, Timestamp=2013-11-21 15:44:32.073, Address=130.35.99.28:8092, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7872, Role=OracleHandsonProcessorExample) due to a peer departure; removing the member.

...
In this exercise, you learn how to use Java Persistence API (JPA) to perform object-relational mapping. It highlights the use of the Coherence memory-based backing map and Oracle TopLink Grid.

This chapter contains the following sections:

- **Introduction**
- **Mapping Relational Data to Java Objects with JPA**

You must have a working version of the Oracle Database 12c installed on your system. If you do not have the database, you can download it from this URL:


## Introduction

JPA defines how relational data is mapped to Java objects (persistent entities), the way that these objects are stored in a relational database so that they can be accessed at a later time, and the continued existence of an entity’s state even after the application that uses it ends. In addition to simplifying the entity persistence model, the JPA standardizes object-relational mapping.

To determine how data is stored within a Coherence cluster, a backing map is used. By default, Coherence uses a memory-based backing map. To persist data, there are several backing map implementations.

The JPA implementation used in this exercise provides Object Relational Mapping (ORM) from the Java world to the database world. It also allows you to use standard Coherence `get` and `put` methods, and have Coherence calls translated into database calls using JPA and Oracle TopLink (based on the open source EclipseLink project).

### What is Oracle TopLink?

Oracle TopLink is a persistence framework including development tools and run-time capabilities for providing transformation, mapping, and persistence operations in Java SE and Java EE environments. The core technology of TopLink is provided by EclipseLink, the open-source persistence framework from the Eclipse Foundation.

TopLink includes additional features beyond EclipseLink. One of the additional components provided by TopLink is TopLink Grid.

### What is Oracle TopLink Grid?

Oracle TopLink Grid is a feature used for integrating the TopLink JPA implementation, provided by EclipseLink, with Oracle Coherence.
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.

You can build applications using JPA and transparently use the power of the data grid for improved scalability and performance. TopLink Grid provides the means for scaling JPA applications using Oracle Coherence. Applications can be scaled in a number of ways, ranging from using Coherence as a distributed shared (L2) cache up to directing JPQL queries to Coherence for parallel execution across the grid to reduce database load. 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.

The TopLink Grid cache store and cache loader implementations are shipped in the toplink-grid.jar file. 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.

This project 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.eclipselink.coherence.standalone package. For more information on TopLink Grid cache store and cache loader classes, see "Using Coherence Caches Backed by TopLink Grid" in Oracle Fusion Middleware Integrating Oracle Coherence.

The JPA on the Grid approach is not illustrated in this project. For information on this technique, see "Integrating TopLink Grid with Oracle Coherence" in Oracle Fusion Middleware Integrating Oracle Coherence.

---

**Mapping Relational Data to Java Objects with JPA**

In this exercise, you use Eclipse to perform the following tasks:

1. Unlock the Oracle Database
2. Configure the Project for JPA
3. Create the JPA Persistence Unit and Entities
4. Edit the persistence.xml File
5. Create the Cache Configuration File for JPA
6. Create a Cache Server Start-Up Configuration
7. Create a Class to Interact with the Data Object
8. Create a Run Configuration for RunEmployeeExample
9. Run the JPA Example

**Unlock the Oracle Database**

This chapter assumes that you have installed the Oracle 12c database and that the account associated with the HR user name was unlocked and assigned the password hr during the installation process.
If you did not unlock the account associated with the HR user name during installation, follow these steps:

1. Navigate to Start, then All Programs, then Oracle database home (such as Oracle-OraDB12Home1), then Application Development, then SQL Plus to open the SQL command line tool.

2. Login to the database as the system user, and enter the password, such as Welcome1. Connect to the database as sysdba:

   ```
   connect system as sysdba
   ```
   and then enter the sysdba password, such as Welcome1. (Note: your user name is system and your password is Welcome1.)

3. Enter the command to unlock the account associated with user HR. The password associated with the HR user is also hr.

   ```
   alter user hr identified by hr account unlock;
   ```

These commands are illustrated in Figure 8–1.

**Figure 8–1  Connecting to the Database**

Configure the Project for JPA

Create a new project in Eclipse IDE called JPAProject. See “Creating a New Project in the Eclipse IDE” on page 2-3 for detailed information.

1. In the Eclipse IDE, click Window then Open Perspective then Other to open the Open Perspective dialog box. Select the JPA perspective, as illustrated in Figure 8–2.
2. **Select File then New then JPA Project.** Enter JPAProject as the project name. Ensure that the default location points to home\oracle\workspace\JPAProject. Click **Modify** in the **Configuration** field to open the **Project Facets** dialog box.

3. **Select the Oracle Coherence facet.** The JPA and Java facets should already be selected.

4. **Click Save As in the Configuration field.** Enter JPAConfiguration in the **Save Preset** dialog box and click **OK.** The contents of the **Project Facets** dialog box should look similar to **Figure 8–3.**

---

**Figure 8–2  Selecting the JPA Perspective in the Open Perspective Dialog Box**

![Open Perspective dialog box](image)

---

**Figure 8–3  Project Facets for a JPA Project**

![Project Facets dialog box](image)
The contents of the New JPA Project dialog box should look similar to Figure 8–4. Click Next to go to the Java page.

Figure 8–4 Contents of the New JPA Project Dialog Box

5. Click Next in the Java page to accept the default output folder location.

6. In the JPA Facet page, select EclipseLink 2.5.x in the Platform drop-down list. Click the Manage Libraries icon to add the TopLink Grid, EclipseLink, and Java Persistence files.

7. Click New in the Preferences dialog box. In the New User Library dialog box, enter TopLink. Select the System library checkbox, as illustrated in Figure 8–5.
Click OK to dismiss the New User Library dialog box.

In the Preference dialog box, select TopLink [system library] and click Add External JARS.

Navigate to the Oracle_Home\oracle_common\modules\oracle.toplink_12.1.3 folder. Select the toplink-grid.jar and eclipselink.jar files and click Open. The toplink-grid.jar and eclipselink.jar files are added to the TopLink library. Click Add External JARS again and navigate to the Oracle_Home\oracle_common\modules folder. Select the javax.persistence_2.2.0.0_1-0-2.jar file and click Open. When you are finished, User Libraries should look similar to Figure 8–6.
11. Click OK to dismiss the Preferences dialog box. Select the Coherence12.1.3 and TopLink user libraries. The JPA Facet page should now look similar to Figure 8–7.

Figure 8–7 TopLink Libraries Added to the JPA Facet Page

12. Create a connection to the Oracle Database. Click Add connection.
a. In **Connection Profile** dialog box, select **Oracle Database Connection** and enter XE_HR in the **Name** field, as illustrated in **Figure 8–8**. Click Next.

**Figure 8–8  Connection Profile Page**

b. Select **Oracle Database Driver Default** in the Drivers field. Edit the **General** tab. Enter hr in the **User name** field and hr in the **Password** field. Select the **Save Password** check box. Enter localhost in the **Host** field. Select the **Connect when the wizard completes** check box. Click **Test Connection** button. The test should return an alert box with a success message, as illustrated in **Figure 8–9**. Click **OK**, then **Next** to see the Summary Page. Click **Finish**.
c. In the JPA Facet page, click Add driver library to build path, then click Next.

13. In the Coherence page, ensure that the Coherence 12.1.3, Oracle Database Driver, and TopLink user libraries are present and selected. Click Finish.
Create the JPA Persistence Unit and Entities

A persistence unit provides an easy way to identify the set of metadata files, classes, and JARs that contain all classes that need to be persisted as a group. The name of the persistence unit is used to identify it. Entities contain persistent data that can be saved in persistent data stores. The JPA entity can belong to a persistence unit. The persistence unit is described by the.persistence.xml file.

To create the JPA persistence unit and the JPA entities:

1. Right-click the JPAProject project and select New then select JPA Entities from Tables. The Select Tables dialog box opens.

2. Select the EMPLOYEES table, as illustrated in Figure 8–11 and click Next.

3. In the Table Associations page, illustrated in Figure 8–12, click Next to accept the defaults.
4. In the Customize Defaults page, select Collection properties type `java.util.List`. Enter `com.oracle.handson` in the Package field. Select Lazy in the Associations fetch field.

When you are finished, the Customize Default Entity Generation page should look similar to Figure 8–13. Click Next.
5. In the **Customize Individual Entities** page, enter `java.lang.Object` in the **Superclass** field. Change the **Class name** from `Employee` to `Employees`, as illustrated in **Figure 8–14**.

---

**Figure 8–13  Customize Default Entity Generation Page**

---

You can use the patterns `Table` and/or `Spk` in the sequence name. These patterns will be replaced by the table name and the primary key column name when a table mapping is generated.
Figure 8–14 Customize Individual Entities Page

6. Click Finish to generate the JPA Entities. An Employees.java file is generated in the JPAProject/src/com.oracle.handson node in the Project Explorer.

Edit the persistence.xml File

The persistence.xml file defines one or more persistence units. Use the persistence.xml Editor tool in the Eclipse IDE to edit the persistence.xml file.

1. Open the persistence.xml file in the Eclipse editor.
2. Click the General tab. Enter the name of the persistence provider if it is not already provided. It will be org.eclipse.persistence.jpa.PersistenceProvider.
3. In the Connection tab, select Resource Local from the Transaction type drop down list.

In EclipseLink connection pool section, click Populate from connection link, then click the XE_HR item in the Connection Selection dialog box. The values in this field will be provided from the database connection you defined in "Configure the Project for JPA" on page 8-3. The Connection Properties tab should look similar to Figure 8–16.
4. Open the Options tab and select Fine from the Logging level drop down list. Select the Exceptions checkbox. Deselect the Timestamp, Thread, Session, and Connection checkboxes. When you are finished, the Options tab should look similar to Figure 8–17.
5. Inspect the Properties tab. The contents should look similar to Figure 8–18.

6. Open the Source tab. The persistence.xml file should look similar to Example 8–1. Save the file.

Example 8–1 Generated persistence.xml File

```xml
<?xml version="1.0" encoding="UTF-8"?>
<persistence version="2.1" xmlns="http://xmlns.jcp.org/xml/ns/persistence"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/persistence http://xmlns.jcp.org/xml/ns/persistence/persistence_2_1.xsd">
  <persistence-unit name="JPAProject" transaction-type="RESOURCE_LOCAL">
    <provider>org.eclipse.persistence.jpa.PersistenceProvider</provider>
    <class>com.oracle.handson.Employees</class>
    <properties>
      <property name="eclipselink.target-server" value="None"/>
    </properties>
  </persistence-unit>
</persistence>
```
<property name="javax.persistence.jdbc.url" value="jdbc:oracle:thin:@localhost:1521:orcl"/>
<property name="javax.persistence.jdbc.user" value="hr"/>
<property name="javax.persistence.jdbc.password" value="hr"/>
<property name="javax.persistence.jdbc.driver" value="oracle.jdbc.OracleDriver"/>
<property name="eclipselink.logging.level" value="FINE"/>
<property name="eclipselink.logging.timestamp" value="false"/>
<property name="eclipselink.logging.thread" value="false"/>
<property name="eclipselink.logging.session" value="false"/>
<property name="eclipselink.logging.connection" value="false"/>
<property name="eclipselink.logging.exceptions" value="true"/>
</properties>
</persistence-unit>
</persistence>

Create the Cache Configuration File for JPA

Create a cache configuration file for the JPA project.

1. Right click coherence-cache-config.xml file in the project and select Open.
2. Enter the code illustrated in Example 8–2. Use Rename or Save As to save the file as jpa-cache-config.xml. The file will be saved to the home\oracle\workspace\JPAProject\src folder.
3. Ensure that the original coherence-cache-config.xml file no longer appears in Project Explorer.

   In Example 8–2, note the use of distributed-eclipselink as the value of the scheme-name element, EclipseLinkJPA as the value of the service-name element, and oracle.eclipselink.coherence.standalone.EclipseLinkJPACacheStore as the value of the class-name subelement of the cachestore-scheme element.

Example 8–2  Cache Configuration for JPA

```xml
<?xml version="1.0"?>
<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
    <defaults>
        <serializer system-property="tangosol.coherence.serializer"/>
        <socket-provider system-property="tangosol.coherence.socketprovider"/>
    </defaults>
    <caching-scheme-mapping>
        <cache-mapping>
            <!-- Set the name of the cache to be the entity name -->
            <cache-name>Employees</cache-name>
            <!-- Configure this cache to use the scheme defined below -->
            <scheme-name>distributed-eclipselink</scheme-name>
        </cache-mapping>
    </caching-scheme-mapping>
    </caching-schemes>
</cache-config>
```
Create a Cache Server Start-Up Configuration

Create a configuration to start the cache server for the JPA project.

1. Right click the project and select Run As then Run Configurations. Double click the Oracle Coherence icon in the Run Configurations dialog box to create a new launch configuration.

2. In the Main tab, enter JPAServer in the Name field. Click Browse in the Project field and select the JPAProject project in the Project Selection dialog box. Select the Include system libraries when searching for a main class checkbox and click Search. Enter DefaultCacheServer in the Select Type field and select com.tangosol.net.DefaultCacheServer. Click Apply. The Main tab should look similar to Figure 8–19.
3. In the **General** tab of the **Coherence** tab, identify the path to the cache configuration file under **Cache configuration descriptor**. Click the **Browse** button to navigate to the **Absolute file path** of the JPA cache configuration file `C:\home\oracle\workspace\JPAProject\src\jpa-cache-config.xml`. Select **Enabled (cache server)** under **Local storage**. Enter a unique value, such as 3155, for the **Cluster port**.

   In the **Other** tab, ensure that the **tangosol.pof.config** item is set to the default `pof-config.xml`.

4. In the **Common** tab, select **Shared file** and browse to the `/JPAProject`.

5. The **Classpath** tab should look similar to **Figure 8–20**.

   ![Figure 8–20 Classpath Tab for the JPA Cache Server Executable](image)

You will start the cache server in a later step: "Run the JPA Example" on page 8-21.

**Create a Class to Interact with the Data Object**

Create a new class in the JPAProject project to interact with the Employees object. The objective of the class will be to change the value of an employee's salary.

1. Create a new class with a `main` method called `RunEmployeeExample`. See "Creating a Java Class" on page 2-11 for detailed information.

2. Create the code to perform the following:
   a. Get an employee using the `EMPLOYEE_ID` attribute. `EMPLOYEE_ID` is a `long` data type.
   b. Display the salary.
c. Give the employee a 10% pay raise.

d. Get the value again to confirm the pay raise.

Example 8–3 illustrates a possible implementation of the `RunEmployeeExample` class.

**Example 8–3 Sample Employee Class File**

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import java.math.BigDecimal;

public class RunEmployeeExample
{
    public RunEmployeeExample()
    {
    }

    public static void main(String[] args)
    {
        long empId = 190L;  // emp 190 - Timothy Gates

        NamedCache employees = CacheFactory.getCache("Employees");
        Employees emp = (Employees)employees.get(empId);

        System.out.println("Employee "+ emp.getFirstName() + " "+
                emp.getLastName() + ", salary = $"+ emp.getSalary() + "");

        // give them a 10% pay rise
        emp.setSalary(emp.getSalary().multiply(BigDecimal.valueOf(1.1)));

        employees.put(empId, emp);

        Employees emp2 = (Employees)employees.get(empId);

        System.out.println("New Employee details are "+ emp2.getFirstName() + " "+
                emp2.getLastName() + ", salary = $" + emp2.getSalary() + "");
    }
}
```

**Create a Run Configuration for RunEmployeeExample**

To create a run configuration, modify the run-time properties and edit the class path in Eclipse.

1. Right click `RunEmployeeExample.java` in the Project Explorer and choose Run As then Run Configurations. In the Run Configurations dialog box, double-click the Oracle Coherence icon to create a new launch configuration.

2. In the Main tab, enter RunEmployee in the Name field. Click Browse and select the JPAProject project. In the Main class field, click Search and choose `com.oracle.handson.RunEmployeeExample`. Click Apply.

3. In the General tab of the Coherence tab, browse to the C:\home\oracle\workspace\JPAProject\src\jpa-cache-config.xml file in the Cache configuration descriptor field. Select the Disabled (cache client) button. Enter 3155 in the Cluster port field. Click Apply.
4. In the **Other** tab, ensure that the default `pof-config.xml` appears in the `tangosol.pof.config` field.

5. In the **Common** tab, select **Shared file** and browse to the `\JPAProject` project. The **Classpath** tab should look similar to Figure 8–21.

**Figure 8–21** Classpath Tab for the RunEmployee Executable

![Classpath Tab](image)

**Run the JPA Example**

Now that the `Employee` class has been annotated to persist to the database using JPA, and you have included the `persistence.xml` file to tell JPA where your database is, Coherence employs a CacheStore implementation that uses TopLink Grid to load and store objects in the database. When you use the `get(Object key)` method, the following happens:

- Coherence looks for the entry with the key.
- If the entry is not already in the cache, or if it is expired from the cache, then Coherence calls the backing map, which uses the TopLink Grid cache store, to retrieve the data.
- If the entry is in the cache, Coherence returns the entry directly to the application without going through the TopLink Grid cache store. When you use the `put(object key,object value)` method, Coherence uses EclipseLink JPA through TopLink Grid to persist any changes to the database.

In the **Run Configurations** dialog box, select the **JPAServer** launch configuration and click **Run** to start the cache server. After the cache server starts, select the **RunEmployee** configuration and click **Run**. The output from the executable should look similar to Example 8–4.

**Example 8–4** Output from the RunEmployee Executable

...  
2013-12-19 14:46:50.395/3.800 Oracle Coherence GE 12.1.3.0.0 <DS> (thread=Invocation:Management, member=2): Service Management joined the cluster with senior service member 1  
2013-12-19 14:46:50.415/3.820 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=2): Loaded Reporter configuration from "jar:file:/C:/Oracle/coherence/lib/coherence.jar!/reports/report-group.xml"  
2013-12-19 14:46:50.745/4.150 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=2): TcpAcceptor now listening for connections on 130.35.99.14:8090.3  
2013-12-19 14:46:51.105/4.510 Oracle Coherence GE 12.1.3.0.0 <DS> (thread=DistributedCache:EclipseLinkJPA, member=2): Service EclipseLinkJPA joined the cluster with senior service member 1  
**Employee Timothy Gates, salary = $2900**  
**New Employee details are Timothy Gates, salary = $3190.0**
The response from the cache server displays a successful login to retrieve information from the database, as illustrated in Example 8–5. Note the logging information returned (in bold).

**Example 8–5  Cache Server Response to Logging In to the Database**

... Started DefaultCacheServer...

2013-12-19 14:46:50.143/42.045 Oracle Coherence GE 12.1.3.0.0 <D5> {thread=Cluster, member=1}:
Member (Id=2, Timestamp=2013-12-19 14:46:49.953, Address=130.35.99.14:8090, MachineId=47251, Location=site:,machine:TPPAEFL-LAP,process:3076, Role=OracleHandsonRunEmployeeExample) joined Cluster with senior member 1
2013-12-19 14:46:50.395/42.297 Oracle Coherence GE 12.1.3.0.0 <D5> {thread=Invocation:Management, member=1}: Member 2 joined Service Management with senior member 1
2013-12-19 14:46:51.125/43.027 Oracle Coherence GE 12.1.3.0.0 <D5> {thread=DistributedCache:EclipseLinkJPA, member=1}: Member 2 joined Service EclipseLinkJPA with senior member 1

[EL Config]: metadata: The access type for the persistent class [class com.oracle.handson.Employees] is set to [FIELD].
[EL Config]: metadata: The target entity (reference) class for the many to one mapping element [field employee] is being defaulted to: class com.oracle.handson.Employees.
[EL Config]: metadata: The target entity (reference) class for the one to many mapping element [field employees] is being defaulted to: class com.oracle.handson.Employees.
[EL Config]: metadata: The alias name for the entity class [class com.oracle.handson.Employees] is being defaulted to: Employees.
[EL Config]: metadata: The table name for entity [class com.oracle.handson.Employees] is being defaulted to: EMPLOYEES.
[EL Config]: metadata: The column name for element [email] is being defaulted to: EMAIL.
[EL Config]: metadata: The column name for element [salary] is being defaulted to: SALARY.
[EL Config]: metadata: The primary key column name for the mapping element [field employee] is being defaulted to: EMPLOYEE_ID.
[EL Info]: EclipseLink, version: Eclipse Persistence Services - 2.5.2.v20131130-72ace27
[EL Config]: connection: connecting(DatabaseLogin(
   platform=>Oracle11Platform
   user name=> "hr"
   datasource URL=> "jdbc:oracle:thin:@localhost:1521:orcl"
 ))
User: HR
Database: Oracle Version: Oracle Database 12c Enterprise Edition Release 12.1.0.1.0 - 64bit
Production
With the Partitioning, OLAP, Advanced Analytics and Real Application Testing options
Driver: Oracle JDBC driver Version: 11.2.0.3.0
[EL Info]: connection: file:/C:/home/oracle/workspace/JPAProject/build/classes/_JPAProject login successful
[EL Fine]: sq1: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
   bind => [190]
[EL Fine]: sq1: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
   bind => [122]
[EL Fine]: sq1: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
   bind => [100]
[EL Fine]: sq1: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
bind => [190]
[EL Fine]: sql: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
bind => [122]
[EL Fine]: sql: SELECT EMPLOYEE_ID, COMMISSION_PCT, DEPARTMENT_ID, EMAIL, FIRST_NAME, HIRE_DATE, JOB_ID, LAST_NAME, PHONE_NUMBER, SALARY, MANAGER_ID FROM EMPLOYEES WHERE (EMPLOYEE_ID = ?)
bind => [100]
[EL Fine]: sql: UPDATE EMPLOYEES SET SALARY = ? WHERE (EMPLOYEE_ID = ?)
bind => [3190.0, 190]

2013-12-19 14:46:53.397/45.299 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): TcpRing disconnected from Member(Id=2, Timestamp=2013-12-19 14:46:49.953, Address=130.35.99.14:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3076, Role=OracleHandsonRunEmployeeExample) due to a peer departure; removing the member.

2013-12-19 14:46:53.397/45.299 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): Member(Id=2, Timestamp=2013-12-19 14:46:53.397, Address=130.35.99.14:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:3076, Role=OracleHandsonRunEmployeeExample) left Cluster with senior member 1

2013-12-19 14:46:53.397/45.300 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:EclipseLinkJPA, member=1): Member 2 left service EclipseLinkJPA with senior member 1

2013-12-19 14:46:53.398/45.300 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 left service Management with senior member 1
Interacting with the Cache and the Database

In this exercise, you will create and configure an Oracle Coherence cache in Eclipse. It highlights the use of the Coherence CacheStore, ContinuousQueryCache, IdentityExtractor, and Filter APIs.

In this exercise you will create these items:

- A Java class that creates a NamedCache instance and can put and get cache entries.
- A cache configuration file to define the mapping for cache names, cache types, and naming patterns.
- A Java class that creates a connection to Oracle Database and can retrieve and store table data.
- A database cache. This class will add cache entries, query the database cache, and retrieve entries.

This chapter contains the following sections:

- Introduction
- Creating a Cache Application
- Creating a Database Cache

Introduction

A Coherence cache is a collection of data objects that acts as an intermediary between the database and the client applications. Database data can be loaded into a cache and made available to different applications. Thus, Coherence caches reduce load on the database and provide faster access to database data.

Coherence caches provide higher availability through database isolation and data replication. Modifications made to a cache can be synchronized with the database whenever the database is available. Even if the database or an application server node is not available, database updates are still reliable due to the lazy load and lazy write mechanism used by a Coherence cache and due to the failover and fail back provided by Coherence.

Coherence caches provide distributed processing not only across a cluster of application server nodes but also across the data objects in the cache, because data modification operations can be performed on the data objects.

Coherence also provides event-based processing. The state of data objects in a cache can be monitored and actions invoked on other processes such as the start of a business process execution language (BPEL) process.
Coherence supports different types of caches:

- Replicated caches, where data is replicated to each of the application server nodes in the cluster. This type of cache is recommended if faster read access is required but not suitable for write operations, because data must be written to each of the nodes. The drawback of replicated caches is that they require a large amount of memory because every node has a copy of every object.

- Distributed (or partitioned) caches, where data is distributed (load-balanced) across different nodes. Failover is implemented in a distributed cache using backups, which are also distributed across the cluster nodes.

Coherence is implemented by using services such as the cluster service, the distributed cache service, and the replicated cache service. Whichever type of cache is used, an application uses the same API to access and store data.

A cache configuration deployment descriptor is used to configure a cache. The root element of the cache configuration file is `cache-config`. Cache names and name patterns are mapped to cache types in the `caching-scheme-mapping` element using the subelement `cache-mapping`. Cache types are defined in the `caching-schemes` element. Table 9–1 describes some of the cache types commonly used by Coherence.

<table>
<thead>
<tr>
<th>Cache Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>distributed scheme</td>
<td>Defines a distributed cache in which data is stored across a cluster of nodes.</td>
</tr>
<tr>
<td>replicated scheme</td>
<td>Defines a cache in which cache entries are replicated across all the cluster nodes.</td>
</tr>
<tr>
<td>read-write-backing-map scheme</td>
<td>Defines a map, which provides a cache of a persistent store such as a relational database.</td>
</tr>
<tr>
<td>external scheme</td>
<td>Defines an external cache such as a disk.</td>
</tr>
<tr>
<td>class scheme</td>
<td>Defines a custom cache implementation, which is required to implement the java.util.Map interface.</td>
</tr>
</tbody>
</table>

Creating a Cache Application

This section describes how to create and run an application that puts data into the cache and retrieves it.

1. Create an Application that Constructs a Cache
2. Create a Cache Configuration File
3. Create a Run Configuration for the Application
4. Create the Cache Server Start-Up Configuration
5. Run the Cache Creation Application

Create an Application that Constructs a Cache

To create a Java class that constructs a Coherence cache:

1. Create a project in Eclipse.
   a. Use the JPA perspective in Eclipse to create a JPA Project called Interaction. Select the JPA Configuration you created in Chapter 8, "Using JPA with Coherence."
b. In the JPA Facet page, ensure that EclipseLink 2.5.x appears in the Platform field. Ensure that Coherence12.1.3, Oracle Database Driver, and TopLink are selected under User Libraries. In the Connection field, select the connection you created in "Configure the Project for JPA" on page 8-3 (XE_HR), from the Connection drop down list. Click the Connect link to connect to the Oracle Database if necessary. (Note, this assumes that the database connection that you created is still running.) Select Add Driver Library to Build Path and select Oracle Database Driver Default from the drop-down list. Click Next.

c. In the Coherence page, ensure that Coherence12.1.3, Oracle Database Driver, and TopLink are selected. Click Finish.

2. Create a Java class, CoherenceCache, that will be used to create a Coherence cache. Include a main method in the class. See “Creating a Java Class” on page 2-11 for detailed information on creating a class.

a. Create a cache in the CoherenceCache Java class. Import the CacheFactory class and the NamedCache interface.

```java
import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
```

b. Create the cache (NamedCache) instance by using the CacheFactory. getCache method. Use the cache name VirtualCache, which is mapped to a distributed caching scheme.

```java
NamedCache cache = CacheFactory.getCache ("VirtualCache");
```

c. A NamedCache is a java.util.Map instance that holds resources that are shared across nodes in a cluster. Add a cache entry by using the put method.

```java
cache.put (key, "Hello Cache");
```

d. Retrieve a cache entry by using the get method.

```java
System.out.println((String)cache.get("hello"));
```

Example 9–1 illustrates a possible implementation of CoherenceCache class. You can copy the code to the CoherenceCache file in Eclipse.

**Example 9–1 Implementation of a Coherence Cache**

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

public class CoherenceCache{
    NamedCache cache;
    public CoherenceCache(){}
    public void putCache() {
        cache = CacheFactory.getCache ("VirtualCache");
        String key = "hello";
        cache.put (key, "Hello Cache");
    }
    public void retrieveCache() {
    }
```
System.out.println((String)cache.get("hello"));
}

public static void main (String [] args)
{
    CoherenceCache cache = new CoherenceCache();
    cache.putCache();
    cache.retrieveCache();
}

Create a Cache Configuration File

In the Project Explorer, rename the coherence-cache-config.xml cache configuration file to be cache-config.xml. Open the file in the Eclipse Editor.

In the cache configuration file:

- Define mappings for cache names and naming patterns with the cache-mapping elements in the caching-scheme-mapping element.
- Map the cache name VirtualCache to cache type distributed-eclipselink.
- Define the distributed caching scheme with the distributed-scheme element using the EclipseLinkJPA service.

The cache configuration file is illustrated in Example 9–2. Copy the contents of this example to the cache-config.xml.

**Example 9–2  Cache Configuration File**

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

    <defaults>
        <serializer system-property="tangosol.coherence.serializer"/>
        <socket-provider system-property="tangosol.coherence.socketprovider"/>
    </defaults>
    <caching-scheme-mapping>
        <cache-mapping>
            <cache-name>VirtualCache</cache-name>
            <scheme-name>distributed-eclipselink</scheme-name>
        </cache-mapping>
    </caching-scheme-mapping>
    <!-- Default Distributed caching scheme. -->
    <distributed-scheme>
        <scheme-name>distributed-eclipselink</scheme-name>
        <service-name>EclipseLinkJPA</service-name>
        <backing-map-scheme>
            <class-scheme>
                <schema-ref>default-backing-map</schema-ref>
            </class-scheme>
        </backing-map-scheme>
    </distributed-scheme>
</cache-config>
```
Create a Run Configuration for the Application

Create a run configuration for the application to add the cache configuration file as a run-time Java option.

1. Right click CoherenceCache.java in the Project Explorer and choose Run As then Run Configurations. In the Run Configurations dialog box, click the New launch configuration icon.

2. Enter CoherenceCacheServer in the Name field. Ensure that Interaction is in the Project field and com.oracle.handson.CoherenceCache is in the Main class field.

3. In the Coherence tab, enter the path to the cache configuration file, C:\home\oracle\workspace\Interaction\src\cache-config.xml. Select the Enabled (cache server) button. Enter a unique value, such as 3155, in the Cluster port field. Click Apply.

The Classpath tab should look similar to Figure 9–1.

Create the Cache Server Start-Up Configuration

To create a cache sever start-up configuration for the Interaction project:

1. Right click the Interaction project and select Properties. In the Properties for Interact dialog box, select Java Build Path. In the Order and Export tab, the Interaction project, the JRE, Coherence12.1.3, TopLink, and the Oracle Database Driver Default libraries should be present. Ensure that they are all selected. The Order and Export tab should look similar to Figure 9–2.
2. Edit the JPA cache server start-up configuration (JPAServer) that you created in Chapter 8, "Using JPA with Coherence".
   a. Right click the Interaction project and select Run As then Run Configurations. In the Main tab click Browse and select the Interaction project from the Project Selection dialog box.
   b. In the General tab of the Coherence tab, replace the name and path of the configuration file with `C:\home\oracle\workspace\Interaction\src\cache-config.xml`.
   c. In the Classpath tab, remove the JPA (default classpath) folder if it appears. Click Add Project to add the Interaction project. The Classpath tab should look similar to Figure 9–3.
   d. In the Shared file field of the Common tab, click Browse to select the Interaction project. Click Apply, then Close.

**Run the Cache Creation Application**

To run the cache creation application CoherenceCache.java:

1. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.
2. Run the JPAServer to start the cache server.
3. Right-click the Coherence application CoherenceCache.java and click Run As then Run Configurations. Select the CoherenceCacheServer configuration and click Run. The Eclipse console window displays the output:
Creating a Database Cache

In this section, create a cache backed by Oracle Database. This is also referred to as an Oracle Database cache.

1. Create an Oracle Database Cache
2. Create a Class to Define a Custom Cache Store
3. Modify the Cache Configuration File
4. Create a Class to Construct the Database Cache
5. Run the Database Cache Application

Create an Oracle Database Cache

To use SQL*Plus and the Oracle Database to create an Oracle Database cache follow these steps. You must have the database installed on your system.

1. Invoke SQL*Plus.
   
   Navigate to Start then All Programs then Oracle Database Home (for example, Oracle-OraDB12Home1) then Application Development, and then SQL Plus.

2. Connect as hr user with hr as the password.
   
   connect hr/hr;

3. Create an Oracle Database table.
Open a text editor and copy the following SQL code. Save it as a file named dbscript.sql in the /home/oracle/workspace/ folder.

**Example 9–4  SQL Script for Creating a Database Table**

```sql
CREATE TABLE HR.CATALOG(id VARCHAR(25) PRIMARY KEY, value VARCHAR(96));
INSERT INTO HR.CATALOG VALUES('catalog1', 'Tuning Undo Tablespace');
INSERT INTO HR.CATALOG VALUES('catalog2', 'Tuning Your View Objects');
```

4. Run the SQL script.

**Example 9–5  Running the SQL Script for Creating a Database Table**

Copyright (c) 1982, 2013, Oracle. All rights reserved.

Enter user-name: system
Enter password:
Last Successful login time: Thu Dec 19 2013 11:35:04 -08:00

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.1.0 - 64bit Production
With the Partitioning, OLAP, Advanced Analytics and Real Application Testing options

SQL> connect hr/hr;
Connected.
SQL> @/home/oracle/workspace/dbscript.sql

Table created
1 row created
1 row created

**Create a Class to Define a Custom Cache Store**

To create a Java class that connects to the database and retrieves table data:

1. Create a Java class DBCacheStore in the Interaction project in Eclipse. See “Creating a Java Class” on page 2-11 for detailed information.

2. Create the code to connect to the database and get table data.

**Example 9–6  Database Cache Store Implementation**

```java
package com.oracle.handson;

import com.tangosol.net.cache.CacheStore;
import com.tangosol.util.Base;
import java.sql.DriverManager;
import java.sql.Connection;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
```
public class DBCacheStore
    extends Base
    implements CacheStore {

    protected Connection m_con;
    protected String m_sTableName;
    private static final String DB_DRIVER   = "oracle.jdbc.OracleDriver";
    private static final String DB_URL      = "jdbc:oracle:thin:@localhost:1521:orcl";
    private static final String DB_USERNAME = "hr";
    private static final String DB_PASSWORD = "hr";

    public DBCacheStore(String sTableName)
    {
        m_sTableName = sTableName;
        configureConnection();
    }

    protected void configureConnection()
    {
        try
        {            
            Class.forName("oracle.jdbc.OracleDriver");
            m_con = DriverManager.getConnection(DB_URL, DB_USERNAME, DB_PASSWORD);
            m_con.setAutoCommit(true);
        }
        catch (Exception e)
        {
            throw ensureRuntimeException(e, "Connection failed");
        }
    }

    public String getTableName()
    {
        return m_sTableName;
    }

    public Connection getConnection()
    {
        return m_con;
    }

    public Object load(Object oKey)
    {
        Object oValue = null;
        Connection con = getConnection();
        String sSQL = "SELECT id, value FROM " + getTableName()
                      + " WHERE id = ?";
        try
        {            
            // SQL execution
        }
    }
Creating a Database Cache

```java
PreparedStatement stmt = con.prepareStatement(sSQL);
stmt.setString(1, String.valueOf(oKey));
ResultSet rslt = stmt.executeQuery();
if (rslt.next())
{
    oValue = rslt.getString(2);
    if (rslt.next())
    {
        throw new SQLException("Not a unique key: " + oKey);
    }
}
stmt.close();
}
catch (SQLException e)
{
    throw ensureRuntimeException(e, "Load failed: key=" + oKey);
}
return oValue;

public void store(Object oKey, Object oValue)
{
    Connection con = getConnection();
    String sTable = getTableName();
    String sSQL;
    if (load(oKey) != null)
    {
        sSQL = "UPDATE " + sTable + " SET value = ? where id = ?";
    }
    else
    {
        sSQL = "INSERT INTO " + sTable + " (value, id) VALUES (?,?)";
    }
    try
    {
        PreparedStatement stmt = con.prepareStatement(sSQL);
        int i = 0;
        stmt.setString(++i, String.valueOf(oValue));
        stmt.setString(++i, String.valueOf(oKey));
        stmt.executeUpdate();
        stmt.close();
    }
    catch (SQLException e)
    {
        throw ensureRuntimeException(e, "Store failed: key=" + oKey);
    }
}

public void erase(Object oKey)
{
    Connection con = getConnection();
    String sSQL = "DELETE FROM " + getTableName() + " WHERE id=?";
    try
    {
        PreparedStatement stmt = con.prepareStatement(sSQL);
        stmt.setString(1, String.valueOf(oKey));
    }
    catch (SQLException e)
    {
        throw ensureRuntimeException(e, "Erase failed: key=" + oKey);
    }
}
```
stmt.executeUpdate();
stmt.close();
}

public void eraseAll(Collection colKeys)
{
    throw new UnsupportedOperationException();
}

public Map loadAll(Collection colKeys)
{
    throw new UnsupportedOperationException();
}

public void storeAll(Map mapEntries)
{
    throw new UnsupportedOperationException();
}

public Iterator keys()
{
    Connection con  = getConnection();
    String     sSQL = "SELECT id FROM " + getTableName();
    List       list = new LinkedList();

    try
    {
        PreparedStatement stmt = con.prepareStatement(sSQL);
        ResultSet         rslt = stmt.executeQuery();
        while (rslt.next())
        {
            Object oKey = rslt.getString(1);
            list.add(oKey);
        }
        stmt.close();
    }
    catch (SQLException e)
    {
        throw ensureRuntimeException(e, "Iterator failed");
    }

    return list.iterator();
}

Modify the Cache Configuration File

Modify the cache configuration file (cache-config.xml) that you created earlier for the database cache. To connect a cache to a database, you must configure the cachestore-scheme element with a custom class that implements either the com.tangosol.net.cache.CacheLoader or com.tangosol.net.cache.CacheStore interface.

Replace the code in the existing cache-config.xml file in Eclipse with the cache configuration code for the database cache in Example 9–7.
Creating a Database Cache

Example 9–7  Database Cache Configuration File

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<cache-config>

  <caching-scheme-mapping>
    <!--
    Caches with names that start with 'DBBacked' will be created as distributed-db-backed.
    -->
    <cache-mapping>
      <cache-name>DBBacked*</cache-name>
      <scheme-name>distributed-db-backed</scheme-name>
    </cache-mapping>
    </caching-scheme-mapping>
    <caching-schemes>
      <!--
      DB Backed Distributed caching scheme.
      -->
      <distributed-scheme>
        <scheme-name>distributed-db-backed</scheme-name>
        <service-name>DistributedCache</service-name>
        <backing-map-scheme>
          <read-write-backing-map-scheme>
            <internal-cache-scheme>
              <class-scheme>
                <class-name>com.tangosol.util.ObservableHashMap</class-name>
              </class-scheme>
            </internal-cache-scheme>
            <cachestore-scheme>
              <class-scheme>
                <class-name>com.oracle.handson.DBCacheStore</class-name>
              </class-scheme>
              <init-params>
                <init-param>
                  <param-type>java.lang.String</param-type>
                  <param-value>CATALOG</param-value>
                </init-param>
              </init-params>
            </cachestore-scheme>
          </read-write-backing-map-scheme>
          </backing-map-scheme>
        </distributed-scheme>
      </caching-schemes>

In the cache configuration file, you have done the following:

- Defined a cache name pattern `DBBacked*`, which is mapped to a distributed caching scheme `distributed-db-backed`.
- Specified the `CacheStore` scheme in the distributed scheme using the class `coherence.DBCacheStore`, which implements the `CacheStore` interface.
- Specified for the `DBCacheStore` class an `init` parameter for the database table that is at the back end of the cache. The table name is specified in the `init-param`
element. The DBCacheStore class performs database operations such as reading and writing cache entries.

- Specified a read-write-backing-map-scheme as the backing map. This scheme defines a backing map, which provides a size-limited cache of a persistent store. Here, by setting the write-delay-seconds parameter to 0, you specify the write-through mechanism.

Table 9–2 describes the types of read/write caching that you can use with Coherence.

<table>
<thead>
<tr>
<th>Types of Read/Write Caching</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>read-through</td>
<td>A cache entry is read into a cache from the database when required and made available to an application.</td>
</tr>
<tr>
<td>write-through</td>
<td>Updates to cache entries are synchronized with the database without a delay.</td>
</tr>
<tr>
<td>refresh-ahead</td>
<td>Cache entries are refreshed periodically.</td>
</tr>
<tr>
<td>write-behind</td>
<td>Updates to cache entries are asynchronously written to a database after a delay specified in the write-delay-seconds element in the cache configuration file.</td>
</tr>
</tbody>
</table>

Create a Class to Construct the Database Cache

Create a Java class DatabaseCache for the database cache in the Interaction project in Eclipse. The class must contain a main method. See "Creating a Java Class" on page 2-11 for detailed information.

In the class file, provide the code to add a cache entry, query a database cache, and retrieve a cache entry. Add the following methods: createCache(), addEntry(), retrieveEntry(), eraseEntry(), and queryCache(). Example 9–8 illustrates a possible implementation.

**Example 9–8 Implementation for the DatabaseCache Class File**

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.net.cache.ContinuousQueryCache;
import com.tangosol.util.Filter;
import com.tangosol.util.extractor.IdentityExtractor;
import com.tangosol.util.filter.LikeFilter;
import java.util.HashSet;
import java.util.Iterator;
import java.util.Map;
import java.util.Set;

public class DatabaseCache {
    NamedCache cache;
    public DatabaseCache() {
    }

    public void createCache() {
        cache = CacheFactory.getCache("DBBackedCache");
    }
}
```

Interacting with the Cache and the Database 9-13
Creating a Database Cache

```java
public void addEntry()
{
    // Add entries to the cache.
    cache.put(new String("catalog3"), new String("Tuning Grid Management"));
    cache.put(new String("catalog4"), new String("Tuning Coherence"));
    cache.put(new String("catalog5"), new String("Tuning Database"));
}

public void retrieveEntry()
{
    // Retrieve an entry from the cache.
    System.out.println((String) cache.get("catalog3"));
}

public void eraseEntry()
{
    // Erase an entry from the cache.
    cache.remove(new String("catalog3"));
}

public void queryCache()
{
    // Query the cache.
    Filter filter = new LikeFilter(IdentityExtractor.INSTANCE, "Tuning", '\', true);
    HashSet hashSet = new HashSet();
    hashSet.add(new String("catalog3"));
    hashSet.add(new String("catalog4"));
    hashSet.add(new String("catalog5"));
    Map map = cache.getAll(hashSet);
    Set results = cache.entrySet(filter);
    for (Iterator i = results.iterator(); i.hasNext();)
    {
        Map.Entry e = (Map.Entry) i.next();
        System.out.println("Catalog ID: "+e.getKey() + ", Title: "+e.getValue());
    }
}

public static void main(String[] args)
{
    DatabaseCache databaseCache = new DatabaseCache();
    databaseCache.createCache();
    databaseCache.addEntry();
    databaseCache.queryCache();
}
```

Note the following features of the database cache class file:

- A NamedCache object is created using the `getCache` method of the `CacheFactory` class in the `createCache` method.

```java
NamedCache cache = CacheFactory.getCache("DBBackedCache");
```

- The `DBBackedCache` matches the cache pattern `DBBacked*` and is, therefore, mapped to a distributed caching scheme `distributed-db-backed` in the cache-config.xml file. Add a cache entry using the `put()` method of the NamedCache object.

```java
cache.put(new String("catalog3"), new String("Tuning Grid Management"));
```
Because the write-through mechanism is used, the new cache entry gets synchronized with the database; a new row is added to the CATALOG table. Comment out all the methods except the createCache and addEntry methods.

When the put method is invoked, the store method, which maps the new cache entry to the database table CATALOG using JDBC, gets invoked in the DBCacheStore class. The output from the Coherence application is displayed in the Log window and a new cache entry is added. The output shows that the operational configuration deployment descriptor is loaded, the cache configuration is loaded, a new cluster is created, and the DistributedCache service has joined the cluster.

The new cache entry can be removed with the remove method of the NamedCache object.

```java
cache.remove(new String("catalog3"));
```

Bulk uploading of cache entries is performed using the putAll method.

```java
A cache entry is retrieved using the get method of the NamedCache object. For example, retrieving the cache entry for ID catalog1:
```n
```java
System.out.println((String) cache.get("catalog1"));
```

When the get() method is invoked, the load method, which retrieves database table data using JDBC, gets invoked in the DBCacheStore class.

Bulk retrieval is performed using the getAll method of the NamedCache object.

Coherence supports searching for cache entries based on a search criteria using filters. Coherence filters are available in the com.tangosol.util.filter package. In Oracle Coherence Enterprise Edition and Grid Edition, indexes can be added to the Coherence cache to improve performance. You query the database cache using a LikeFilter filter, which matches cache entries with a specified pattern. To query a database cache, the cache entries must be created before querying, and the cache entries must be retrieved into the cache using the get() or getAll() method before a query using a filter can be performed. Therefore, you can retrieve database data and create a collection of cache entries using the getAll() method.

```java
HashSet hashSet=new HashSet();
hashSet.add(new String("catalog1"));
hashSet.add(new String("catalog2"));
hashSet.add(new String("catalog3"));
Map map=cache.getAll(hashSet);
```

Create a LikeFilter filter to search for cache entries starting with Tuning.

```java
Filter filter = new LikeFilter(IdentityExtractor.INSTANCE, "Tuning%", '\\', true);
```

Query the database cache using the entrySet() method with the LikeFilter filter.

```java
Set results = cache.entrySet(filter);
```

Iterate over the results of the query. Display the key and value of the cache entries that are retrieved.

```java
for (Iterator i = results.iterator(); i.hasNext();)
{
  
```
Creating a Database Cache

```
Map.Entry e = (Map.Entry) i.next();
System.out.println("Catalog ID: "+e.getKey() + ", Title: "+e.getValue());
```

- Coherence supports continuous query using the `com.tangosol.net.cache.ContinuousQueryCache` class. A continuous query is a query that is kept up-to-date using a continuous query cache. In a `ContinuousQueryCache`, the results of a query are updated using event listeners on events that could change the results of the query. Create a `ContinuousQueryCache` object using the `NamedCache` object and the `LikeFilter` object.

```
ContinuousQueryCache queryCache = new ContinuousQueryCache(cache, filter);
```

- Create a result set by using the `entrySet()` method.

```
Set results = queryCache.entrySet(filter);
```

### Run the Database Cache Application

To run the Oracle Database cache application:

1. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.

2. Start the cache server (`JPAServer`). Right click the project and select **Run As** then **Run Configurations**. In the **Run Configurations** dialog box, select `JPACacheServer` to display its configuration. Click **Run**.

3. Create a run configuration for the `DatabaseCache` program.
   a. In the **Run Configurations** dialog box, click the **New launch configuration** icon.
   b. Enter `DatabaseCacheClient` in the **Name** field. Ensure that Interaction is in the **Project** field and `com.oracle.handson.DatabaseCache` is in the **Main class** field.
   c. In the **Coherence** tab, enter the path to the cache configuration file in the **Cache configuration descriptor** field: 
      
      `C:\home\oracle\workspace\Interaction\src\cache-config.xml`

      Select **Local storage: Disabled (cache client)**. Enter a unique value, such as `3155`, in the **Cluster port** field.
   d. Open the **Classpath** tab. The **Classpath** tab should look similar to Figure 9–4.

4. **Figure 9–4 Classpath for the DatabaseCache Program**

   ![Classpath for the DatabaseCache Program](image)

   - Click **Apply** then **Run**.

   **Example 9–9** illustrates the expected results.
Example 9–9  Output of the DatabaseCache Program

...  
Group{Address=224.12.1.0, Port=3155, TTL=4}

MasterMemberSet{
  ThisMember=Member(Id=2, Timestamp=2013-12-20 12:28:41.013, Address=10.159.165.75:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:1976, Role=OracleHandsonDatabaseCache)
  OldestMember=Member(Id=1, Timestamp=2013-12-20 12:27:53.503, Address=10.159.165.75:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7320, Role=CoherenceServer)
  ActualMemberSet=MemberSet(Size=2)
    Member(Id=1, Timestamp=2013-12-20 12:27:53.503, Address=10.159.165.75:8088, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:7320, Role=CoherenceServer)
    Member(Id=2, Timestamp=2013-12-20 12:28:41.013, Address=10.159.165.75:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:1976, Role=OracleHandsonDatabaseCache)
  }
MemberId|ServiceVersion|ServiceJoined|MemberState
  1|12.1.3|2013-12-20 12:27:53.503|JOINED,
  2|12.1.3|2013-12-20 12:28:41.013|JOINED
RecycleMillis=1200000
RecycleSet=MemberSet(Size=0)
}

TcpRing{Connections=[1]}
IpMonitor{Addresses=0}

2013-12-20 12:28:41.265/3.800 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=2): Service Management joined the cluster with senior service member 1
2013-12-20 12:28:41.295/3.830 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=2): Loaded Reporter configuration from 'jar:file:/C:/Oracle/coherence/lib/coherence.jar!/reports/report-group.xml'
2013-12-20 12:28:41.715/4.250 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=NameService:TcpAcceptor, member=2): TcpAcceptor now listening for connections on 10.159.165.75:8090.3
2013-12-20 12:28:42.086/4.621 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=2): Service DistributedCache joined the cluster with senior service member 1
Catalog ID: catalog5, Title: Tuning Database
Catalog ID: catalog4, Title: Tuning Coherence
Catalog ID: catalog3, Title: Tuning Grid Management

Example 9–10  illustrates the cache server response to the DatabaseCache program.

Example 9–10  Cache Server Response to the DatabaseCache Program

...  
Started DefaultCacheServer...

2013-12-20 12:28:41.208/50.536 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1):
Member(Id=2, Timestamp=2013-12-20 12:28:41.013, Address=10.159.165.75:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:1976, Role=OracleHandsonDatabaseCache) joined Cluster with senior member 1
2013-12-20 12:28:41.275/50.603 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 joined Service Management with senior member 1
2013-12-20 12:28:42.296/51.624 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache, member=1): Member 2 joined Service DistributedCache with senior member 1
2013-12-20 12:28:42.377/51.705 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1): TcpRing disconnected from Member(Id=2, Timestamp=2013-12-20 12:28:41.013, Address=10.159.165.75:8090, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:1976, Role=OracleHandsonDatabaseCache) due to a peer departure; removing the member.
Creating a Database Cache

If you receive any exceptions, such as the following:

```
java.lang.IllegalArgumentException: No scheme for cache: "cachename,
```

You may be able to remove them by editing the cache-config.xml file and replacing DBBacked* in the <cache-name> element with *. Re-run the DatabaseCache application in Eclipse. You should not see any exceptions.

4. Note that because you are using a write-through cache, the database table is also updated. From the SQL prompt, enter the following code:

```
select * from hr.catalog;
```

Example 9–11 illustrates the results.

**Example 9–11  Output from the SELECT Statement**

```
... SQL> select * from hr.catalog;

ID -------------------------
VALUE --------------------------------------------------------------------------------
catalog1                  Tuning Undo Tablespace
catalog2                  Tuning Your View Objects
catalog3                  Tuning Grid Management

ID -------------------------
VALUE --------------------------------------------------------------------------------
catalog4                  Tuning Coherence
catalog5                  Tuning Database

SQL>
```
This exercise describes how to apply security to a Oracle Coherence®Extend client and highlights the use of the Coherence SecurityHelper, PofPrincipal, IdentityTransformer, IdentityAsserter, and WrapperCacheService APIs.

Coherence®Extend allows a wide range of access to Coherence caches. These include desktop applications, remote servers, and machines located across wide area network (WAN) connections.

This chapter contains the following sections:

- Introduction
- Enabling Token-Based Security
- Including Role-Based Access Control to the Cluster
- Including Role-Based Access Control to an Invocable Object

**Introduction**

Coherence®Extend consists of an extend client running outside the cluster and a proxy service running inside the cluster, hosted by one or more cache servers. The client APIs route all requests to the proxy. The proxy responds to client requests by delegating to Coherence clustered services, such as a partitioned or replicated cache service or an invocation service.

Because the extend client exists outside of the cluster, the issue of securing access to the cluster takes on greater importance. This chapter describes three techniques that you can use to secure access between the client and the cluster. The techniques include using identity token-based passwords, an entitled cache service, and an invocation service.

A detailed discussion of these security techniques and extend clients is beyond the scope of this tutorial. For more information on these topics, see *Oracle Fusion Middleware Securing Oracle Coherence*.

**Enabling Token-Based Security**

You can implement token-based security to enable access between an extend client and an extend proxy in the cluster. To enable access between the extend client and an extend proxy the following files are typically required:

- Client application files, which describe the functionality that will access the cluster
- Cache configuration files, where the extend client and the extend proxy each have their own cache configuration
Enabling Token-Based Security

- Operational override file, which overrides the operational and run-time settings in the default operational deployment descriptor
- Server start-up files, where there is a start-up file for the extend proxy and for the cache server in the cluster
- POF configuration deployment descriptor, which specifies custom data types when using POF to serialize objects

To add token-based security, you must also provide identity transformer and asserter implementations. The transformer generates the token on the client side and the asserter validates it on the cluster side.

The following steps describe how to create and run an application for an extend client that uses token-based security to access the cluster.

1. **Use a Security Helper File**
2. **Create an Identity Transformer**
3. **Create an Identity Asserter**
4. **Create the Password File**
5. **Enable the Identity Transformer and Asserter**
6. **Create a Cache Configuration File for the Extend Client**
7. **Create a Cache Configuration File for the Extend Proxy**
8. **Create a Start-Up Configuration for a Cache Server with a Proxy Service**
9. **Create a Start-Up Configuration for a Cache Server**
10. **Run the Password Example**

**Use a Security Helper File**

The examples in this chapter reference a security helper file that defines role-based security policies and access control to the cache. For the purpose of these examples, a file with simplified mappings is provided for you.

Cache access is determined by a user’s role. The security helper file defines several roles: `role_reader`, `role_writer`, and `role_admin`. It defines the mappings of various users to the roles, such as BuckarooBanzai to `ROLE_ADMIN`. It defines the mappings of roles to integer IDs, such as `ROLE_ADMIN` to 9. The helper file also defines the cache name and the invocation service name used in the examples.

The key features of this file are the `login` and `checkAccess` methods. The `login` method takes a user name and constructs a simplified distinguished name (DN). It then associates a role with the name. `PofPrincipal` provides the `Principal` implementation.

The `checkAccess` method shows where the authorization code is placed. It determines whether the user can access the cache based on a provided user role.

To create a new project and the security helper file:

1. In Eclipse IDE, select the Java EE perspective and create a new Application Client Project called `Security`. Select `CoherenceConfig` from the `Configuration` drop-down list. Ensure that the `Create a default main` is not selected on the Application Client module page.

   In the Coherence page, select only `Coherence12.1.3`.
See "Creating a New Project in the Eclipse IDE" on page 2-3 for detailed information on creating a project.

2. Create a new Java file named SecurityExampleHelper.java. Ensure that the package path is com.oracle.handson.

   See "Creating a Java Class" on page 2-11 for detailed information on creating a Java class.

3. Copy the code illustrated in Example 10–1 into the file.

   **Example 10–1  A Security Helper File**

```java
package com.oracle.handson;

import com.tangosol.io.pof.PofPrincipal;
import com.tangosol.net.security.SecurityHelper;
import java.util.HashMap;
import java.util.HashSet;
import java.util.Iterator;
import java.util.Map;
import java.util.Set;
import java.security.Principal;
import javax.security.auth.Subject;

/**
 * This class provides extremely simplified role based policies and access control.
 */
public class SecurityExampleHelper
{
    // ----- static methods -----------------------------------------------

    /**
     * Login the user.
     * 
     * @param sName  the user name
     * @return the authenticated user
     */
    public static Subject login(String sName)
    {
        // For simplicity, just create a Subject. Normally, this would be
        // done using JAAS.
        String sUserDN       = "CN=\" + sName + ",OU=Yoyodyne";
        Set setPrincipalUser = new HashSet();
        setPrincipalUser.add(new PofPrincipal(sUserDN));
        setPrincipalUser.add(new PofPrincipal((String) s_mapUserToRole.get(sName)));
        return new Subject(true, setPrincipalUser, new HashSet(), new HashSet());
    }
}
```
/*
 * Assert that a Subject is associated with the calling thread with a
 * Principal representing the required role.
 * @param sRoleRequired the role required for the operation
 * @throws SecurityException if a Subject is not associated with the
 * calling thread or does not have the specified role Principal
 */
public static void checkAccess(String sRoleRequired)
{
    checkAccess(sRoleRequired, SecurityHelper.getCurrentSubject());
}

/*
 * Assert that a Subject contains a Principal representing the required
 * role.
 * @param sRoleRequired the role required for the operation
 * @param subject the Subject requesting access
 * @throws SecurityException if a Subject is null or does not have the
 * specified role Principal
 */
public static void checkAccess(String sRoleRequired, Subject subject)
{
    if (subject == null)
    {
        throw new SecurityException("Access denied, authentication
required");
    }

    Map     mapRoleToId   = s_mapRoleToId;
    Integer nRoleRequired = (Integer) mapRoleToId.get(sRoleRequired);

    for (Iterator iter = subject.getPrincipals().iterator(); iter.hasNext();)
    {
        Principal principal = (Principal) iter.next();
        String    sName     = principal.getName();
        if (sName.startsWith("role_"))
        {
            Integer nRolePrincipal = (Integer) mapRoleToId.get(sName);

            if (nRolePrincipal == null)
            {
                // invalid role
                break;
            }

            if (nRolePrincipal.intValue() >= nRoleRequired.intValue())
            {
                return;
            }
        }
    }

    throw new SecurityException("Access denied, insufficient privileges");
}
// ----- constants ----------------------------------------------------------

public static final String ROLE_READER = "role_reader";

public static final String ROLE_WRITER = "role_writer";

public static final String ROLE_ADMIN = "role_admin";

/**
 * The cache name for security examples
 */
public static final String SECURITY_CACHE_NAME = "security";

/**
 * The name of the InvocationService used by security examples.
 */
public static String INVOCATION_SERVICE_NAME = "ExtendTcpInvocationService";

// ----- static data --------------------------------------------------------

/**
 * The map keyed by user name with the value being the user's role.
 * Represents which user is in which role.
 */
private static Map s_mapUserToRole = new HashMap();

/**
 * The map keyed by role name with the value the role id.
 * Represents the numeric role identifier.
 */
private static Map s_mapRoleToId = new HashMap();

// ----- static initializer --------------------------------------------------

static {

    // User to role mapping
    s_mapUserToRole.put("BuckarooBanzai", ROLE_ADMIN);
    s_mapUserToRole.put("JohnWhorfin", ROLE_WRITER);
    s_mapUserToRole.put("JohnBigboote", ROLE_READER);

    // Role to Id mapping
    s_mapRoleToId.put(ROLE_ADMIN, Integer.valueOf(9));
    s_mapRoleToId.put(ROLE_WRITER, Integer.valueOf(2));
    s_mapRoleToId.put(ROLE_READER, Integer.valueOf(1));
}

Create an Identity Transformer

An identity transformer (com.tangosol.net.security.IdentityTransformer) is a client-side component that converts a subject or principal into an identity token. The token must be a type that Coherence can serialize. Coherence automatically serializes the token at run time and sends it as part of the connection request to the proxy.
To create an identity transformer implementation:

1. Create a new Java class in the Security project named `PasswordIdentityTransformer`.
   See "Creating a Java Class" on page 2-11 for detailed information.

2. Import the `IdentityTransformer` interface. Ensure that the `PasswordIdentityTransformer` class implements the `IdentityTransformer` interface.

3. Implement the `transformIdentity` method so that it performs the following tasks:
   - Tests whether the subject exists and is complete
   - Gets the principal names from the subject and saves them in a `String` array
   - Constructs the token, as a combination of the password plus the principal names, that can be serialized as POF types

   Example 10–2 illustrates a possible implementation of the `PasswordIdentityTransformer` class.

   **Example 10–2 Sample Identity Transformer Implementation**

```java
package com.oracle.handson;

import com.tangosol.net.security.IdentityTransformer;
import java.security.Principal;
import java.util.Iterator;
import java.util.Set;
import javax.security.auth.Subject;
import com.tangosol.net.Service;

/**
 * PasswordIdentityTransformer creates a security token that contains the
 * required password and then adds a list of Principal names.
 *
 */
public class PasswordIdentityTransformer
    implements IdentityTransformer {

    // ----- IdentityTransformer interface ----------------------------------
    /**
     * Transform a Subject to a token that asserts an identity.
     *
     * @param subject the Subject representing a user.
     *
     * @return the token that asserts identity.
     *
     * @throws SecurityException if the identity transformation fails.
     *
     */
    public Object transformIdentity(Subject subject, Service service)
            throws SecurityException {
        // The service is not needed so the service argument is being ignored.
        // It could be used, for example, if there were different token types
```
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// required per service.

if (subject == null)
{
    throw new SecurityException("Incomplete Subject");
}

Set setPrincipals = subject.getPrincipals();

if (setPrincipals.isEmpty())
{
    throw new SecurityException("Incomplete Subject");
}

String[] asPrincipalName = new String[setPrincipals.size() + 1];
int     i                = 0;

asPrincipalName[i++] = System.getProperty("coherence.password", "secret-password");

for (Iterator iter = setPrincipals.iterator(); iter.hasNext();)
{
    asPrincipalName[i++] = ((Principal) iter.next()).getName();
}

// The token consists of the password plus the principal names as an
// array of pof-able types, in this case strings.
return asPrincipalName;
}

Create an Identity Asserter

An identity asserter (com.tangosol.net.security.IdentityAsserter) is a
cluster-side component on the cache server that hosts an extend proxy service. The
asserter validates that the token created by the identity transformer on the extend
client contains the required credentials to access the cluster.

To create an identity asserter implementation:

1. Create a new Java class in the Security project named
   PasswordIdentityAsserter.
   See "Creating a Java Class" on page 2-11 for detailed information.

2. Import the IdentityAsserter interface. Ensure that the
   PasswordIdentityAsserter class implements the IdentityAsserter
   interface.

3. Implement the assertIdentity method such that it:

   ■ Validates that the token contains the correct password and that the password
     is the first name in the token.

Example 10–3 illustrates a a possible implementation of the
PasswordIdentityAsserter class.

Example 10–3   Sample Identity Asserter Implementation

package com.oracle.handson;

import com.tangosol.io.pof.PofPrincipal;

import com.tangosol.net.security.IdentityAsserter;
import java.util.HashSet;
import java.util.Set;
import javax.security.auth.Subject;
import com.tangosol.net.Service;

/**
 * PasswordIdentityAsserter asserts that the security token contains the
 * required password and then constructs a Subject based on a list of
 * Principal names.
 *
 */
public class PasswordIdentityAsserter
    implements IdentityAsserter
{
    // ----- IdentityAsserter interface -------------------------------------

    /**
     * Asserts an identity based on a token-based identity assertion.
     * 
     * @param oToken the token that asserts identity.
     * 
     * @return a Subject representing the identity.
     * 
     * @throws SecurityException if the identity assertion fails.
     * 
     */
    public Subject assertIdentity(Object oToken, Service service)
        throws SecurityException
    {
        // The service is not needed so the service argument is being ignored.
        // It could be used, for example, if there were different token types
        // required per service.
        if (oToken instanceof Object[])
        {
            String sPassword        = System.getProperty("coherence.password", "secret-password");
            Set      setPrincipalUser = new HashSet();
            Object[] asName           = (Object[]) oToken;

            // first name must be password
            if (((String) asName[0]).equals(sPassword))
                {
                    // prints the user name to server shell to ensure we are
                    // communicating with it and to ensure user is validated
                    System.out.println("Password validated for user: " + asName[1]);
                    for (int i = 1, len = asName.length; i < len; i++)
                        {
                            setPrincipalUser.add(new PofPrincipal((String)asName[i]));
                        }
                
                return new Subject(true, setPrincipalUser, new HashSet(),
                    new HashSet());
        }
        throw new SecurityException("Access denied");
    }
}
Create the Password File

Create a Java file that requires a password to get a reference to a cache. Use the SecurityExampleHelper.login("BuckarooBanzai") to call the login method in the SecurityExampleHelper file to generate a token. At run time, the user name is associated with its subject defined in the SecurityExampleHelper class. A token is generated from this subject by the PasswordIdentityTransformer class and validated by the PasswordIdentityAsserter class as part of the connection request. If the validation succeeds, then a connection to the proxy and a reference to the cache is granted. Use the Subject.doAs method to make the subject available in the security context.

1. Create a new Java class with a main method in the Security project named PasswordExample.
   See "Creating a Java Class" on page 2-11 for detailed information.
2. Implement the main method to get a reference to the cache.
3. Use the SecurityExampleHelper.login method to get a subject for user BuckarooBanzai
4. Implement the doAs method to make the subject part of the Java security context. The subject will be available to any subsequent code. In this case, the doAs method is implemented to validate whether the user can access the cache based on its defined role.

Example 10–4 illustrates a possible implementation of PasswordExample.

Example 10–4  Sample Implementation to Run the Password Example

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import java.io.IOException;
import java.security.PrivilegedExceptionAction;
import javax.security.auth.Subject;
import com.tangosol.net.Service;

/**
 * This class shows how a Coherence Proxy can require a password to get a
 * reference to a cache.
 * <p>
 * The PasswordIdentityTransformer will generate a security token that
 * contains the password. The PasswordIdentityAsserter will validate the
 * security token to enforce the password. The token generation and
 * validation occurs automatically when a connection to the proxy is made.
 * *
 * */
public class PasswordExample {
    // ----- static methods ---------------------------------
```
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/**
 * Get a reference to the cache. Password will be required.
 */
public static void main (String[] args){
    getCache();
}

public static void getCache()
{
    System.out.println("------password example begins------");

    Subject subject = SecurityExampleHelper.login("BuckarooBanzai");

    try
    {
        NamedCache cache = (NamedCache) Subject.doAs(
            subject, new PrivilegedExceptionAction()
            {
                public Object run()
                throws Exception
                {
                    NamedCache cache;

                    cache = CacheFactory.getCache(
                        SecurityExampleHelper.SECURITY_CACHE_NAME);
                    System.out.println("------password example succeeded------");
                    return cache;
                }
            });
    }
    catch (Exception e)
    {
        // get exception if the password is invalid
        System.out.println("Unable to connect to proxy");
        e.printStackTrace();
    }

    System.out.println("------password example completed------");
}

Enable the Identity Transformer and Asserter

Configure an operational override file (tangosol-coherence-override.xml) to identify the classes that define the identity transformer (the class that transforms a Subject to a token on the extend client) and the identity asserter (the class that validates the token on the cluster).

1. Open the tangosol-coherence-override.xml file from the Project Explorer window. You can find the file under Security/appClientModule.

2. Use the identity-transformer and identity-asserter elements within the security-config stanza to identify the full path to the PasswordIdentityTransformer and PasswordIdentityAsserter implementation classes, respectively. Set the subject-scope parameter to true to associate the identity from the current security context with the cache and remote invocation service references that are returned to the client.

Example 10–5 illustrates a possible implementation of the tangosol-coherence-override.xml file.
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Example 10–5  Specifying an Identity Transformer and an Asserter

```xml
<?xml version="1.0" encoding="UTF-8"?>
<coherence xmlns="http://xmlns.oracle.com/coherence/coherence-operational-config"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-operational-config
http://xmlns.oracle.com/coherence/coherence-operational-config/1.2/coherence-operational-config.xsd">
  <!--coherence-version:12.1.3-->  
  <security-config>
    <identity-asserter>
      <class-name>com.oracle.handson.PasswordIdentityAsserter</class-name>
    </identity-asserter>
    <identity-transformer>
      <class-name>com.oracle.handson.PasswordIdentityTransformer</class-name>
    </identity-transformer>
    <subject-scope>true</subject-scope>
  </security-config>
</coherence>
```

Create a Cache Configuration File for the Extend Client

The cache configuration file for the extend client routes cache operations to an extend proxy in the cluster. At run time, cache operations are not executed locally; instead, they are sent to the extend proxy service.

To create a cache configuration file for an extend client:

1. Open the coherence-cache-config.xml file from the Project explorer window. You can find the file under Security/appClientModule.
2. Save the file as client-cache-config.xml.
3. Write the extend client cache configuration. The following list highlights some key elements:
   - Use the cache-name element to define security as the name of the cache. Note that there must be a cache defined in the cluster-side cache configuration that is also named security.
   - Use the remote-cache-scheme stanza to define the details about the remote cache.
   - Use the address and port elements in the tcp-initiator stanza to identify the extend proxy service that is listening on the localhost address at port 9099.
   - Use defaults and serializer with a value of pof to call the serializer for the custom POF configuration file (which you will create later in this chapter).

Example 10–6 illustrates a possible implementation for the client-cache-config.xml file.

Example 10–6  Sample Extend Client Cache Configuration File

```xml
<?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">
  <defaults>
```
Create a Cache Configuration File for the Extend Proxy

To create a cache configuration file for the extend proxy service:

1. Open the coherence-cache-config.xml file from the Project explorer window. You can find the file under Security/appClientModule.
2. Save the file as examples-cache-config.xml.
3. Configure the extend proxy cache configuration file. The following list highlights some key elements:
Use the `cache-name` element to define `security` as the name of the cache. Note that there must be a cache defined in the extend client cache configuration that is also named `security`.

Use the `address` and `port` elements in the `acceptor-config` stanza to identify the extend proxy service that is listening on the `localhost` address at port `9099`.

Use the `autostart` element with the `tangosol.coherence.extend.enabled` system property to prevent the cache server from running a proxy service.

Use `defaults` and `serializer` with a value of `pof` to call the serializer for the custom `POF` configuration file (which you will create later in this chapter).

Example 10–7 illustrates a possible implementation for the `examples-cache-config.xml` file.

**Example 10–7 Sample Cache Configuration File for the Proxy Server**

```xml
<?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">
    <defaults>
        <serializer>pof</serializer>
    </defaults>

    <caching-scheme-mapping>
        <cache-mapping>
            <cache-name>security</cache-name>
            <scheme-name>ExamplesPartitionedPofScheme</scheme-name>
        </cache-mapping>
    </caching-scheme-mapping>

    <caching-schemes>
        <distributed-scheme>
            <scheme-name>ExamplesPartitionedPofScheme</scheme-name>
            <service-name>PartitionedPofCache</service-name>
            <backing-map-scheme>
                <local-scheme>
                    <!-- each node will be limited to 32MB -->
                    <high-units>32M</high-units>
                    <unit-calculator>binary</unit-calculator>
                </local-scheme>
            </backing-map-scheme>
            <autostart>true</autostart>
        </distributed-scheme>

        <!--
        Proxy Service scheme that allows remote clients to connect to the cluster over TCP/IP.
        -->
        <proxy-scheme>
            <scheme-name>secure-proxy</scheme-name>
            <service-name>ProxyService</service-name>
            <thread-count system-property="tangosol.coherence.extend.threads">2</thread-count>
        </proxy-scheme>
    </caching-schemes>
</cache-config>
```
Create a Start-Up Configuration for a Cache Server

Create a start-up configuration for a cache server cluster node. The configuration must include the system properties to designate a proxy service and the cluster-side cache configuration file. You must also include the application class files and the XML configuration files on the class path.

To create a start-up file for a cache server:

1. Create a start-up configuration in Eclipse. Right-click the Security project and select Run As then Run Configurations. In the Name field, enter SecurityCacheServer.

2. In the Main tab, click Browse in the Project field to select the Security project. Select the Include system libraries when searching for a main class and click the Search button in the Main class field. Enter DefaultCacheServer in the Select type field of the Select Main Type dialog box. Select DefaultCacheServer - com.tangosol.net and click OK. Click Apply.

3. In the Coherence tab, enter the name and absolute path to the cluster-side cache configuration file (in this case, C:\home\oracle\workspace\Security\appClientModule\examples-cache-config.xml). Select Enabled (cache server) in the Local storage field. Enter a unique value, such as 3155, in the Cluster port field. Click Apply.

4. The Classpath tab should look similar to Figure 10–1.

5. In the Common tab, click Browse in the Shared file field to select the Security project. Click Apply.
Create a Start-Up Configuration for a Cache Server with a Proxy Service

Create a configuration to start an extend proxy service on a cache server in the cluster. The extend client connects to this service. The configuration must include the system properties to designate a proxy service and the cluster-side cache configuration file. You must also include the application class files and the XML configuration files on the class path.

For these examples, the cache server with proxy service start-up configuration will have the same configuration as the cache server start-up configuration, but it will include the system property to enable the extend proxy.

To create a start-up file for a cache server with a proxy service:

1. Create a start-up configuration in Eclipse. Right-click the `Security` project and select Run As then Run Configurations. In the Name field, enter `SecurityRunProxy`.

2. In the Main tab, click Browse in the Project field to select the `Security` project. Select the Include system libraries when searching for a main class and click the Search button in the Main class field. Enter `DefaultCacheServer` in the Select type field of the Select Main Type dialog box. Select `DefaultCacheServer - com.tangosol.net` and click OK. Click Apply.

3. In the Coherence tab, enter the name and absolute path to the cluster-side cache configuration file (in this case, C:\home\oracle\workspace\Security\appClientModule\examples-cache-config.xml). Select Enabled (cache server) in the Local storage field. Enter a unique value (such as 3155) in the Cluster port field. Click Apply.

4. In the Arguments tab, enter the system property `-Dtangosol.coherence.extend.enabled=true` to designate a proxy service in the VM arguments field.

Figure 10–2 Arguments Tab for the Security Proxy Server

5. The Classpath tab should look similar to Figure 10–3.
Figure 10–3  Class Path for the Proxy Server

6. In the Common tab, click Browse in the Shared file field to select the Security project. Click Apply.

Run the Password Example

Run the password example to generate and validate the token, and pass it to the proxy service.

1. Create a run configuration for the PasswordExample.java file.
   a. Right click PasswordExample.java in the Project Explorer, and select Run As then Run Configurations.
   b. Click the New launch configuration icon. Ensure that PasswordExample appears in the Name field, Security appears in the Project field, and com.oracle.handson.PasswordExample appears in the Main class field. Click Apply.
   c. In the Coherence tab, enter the path to the client cache configuration file, C:\home\oracle\workspace\Security\appClientModule\client-cache-config.xml in the Cache configuration descriptor field. Select Disabled (cache client) in the Local cache field. Enter a unique value, such as 3155, in the Cluster port field.
   d. The Classpath tab should look similar to Figure 10–4.

Figure 10–4  Classpath Tab for the PasswordExample Program

   e. In the Common tab, click Browse in the Shared file field to select the Security project. Click Apply.

2. Stop any running cache servers. See “Stopping Cache Servers” on page 2-14 for more information.
3. Run the security proxy server, the security cache server then the PasswordExample.java program.

a. Right click the project and select Run As then Run Configurations. Run the SecurityRunProxy configuration from the Run Configurations dialog box.

b. Right click the project and select Run As then Run Configurations. Run the SecurityCacheServer configuration from the Run Configurations dialog box.

c. Right click the PasswordExample.java file in the Project Explorer and select Run As then Run Configurations. Select PasswordExample in the Run Configurations dialog box and click Run.

The output of the PasswordExample program should be similar to Example 10–8 in the Eclipse console. It indicates the start of the password example, the opening of the socket to the proxy server, and the completion of the example.

Example 10–8 Password Example Output in the Eclipse Console

------password example begins------
2014-01-09 11:05:04.690/0.380 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/OracleCoherence/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2014-01-09 11:05:04.800/0.490 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from "jar:file:/C:/OracleCoherence/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
...
Oracle Coherence Version 12.1.3.0.0 Build 49331
Grid Edition: Development mode
Copyright (c) 2000, 2014, Oracle and/or its affiliates. All rights reserved.
...
2014-01-09 11:05:06.472/2.162 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=main, member=n/a):
Connecting Socket to 10.159.156.144:9099
2014-01-09 11:05:06.473/2.163 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a):
Connected Socket to 10.159.156.144:9099
------password example succeeded------
------password example completed------

The response in the proxy server shell should be similar to Example 10–9. It lists the CN and OU values from the distinguished name and whether the password was validated.

Example 10–9 Response from the Cache Server Running the Proxy Service Shell

... Started DefaultCacheServer...
...
2014-01-09 11:04:35.313/34.291 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=1):
Member(Id=2, Timestamp=2014-01-09 11:04:35.113, Address=10.159.156.144:8090, MachineId=47251,
Location=site:,machine:TPPAEFL-LAP,process:3896, Role=CoherenceServer) joined Cluster with senior member 1
2014-01-09 11:04:35.405/34.383 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 joined Service Management with senior member 1
2014-01-09 11:04:36.175/35.153 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): Member 2 joined Service PartitionedPofCache with senior member 1
2014-01-09 11:04:37.243/36.221 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedPofCache, member=1): Transferring 129B of backup[1] for PartitionSet(128..256) to member 2
Including Role-Based Access Control to the Cluster

This section describes how to create an example that uses role-based policies to access the cluster. The code logs in to get a subject with a user ID assigned to a particular role. It gets a cache reference running in the context of the subject and then attempt various cache operations. Depending on the role granted to the user, the cache operation is allowed or denied. Note that the role mapping and role-based authorization in the example is simplified and not intended for real security use.

For example, a user with a writer role can use the put and get methods. A user with a reader role can use the get method, but not the put method. A user with a writer role cannot destroy a cache; however, a user with an admin role can.

Note that when the cache reference is created in the context of a subject that identity is permanently associated with that reference. Any use of that cache reference is on behalf of that identity.

The example will use the PasswordIdentityTransformer and PasswordIdentityAsserter classes that you created in the previous section. The PasswordIdentityTransformer class generates a security token that contains the password, the user ID, and the roles. The PasswordIdentityAsserter class (running in the proxy) validates the security token to enforce the password and construct a subject with the proper user ID and roles. The production and assertion of the security token happens automatically.

To create the example:

1. **Define Which User Roles Are Entitled to Access Cache Methods**
2. **Apply the Entitlements to the Cache Service**
3. **Create the Access Control Example Program**
4. **Edit the Cluster-Side Cache Configuration File**
5. **Run the Access Control Example**

Define Which User Roles Are Entitled to Access Cache Methods

Create a Java file that enables access to cache methods on the basis of a user’s role. To do this, you can apply access permissions to a wrapped NamedCache using the Subject object passed from the client by using Coherence*Extend. The implementation allows only clients with a specified role to access the wrapped NamedCache.

The class that you create in this section extends the com.tangosol.net.cache FacadeNamedCache class. This class is a convenience function that enables you to secure the methods on the NamedCache interface.

To determine which user role can access a cache method, include a call to the SecurityExampleHelper.checkAccess method in each cache method’s implementation. As the argument to checkAccess, provide the user role that is permitted to access the method. Close the implementation with a call to super.
For example, the following code indicates that users with the admin role can destroy the cache.

```java
public void destroy()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_ADMIN);
    super.destroy();
}
```

In this example, users with the reader role can call the aggregate method.

```java
public Object aggregate(Filter filter, EntryAggregator agent)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.aggregate(filter, agent);
}
```

To create a file that determines which user role can call cache methods:

1. Create a new Java class named `EntitledNamedCache` in the Security project. See "Creating a Java Class" on page 2-11 if you need detailed information.
2. Ensure that the class imports and extends `WrapperNamedCache`.
3. Import the `Filter`, `MapListener`, `ValueExtractor`, `Collection`, `Comparator`, `Map`, `Service`, and `Set` classes. The methods in `WrapperNamedCache` (and by extension, `EntitledNamedCache`) use arguments with these types.
4. Implement the methods in `EntitledNamedCache` such that only a user with a specific role can call the method.

**Example 10–10** illustrates a possible implementation of `EntitledNamedCache`.

**Example 10–10   Entitled Named Cache**

```java
package com.oracle.handson;

import com.tangosol.net.NamedCache;
import com.tangosol.net.security.SecurityHelper;
import com.tangosol.net.Service;
import com.tangosol.net.cache.WrapperNamedCache;
import com.tangosol.util.Filter;
import com.tangosol.util.MapEvent;
import com.tangosol.util.MapListener;
import com.tangosol.util.ValueExtractor;
import java.util.Collection;
import java.util.Comparator;
import java.util.Map;
import java.util.Set;
import javax.security.auth.Subject;

/**
 * Example WrapperNamedCache that demonstrates how entitlements can be applied
 * to a wrapped NamedCache using the Subject passed from the client through
 * Coherence*Extend. This implementation only allows clients with a specified
 * role to access the wrapped NamedCache.
 */
public class EntitledNamedCache extends WrapperNamedCache {

/**
 * Create a new EntitledNamedCache.
 * @param cache the wrapped NamedCache
 */
public EntitledNamedCache(NamedCache cache) {
    super(cache, cache.getCacheName());
}

// ----- NamedCache interface -------------------------------------------

/**
 * @inheritDoc
 */
public void release() {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    super.release();
}

/**
 * @inheritDoc
 */
public void destroy() {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_ADMIN);
    super.destroy();
}

/**
 * @inheritDoc
 */
public Object put(Object oKey, Object oValue, long cMillis) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.put(oKey, oValue, cMillis);
}

/**
 * @inheritDoc
 */
public void addMapListener(MapListener listener) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    super.addMapListener(new EntitledMapListener(listener));
}

/**
 * @inheritDoc
 */
public void removeMapListener(MapListener listener) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
super.removeMapListener(listener);
}

/**
 * {@inheritDoc}
 */
public void addMapListener(MapListener listener, Object oKey, boolean fLite)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    super.addMapListener(new EntitledMapListener(listener), oKey, fLite);
}

/**
 * {@inheritDoc}
 */
public void removeMapListener(MapListener listener, Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.removeMapListener(listener, oKey);
}

/**
 * {@inheritDoc}
 */
public void addMapListener(MapListener listener, Filter filter, boolean fLite)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    super.addMapListener(new EntitledMapListener(listener), filter, fLite);
}

/**
 * {@inheritDoc}
 */
public void removeMapListener(MapListener listener, Filter filter)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.removeMapListener(listener, filter);
}

/**
 * {@inheritDoc}
 */
public int size()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.size();
}

/**
 * {@inheritDoc}
 */
public void clear()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.clear();
}
public boolean isEmpty()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.isEmpty();
}

/**
 * {@inheritDoc}
 */
public boolean containsKey(Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.containsKey(oKey);
}

/**
 * {@inheritDoc}
 */
public boolean containsValue(Object oValue)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.containsValue(oValue);
}

/**
 * {@inheritDoc}
 */
public Collection values()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.values();
}

/**
 * {@inheritDoc}
 */
public void putAll(Map map)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.putAll(map);
}

/**
 * {@inheritDoc}
 */
public Set entrySet()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.entrySet();
}

/**
 * {@inheritDoc}
 */
public Set keySet()
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.keySet();
}
/**
 * {(@inheritdoc)}
 */
public Object get(Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.get(oKey);
}

/**
 * {(@inheritdoc)}
 */
public Object remove(Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.remove(oKey);
}

/**
 * {(@inheritdoc)}
 */
public Object put(Object oKey, Object oValue)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.put(oKey, oValue);
}

/**
 * {(@inheritdoc)}
 */
public Map getAll(Collection colKeys)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.getAll(colKeys);
}

/**
 * {(@inheritdoc)}
 */
public boolean lock(Object oKey, long cWait)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.lock(oKey, cWait);
}

/**
 * {(@inheritdoc)}
 */
public boolean lock(Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.lock(oKey);
}

/**
 * {(@inheritdoc)}
 */
public boolean unlock(Object oKey)
{
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
 Including Role-Based Access Control to the Cluster

```java
public Set keySet(Filter filter) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.keySet(filter);
}

/**
 * {@inheritDoc}
 */
public Set entrySet(Filter filter) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.entrySet(filter);
}

/**
 * {@inheritDoc}
 */
public Set entrySet(Filter filter, Comparator comparator) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
    return super.entrySet(filter, comparator);
}

/**
 * {@inheritDoc}
 */
public void addIndex(ValueExtractor extractor, boolean fOrdered, Comparator comparator) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.addIndex(extractor, fOrdered, comparator);
}

/**
 * {@inheritDoc}
 */
public void removeIndex(ValueExtractor extractor) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    super.removeIndex(extractor);
}

/**
 * {@inheritDoc}
 */
public Object invoke(Object oKey, EntryProcessor agent) {
    SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
    return super.invoke(oKey, agent);
}
```

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public Map invokeAll(Collection collKeys, EntryProcessor agent) {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
        return super.invokeAll(collKeys, agent);
    }

    /**
     * {@inheritDoc}
     */
    public Map invokeAll(Filter filter, EntryProcessor agent) {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
        return super.invokeAll(filter, agent);
    }

    /**
     * {@inheritDoc}
     */
    public Object aggregate(Collection collKeys, EntryAggregator agent) {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
        return super.aggregate(collKeys, agent);
    }

    /**
     * {@inheritDoc}
     */
    public Object aggregate(Filter filter, EntryAggregator agent) {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
        return super.aggregate(filter, agent);
    }

    // ----- inner class ----------------------------------------------------

    /**
     * Example MapListener that adds authorization to map events.
     */
    public class EntitledMapListener implements MapListener {
    
    // ----- constructors -------------------------------------------

    /**
     * Construct an EntitledMapListener with the current subject.
     * The subject will not be available in the security context
     * when events are received by the proxy at runtime.
     *
     * @param  listener  the MapListener
     */
    public EntitledMapListener(MapListener listener) {
        m_listener = listener;
        m_subject  = SecurityHelper.getCurrentSubject();
    }

    // ----- MapListener interface -----------------------------------
/**
 * {@inheritDoc}
 */
public void entryInserted(MapEvent mapEvent)
{
    try
    {
        SecurityExampleHelper.checkAccess(
            SecurityExampleHelper.ROLE_WRITER, m_subject);
    }
    catch (SecurityException e)
    {
        System.out.println("Access denied for entryInserted");
        return;
    }
    m_listener.entryInserted(mapEvent);
}

/**
 * {@inheritDoc}
 */
public void entryUpdated(MapEvent mapEvent)
{
    try
    {
        SecurityExampleHelper.checkAccess(
            SecurityExampleHelper.ROLE_WRITER, m_subject);
    }
    catch (SecurityException e)
    {
        System.out.println("Access denied for entryUpdated");
        return;
    }
    m_listener.entryUpdated(mapEvent);
}

/**
 * {@inheritDoc}
 */
public void entryDeleted(MapEvent mapEvent)
{
    try
    {
        SecurityExampleHelper.checkAccess(
            SecurityExampleHelper.ROLE_WRITER, m_subject);
    }
    catch (SecurityException e)
    {
        System.out.println("Access denied for entryDeleted");
        return;
    }
    m_listener.entryDeleted(mapEvent);
}

// ----- data members ------------------------------------------
Including Role-Based Access Control to the Cluster

/**
 * Subject from security context when the MapListener was registered
 */
private Subject m_subject;

/**
 * Registered listener
 */
private MapListener m_listener;

// ----- helper methods -------------------------------------------------

/**
 * Return the wrapped NamedCache.
 *
 * @return  the wrapped CacheService
 */
public NamedCache getNamedCache()
{
    return (NamedCache) getMap();
}

Apply the Entitlements to the Cache Service

Create a file that demonstrates how access entitlements can be applied to a wrapped CacheService using the Subject passed from the client through Coherence*Extend. The implementation delegates access control for cache operations to the EntitledNamedCache you created in the previous section.

The class that you create extends the com.tangosol.net.WrapperCacheService class. This is a convenience function that allows you to secure the methods on the CacheService. It also provides a mechanism to delegate between the cache service on the proxy and the client request.

Implement the methods ensureCache, releaseCache, and destroyCache to ensure that only users with specific roles can use them. In the implementations, include a call to the SecurityExampleHelper.checkAccess method with a specific user role as its argument. For example, the following code ensures that only users with the role admin can destroy the cache.

public void destroyCache(NamedCache map)
{
    if (map instanceof EntitledNamedCache)
    {
        EntitledNamedCache cache = (EntitledNamedCache) map;
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_ADMIN);
        map = cache.getNamedCache();
    }
    super.destroyCache(map);
}

To create a file that applies entitlements to access the cache service:

1. Create a new Java class named EntitledCacheService in the Security project.
2. Ensure that the class imports and extends the WrapperCacheService class.
3. Implement the ensureCache, releaseCache, and destroyCache methods to ensure that only users with specific roles can use them.

Example 10–11 illustrates a possible implementation of EntitledCacheService.

Example 10–11  Entitled Cache Service

```java
package com.oracle.handson;

import com.tangosol.net.CacheService;
import com.tangosol.net.NamedCache;
import com.tangosol.net.WrapperCacheService;

/**
 * Example WrapperCacheService that demonstrates how entitlements can be
 * applied to a wrapped CacheService using the Subject passed from the
 * client through Coherence*Extend. This implementation delegates access control
 * for cache operations to the EntitledNamedCache.
 *
 */
public class EntitledCacheService extends WrapperCacheService {
    /**
     * Create a new EntitledCacheService.
     *
     * @param service the wrapped CacheService
     */
    public EntitledCacheService(CacheService service) {
        super(service);
    }

    // ----- CacheService interface -----------------------------------------
    /**
     * {@inheritDoc}
     */
    public NamedCache ensureCache(String sName, ClassLoader loader) {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
        return new EntitledNamedCache(super.ensureCache(sName, loader));
    }

    /**
     * {@inheritDoc}
     */
    public void releaseCache(NamedCache map) {
        if (map instanceof EntitledNamedCache) {
            EntitledNamedCache cache = (EntitledNamedCache) map;
            SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_READER);
            map = cache.getNamedCache();
        }
        super.releaseCache(map);
    }
}
```
/**
   * public void destroyCache(NamedCache map)
   * {
   *   if (map instanceof EntitledNamedCache)
   *   {
   *     EntitledNamedCache cache = (EntitledNamedCache) map;
   *     SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_ADMIN);
   *     map = cache.getNamedCache();
   *   }
   *   super.destroyCache(map);
   * }
   */

Create the Access Control Example Program

Create a file to run the access control example. The role policies are defined in the SecurityExampleHelper class. The EntitledCacheService and EntitledNamedCache classes enforce the policies.

The program should specify various users as arguments to the SecurityHelperFile.login method, and then attempt to perform cache read, write, and destroy operations. Based on the entitlement policies defined in the EntitledCacheService and EntitledNamedCache classes, the operations succeed or fail.

1. Create a new Java class with a main method in the Security project named AccessControlExample.

   See "Creating a Java Class" on page 2-11 for detailed information.

2. Implement the main method to access the cache.

3. Specify users defined in the SecurityExampleHelper file as arguments to its login method.

4. For each user, execute read (get), write (put), and destroy operations on the cache and provide success or failure messages in response.

Example 10–12 illustrates a possible implementation of the AccessControlExample.java class.

Example 10–12 Sample Program to Run the Access Control Example

package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.InvocationService;
import com.tangosol.net.NamedCache;
import com.tangosol.net.Service;
import com.tangosol.util.MapEvent;
import com.tangosol.util.MapListener;
import java.security.PrivilegedExceptionAction;
import javax.security.auth.Subject;

/**
   * This class demonstrates simplified role based access control.
   *<p>
   * The role policies are defined in SecurityExampleHelper. Enforcement
   * is done by EntitledCacheService and EntitledNamedCache.
   */
public class AccessControlExample
{
    // ----- static methods -----------------------------------------------

    public static void main (String[] args){
        accessCache();
    }

    /**
     * Demonstrate role based access to the cache.
     */
    public static void accessCache()
    {
        System.out.println("------cache access control example begins------");

        Subject subject = SecurityExampleHelper.login("JohnWhorfin");

        // Someone with writer role can write and read
        try
        {
            NamedCache cache = (NamedCache) Subject.doAs(
                subject, new PrivilegedExceptionAction()
                {
                    public Object run()
                        throws Exception
                    {
                        return CacheFactory.getCache(SecurityExampleHelper.SECURITY_CACHE_NAME);
                    }
                });
            cache.put("myKey", "myValue");
            cache.get("myKey");
            System.out.println("    Success: read and write allowed");
        }
        catch (Exception e)
        {
            // get exception if not allowed to perform the operation
            e.printStackTrace();
        }

        // Someone with reader role can read but not write
        subject = SecurityExampleHelper.login("JohnBigboote");
        try
        {
            NamedCache cache = (NamedCache) Subject.doAs(
                subject, new PrivilegedExceptionAction()
                {
                    public Object run()
                        throws Exception
                    {
                        return CacheFactory.getCache(SecurityExampleHelper.SECURITY_CACHE_NAME);
                    }
                });
            cache.get("myKey");
            System.out.println("    Success: read allowed");
            cache.put("anotherKey", "anotherValue");
        }
        catch (Exception e)
// get exception if not allowed to perform the operation
System.out.println("    Success: Correctly cannot write");
}

// Someone with writer role cannot call destroy
subject = SecurityExampleHelper.login("JohnWhorfin");
try {
    NamedCache cache = (NamedCache) Subject.doAs(
        subject, new PrivilegedExceptionAction()
        {
            public Object run()
                throws Exception
            {
                return CacheFactory.getCache(SecurityExampleHelper.SECURITY_
                CACHE_NAME);
            }
        });
    cache.destroy();
} catch (Exception e) {
    // get exception if not allowed to perform the operation
    System.out.println("    Success: Correctly cannot " +
        "destroy the cache");
}

// Someone with admin role can call destroy
subject = SecurityExampleHelper.login("BuckarooBanzai");
try {
    NamedCache cache = (NamedCache) Subject.doAs(
        subject, new PrivilegedExceptionAction()
        {
            public Object run()
                throws Exception
            {
                return CacheFactory.getCache(SecurityExampleHelper.SECURITY_
                CACHE_NAME);
            }
        });
    cache.destroy();
    System.out.println("    Success: Correctly allowed to " +
        "destroy the cache");
} catch (Exception e) {
    // get exception if not allowed to perform the operation
    e.printStackTrace();
}

System.out.println("------cache access control example completed------");

Edit the Cluster-Side Cache Configuration File

Edit the cluster-side cache configuration file examples-cache-config.xml. Specify the full path of the class name of the cache service in the cache-service-proxy
stanza under proxy-config. The cache-service-proxy stanza contains the configuration information for a cache service proxy managed by a proxy service.

In this case, the cache service class name is com.oracle.handson.EntitledCacheService proxy and the param-type is com.tangosol.net.CacheService.

Example 10–13 illustrates the XML code to add to the configuration.

Example 10–13  Cache Service Proxy Configuration for a Cluster-Side Cache Configuration

```xml
...<proxy-config>
  <cache-service-proxy>
    <class-name>com.oracle.handson.EntitledCacheService</class-name>
    <init-params>
      <init-param>
        <param-type>com.tangosol.net.CacheService</param-type>
        <param-value>{service}</param-value>
      </init-param>
    </init-params>
  </cache-service-proxy>
</proxy-config>
...```

Run the Access Control Example

Run the access control example to demonstrate how access to the cache can be granted or denied, based on a user’s role.

1. Create a run configuration for the AccessControlExample.java.
   a. Right click AccessControlExample in the Project Explorer. Select Run As then Run Configurations.
   b. Click Oracle Coherence then New launch configuration icon. Ensure that AccessControlExample appears in the Name field, Security appears in the Project field, and com.oracle.handson.AccessControlExample appears in the Main class field. Click Apply.
   c. In the Coherence tab, enter the path to the client-cache-config.xml file in the Cache configuration descriptor field. Select Disabled (cache client) in the Local storage field. Enter 3155 in the Cluster port field.
   d. In the Classpath tab, ensure that User Entries looks similar to Figure 10–5. Click Apply then Close.
e. In the Common tab, click Browse in the Shared file field to select the Security project. Click Apply.

2. Stop any running cache servers. See "Stopping Cache Servers" on page 2-14 for more information.

3. Run the security proxy server, the security cache server then the AccessControlExample.java program.
   a. Right click the project and select Run As then Run Configurations. Run the SecurityRunProxy configuration from the Run Configurations dialog box.
   b. Right click the project and select Run As then Run Configurations. Run the SecurityCacheServer configuration from the Run Configurations dialog box.
   c. Right click the AccessControlExample.java file in the Project Explorer and select Run As then Run Configurations. Run the AccessControlExample configuration from the Run Configurations dialog box.

The output is similar to Example 10–14 in the Eclipse console. The messages correspond to the various users specified in AccessControlExample executing read, write, and destroy operations on the cache.

- The Success: read and write allowed message corresponds to the user with role writer attempting to read from and write to the cache
- The Success: read allowed message corresponds to the user with role reader attempting to read from the cache
- The Success: Correctly cannot write message corresponds to the user with role reader attempting to write to the cache
- The Success: Correctly cannot destroy the cache message corresponds to the user with role writer attempting to destroy the cache
- The Success: Correctly allowed to destroy the cache message corresponds to the user with role admin attempting to destroy the cache

**Example 10–14 Access Control Example Output in the Eclipse Console**

```
------ cache access control example begins ------
2014-01-16 13:15:02.802/0.413 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from 'jar:file:/C:/OracleCoherence/coherence/lib/coherence.jar!/tangosol-coherence.xml'
```
Including Role-Based Access Control to the Cluster

Example 10–15 lists the output in the shell where the cache server is running the proxy service. Notice that the security exceptions in the output correspond to the Success: Correctly cannot write and Success: Correctly cannot destroy the cache messages in the Eclipse console.

Example 10–15  Output for the Cache Server Running the Proxy Service

Started DefaultCacheServer...

Password validated for user: role_writer
Password validated for user: role_writer
Password validated for user: role_writer
Password validated for user: role_reader
Password validated for user: role_reader
Password validated for user: role_reader

at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:105)
at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:59)
at com.oracle.handson.EntitledNamedCache.put(EntitledNamedCache.java:68)
Including Role-Based Access Control to the Cluster

at com.tangosol.coherence.component.net.extend.proxy.NamedCacheProxy.put$Router(NamedCacheProxy.CDB:1)
at com.tangosol.coherence.component.net.extend.proxy.NamedCacheProxy.put(NamedCacheProxy.CDB:2)
at com.tangosol.coherence.component.net.extend.messageFactory.NamedCacheFactory$PutRequest.onRun(NamedCacheFactory.CDB:6)
at com.tangosol.coherence.component.net.extend.message.Request.run(Request.CDB:4)
at com.tangosol.coherence.component.net.extend.proxy.NamedCacheProxy.onMessage(NamedCacheProxy.CDB:11)
at com.tangosol.coherence.component.net.extend.Channel$MessageAction.run(Channel.CDB:13)
at java.security.AccessController.doPrivileged(Native Method)
at com.tangosol.coherence.component.net.extend.Channel.execute(Channel.CDB:48)
at com.tangosol.coherence.component.net.extend.Channel.receive(Channel.CDB:26)
at com.tangosol.coherence.component.net.extend.proxy.daemon.queueProcessor.service.Peer$DaemonPool$WrapperTask.run(Peer.CDB:9)
at com.tangosol.coherence.component.util.DaemonPool$WrapperTask.run(DaemonPool.CDB:32)
at com.tangosol.coherence.component.util.Daemon$Daemon.onNotify(DaemonPool.CDB:65)
at com.tangosol.coherence.component.util.Daemon.run(DaemonPool.CDB:51)
at java.lang.Thread.run(Thread.java:724)

Password validated for user: CN=BuckarooBanzai,OU=Yoyodyne
Password validated for user: CN=BuckarooBanzai,OU=Yoyodyne
Password validated for user: CN=BuckarooBanzai,OU=Yoyodyne
2014-01-16 13:15:05.742/44.675 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Proxy:ProxyService:TcpAcceptorWorker:1, member=1): An exception occurred while processing a
denied, insufficient privileges
at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:105)
at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:59)
at com.oracle.handson.EntitledCacheService.destroyCache(EntitledCacheService.java:60)
at com.tangosol.coherence.component.net.extend.messageFactory.CacheServiceFactory$DestroyCacheRequest.onRun(CacheServiceFactory.CDB:6)
at com.tangosol.coherence.component.net.extend.message.Request.run(Request.CDB:4)
at com.tangosol.coherence.component.net.extend.proxy.serviceProxy.CacheServiceProxy.onMessage(CacheServiceProxy.CDB:12)
at com.tangosol.coherence.component.net.extend.Channel$MessageAction.run(Channel.CDB:13)
at java.security.AccessController.doPrivileged(Native Method)
at com.tangosol.coherence.component.net.extend.Channel.execute(Channel.CDB:48)
at com.tangosol.coherence.component.net.extend.Channel.receive(Channel.CDB:26)
at com.tangosol.coherence.component.net.extend.proxy.daemon.queueProcessor.service.Peer$DaemonPool$WrapperTask.run(Peer.CDB:9)
at com.tangosol.coherence.component.util.DaemonPool$WrapperTask.run(DaemonPool.CDB:32)
at com.tangosol.coherence.component.util.Daemon$Daemon.onNotify(DaemonPool.CDB:65)
at com.tangosol.coherence.component.util.Daemon.run(DaemonPool.CDB:51)
at java.lang.Thread.run(Thread.java:724)
Including Role-Based Access Control to an Invocable Object

An invocation service cluster service enables extend clients to execute invocable objects on the cluster. This example demonstrates how you can use role-based policies to determine which users can run the invocable objects.

For example, a user with a writer role can run an invocable object. A user with a reader role cannot.

In this example, you create a simple invocable object that can be called from a client program. Since the invocable object will be serializable, you must also list it in a POF configuration file. You also create an invocation service program that tests whether a user can execute methods on the service based on the user’s role.

As in the previous example, this example uses the PasswordIdentityTransformer class to generate a security token that contains the password, the user ID, and the roles. The PasswordIdentityAsserter (running in the proxy) will be used to validate the security token to enforce the password and construct a subject with the proper user ID and roles. The production and assertion of the security token happens automatically.

To create the example:

1. Create an Invocable Object
2. Create an Entitled Invocation Service
3. Create the Access Invocation Service Example Program
4. Edit the Cluster-Side Cache Configuration File
5. Create a POF Configuration File
6. Edit the Run Configurations for the Servers
7. Run the Access Invocation Service Example

Create an Invocable Object

Create an implementation of a simple invocable object that will be used by an entitled invocation service. For example, the invocable object can be written to increment and return an integer.

To create an invocable object:

1. Create a new Java class named ExampleInvocable in the Security project.
   See “Creating a Java Class” on page 2-11 for detailed information.
2. Import the Invocable and InvocationService interfaces. Because this class will be working with serializable objects, import the PortableObject, PofReader and PofWriter classes.
3. Ensure that the ExampleInvocable class implements Invocable and PortableObject.
4. Implement the ExampleInvocable class to increment an integer and return the result.
5. Implement the PofReader.readExternal and PofWriter.writeExternal methods.

Example 10–16 illustrates a possible implementation of ExampleInvocable.java.
Example 10–16 A Sample Invocable Object

package com.oracle.handson;

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

import com.tangosol.net.Invocable;
import com.tangosol.net.InvocationService;

import java.io.IOException;

/**
 * Invocable implementation that increments and returns a given integer.
 */
public class ExampleInvocable
    implements Invocable, PortableObject
{
    // ----- constructors ---------------------------------------------

    /**
    * Default constructor.
    */
    public ExampleInvocable()
    {
    // ----- Invocable interface --------------------------------------

    /**
    * @inheritDoc
    */
    public void init(InvocationService service)
    {
        m_service = service;
    }

    /**
    * @inheritDoc
    */
    public void run()
    {
        if (m_service != null)
        {
            m_nValue++;
        }
    }

    /**
    * @inheritDoc
    */
    public Object getResult()
{  
  return new Integer(m_nValue);  
}

// ----- PortableObject interface -----------------------------------

/**
 * {@inheritDoc}
 */
public void readExternal(PofReader in)  
  throws IOException
{
  m_nValue = in.readInt(0);
}

/**
 * {@inheritDoc}
 */
public void writeExternal(PofWriter out)  
  throws IOException
{
  out.writeInt(0, m_nValue);
}

// ----- data members -----------------------------------------------

/**
 * The integer value to increment.
 */
private int m_nValue;

/**
 * The InvocationService that is executing this Invocable.
 */
private transient InvocationService m_service;

Create an Entitled Invocation Service

This example shows how a remote invocation service can be wrapped to provide access control. Access entitlements can be applied to a wrapped InvocationService using the Subject passed from the client by using Coherence*Extend. This implementation enables only clients with a specified role to access the wrapped invocation service.

The class that you create should extend the com.tangosol.net.WrapperInvocationService class. This is a convenience function that enables you to secure the methods on InvocationService. It also provides a mechanism to delegate between the invocation service on the proxy and the client request.

To create an entitled invocation service:

1. Create a new Java class named EntitledInvocationService in the Security project.

2. Import the Invocable, InvocationObserver, InvocationService, WrapperInvocationService, Map, and Set interfaces. Ensure that the
EntitledInvocationService class extends the WrapperInvocationService class.

3. Implement the query and execute methods. In the implementations, include a call to the SecurityExampleHelper.checkAccess method to determine whether a specified user role, in this case, ROLE_WRITER, can access these operations.

Example 10–17 illustrates a possible implementation of EntitledInvocationService.java.

Example 10–17  A Sample Entitled Invocation Service
	nothing

```java
package com.oracle.handson;

import com.tangosol.net.Invocable;
import com.tangosol.net.InvocationObserver;
import com.tangosol.net.InvocationService;
import com.tangosol.net.WrapperInvocationService;
import java.util.Map;
import java.util.Set;

/**
 * Example WrapperInvocationService that demonstrates how entitlements can be
 * applied to a wrapped InvocationService using the Subject passed from the
 * client through Coherence*Extend. This implementation only allows clients with a
 * specified role to access the wrapped InvocationService.
 * *
 */
public class EntitledInvocationService
    extends WrapperInvocationService
{

    /**
     * Create a new EntitledInvocationService.
     *
     * @param service the wrapped InvocationService
     */
    public EntitledInvocationService(InvocationService service)
    {
        super(service);
    }

    // ----- InvocationService interface ------------------------------------

    /**
     * (inheritedDoc)
     */
    public void execute(Invocable task, Set setMembers, InvocationObserver observer)
    {
        SecurityExampleHelper.checkAccess(SecurityExampleHelper.ROLE_WRITER);
        super.execute(task, setMembers, observer);
    }

    /**
     * (inheritedDoc)
     */
```

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Create the Access Invocation Service Example Program

Create a program to run the access invocation service example. The objective of the program is to test whether various users defined in the SecurityExampleHelper class are able to access and run an invocable object. The enforcement of the role-based policies is provided by the EntitledInvocationService class.

To create a program to run the Access Invocation Service example:

1. Create a Java class with a main method in the Security project named AccessInvocationServiceExample.java. See “Creating a Java Class” on page 2-11 for detailed information.

2. Among other classes, import ExampleInvocable, CacheFactory, and InvocationService.

3. Implement the main method to invoke the accessInvocationService method.

4. Implement the accessInvocationService class so that various users defined in the SecurityExampleHelper class attempt to log in to the service and run the object defined in ExampleInvocable. Use the SecurityExampleHelper.login method to test whether various users can access the invocable service.

Example 10–18 illustrates a possible implementation of AccessInvocationServiceExample.java.

Example 10–18  Sample Program to Run the Access Invocation Service Example

```java
package com.oracle.handson;

import com.oracle.handson.ExampleInvocable;
import com.tangosol.net.CacheFactory;
import com.tangosol.net.InvocationService;
import java.security.PrilegedExceptionAction;
import javax.security.auth.Subject;

/**
 * This class demonstrates simplified role based access control for the invocation service.
 * <p>
 * The role policies are defined in SecurityExampleHelper. Enforcement is done by EntitledInvocationService.
 * *
 */
public class AccessInvocationServiceExample
{
    /**
     * Invoke the example
     */
```
* @param asArg  command line arguments (ignored in this example)
*/
public static void main(String[] asArg)
{
    accessInvocationService();
}

/**
* Access the invocation service
*/
public static void accessInvocationService()
{
    System.out.println("------InvocationService access control example " +
    "begins-----");

    // Someone with writer role can run invocables
    Subject subject = SecurityExampleHelper.login("JohnWhorfin");

    try
    {
        InvocationService service = (InvocationService) Subject.doAs(
            subject, new PrivilegedExceptionAction()
            {
                public Object run()
                {
                    return CacheFactory.getService(
                        SecurityExampleHelper.INVOCATION_SERVICE_NAME);
                }
            };
        service.query(new ExampleInvocable(), null);
    System.out.println("    Success: Correctly allowed to " +
        "use the invocation service");
    }
    catch (Exception e)
    {
        // get exception if not allowed to perform the operation
        e.printStackTrace();
    }

    // Someone with reader role cannot cannot run invocables
    subject = SecurityExampleHelper.login("JohnBigboote");
    try
    {
        InvocationService service = (InvocationService) Subject.doAs(
            subject, new PrivilegedExceptionAction()
            {
                public Object run()
                {
                    return CacheFactory.getService(
                        SecurityExampleHelper.INVOCATION_SERVICE_NAME);
                }
            });
        service.query(new ExampleInvocable(), null);
    }
    catch (Exception ee)
    {
        System.out.println("    Success: Correctly unable to " +
            "use the invocation service");
    }
System.out.println("------InvocationService access control example " +

Including Role-Based Access Control to an Invocable Object

Edit the Cluster-Side Cache Configuration File

Edit the examples-cache-config.xml file to add the full path to the invocation service to the invocation-service-proxy stanza under the proxy-config. The invocation-service-proxy stanza contains the configuration information for an invocation service proxy managed by a proxy service.

In this case, the invocation service class name is com.oracle.handson.EntitledInvocationService and its param-type is com.tangosol.net.InvocationService.

Example 10–19  Invocation Service Proxy Configuration for a Cluster-Side Cache

```
...<proxy-config>
...
<invocation-service-proxy>
  <class-name>com.oracle.handson.EntitledInvocationService</class-name>
  <init-params>
    <init-param>
      <param-type>com.tangosol.net.InvocationService</param-type>
      <param-value>{service}</param-value>
    </init-param>
  </init-params>
</invocation-service-proxy>
...```

Create a POF Configuration File

Create a POF configuration file to declare ExampleInvocable as a user type.

1. Locate the pof-config.xml file under Security\appClientModule in the Project Explorer and open it in the Eclipse IDE.

2. Enter the code to declare ExampleInvocable as a user type and save the file. The contents of the file should look similar to Example 10–20. The file will be saved to the C:\home\oracle\workspace\Security\appClientModule folder.

Example 10–20  POF Configuration File with ExampleInvocable User Type

```xml
<?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/1.2/coherence-pof-config.xsd">
  <user-type-list>
    <!-- include all 'standard' Coherence POF user types -->
    <include>coherence-pof-config.xml</include>
    <!-- com.tangosol.examples package -->
    <include>coherence-pof-config.xml</include>
    <!-- com.tangosol.examples package -->
    <user-type>
      <type-id>1007</type-id>
      <class-name>com.oracle.handson.ExampleInvocable</class-name>
```
<user-type>
</user-type>

<user-type-list>
</allow-interfaces>true</allow-interfaces>
</allow-subclasses>true</allow-subclasses>
</pof-config>

### Edit the Run Configurations for the Servers

The classloader must encounter the custom POF configuration file (which must be named `pof-config.xml`) before it references the one in the `coherence.jar` file. If it does not, then the custom POF configuration file will be ignored and the default file in the `coherence.jar` file will be used instead.

To make the application use the XML configuration files in the `C:\home\oracle\workspace\Security\appModule`, ensure that the Coherence12.1.3 library does not appear in the **Bootstrap Entries** section of the servers’ class path. Also, position the `coherence.jar` file after the Security folder in the **User Entries** section.

If the Coherence12.1.3 library does appear in the **Bootstrap Entries** section of the servers’ class path, follow these steps to remove it:

1. Right click the project in the **Project Explorer** and select **Run As** then **Run Configurations**.

2. Select **SecurityRunProxy**. In the **Classpath** tab, remove **Coherence12.1.3** from the list of **Bootstrap Entries** if it appears. Click **Add External Jars** and select the `coherence.jar` file from the `Oracle_Home\coherence\lib` folder. Click **Apply**.

3. Select **SecurityCacheServer**. In the **Classpath** tab, remove **Coherence12.1.3** from the list of **Bootstrap Entries** if it appears. Click **Add External Jars** and select the `coherence.jar` file from the `Oracle_Home\coherence\lib` folder. Click **Apply**.

---

**Note:** Ensure that the XML configuration files (in the `C:\home\oracle\workspace\Security\Security\build\classes` folders) appear before the `coherence.jar` file on the class path. The classloader must encounter the custom POF configuration file (which must be named `pof-config.xml`) before it references the one in the `coherence.jar` file.

---

When you are finished, the **Classpath** tab for **SecurityRunProxy** and **SecurityCacheServer** should look similar to Figure 10–6.
Run the Access Invocation Service Example

Run the access invocation service example to demonstrate how access to the invocable object can be granted or denied, based on a user’s role.

1. Create a run configuration for the `AccessInvocationServiceExample.java` file.
   a. Right click `AccessInvocationServiceExample.java` in the Project Explorer and select Run As then Run Configurations.
   b. Click Oracle Coherence, then the New launch configuration icon. Ensure that `AccessInvocationServiceExample` appears in the Name field, `Security` appears in the Project field, and `com.oracle.handson.AccessInvocationServiceExample.java` appears in the Main class field. Click Apply.
   c. In the Coherence tab, enter the path to the `client-cache-config.xml` file in the Cache configuration descriptor field. Select Disabled (cache client) in the Local storage field.
   d. In the Classpath tab, remove `Coherence12.1.3` from the Bootstrap Entries list if it appears there. Click Add External Jars to add the `coherence.jar` file to User Entries. Move the Security folder to the top of User Entries followed by the coherence.jar file if it does not already appear there. When you are finished, the Classpath tab should look similar to Figure 10–7. Click Apply then Close.

2. Stop any running cache servers. See “Stopping Cache Servers” on page 2-14 for more information.
3. Run the security proxy server, the security cache server then the AccessInvocationServiceExample.java program.

   a. Right click the project and select Run As then Run Configurations. Run the SecurityRunProxy configuration from the Run Configurations dialog box.

   b. Right click the project and select Run As then Run Configurations. Run the SecurityCacheServer configuration from the Run Configurations dialog box.

   c. Right click the AccessInvocationServiceExample.java file in the Project Explorer and select Run As then Run Configurations. Select AccessControlExample in the Run Configurations dialog box and click Run.

The output is similar to Example 10–21 in the Eclipse console. The messages correspond to the users specified in the AccessInvocationServiceExample class that are trying to run the invocable object ExampleInvocable.

- The message Success: Correctly allowed to use the invocation service corresponds to the user with role writer attempting to run ExampleInvocable.

- The message Success: Correctly unable to use the invocation service corresponds to the user with role reader attempting to run ExampleInvocable.

**Example 10–21 Client Program Response in the Eclipse Console**

```
-------InvocationService access control example begins-------
2014-01-16 14:20:34.509/0.370 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from 'jar:file:/C:/OracleCoherence/coherence/lib/coherence.jar!/tangosol-coherence.xml'
2014-01-16 14:20:34.609/0.470 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'jar:file:/C:/OracleCoherence/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml'
2014-01-16 14:20:34.689/0.550 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational overrides from 'file:/C:/home/oracle/workspace_jan_2014/Security/build/classes/tangosol-coherence-override.xml'
2014-01-16 14:20:34.699/0.560 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-config.xml" is not specified
2014-01-16 14:20:34.699/0.560 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "cache-factory-builder-config.xml" is not specified
2014-01-16 14:20:34.699/0.560 Oracle Coherence 12.1.3.0.0 <D5> (thread=main, member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified

Oracle Coherence Version 12.1.3.0.0 Build 49721
Grid Edition: Development mode
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2014-01-16 14:20:35.039/0.900 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded cache configuration from 'file:/C:/home/oracle/workspace_jan_2014/Security/appClientModule/client-cache-config.xml'
2014-01-16 14:20:35.699/1.559 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2014-01-16 14:20:36.187/2.048 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=main, member=n/a): Connecting Socket to 130.35.99.90:9099
2014-01-16 14:20:36.190/2.051 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main, member=n/a): Connected to 130.35.99.90:9099

Success: Correctly allowed to use the invocation service
```
Including Role-Based Access Control to an Invocable Object

Example 10–22 lists the output in the shell where the cache server is running the proxy service. Notice that the security exception in the output corresponds to the Success: Correctly unable to use the invocation service message in the Eclipse console, where the user with role reader attempts to run ExampleInvocable.

**Example 10–22 Proxy Service Response in the Eclipse Console**

Started DefaultCacheServer...
...
2014-01-16 14:18:33.043/27.491 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=1): Member 2 left service Management with senior member 1
Password validated for user: role_writer
Password validated for user: role_writer
Password validated for user: role_reader
Password validated for user: role_reader
    at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:105)
    at com.oracle.handson.SecurityExampleHelper.checkAccess(SecurityExampleHelper.java:59)
    at com.oracle.handson.EntitledInvocationService.query(EntitledInvocationService.java:50)
    at com.tangosol.coherence.component.net.extend.messageFactory.InvocationServiceFactory$InvocationRequest.onRun(InvocationServiceFactory.CDB:12)
    at com.tangosol.coherence.component.net.extend.message.Request.run(Request.CDB:4)
    at com.tangosol.coherence.component.net.extend.proxy.serviceProxy.InvocationServiceProxy.onMessage(InvocationServiceProxy.CDB:9)
    at com.tangosol.coherence.component.net.extend.Channel$MessageAction.run(Channel.CDB:13)
    at java.security.AccessController.doPrivileged(Native Method)
    at javax.security.auth.Subject.doAs(Subject.java:356)
    at com.tangosol.coherence.component.net.extend.Channel.execute(Channel.CDB:48)
    at com.tangosol.coherence.component.net.extend.Channel.receive(Channel.CDB:26)
    at com.tangosol.coherence.component.util.daemon.queueProcessor.service.Peer$DaemonPool$WrapperTask.run(Peer.CDB:9)
    at com.tangosol.coherence.component.util.DaemonPool$WrapperTask.run(DaemonPool.CDB:32)
    at com.tangosol.coherence.component.util.DaemonPool$Daemon.onNotify(DaemonPool.CDB:65)
    at com.tangosol.coherence.component.util.Daemon.run(Daemon.CDB:51)
    at java.lang.Thread.run(Thread.java:724)
In this exercise you learn how to work with entry and EntryProcessor events, and how to be notified of events using event interceptors. This exercise provides instructions for creating a project where you create event interceptors and cause events to exercise the features of the Live Events framework.

A brief overview of the Live Events framework is also provided. For a more detailed description of the framework and the API discussed in this chapter, see "Using Live Events" in Oracle Fusion Middleware Developing Applications with Oracle Coherence and Oracle Fusion Middleware Java API Reference for Oracle Coherence.

This chapter contains the following sections:

- Introduction
- Creating, Registering, and Executing an Event Interceptor
- Vetoing Pre- and Post-commit Events Using an Event Interceptor
- Logging Partition Activity Using an Event Interceptor

11.1 Introduction

Coherence provides an event framework that allows your applications to react to operations performed in the data grid. The framework uses an event-based model where events represent observable occurrences of cluster operations. The supported events include partitioned service, cache, and application events. These events can be consumed by registering event interceptors (classes that implement EventInterceptor) either programmatically or by using the cache configuration.

11.1.1 About Event Interceptors

Applications can react to Live Events by registering event interceptors (EventInterceptor). The interceptors explicitly define which events to receive and what action, if any, to take. Any number of event interceptors can be created and registered for a specific cache or for all caches managed by a specific partitioned service. Multiple interceptors that are registered for the same event type are automatically chained together and executed in the context of a single event.

Event interceptors are created by implementing the EventInterceptor interface. The interface is defined using generics and allows you to filter the events of interest by specifying the generic type of the event as a type parameter. The inherited onEvent method provides the ability to perform any necessary processing upon receiving an event. For details on the EventInterceptor API, see Oracle Fusion Middleware Java API Reference for Oracle Coherence.
The `@Interceptor` annotation is used to restrict the events to specific event types and also provides further configuration of the interceptor. The `@Interceptor` annotation includes the following attributes:

- **identifier**—Specifies a unique identifier for the interceptor. This value can be overridden when registering an interceptor class in the cache configuration file.
- **entryEvents**—Specifies an array of entry event types to which the interceptor wants to subscribe.
- **entryProcessorEvents**—Specifies an array of entry processor event types to which the interceptor wants to subscribe.
- **transferEvents**—Specifies an array of transfer event types to which the interceptor wants to subscribe.
- **transactionEvents**—Specifies an array of transaction event types to which the interceptor wants to subscribe.
- **order**—Specifies whether the interceptor is placed at the front of a chain of interceptors. The legal values are `HIGH` and `LOW`. A value of `HIGH` indicates that the interceptor is placed at the front in the chain of interceptors. A value of `LOW` indicates no order preference. The default value is `LOW`. This value can be overridden when registering an interceptor class in the cache configuration file.

For more information on the `@Interceptor` annotation, see "Creating Event Interceptors" in Oracle Fusion Middleware Developing Applications with Oracle Coherence

### 11.1.2 About Cache Events

Cache events are raised due to some operation performed against one or many entries in a cache. Cache events include entry events and entry processor events. An entry event (`EntryEvent`) can represent one of several operations (inserting, updating, and removing) performed against entries in a cache. Entry events can be divided into precommit events (`INSERTING`, `UPDATING`, and `REMOVING`), which are raised before the operation is performed to allow modification to an entry, and post-commit events (`INSERTED`, `UPDATED`, and `REMOVED`) which are raised after an operation has completed and in the same order as the events occurred.

Entry processor (`EntryProcessor`) events represent the execution of an `EntryProcessor` on a set of entries in a cache. Entry processor events can be divided into precommit events (`EXECUTING`), which are raised before an entry processor is executed to allow modification to the entry processor implementation, and post-commit events (`EXECUTED`), which are raised after an entry processor is executed and in the same order that the events occurred.

### 11.1.3 About Partitioned Service Events

Partitioned service (`PartitionedService`) events are comprised of transfer events, which represent partition transfers between storage-enabled members, and transaction events. Transfer events are dispatched in the context of a partition being transferred, however the contents belonging to a partition are immutable.

### 11.1.4 About Event Interceptor Registration

You register an event interceptor either in a cache configuration file or programmatically. An event interceptor is registered either for one or many caches, or for a specific partitioned service. An event interceptor that is registered for a specific cache only receives events that pertain to that cache. An event interceptor that is
registered for a specific partitioned service receives events for all caches that are managed by the service.

In the cache configuration file, the full class name of the event interceptor is specified in the `<interceptor>` element, which appears under `<cache-name>` in the `<cache-mapping>` stanza. The interceptor is associated with the cache specified in the `<cache-name>` element. An event interceptor can also be registered for a partitioned service in the `<caching-schemes>` stanza. To do this, include an `<interceptors>` element, within `<distributed-scheme>` element, that includes any number of `<interceptor>` subelements.

Instead of using the cache configuration file, event interceptors can be registered programmatically. The key classes and methods to register event interceptors are the `getInterceptorRegistry` method on the `ConfigurableCacheFactory` interface and the `getEventInterceptor` and `registerEventInterceptor` methods on the `InterceptorRegistry` interface. For example, the following code registers the `TimedTraceInterceptor`, which is an EventInterceptor introduced later in this chapter:

```java
ConfigurableCacheFactory ccf = CacheFactory.getConfigurableCacheFactory();
InterceptorRegistry reg = ccf.getInterceptorRegistry();
reg.registerEventInterceptor(new TimedTraceInterceptor(), RegistrationBehavior.FAIL);
```

A detailed description and examples of registering event interceptors programmatically is beyond the scope of this documentation. For more information, see "Using Live Events" in Oracle Fusion Middleware Developing Applications with Oracle Coherence and Oracle Fusion Middleware Java API Reference for Oracle Coherence.

## 11.2 Creating, Registering, and Executing an Event Interceptor

The following sections describe how to create, register, and execute an event interceptor. In this exercise, you will work with an event interceptor that will measure the timing between pre- and post-commit events.

To complete this exercise, follow these steps:

1. Create a Event Interceptor to Measure the Time Between a Pre- and a Post-commit Event
2. Create a Class to Delay the Processing of Events
3. Register the Timed Events Event Interceptor
4. Create a POF Configuration File for the Lazy Processor Class
5. Create a Class to Exercise the Timed Events Event Interceptor
6. Create a Driver File for Timed Events Example
7. Create a Cache Server Startup Configuration
8. Create a Startup Configuration for the Timed Events Driver
9. Run the Timed Events Example
11.2.1 Create a Event Interceptor to Measure the Time Between a Pre- and a Post-commit Event

Create a event interceptor named TimedTraceInterceptor to measure the timings between precommit and post-commit events (that is, INSERTING/INSERTED, UPDATING/UPDATED, and REMOVING/REMOVED) for each type of event.

To create the TimedTraceInterceptor event interceptor class:

1. Create a new Application Client Project in Eclipse named UEMEvents. Ensure that CoherenceConfig is selected in the Configuration field on the opening page and the Create a default main is not selected on the Application Client module page. See “Creating a New Project in the Eclipse IDE” on page 2-3 for detailed information.

2. Create a new Java class called TimedTraceInterceptor. Ensure that the Default Package is com.oracle.handson. Do not select the Main Method check box. See “Creating a Java Class” on page 2-11 for more information.

3. Write an event interceptor that implements the EventInterceptor interface. The interceptor should provide timings between pre- and post-commit events for each type of event: inserts, updates, removes, and an entry processor. You can write your own interceptor or use the code that is provided in Example 11–1.

Example 11–1 illustrates the event interceptor TimedTraceInterceptor. The interceptor implements the EventInterceptor interface. The @Interceptor annotation provides the unique name of the interceptor with the identifier attribute and the order in which it should be executed (Order.HIGH) with the order attribute.

The interceptor also contains a protected EventTimer inner-class. This class times the elapsed time for each event it is notified of. The interceptor tracks the time between a pre- and post-commit event for each entry and the respective event types (INSERT, UPDATE, REMOVE). The timings are sent to the Coherence log in batches displaying sample and cumulative statistics.

As the generic argument is com.tangosol.net.events.partition.cache.Event you will only get events that are consumers of that event, that is, EntryEvent and EntryProcessorEvent, without specifying any filtering.

Example 11–1 Class to Provide Timings Between Pre- and Post-commit Events

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.net.events.EventInterceptor;
import com.tangosol.net.events.annotation.Interceptor;
import com.tangosol.net.events.annotation.Interceptor.Order;
import com.tangosol.net.events.partition.cache.EntryEvent;
import com.tangosol.net.events.partition.cache.EntryEvent.Type;
import com.tangosol.net.events.partition.cache.EntryProcessorEvent;
import com.tangosol.net.events.partition.cache.Event;
import com.tangosol.util.Binary;
import com.tangosol.util.BinaryEntry;
import java.util.HashMap;
import java.util.Map;
```
import java.util.concurrent.ConcurrentHashMap;
import java.util.concurrent.atomic.AtomicInteger;
import java.util.concurrent.atomic.AtomicLong;

/**
 * TimedTraceInterceptor provides timings between pre- and post-commit events
 * for each type of event i.e. inserts, updates, removes, and entry processor
 * execution.
 * <p>
 * These timings are collected and averaged at a sample rate defined by
 * parameter <tt>cSample</tt>. Additionally they are output to the log
 * at the same time. This implementation does maintain a strong reference to
 * the each binary key however this is removed upon receiving the post-commit
 * event
 * for the same key.
 * <p>
 * @since Coherence 12.1.2
 */
@Interceptor(identifier = "trace", order = Order.HIGH)
public class TimedTraceInterceptor
        implements EventInterceptor<Event<? extends Enum<?>>>
{

    // ----- constructors ---------------------------------------------------

    /**
     * Default no-arg constructor.
     */
    public TimedTraceInterceptor()
    {
        this(DEFAULT_SAMPLE_RATE);
    }

    /**
     * Construct an TimedTraceInterceptor with specified Event
     * types and chain position.
     * @param cSample sample size to calculate mean and output statistics
     */
    public TimedTraceInterceptor(int cSample)
    {
        Map<Enum, EventTimer> mapTimedEvents = m_mapTimedEvents = new
                ConcurrentHashMap<Enum, EventTimer>(3);
        EventTimer insertTimer = new EventTimer(Type.INSERTED, cSample);
        EventTimer updateTimer = new EventTimer(Type.UPDATED, cSample);
        EventTimer removeTimer = new EventTimer(Type.REMOVED, cSample);
        EventTimer invocationTimer = new EventTimer(EntryProcessorEvent.Type.
                EXECUTED, cSample);

        mapTimedEvents.put(Type.INSERTED, insertTimer);
        mapTimedEvents.put(Type.UPDATING, updateTimer);
        mapTimedEvents.put(Type.REMOVING, removeTimer);
        mapTimedEvents.put(Type.REMOVED, removeTimer);
        mapTimedEvents.put(EntryProcessorEvent.Type.EXECUTED, invocationTimer);
    }

    // ----- EventInterceptor methods ---------------------------------------

Creating, Registering, and Executing an Event Interceptor

```java
/**
 * @inheritDoc
 */
public void onEvent(Event event)
{
    if (event instanceof EntryEvent)
    {
        process((EntryEvent) event);
    }
    else if (event instanceof EntryProcessorEvent)
    {
        process((EntryProcessorEvent) event);
    }
}

/**
 * This method will be invoked upon execution of an entry processor and
 * will time its execution from prior to post execution, including any
 * backup requests that need to be made as a result.
 * @param event the EntryProcessorEvent that encompasses the requested event
 */
protected void process(EntryProcessorEvent event)
{
    EventTimer mapTimedEvents = m_mapTimedEvents.get(event.getType());
    for (BinaryEntry binEntry : event.getEntrySet())
    {
        if (event.getType() == EntryProcessorEvent.Type.EXECUTING)
        {
            mapTimedEvents.starting(binEntry);
        }
        else if (event.getType() == EntryProcessorEvent.Type.EXECUTED)
        {
            mapTimedEvents.started(binEntry);
        }
    }
}

/**
 * This method will be invoked upon execution of a data mutating request
 * and will time its execution from prior to post execution, including
 * any backup requests that need to be made as a result.
 * @param event the EntryEvent that encompasses the requested event
 */
protected void process(EntryEvent event)
{
    EventTimer mapTimedEvents = m_mapTimedEvents.get(event.getType());
    switch ((Type) event.getType())
    {
        case INSERTING:
        case UPDATING:
        case REMOVING:
        for (BinaryEntry binEntry : event.getEntrySet())
        {
            for (BinaryEntry binEntry : event.getEntrySet())
        }
```
mapTimedEvents.starting(binEntry);
}  
break;

case INSERTED:
    case UPDATED:
    case REMOVED:
    for (BinaryEntry binEntry : event.getEntrySet())
    {
        mapTimedEvents.started(binEntry);
    }
    break;

// ----- inner class: EventTimer ----------------------------------------

/**
 * The EventTimer times the elapsed time for each event it is notified
 * of. It correlates the completion event based on equality comparisons
 * of the Binary provided. Additionally it calculates the mean based on a
 * sample set of <tt>cSample</tt> size. When reaching this sample set
 * a log will be made of the current sample set mean and the cumulative
 * mean.
 */
protected class EventTimer
{

    // ----- constructors -----------------------------------------------

    /**
     * Construct an EventTimer with the event type provided.
     * 
     * @param eventType  the type of event this timer will be timing
     */
    protected EventTimer(Enum eventType, int cSample)
    {
        m_eventType = eventType;
        m_cSampleSize = cSample;
    }

    /**
     * Notifies the timer of the execution of the provided key will
     * imminently commence.
     * 
     * @param binEntry  the event will commence for this <tt>binEntry</tt>
     */
    public void starting(BinaryEntry binEntry)
    {
        m_mapElapsedTimes.put(binEntry.getBinaryKey(), System.nanoTime());
    }

    /**
     * Notifies the timer of the completion of the event for the provided
     * key.
     * 
     * @param binEntry  the event has completed for this <tt>binEntry</tt>
     */
    public void started(BinaryEntry binEntry)
    {
        Long lStart = m_mapElapsedTimes.remove(binEntry.getBinaryKey());
    }
if (lStart == null) {
    return;
}

add(System.nanoTime() - lStart);
}

/**
 * Regardless of the specific data item add the elapsed time taken to
 * process the data item. Upon reaching the sample set size of events
 * calculate the mean, reset timings and continue.
 * @param lElapsed the number of nanos taken for a data item to
 * process
 */
protected void add(long lElapsed) {
    AtomicInteger nEvents           = m_nEvents;
    AtomicLong    lTotalElapsed     = m_lTotalElapsed;
    int           nCurrEvents       = nEvents.incrementAndGet();
    long          lCurrTotalElapsed = lTotalElapsed.addAndGet(lElapsed);

    if (nCurrEvents % m_cSampleSize == 0) {
        nEvents.set(0);
        lTotalElapsed.set(0L);
        ++m_cSamples;
        long lMean   = lCurrTotalElapsed / nCurrEvents;
        m_lMean = m_lMean == 0 ? lMean : lMean + m_lMean / 2;

        String sStats = String.format("EventStats[name = %s, sampleMean =
            %fms, mean = %fms]",
            m_eventType, (double) lMean / 1000000, (double) m_lMean / 1000000);
        CacheFactory.log(sStats, CacheFactory.LOG_INFO);

        NamedCache cacheResults = CacheFactory.getCache("events-results");
        int        nMemberId    = CacheFactory.getCluster().getLocalMember().getId();
        cacheResults.put(String.format("%d-%s-%d", nMemberId, m_eventType.name(),
            m_cSamples),
            sStats);
    }
}

// ----- data members -----------------------------------------------

/**
 * Sample size to calculate mean and output statistics.
 */
private int m_cSampleSize;

/**
 * The start times for a number of Binary keys.
 */
private Map<Binary, Long> m_mapElapsedTimes = new ConcurrentHashMap<Binary, Long>();

/**
 * A counter of the total elapsed time.
 */
private AtomicLong m_lTotalElapsed = new AtomicLong();

/**
 * A counter of the number of events processed
 */
private AtomicInteger m_nEvents = new AtomicInteger();

/**
 * An average over time.
 */
private long m_lMean;

/**
 * The number of samples taken.
 */
private int m_cSamples;

/**
 * The type of event being timed.
 */
private Enum m_eventType;
}

// ----- constants ------------------------------------------------------

/**
 * The sample size for elapsed times.
 */
protected static final int DEFAULT_SAMPLE_RATE = 100;

// ----- data members ---------------------------------------------------

/**
 * A map of event types to their timers.
 */
private Map<Enum, EventTimer> m_mapTimedEvents;

11.2.2 Create a Class to Delay the Processing of Events

Create a class named LazyProcessor to create a superficial delay between the processing of events. The class should be able to specify the number of milliseconds this processor should sleep between processing events. This class will be used by the EventsTimingExample subclass in the EventsExamples class. You will create the EventsExamples class in a later step.

The data that the LazyProcessor class produces will be sent across the wire, so the class should use POF (Portable Object Format). You will add the LazyProcessor class to the POF configuration file in a later step.

To create the LazyProcessor class:

1. Create a new Java class called LazyProcessor. Do not include a main method.

See "Creating a Java Class" on page 2-11 for more information.
2. Create the code for the LazyProcessor class. Because the class uses the PortableObject interface for data serialization, the LazyProcessor class must implement PortableObject interface. The class must also extend the AbstractProcessor class. Import the Base, InvocableMap.Entry, AbstractProcessor, PortableObject, PofReader, and PofWriter classes and interfaces. You can write your own code for the LazyProcessor class or use the code that is provided in Example 11–2.

**Example 11–2  Class to Delay the Processing of Events**

```java
package com.oracle.handson;

import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PofWriter;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.util.Base;
import com.tangosol.util.InvocableMap.Entry;
import com.tangosol.util.processor.AbstractProcessor;
import java.io.IOException;

/**
 * LazyProcessor will sleep for a specified period of time.
 * @since 12.1.2
 */
public class LazyProcessor
    extends AbstractProcessor
    implements PortableObject
{
    // ----- constructors -----------------------------------------------

    /**
     * Default no-arg constructor.
     */
    public LazyProcessor()
    {
    }

    /**
     * Constructs a LazyProcessor with a specified time to sleep.
     * @param lSleepTime the number of milliseconds this processor should sleep
     */
    public LazyProcessor(long lSleepTime)
    {
        m_lSleepTime = lSleepTime;
    }

    /**
     * @inheritDoc
     */
    public Object process(Entry entry)
    {
    }
}
```
try {
    Thread.sleep(m_lSleepTime);
} catch (InterruptedException e) {
    throw Base.ensureRuntimeException(e);
} return null;

// ----- PortableObject members -----------------------------------------

/**
 * @inheritDoc
 */
public void readExternal(PofReader in) throws IOException {
    m_lSleepTime = in.readLong(0);
}

/**
 * @inheritDoc
 */
public void writeExternal(PofWriter out) throws IOException {
    out.writeLong(0, m_lSleepTime);
}

// ----- data members ---------------------------------------------------

/**
 * The number of milliseconds this processor should sleep.
 */
private long m_lSleepTime;

11.2.3 Register the Timed Events Event Interceptor

In the UEMEvents project, the interceptors are registered in the cache configuration file. The fully-qualified name of the event interceptor is specified in the <interceptor> element, which appears under <cache-name> element in the <cache-mapping> stanza. The interceptor is associated with the cache specified in the <cache-name> element. In this example, TimedTraceInterceptor is the event interceptor on the events cache.

To create a cache configuration file which defines the event interceptors:

1. Open the coherence-cache-config.xml file from the Project Explorer window. You can find the file under Events/appClientModule.
2. Save the file as uem-cache-config.xml.
3. Write the cache configuration that calls the event interceptors. The following list highlights some key elements:
   ■ Under the <cache-mapping> element there is a reference from the com.oracle.handson.TimedTraceInterceptor class in the <interceptor> element to the events cache in the <cache-name> element. The events cache uses the events-distributed-scheme This scheme uses the PartitionedPofCache service which is listed under <distributed-schemes>.
There is a mapping between the `events-results` cache and the `dist-events-results` scheme. In the `<distributed-scheme>` section, there is an association between the `dist-events-results` scheme and the `PartitionedEventsResults` service.

Example 11–3 illustrates a possible implementation for the `uem-cache-config.xml` file.

Example 11–3  Cache Configuration File That Registers the TimedTraceInterceptor

```xml
<?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">
    <defaults>
        <serializer>pof</serializer>
    </defaults>

    <caching-scheme-mapping>
        <cache-mapping>
            <cache-name>events</cache-name>
            <scheme-name>events-distributed-scheme</scheme-name>
            <interceptors>
                <interceptor>
                    <instance>
                        <class-name>com.oracle.handson.TimedTraceInterceptor</class-name>
                        <init-params>
                            <init-param>
                                <param-type>int</param-type>
                                <param-value>100</param-value>
                            </init-param>
                        </init-params>
                    </instance>
                </interceptor>
            </interceptors>
        </cache-mapping>
        <cache-mapping>
            <cache-name>events-results</cache-name>
            <scheme-name>dist-events-results</scheme-name>
        </cache-mapping>
    </caching-scheme-mapping>

    <caching-schemes>
        <distributed-scheme>
            <scheme-name>events-distributed-scheme</scheme-name>
            <service-name>PartitionedPofCache</service-name>
            <thread-count>5</thread-count>
            <backing-map-scheme>
                <local-scheme>
                    <!-- each node will be limited to 32MB -->
                    <high-units>32M</high-units>
                    <unit-calculator>binary</unit-calculator>
                </local-scheme>
            </backing-map-scheme>
            <autostart>true</autostart>
        </distributed-scheme>
    </caching-schemes>

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<!-- A PartitionedCache service used to store results for events examples}
Creating, Registering, and Executing an Event Interceptor

11.2.4 Create a POF Configuration File for the Lazy Processor Class

All of the information produced by the TimedTraceInterceptor class is exclusive to its local member. The LazyProcessor, and its state, is transmitted to storage-enabled members and executed, thus it must be added to the POF configuration file. In the Eclipse Project Explorer, right-click the pof-config.xml file and rename it uem-pof-config.xml. Open the uem-pof-config.xml file in the editor and replace its contents with the code in Example 11–4. The example illustrates a POF configuration file containing this class.

**Example 11–4 POF Configuration File for the LazyProcessor Class**

```xml
<?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/1.2/coherence-pof-config.xsd">
  <user-type-list>
    <!-- include all "standard" Coherence POF user types -->
    <include>coherence-pof-config.xml</include>
  </user-type-list>
  <user-type>
    <type-id>1008</type-id>
    <class-name>com.oracle.handson.LazyProcessor</class-name>
  </user-type>
</pof-config>
```

11.2.5 Create a Class to Exercise the Timed Events Event Interceptor

Create a class named EventsExamples to trigger actions to be performed by the TimedTraceInterceptor class. The class should illustrate how the elapsed time can be measured between pre- and post-commit events inserted into a results cache. The
entries inserted into the results cache are sent to standard output by the process executing this class.

To create the `EventsExamples` class:

1. Create a new Java class called `EventsExamples`. Do not include a `main` method.
   
   See "Creating a Java Class" on page 2-11 for more information.

2. Write the code for the `EventsExamples` class. Import the `LazyProcessor`, `CacheFactory`, `NamedCache`, `PartitionedService`, `MapEvent`, `MapListener`, `MultiplexListener`, and `Callable` classes and interfaces. You can write your own code or use the code supplied in Example 11–5.

Example 11–5 illustrates a sample implementation of the `EventsExamples` class. The example contains the `EventsTimingExample` inner-class. This inner-class accesses the events and event-results caches and obtains the number of cache cluster members, the name of the triggering event, and the sample size from the `TimedTraceInterceptor` class logs. The calculation of the time for the sample to be processed and the mean time for all of the samples to be processed are provided by the `TimedTraceInterceptor` class.

The `EventsTimingExample` subclass provides the values for the total amount of time for event processing and the number of threads on which the events can run. It also calls the `LazyProcessor` class to calculate the amount of time between processing events (sleep time).

**Example 11–5  Class to Exercise the TimedTraceInterceptor Event Interceptor**

```java
package com.oracle.handson;

import com.oracle.handson.LazyProcessor;
import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.net.PartitionedService;
import com.tangosol.util.MapEvent;
import com.tangosol.util.MapListener;
import com.tangosol.util.MultiplexingMapListener;
import java.util.concurrent.Callable;

/**
 * EventsExamples illustrates various features within the Live Events Model. This includes providing mean elapsed times split by event type.
 * @since Coherence 12.1.2
 */
@SuppressWarnings("unchecked")
public class EventsExamples {

    // ----- inner-class: EventsTimingExample ----------------------------------------

    /**
     * The EventsTimingExample is a catalyst for action to be performed by
     * {@link TimedTraceInterceptor}. This illustrates how the elapsed time
     * between pre- and post-commit events can be measured which are inserted
     * into a results cache. The entries inserted into the results cache are
     * displayed via the stdout of the process executing this class.
     */
```
public static class EventsTimingExample
    implements Callable<Boolean>
    {
    // ----- Callable methods ----------------------------------------
    
    /**
     * @inheritDoc
     */
    public Boolean call() throws Exception
    {
    NamedCache cacheEvents = CacheFactory.getCache("events");
    NamedCache cacheResults = CacheFactory.getCache("events-results");
    int cFrequency = ((PartitionedService) cacheEvents.
        getCacheService()).getOwnershipEnabledMembers().size();
    int cSet = 110;
    MapListener ml = new MultiplexingMapListener()
    {
    @Override
    protected void onMapEvent(MapEvent evt)
    {
    String[] asKey = ((String) evt.getKey()).split("-");
    asKey[0], asKey[1], asKey[2], ev
    
    try
    {
    cacheResults.addMapListener(ml);
    
    // execute inserts and updates
    for (int i = cFrequency; i > 0; --i)
    {
    for (int j = 1, cMax = cSet * cFrequency; j <= cMax; ++j)
    {
    cacheEvents.put(j, "value " + j);
    }
    }
    
    // execute processors
    int nTotalTime = 3000;
    int cThreads = 5;
    int nSleepTime = nTotalTime / (cThreads * cSet * cFrequency);
    for (int i = 1, cMax = cSet * cFrequency; i <= cMax; ++i)
    {
    cacheEvents.invoke(i, new LazyProcessor(nSleepTime));
    }
    }
    
    finally
    {
    cacheEvents.clear();
    cacheResults.removeMapListener(ml);
    cacheResults.clear();
    } return true;
    }
    
}
11.2.6 Create a Driver File for Timed Events Example

Create a driver file to run the EventsTimingExample example defined in the EventsExamples class.

To create a driver file:

1. Create a new Java class called Driver in the UEMEvents project. Ensure that it includes a main method.
   
   See "Creating a Java Class" on page 2-11 for detailed information.

2. Write the code to run the EventsTimingExample example defined in the EventsExamples class. You can write your own driver or use the code supplied in Example 11–6.

Example 11–6 Driver File for Timed Events Example

```java
package com.oracle.handson;
import com.oracle.handson.EventsExamples.EventsTimingExample;
import java.util.LinkedHashMap;
import java.util.Map;
import java.util.concurrent.Callable;
/**
 * Driver executes all the Coherence Events examples.
 * <p>
 * `<strong>Timed Events Example</strong>` - In this example we time
 * the elapsed time between pre- and post-commit events for each of the events
 * that occur.
 * <p>
 * @since Coherence 12.1.2
 */
public class Driver {
    // ----- static methods -----------------------------------------------
    /**
     * Execute Events examples.
     *
     * @param asArg command line arguments
     */
    public static void main(String[] asArg)
    {
        System.out.println("------ events examples begin ------");
        // Run examples
        for (Map.Entry<String, Callable<Boolean>> example : EVENTS_EXAMPLES.entrySet())
        {
            String sExample = example.getKey();
            try
            {
                System.out.printf("------ %s begin\n\n", sExample);
                boolean fSuccess = example.getValue().call();
            }
        }
```
System.out.printf("\n----- %s completed %ssuccessfully\n", sExample, fSuccess ? "" : "un");
}
catch(Exception e)
{
    System.err.printf("----------%s completed unsuccessfully with the
following exception:\n", sExample);
e.printStackTrace();
}
}
System.out.println("------ events examples completed------");
}

// ----- constants -----------------------------------------------
/**
 * All the examples to be executed in insertion order.
 */
protected static final Map<String, Callable<Boolean>> EVENTS_EXAMPLES = new
LinkedHashMap<String, Callable<Boolean>>() {
    /**
     * Default examples.
     */
    static {
        EVENTS_EXAMPLES.put("timing interceptor", new EventsTimingExample());
    }
};

11.2.7 Create a Cache Server Startup Configuration

Create a configuration to start the cache server for the UEMEvents project.

1. Right click the project and select Run As then Run Configurations. Double click
the Oracle Coherence icon in the Run Configurations dialog box to create a new
launch configuration.

2. In the Main tab, enter UEMEventsServer in the Name field. Click Browse in the
Project field and select the UEMEvents project in the Project Selection dialog box.
Select the Include system libraries when searching for a main class checkbox and
click Search. Enter DefaultCacheServer in the Select Type field and select com.
tangosol.net.DefaultCacheServer. Click Apply. The Main tab should look similar
to Figure 11–1.
In the **General** tab of the **Coherence** tab, identify the path to the cache configuration file under **Cache configuration descriptor**. Click the **Browse** button to navigate to the **Absolute file path** of the cache configuration file C:\home\oracle\workspace\UEMEvents\appClientModule\uem-cache-config.xml. Select **Enabled (cache server)** under **Local storage**. Enter a unique value, such as 3155, for the **Cluster port**.

In the **Other** tab, set the **tangosol.pof.config** item to uem-pof-config.xml.

4. In the **Common** tab, select **Shared file** and browse to the \UEMEvents project.

5. The **Classpath** tab should look similar to **Example 11–2**. The **UEMEvents** project appears below **User Entries**. The **JRE System Library** and **Coherence12.1.3** library appear in the **Bootstrap Entries** section.

**Figure 11–2 Classpath Tab for the Events Server Startup Configuration**

**11.2.8 Create a Startup Configuration for the Timed Events Driver**

Create a configuration to start the client driver for the **UEMEvents** project.

1. Right click the project and select **Run As** then **Run Configurations**. Double click the **Oracle Coherence** icon in the **Run Configurations** dialog box to create a new launch configuration.

2. In the **Main** tab, enter **UEMEventDriver** in the **Name** field. Click **Browse** in the **Project** field and select the **UEMEvents** project in the **Project Selection** dialog box. Select the **Include system libraries when searching for a main class** checkbox and click **Search**. Enter **Driver** in the **Select Type** field and select **com.oracle.handson.Driver**. Click **Apply**. The **Main** tab should look similar to **Figure 11–3**.
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Figure 11–3  Main Tab for the Events Client Startup Configuration

3. In the General tab of the Coherence tab, identify the path to the cache configuration file under Cache configuration descriptor. Click the Browse button to navigate to the Absolute file path of the cache configuration file C:\home\oracle\workspace\UEMEvents\appClientModule\uem-cache-config.xml. Select Disabled (cache client) under Local storage. Enter a unique value, such as 3155, for the Cluster port.

   In the Other tab, set the tangosol.pof.config item to the uem-pof-config.xml.

4. In the Common tab, select Shared file and browse to the \UEMEvents project.

5. The Classpath tab should look similar to Example 11–4. The UEMEvents project appears below User Entries. The JRE System Library and Coherence12.1.3 library appear in the Bootstrap Entries section.

Figure 11–4  Classpath Tab for the Events Client Startup Configuration

11.2.9 Run the Timed Events Example

Right-click the UEMEvents project in the Project Explorer and select Run As, then Run Configurations. In the Run Configurations dialog box, select the UEMEventsServer launch configuration and click Run to start the cache server. After the cache server starts, select UEMEventsServer and click Run a second and a third time to start a total of three cache servers.

After the third cache server starts, select the UEMEventDriver configuration and click Run. The output from the cache client should look similar to Example 11–7.

Example 11–7  Output from the Cache Client

-------- events examples begin --------
-------- timing interceptor begin
2014-01-02 15:43:20.284/0.340 Oracle Coherence 12.1.3.0.0 <Info> (thread=main,
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```
member=n/a): Loaded operational configuration from
"jar:file:/C:/Oracle/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2014-01-02 15:43:20.384/0.440 Oracle Coherence 12.1.3.0.0 <Info> (thread=main,
member=n/a): Loaded operational overrides from
"jar:file:/C:/Oracle/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.
xm"
2014-01-02 15:43:20.464/0.520 Oracle Coherence 12.1.3.0.0 <Info> (thread=main,
member=n/a): Loaded operational overrides from
"file:/C:/home/oracle/workspace/UEMEvents/build/classes/tangosol-coherence-overrid
ej.xml"
2014-01-02 15:43:20.474/0.530 Oracle Coherence 12.1.3.0.0 <D5> (thread=main,
member=n/a): Optional configuration override "cache-factory-config.xml" is not
specified
2014-01-02 15:43:20.474/0.530 Oracle Coherence 12.1.3.0.0 <D5> (thread=main,
member=n/a): Optional configuration override "cache-factory-builder-config.xml" is
not specified
2014-01-02 15:43:20.474/0.530 Oracle Coherence 12.1.3.0.0 <D5> (thread=main,
member=n/a): Optional configuration override "/custom-mbeans.xml" is not specified
...
...
2014-01-02 15:43:24.650/4.706 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=DistributedCache:PartitionedPofCache, member=5): Service
PartitionedPofCache joined the cluster with senior service member 1
(thread=DistributedCache:PartitionedEventsResults, member=5): Service
PartitionedEventsResults joined the cluster with senior service member 1
Received stats [memberId=2, eventType=INSERTED, sample=1] = EventStats[name =
INSERTED, sampleMean = 0.294040ms, mean = 0.294040ms]
Received stats [memberId=3, eventType=INSERTED, sample=1] = EventStats[name =
INSERTED, sampleMean = 0.397855ms, mean = 0.397855ms]
Received stats [memberId=1, eventType=INSERTED, sample=1] = EventStats[name =
INSERTED, sampleMean = 0.373270ms, mean = 0.373270ms]
Received stats [memberId=3, eventType=UPDATED, sample=1] = EventStats[name =
UPDATED, sampleMean = 0.187132ms, mean = 0.187132ms]
Received stats [memberId=2, eventType=UPDATED, sample=1] = EventStats[name =
UPDATED, sampleMean = 0.234314ms, mean = 0.234314ms]
Received stats [memberId=1, eventType=UPDATED, sample=1] = EventStats[name =
UPDATED, sampleMean = 0.237622ms, mean = 0.237622ms]
Received stats [memberId=3, eventType=UPDATED, sample=2] = EventStats[name =
UPDATED, sampleMean = 1.315323ms, mean = 1.432480ms]
Received stats [memberId=2, eventType=UPDATED, sample=2] = EventStats[name =
UPDATED, sampleMean = 0.417201ms, mean = 0.510767ms]
Received stats [memberId=1, eventType=UPDATED, sample=2] = EventStats[name =
UPDATED, sampleMean = 0.190555ms, mean = 0.309366ms]
Received stats [memberId=2, eventType=EXECUTED, sample=1] = EventStats[name =
EXECUTED, sampleMean = 1.766313ms, mean = 1.766313ms]
Received stats [memberId=3, eventType=EXECUTED, sample=1] = EventStats[name =
EXECUTED, sampleMean = 1.672603ms, mean = 1.672603ms]
Received stats [memberId=1, eventType=EXECUTED, sample=1] = EventStats[name =
EXECUTED, sampleMean = 1.676003ms, mean = 1.676003ms]

------- timing interceptor completed successfully
------- events examples completed-------
2014-01-02 15:43:28.344/9.400 Oracle Coherence GE 12.1.3.0.0 <D4>
(thread=ShutdownHook, member=5): ShutdownHook: stopping cluster node
```
11.3 Vetoing Pre- and Post-commit Events Using an Event Interceptor

In this exercise you will create an event interceptor to detect and veto events based on a specified key. To complete this exercise, follow these steps:

1. Create an Event Interceptor to Detect and Veto Events
2. Register the Veto Events Event Interceptor
3. Create a Class to Exercise the Veto Events Event Interceptor
4. Edit the Driver File for the Veto Events Example
5. Run the Veto Events Example

11.3.1 Create an Event Interceptor to Detect and Veto Events

To exercise the ability of Live Events to accept or veto events, create an event interceptor named CantankerousInterceptor. The interceptor will throw exceptions based on events that correspond to a specified key.

1. Create a new Java class called CantankerousInterceptor. Ensure that the Default Package is com.oracle.handson. Do not select the Main Method check box. See "Creating a Java Class" on page 2-11 for more information.

2. Write the code for the event interceptor. Import the Event, EventInterceptor, Interceptor, EntryEvent, and EntryEvent.Type classes and interfaces. You can write your own interceptor code or use the code that is provided in Example 11–8.

Example 11–8 illustrates an event interceptor that throws a runtime exception during pre or post-commit events, based on the key that is attempting to be inserted. If the exception is thrown at precommit time, then a rollback occurs and the exception is propagated to the client. If the exception occurs at post-commit time, then a log event is recorded. The keys used for the exceptions are VETO and NON-VETO. INSERTING and UPDATING are events that can be vetoed, whereas INSERTED and UPDATED events cannot be vetoed.

Example 11–8 Class to Detect and Veto Events

```java
package com.oracle.handson;

import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;

import com.tangosol.net.events.Event;
import com.tangosol.net.events.EventInterceptor;
import com.tangosol.net.events.annotation.Interceptor;
import com.tangosol.net.events.partition.cache.EntryEvent;
import com.tangosol.net.events.partition.cache.EntryEvent.Type;

import com.tangosol.util.BinaryEntry;

/**
 * A CantankerousInterceptor is an @link EventInterceptor implementation
 * that is argumentative in nature, hence the event of inserting certain keys
 * will result in (@link RuntimeException)s at either pre- or post-commit
 * phases. Throwing a (RuntimeException) during the precommit phase
 * will result in a rollback and related exception being propagated to the
 * client. A post-commit exception will result in a log event. A precommit
 * event is considered an *ING event with a post-commit event being a
 * *ED event.
 */
```
This interceptor assumes it will be working against a cache with strings as keys with the following items that will be considered objectionable.

<table>
<thead>
<tr>
<th>Key</th>
<th>Exception Thrown During Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>VETO</td>
<td>INSERTING</td>
</tr>
<tr>
<td>NON_VETO</td>
<td>INSERTED</td>
</tr>
</tbody>
</table>

@since Coherence 12.1.2

@Interceptor(identifier = "cantankerous",
entryEvents = {Type.INSERTING, Type.INSERTED, Type.UPDATING, Type.UPDATED})

public class CantankerousInterceptor implements EventInterceptor<EntryEvent> {
    // ----- EventInterceptor methods -------------------------------------

    /**
     * Throws RuntimeException iff the key used for this event is VETO or NON_VETO.
     *
     * @param event the (EntryEvent) to be processed
     *
     * @throws RuntimeException iff VETO || NON_VETO are keys of the event
     */
    public void onEvent(EntryEvent event) {
        for (BinaryEntry binEntry : event.getEntrySet()) {
            if (VETO.equals(binEntry.getKey())) {
                throw new RuntimeException("Objection! value = " + binEntry.getValue());
            } else if (NON_VETO.equals(binEntry.getKey()) && (event.getType() == Type.INSERTED || event.getType() == Type.UPDATED)) {
                NamedCache cacheResults = CacheFactory.getCache("events-results");
                int nMemberId = CacheFactory.getCluster().getLocalMember().getId();
                String sMessage = "Objection falls on deaf ears! value = " + binEntry.getValue();
                cacheResults.put(String.format("%d-NON_VETO-%d", nMemberId, ++m_cNonVetoableEvents), sMessage);
                throw new RuntimeException(sMessage);
            }
        }
    }
}
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// ----- constants -----------------------------------------------------------------------------

/**
 * String used to determine whether the event should be VETO'd during the
 * precommit phase.
 */
public static final String VETO     = "VETO";

/**
 * String used to determine whether the event should be VETO'd during the
 * post-commit phase.
 */
public static final String NON_VETO = "NON-VETO";

// ----- data members -----------------------------------------------------------------------------

/**
 * A counter of the number of non-vetoable exceptions raised.
 */
private int m_cNonVetoableEvents;

11.3.2 Register the Veto Events Event Interceptor

Open the uem-cache-config.xml cache configuration file and add the code to register
the CantankerousInterceptor event interceptor and its cache. List the cache it
references, vetoed-events, in the <cache-name> element and its associated scheme
events-distributed-scheme in the <scheme-name> element. List the fully-qualified
class name of the CantankerousInterceptor class in the <class-name> subelement of
the <interceptors> stanza. The added code is illustrated in bold font.

Example 11–9  Cache Configuration to Register the CantankerousInterceptor Class

<?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">
    <defaults>
        <serializer>pof</serializer>
    </defaults>
    <caching-scheme-mapping>
        <cache-mapping>
            <cache-name>events</cache-name>
            <scheme-name>events-distributed-scheme</scheme-name>
            <interceptors>
                <interceptor>
                    <instance>
                        <class-name>com.oracle.handson.TimedTraceInterceptor</class-name>
                    </instance>
                    <init-params>
                        <init-param>
                            <param-type>int</param-type>
                            <param-value>100</param-value>
                        </init-param>
                    </init-params>
                </interceptor>
            </interceptors>
        </cache-mapping>
    </caching-scheme-mapping>
</cache-config>
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```xml
<cache-mapping>
  <cache-name>vetoed-events</cache-name>
  <scheme-name>events-distributed-scheme</scheme-name>
  <interceptors>
    <interceptor>
      <instance>
        <class-name>com.oracle.handson.CantankerousInterceptor</class-name>
      </instance>
    </interceptor>
  </interceptors>
</cache-mapping>

<cache-mapping>
  <cache-name>events-results</cache-name>
  <scheme-name>dist-events-results</scheme-name>
</cache-mapping>

<caching-schemes>
  <distributed-scheme>
    <scheme-name>events-distributed-scheme</scheme-name>
    <service-name>PartitionedPofCache</service-name>
    <thread-count>5</thread-count>
    <backing-map-scheme>
      <local-scheme>
        <!-- each node will be limited to 32MB -->
        <high-units>32M</high-units>
        <unit-calculator>binary</unit-calculator>
      </local-scheme>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>

  <!-- A PartitionedCache service used to store results for events examples -->
  <distributed-scheme>
    <scheme-name>dist-events-results</scheme-name>
    <service-name>PartitionedEventsResults</service-name>
    <thread-count>5</thread-count>
    <backing-map-scheme>
      <local-scheme/>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>

  <!-- Invocation Service scheme. -->
  <invocation-scheme>
    <scheme-name>examples-invocation</scheme-name>
    <service-name>InvocationService</service-name>
    <autostart system-property="tangosol.coherence.invocation.autostart">true</autostart>
  </invocation-scheme>
</caching-schemes>
```
Create a Class to Exercise the Veto Events Event Interceptor

Create a class named `VetoExample` to exercise the `CantankerousInterceptor` event interceptor. Within the `VetoExample` class, create a subclass, `VetoedEventsExample`. The `VetoedEventsExample` subclass initiates the action to be performed by `CantankerousInterceptor`. The code illustrates the semantics of throwing exceptions in pre- and post-commit events. The exceptions that are expected only to be logged are inserted into a results cache. The entries inserted into the results cache are displayed by using the standard output of the process executing this class.

Example 11–10  Class to Exercise the TimedTraceInterceptor EventInterceptor

```java
package com.oracle.handson;
import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.util.MapEvent;
import com.tangosol.util.MapListener;
import com.tangosol.util.MultiplexingMapListener;
import java.util.concurrent.Callable;

/**
 * VetoExample illustrates the different semantics in throwing exceptions in pre
 * events compared to post events.
 * @since Coherence 12.1.2
 **/
@SuppressWarnings("unchecked")
public class VetoExample
{

    public static class VetoedEventsExample
    implements Callable<Boolean>
    {

        /**
         * The VetoExample is a catalyst for action to be performed by
         * (@link CantankerousInterceptor). This illustrates the semantics of
         * throwing exceptions in pre- and post-commit events. The exceptions that are
         * expected to only be logged are inserted into a results cache. The
         * entries inserted into the results cache are
         * displayed via the stdout of the process executing this class.
         */
        public Boolean call() throws Exception
        {
            // perform events to cause interceptors to veto said event
            NamedCache cacheVetoEvents = CacheFactory.getCache("vetod-events");
            NamedCache cacheResults    = CacheFactory.getCache("events-results");
            MapListener ml             = new MultiplexingMapListener();
            }@
            protected void onMapEvent(MapEvent evt)
```
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```java
String[] asKey = ((String) evt.getKey()).split("-");
System.out.printf('Received event [memberId=%s, eventType=%s, count=%s] = %s\n",
    asKey[0], asKey[1], asKey[2], evt.getNewValue());
}
};
try {
    int cSet = 110;
    int cVetos = 5;
    int cNonVetos = 10;
    int cVetod = 0;
    cacheResults.addMapListener(ml);
    for (int i = 1; i <= cSet; ++i) {
        boolean fVetod = false;
        if (i % (cSet / cVetos) == 0) {
            try {
                cacheVetoEvents.put(CantankerousInterceptor.VETO,
"value: " + i);
            } catch(Throwable e) {
                fVetod = true;
                ++cVetod;
            }
        }
        if (i % (cSet / cNonVetos) == 0) {
            cacheVetoEvents.put(CantankerousInterceptor.NON_VETO,
"value: " + i);
            fVetod = true;
        }
        if (!fVetod) {
            cacheVetoEvents.put(String.valueOf(i), "value: " + i);
        }
    }
    System.out.printf('Number of veto\d events: %d\n", cVetod);
} finally {
    cacheVetoEvents.clear();
    cacheResults.removeMapListener(ml);
    cacheResults.clear();
    return true;
}
```
11.3.4 Edit the Driver File for the Veto Events Example

Edit the driver file that you created in "Create a Driver File for Timed Events Example" on page 11-16 to run the VetoedEventsExample example defined in the VetoExample class.

To edit the driver file:

1. Replace the import statement for the Events Timing Example:
   
   ```java
   import com.oracle.handson.EventsExamples.EventsTimingExample;
   ```

   with an import statement for the VetoedEventsExample subclass.
   
   ```java
   import com.oracle.handson.VetoExample.VetoedEventsExample;
   ```

2. Replace the command which calls the Timed Events example:

   ```java
   EVENTS_EXAMPLES.put("timing interceptor", new EventsTimingExample());
   ```

   with the following command to run the VetoedEventsExample example defined in the VetoExample class:

   ```java
   EVENTS_EXAMPLES.put("veto interceptor", new VetoedEventsExample());
   ```

11.3.5 Run the Veto Events Example

Right-click the UEMEvents project in the Project Explorer and select Run As, then Run Configurations. In the Run Configurations dialog box, select the UEMEventsServer launch configuration that you created in "Create a Cache Server Startup Configuration" on page 11-17. Click Run to start the cache server. After the cache server starts, select UEMEventsServer and click Run a second and a third time to start a total of three cache servers.

After the third cache server starts, select the UEMEventDriver launch configuration and click Run. The output from the veto events client should look similar to Example 11–11.

Example 11–11  Output from the Veto Events Client

```
----- events examples begin -----
----- veto interceptor begin
2014-01-02 16:07:28.606/0.340 Oracle Coherence 12.1.3.0.0 <Info> (thread=main,
member=n/a): Loaded operational configuration from
'jar:file:/C:/Oracle/coherence/lib/coherence.jar!/tangosol-coherence.xml'
2014-01-02 16:07:28.716/0.450 Oracle Coherence 12.1.3.0.0 <Info> (thread=main,
member=n/a): Loaded operational overrides from
'jar:file:/C:/Oracle/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.
xml'
...
2014-01-02 16:07:33.018/4.752 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=DistributedCache:PartitionedEventsResults, member=4): Service
PartitionedEventsResults joined the cluster with senior service member 1
Received event [memberId=3, eventType=NON_VETO, count=1] = Objection falls on deaf
ears! value = value: 11
Received event [memberId=3, eventType=NON_VETO, count=2] = Objection falls on deaf
ears! value = value: 22
Received event [memberId=3, eventType=NON_VETO, count=3] = Objection falls on deaf
ears! value = value: 33
Received event [memberId=3, eventType=NON_VETO, count=4] = Objection falls on deaf
ears! value = value: 44
Received event [memberId=3, eventType=NON_VETO, count=5] = Objection falls on deaf
```
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received event [memberId=3, eventType=NON_VETO, count=6] = Objection falls on deaf ears! value = value: 55
received event [memberId=3, eventType=NON_VETO, count=7] = Objection falls on deaf ears! value = value: 66
received event [memberId=3, eventType=NON_VETO, count=8] = Objection falls on deaf ears! value = value: 77
received event [memberId=3, eventType=NON_VETO, count=9] = Objection falls on deaf ears! value = value: 88
received event [memberId=3, eventType=NON_VETO, count=10] = Objection falls on deaf ears! value = value: 99
Number of veto'd events: 5

------ events examples completed------

Notice the output from the third cache server illustrated in Example 11–12. The output displays the exceptions caused by the vetoed events.

Example 11–12 Output from the Cache Server

Started DefaultCacheServer...

2014-01-02 16:06:50.262/5.785 Oracle Coherence GE 12.1.3.0.0 <D4>
(thread=DistributedCache:PartitionedPofCache, member=2): Asking member 1 for primary ownership of PartitionSet{0..127}
...

2014-01-02 16:07:33.178/48.701 Oracle Coherence GE 12.1.3.0.0 <Error>
    at com.oracle.handson.CantankerousInterceptor.onEvent(CantankerousInterceptor.java:74)
    at com.oracle.handson.CantankerousInterceptor.onEvent(CantankerousInterceptor.java:1)
    at com.tangosol.net.events.internal.NamedEventInterceptor.onEvent(NamedEventInterceptor.java:240)
    at com.tangosol.net.events.internal.AbstractEvent.nextInterceptor(AbstractEvent.java:116)
    at com.tangosol.net.events.internal.AbstractEventDispatcher$1.proceed(AbstractEventDispatcher.java:254)
    at com.tangosol.coherence.component.util.daemon.queueProcessor.Service$EventDispatcher.onNotify(Service.CDB:26)
    at com.tangosol.coherence.component.util.Daemon.run(Daemon.CDB:51)
    at java.lang.Thread.run(Thread.java:722)

2014-01-02 16:07:33.238/48.761 Oracle Coherence GE 12.1.3.0.0 <Error>
    at com.oracle.handson.CantankerousInterceptor.onEvent(CantankerousInterceptor.java:74)
    at com.oracle.handson.CantankerousInterceptor.onEvent(CantankerousInterceptor.java:1)
    at com.tangosol.net.events.internal.NamedEventInterceptor.
11.4 Logging Partition Activity Using an Event Interceptor

In this exercise you will create an event interceptor to log partition events for a partitioned service. To complete this exercise, follow these steps:

1. Create a Class to Terminate a JVM and to Enable and Disable Logging
2. Create an Event Interceptor to Log Partition Activity
3. Create a Class to Exercise the Log Partition Activity Example
4. Register the Log Partition Activity Event Interceptor
5. Edit the POF Configuration File
6. Edit the Driver File for the Log Partition Activity Example
7. Run the Log Partition Activity Example

11.4.1 Create a Class to Terminate a JVM and to Enable and Disable Logging

Create a class named `RedistributionInvocable` that defines three actionable states that will be executed on various members of the cluster. For this example, define the states as follows:

- **DISABLE**: Disable the logging performed by the `RedistributionInterceptor` event interceptor.
- **ENABLE**: Enable the logging performed by the `RedistributionInterceptor` event interceptor.
- **KILL**: Terminate the JVM that this invocable (`RedistributionInvocable`) is executed on.

You will create the `RedistributionInterceptor` event interceptor in a later step.

For the variable that determines whether logging is enabled or disabled, use the `AtomicBoolean` class. For example:

```java
public static final AtomicBoolean ENABLED = new AtomicBoolean(false)
```

To terminate the invocable, the `KILL` state can simply call `System.exit`.

The data that the class produces will be sent across the wire, so the class should use POF (Portable Object Format). You will add the class to the POF configuration file in a later step.

To create the `RedistributionInvocable` class:

1. Create a new Java class called `RedistributionInvocable`. Ensure that the Default Package is `com.oracle.handson`. Do not select the Main Method check box. See "Creating a Java Class" on page 2-11 for more information.
2. Write the class to define three different states that can be assigned to an interceptor object. Import the `AbstractInvocable`, `AtomicBoolean`, `PortableObject`, `PofReader`, and `PofWriter` classes and interfaces. The `RedistributionInvocable` class should extend the `AbstractInvocable` class and implement the `PortableObject` interface. You can write your own `RedistributionInvocable` class or use the code provided in Example 11–13.

**Example 11–13 Class to Terminate a JVM and to Enable or Disable Logging**

```java
package com.oracle.handson;

import com.tangosol.io.pof.PofReader;
import com.tangosol.io.pof.PofWriter;
import com.tangosol.io.pof.PortableObject;
import com.tangosol.net.AbstractInvocable;
import java.io.IOException;
import java.util.concurrent.atomic.AtomicBoolean;

/**
 * RedistributionInvocable has three states in which appropriate action is
 * taken:
 */
```
* <ol>
*     <li><strong>{@link State#DISABLE}</strong> - Disables the logging performed by {@link com.oracle.handson.RedistributionInterceptor}.</li>
*     <li><strong>{@link State#ENABLE}</strong> - Enables the logging performed by {@link com.oracle.handson.RedistributionInterceptor}.</li>
*     <li><strong>{@link State#KILL}</strong> - Kills the JVM this invocable is executed on.</li>
* </ol>

@since 12.1.2

public class RedistributionInvocable
    extends AbstractInvocable
    implements PortableObject
{
    // ----- constructors --------------------------------------------

    /**
     * Default no-arg constructor.
     */
    public RedistributionInvocable()
    {
        this(State.DISABLE);
    }

    /**
     * Constructs a RedistributionInvocable with the specified state.
     *
     * @param state  the state indicating the action to be performed
     */
    public RedistributionInvocable(State state)
    {
        m_state = state;
    }

    // ----- Invocable methods ---------------------------------------

    /**
     * (Overwrite the inherited run method to change state of
     *   redistribution invocable.)
     */
    public void run()
    {
        switch (m_state)
        {
            case DISABLE:
                ENABLED.set(false);
                break;
            case ENABLE:
                ENABLED.set(true);
                break;
            case KILL:
                System.exit(1);
                break;
        }
    }
}
// ----- PortableObject methods ------------------------------------------
/**
 * {@inheritDoc}
 */
public void readExternal(PofReader in) throws IOException
{
    m_state = State.values()[in.readInt(0)];
}
/**
 * {@inheritDoc}
 */
public void writeExternal(PofWriter out) throws IOException
{
    out.writeInt(0, m_state.ordinal());
}

// ----- inner class: State ---------------------------------------------
/**
 * Representation of the action to be performed when
 * {@link RedistributionInvocable#run()}.  
 */
public enum State
{
    /**
     * Disables the logging performed by
     * {@link com.oracle.handson.RedistributionInterceptor}  
     */
    DISABLE,  
    /**
     * Enables the logging performed by
     * {@link com.oracle.handson.RedistributionInterceptor}  
     */
    ENABLE,  
    /**
     * Terminates the JVM process in which the
     * {@link RedistributionInvocable} is executed.
     */
    KILL
}

// ----- constants ------------------------------------------------------
/**
 * Flag used to determine whether to log partition events.
 */
public static final AtomicBoolean ENABLED = new AtomicBoolean(false);

// ----- data members ---------------------------------------------------
/**
 * The state used to determine which action to perform.  
 */
private State m_state;
11.4.2 Create an Event Interceptor to Log Partition Activity

Create an event interceptor named `RedistributionInterceptor` to log partition events for a partitioned service.

To create the `RedistributionInterceptor` event interceptor:

1. Create a new Java class called `RedistributionInterceptor`. Ensure that the Default Package is `com.oracle.handson`. Do not select the Main Method check box.

   See "Creating a Java Class" on page 2-11 for more information.

2. Write the `RedistributionInterceptor` class to log partition events. Import the `RedistributionInvocable`, `CacheFactory`, `EventInterceptor`, `Interceptor`, `TransferEvent` classes and interfaces. The `RedistributionInterceptor` class should implement the `EventInterceptor<TransferEvent>` interface. You can write your own class to log partition events or use the code provided in Example 11–14.

Example 11–14 illustrates an event interceptor to log partition events. A name can be assigned to the interceptor by using the optional `identifier` attribute in the `@Interceptor` annotation. The event interceptor determines whether the partition event should be logged by referencing the value of the `RedistributionInvocable` `ENABLED` constant.

Example 11–14  Class to Log Partition Events

```java
package com.oracle.handson;

import com.oracle.handson.RedistributionInvocable;
import com.tangosol.net.CacheFactory;
import com.tangosol.net.events.EventInterceptor;
import com.tangosol.net.events.annotation.Interceptor;
import com.tangosol.net.events.partition.TransferEvent;

/**
 * RedistributionInterceptor is an `@link com.tangosol.net.events.EventInterceptor`
 * that logs partition activity when enabled. Logging can be enabled via
 * setting the (`@link RedistributionInvocable#ENABLED`) constant.
 *
 * @since Coherence 12.1.2
 */
@Interceptor(identifier = "redist")
public class RedistributionInterceptor
    implements EventInterceptor<TransferEvent>
{

    // ----- EventInterceptor methods ---------------------------------------

    /**
     * (inheritDoc)
     */
    public void onEvent(TransferEvent event)
    {
        if (RedistributionInvocable.ENABLED.get())
        {
            CacheFactory.log(String.format("Discovered event %s for partition-id
```

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Logging Partition Activity Using an Event Interceptor

11.4.3 Create a Class to Exercise the Log Partition Activity Example

Create a class called LogExample to trigger actions to be performed by the RedistributionInterceptor class.

To create the LogExample class:

1. Create a new Java class called LogExample. Do not include a main method. See “Creating a Java Class” on page 2-11 for more information.

2. Write the code for the LogExample class. Import the RedistributionInvocable, RedistributionInvocable.State, CacheFactory, InvocationService, Member, ArrayList, Collection, Random, Set and Callable classes and interfaces. You can write your own code or use the code supplied in Example 11–15.

Example 11–15 illustrates a sample implementation of the LogExample class. The example contains the subclass RedistributionEventsExample subclass which triggers actions to be performed by the RedistributionInterceptor class. The subclass illustrates how partition redistribution events can be logged. At least two cluster members must be running to run this example.

Example 11–15 Sample Class to Exercise the Log Partition Activity Example

```java
package com.oracle.handson;
import com.oracle.handson.RedistributionInvocable;
import com.oracle.handson.RedistributionInvocable.State;
import com.tangosol.net.CacheFactory;
import com.tangosol.net.InvocationService;
import com.tangosol.net.Member;
import java.util.ArrayList;
import java.util.Collections;
import java.util.Random;
import java.util.Set;
import java.util.concurrent.Callable;

/**
 * LogExample illustrates logging of partition movement when enabled.
 * @since Coherence 12.1.2
 */
@SuppressWarnings("unchecked")
public class LogExample
{
    /**
     * The RedistributionEventsExample is a catalyst for action to be
     * performed by (link RedistributionInterceptor). This illustrates how
     * partition redistribution events can be logged.
     */
    public static class RedistributionEventsExample
        implements Callable<Boolean>
```
// ----- Callable methods -------------------------------------------

/**
 * {@inheritDoc}
 */
public Boolean call() throws Exception {
    // transfer events
    try {
        InvocationService is = (InvocationService) CacheFactory.
        getService("InvocationService");
        Random            rnd = new Random();
        int               cMembers = is.getInfo().getServiceMembers().
        size();

        if (cMembers < 3) {
            System.err.println("<Error> At least two members must exist
for the RedistributionEvent example");
            return false;
        }

        // enable the logging of transfer event
        is.query(new RedistributionInvocable(State.ENABLE), null);

        Set<Member> isMembers = is.getInfo().getServiceMembers();
        isMembers.remove(is.getCluster().getLocalMember());
        Member memChosen = new ArrayList<Member>(isMembers).get(rnd.
        nextInt(isMembers.size()));

        System.out.printf("Choosing to kill member %s\n", memChosen);
        is.query(new RedistributionInvocable(State.KILL), Collections.
        singleton(memChosen));
    }
    finally {
        }
    return true;
}

11.4.4 Register the Log Partition Activity Event Interceptor

The event interceptors can be registered either programmatically or by including
references to them in the cache configuration file.

In the UEMEvents project, the interceptors are registered in the cache configuration file.
The fully-qualified class name of the event interceptor is specified in the
<interceptor> element. The interceptor is associated with the cache specified in the
<cache-name> element.

For the log partition events example, the event interceptor,
RedistributionInterceptor, is registered on the partitioned cache service under the
<distributed-scheme> element.
To edit the cache configuration file to define the `RedistributionInterceptor` event interceptor:

1. Open the `uem-cache-config.xml` file from the Project Explorer window. You can find the file under `Events/appClientModule`.

2. Write the cache configuration that calls the event interceptors. Under the `<distributed-scheme>` element, there should be a reference to the fully-qualified `RedistributionInterceptor` class in the `<interceptor>` element.

Example 11–16 illustrates a possible implementation for the `uem-cache-config.xml` file. The configuration for the `RedistributionInterceptor` event interceptor is illustrated in bold font.

**Example 11–16  Cache Configuration File with Event Interceptors**

```xml
<?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">
  <defaults>
    <serializer>pof</serializer>
  </defaults>
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>events</cache-name>
      <scheme-name>events-distributed-scheme</scheme-name>
      <interceptors>
        <interceptor>
          <instance>
            <class-name>com.oracle.handson.TimedTraceInterceptor</class-name>
          </instance>
        </interceptor>
      </interceptors>
    </cache-mapping>
    <cache-mapping>
      <cache-name>vetoed-events</cache-name>
      <scheme-name>events-distributed-scheme</scheme-name>
      <interceptors>
        <interceptor>
          <instance>
            <class-name>com.oracle.handson.CantankerousInterceptor</class-name>
          </instance>
        </interceptor>
      </interceptors>
    </cache-mapping>
    <cache-mapping>
      <cache-name>events-results</cache-name>
      <scheme-name>dist-events-results</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>
</cache-config>
```
11.4.5 Edit the POF Configuration File

With the exception of the RedistributionInvocable class, all of the information produced by the classes in the log partition activity exercise remain on their own cluster members. The information produced by the RedistributionInvocable class however, will be sent across the wire to other cluster members. Thus, it must be added to the POF configuration file.

To edit the POF configuration file for the RedistributionInvocable data type:
1. Open the `uem-pof-config.xml` file. You can find the file under `UEMEvents/appClientModule/META-INF`.

2. Define `<user-type>` elements for the `com.oracle.handson.RedistributionInvocable` class and assign type ID 1009 to it. The file must include the `coherence-pof-config.xml` file which reserves the first 1000 IDs for Coherence data types.

Example 11–17 illustrates a sample `uem-pof-config.xml` file. The configuration for the `RedistributionInvocable` class is illustrated in bold font.

**Example 11–17  POF Configuration File for the Log Partition Events Example**

```xml
<?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/1.2/coherence-pof-config.xsd">
    <user-type-list>
        <!-- include all 'standard' Coherence POF user types -->
        <include>coherence-pof-config.xml</include>
        <user-type>
            <type-id>1008</type-id>
            <class-name>com.oracle.handson.LazyProcessor</class-name>
        </user-type>
        <user-type>
            <type-id>1009</type-id>
            <class-name>com.oracle.handson.RedistributionInvocable</class-name>
        </user-type>
    </user-type-list>
</pof-config>
```

11.4.6 Edit the Driver File for the Log Partition Activity Example

Edit the driver file that you created in "Create a Driver File for Timed Events Example" on page 11-16 to run the `RedistributionEventsExample` example defined in the `LogExample` class.

To edit the driver file:

1. Replace the import statement for the Vetoed Events example:

   ```java
   import com.oracle.handson.VetoExample.VetoedEventsExample;
   ```

   with an import statement for the `RedistributionEventsExample` subclass of the `LogExample` class.

   ```java
   import com.oracle.handson.LogExample.RedistributionEventsExample;
   ```

2. Replace the command which calls the Vetoed Events example

   ```java
   EVENTS_EXAMPLES.put("veto interceptor", new VetoedEventsExample());
   ```

   with the following command to run the `RedistributionEventsExample` example defined in the `LogExample` class:

   ```java
   EVENTS_EXAMPLES.put("redistribution interceptor", new
                       RedistributionEventsExample());
   ```
11.4.7 Run the Log Partition Activity Example

Right-click the UEMEvents project in the Project Explorer and select Run As, then Run Configurations. In the Run Configurations dialog box, select the UEMEventsServer launch configuration that you created in "Create a Cache Server Startup Configuration" on page 11-17. Click Run to start the cache server. After the cache server starts, select UEMEventsServer and click Run a second and a third time to start a total of three cache servers.

After the third cache server starts, select the UEMEventDriver configuration and click Run. The output from the cache client should look similar to Example 11–18.

Example 11–18  Output from the Cache Client

-------- events examples begin --------
--------  redistribution interceptor begin
2014-01-02 16:38:38.901/0.350 Oracle Coherence 12.1.3.0.0 <Info> (thread=main, member=n/a): Loaded operational configuration from "jar:file:/C:/Oracle/coherence/lib/coherence.jar!/tangosol-coherence.xml"

...  
2014-01-02 16:38:43.249/4.698 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:InvocationService, member=4): Service InvocationService joined the cluster with senior service member 1
Choosing to kill member Member(Id=3, Timestamp=2014-01-02 16:38:17.942, Address=10.159.154.103:8092, MachineId=47251, Location=site:,machine=TPFAEFFL-LAP,process:8168, Role=CoherenceServer)
Choosing to kill member Member(Id=3, Timestamp=2014-01-02 16:38:17.942, Address=10.159.154.103:8092, MachineId=47251, Location=site:,machine=TPFAEFFL-LAP,process:8168, Role=CoherenceServer)
--------  redistribution interceptor completed successfully
-------- events examples completed------
2014-01-02 16:38:43.276/4.725 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=3): TcpRing disconnected from Member(Id=3, Timestamp=2014-01-02 16:38:17.942, Address=10.159.154.103:8092, MachineId=47251, Location=site:,machine=TPFAEFFL-LAP,process:8168, Role=CoherenceServer) due to a peer departure; removing the member.

...

Example 11–19 displays the output from the cache server that was terminated. The output illustrates the client joining the cluster (Member 4) and the shutdown of the current cache server.

Example 11–19  Output from First Cache Server

...
2014-01-02 16:38:20.701/6.178 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=DistributedCache:PartitionedEventsResults, member=3): Transferring 1B of backup[1] for PartitionSet{0} to member 2
2014-01-02 16:38:42.299/27.776 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Cluster, member=4): Member(Id=4, Timestamp=2014-01-02 16:38:17.942, Address=10.159.154.103:8092, MachineId=47251, Location=site:,machine=TPFAEFFL-LAP,process:1620, Role=OracleHandsonDriver) joined Cluster with senior member 1
2014-01-02 16:38:42.495/27.972 Oracle Coherence GE 12.1.3.0.0 <D5> (thread=Invocation:Management, member=3): Member 4 joined Service Management with senior member 1
2014-01-02 16:38:43.254/28.731 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Invocation:InvocationService, member=3): Member 4 joined Service InvocationService with senior member 1
2014-01-02 16:38:43.254/28.731 Oracle Coherence GE 12.1.3.0.0 <D4>
(thread=ShutdownHook, member=1): ShutdownHook: stopping cluster node
In this exercise, you learn how to use JCache, the Java standard APIs for caching on the Java platform. This exercise is similar to Chapter 3, "Accessing the Data Grid from Java" where you created a Java console-based application to access, update, and remove simple types of information from a Coherence clustered cache. However, instead of using NamedCache and the Coherence API, it uses Cache and the JCache API.

This chapter has the following sections:

- Introduction
- Creating a JCache-Based Java Project
- Creating a JCache-Based Application to Put Values in the Cache
- Running a JCache Application in a Cluster

### 12.1 Introduction

Coherence includes a JCache provider implementation. JCache is a common API for using caching in Java. You can use the JCache API and Coherence provides the underlying caching capabilities. The provider-based approach guarantees cross-provider portability and allows developers to focus on application logic rather than creating and managing complex cache subsystems.

The Coherence JCache provider is built upon the existing capabilities of Coherence. The provider relies on the Coherence infrastructure and can be thought of as a wrapper for the Coherence NamedCache API. This allows Coherence to reuse and expose many of its best-in-class technologies using JCache interfaces.

The key files which support JCache are cache-api.jar and coherence-jcache.jar. The cache-api.jar file contains the JCache libraries. The coherence-jcache.jar file contains the Coherence implementation which is built on top of the JCache library. Both of these files must appear on the classpath of the application.

The APIs in the coherence-jcache.jar file allow JCache to support the use of distributed, local, passthrough, and remote caches. It also supports the use of POF serialization, events, and entry processors.

For more information on the JCache provider implementation, see "Introduction to Coherence JCache" in Oracle Fusion Middleware Developing Applications with Oracle Coherence.

Oracle is a lead contributor of the JCache specification. See the following URL to obtain the JCache specification (JSR-107 "Java Caching API"):

12.2 Creating a JCache-Based Java Project

Follow these steps to create a project that uses JCache.

1. In the Eclipse IDE, select File, then New, then Application Client Project to create a new project called JCache. Select CoherenceConfig from the Configuration drop-down list. Click Next.

2. Click Next to accept the defaults in the Java page of the wizard. In the Application Client module page, deselect Create a default Main class. Click Next.

3. Click the Manage Libraries icon in the Coherence page to create a user library to contain the JCache and Coherence JCache libraries.

4. Click New in the User Libraries dialog box to name the user library. In the New User Library dialog box, enter CoherenceJCache and select the System Library checkbox as illustrated in Figure 12–1. Click OK.

5. Select the CoherenceJCache library in the User Libraries dialog box and click Add External JARs.

6. Navigate to the location of the /coherence/lib folder in your Coherence distribution and select the cache-api.jar and the coherence-jcache.jar files. When you are finished, the User Libraries dialog box should look similar to Figure 12–2. Click OK.
Creating a JCache-Based Application to Put Values in the Cache

12.3 Creating a JCache-Based Application to Put Values in the Cache

This section describes how to create a Java program that uses the JCache APIs to access and update simple types of information from a Coherence clustered cache.

To create a JCache-based application:

1. Create a new Application Client Project in Eclipse. Name the project JCache. Ensure that the folder is C:\home\oracle\workspace\JCache.

   In the Configuration section of the New Application Client Project dialog box, click Modify. In the Project Facets dialog box, select CoherenceConfig from the Configuration drop down list.

   See "Creating a New Project in the Eclipse IDE" on page 2-3 for detailed instructions.
2. Create your first Coherence JCache Java program. Name the class `MyFirstJCacheSample` and select the `public static void main(String[] args)` check box in the New Java Class dialog box.

3. In the Eclipse editor, write the code to create a Cache object, enter a value in the cache, and then verify the value that you entered.

Notice that in JCache, as opposed to Coherence, you do need to write more code to create a cache. In JCache, you must first get the cache manager and set the cache configuration parameters before you can create the cache.

Example 12–1 illustrates a sample program.

**Example 12–1 Creating a JCache Cache Object: Inserting and Verifying Values**

```java
package com.oracle.handson;

import javax.cache.Cache;
import javax.cache.CacheManager;
import javax.cache.Caching;
import javax.cache.configuration.MutableConfiguration;
import javax.cache.spi.CachingProvider;

public class MyFirstJCacheSample {
    public MyFirstJCacheSample() {
    }
    public static void main(String[] args) {
        // ensure we are in a cluster
        CacheFactory.ensureCluster();

        // get cache manager
        CachingProvider cachingProvider = Caching.getCachingProvider();
        CacheManager cacheManager = cachingProvider.getCacheManager();

        // set configuration for the cache
        PassThroughCacheConfiguration<String, String> config = new PassThroughCacheConfiguration();
        config.setTypes(String.class, String.class);

        // create and use the cache
        cacheManager.createCache("myCache", config);
        Cache<String, String> cache = cacheManager.getCache("myCache",
                String.class, String.class);

        // put key, value pair into the cache.
        cache.put("Name", "Gene Smith");

        System.out.println("Value in cache is " + cache.get("Name"));
    }
}
```

4. Stop any running cache servers. See “Stopping Cache Servers” on page 2-14 for detailed information.

5. Run the program in the Eclipse IDE:

   a. Right-click the `MyFirstJCacheSample.java` class in the editor and select Run As then Run Configuration. Double-click Oracle Coherence to create a
Running a JCache Application in a Cluster

Coherence configuration. Enter MyFirstJCacheSample in the Name field of the Run Configuration dialog box.

b. In the Main tab, enter JCache in the Project field and com.oracle.handson.MyFirstJCacheSample in the Main class field.

c. In the Coherence tab, enter a unique value, such as 3155, in the Cluster port field to ensure that Coherence is limited to your own host. Select Enabled (cache server) under Local storage.

d. Note that in the Classpath tab, the CoherenceJCache library should appear before the Coherence12.1.3 library in the Bootstrap Entries list. Click Apply, then Run.

Messages similar to Example 12–2 are displayed:

Example 12–2  Output of MyFirstJCacheSample Program

2014-02-20 15:28:53.188/0.377 Oracle Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Loaded operational configuration from
"jar:file:/C:/OracleCoherence1/coherence/lib/coherence.jar!/tangosol-coherence.xml"
2014-02-20 15:28:53.303/0.492 Oracle Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Loaded operational overrides from
"jar:file:/C:/OracleCoherence1/coherence/lib/coherence.jar!/tangosol-coherence-override-dev.xml"
2014-02-20 15:28:53.383/0.572 Oracle Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Loaded operational overrides from
"file:/C:/home/oracle/workspace/JCache/build/classes/tangosol-coherence-override.xml"
...
2014-02-20 15:28:53.668/0.857 Oracle Coherence GE 12.1.3.0.0 <D5> <Info>
(thread=main, member=n/a): Loaded cache configuration from
"jar:file:/C:/OracleCoherence1/coherence/lib/coherence-jcache.jar!/coherence-jcache-cache-config.xml"
2014-02-20 15:28:53.848/1.037 Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Created cache factory com.tangosol.net.ExtensibleConfigurableCacheFactory
2014-02-20 15:28:53.863/1.052 Oracle Coherence GE 12.1.3.0.0 <D5> <Info>
(thread=main, member=n/a): Mapping general javax.cache.Configuration implementation to CoherenceBased JCacheConfiguration of com.tangosol.coherence.jcache.localcache.LocalCacheConfiguration
Value in cache is Gene Smith

12.4 Running a JCache Application in a Cluster

This section describes how to create and run an application that uses the JCache API in a cluster environment.

1. Configure an Example Cluster
2. Store the Object in a Pass-Through Cache
3. Start the Example Cache Server
4. Run the Application
5. Verify the Cache
12.4.1 Configure an Example Cluster

Partitioned caches and pass-through caches use a Coherence cluster to distribute cached data. This task creates an operational override file to modify the out-of-box default cluster configuration. In particular, the default configuration is modified to create a private cluster which ensures that the JVM processes do not attempt to join an existing Coherence cluster that may be running on the network.

To configure an example cluster:

1. Edit the `tangosol-coherence-override.xml` file. Double-click the `tangosol-coherence-override.xml` file in the Project Navigator to open it in the editor.

2. Add the following override configuration and replace `cluster_name` and `port` with values that are unique for this cluster. For example, use `myCluster` for the cluster name and the last four digits of your telephone number for the port.

```xml
<?xml version='1.0'?>
<coherence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns="http://xmlns.oracle.com/coherence/coherence-operational-config"
xsi:schemaLocation="http://xmlns.oracle.com/coherence/
coherence-operational-config coherence-operational-config.xsd">
  <cluster-config>
    <member-identity>
      <cluster-name>cluster_name</cluster-name>
    </member-identity>

    <multicast-listener>
      <address>224.3.6.0</address>
      <port>port</port>
      <time-to-live>0</time-to-live>
    </multicast-listener>
  </cluster-config>
</coherence>
```

3. Save and close the file.

12.4.2 Store the Object in a Pass-Through Cache

A pass-through cache is a cache that delegates to a pre-existing Coherence cache (a cache that is defined in a Coherence cache configuration file). Pass-through caches allow you to use all of the native features of Coherence and provide greater control over cache configuration. The use of pass-through caching requires Coherence-specific changes to the client code and is therefore not intended for JCache applications that are concerned about portability.

In this example, two separate Java processes form the cluster: a cache server process and the `MyFirstJCacheSample` application process. For simplicity, the two processes are collocated on a single computer. The cache server, by default, is configured to store cache data. A Coherence `CacheFactory` is used to verify that the `MyFirstJCacheSample` application successfully created and loaded the cache on the cluster.

1. **Modify the Sample JCache Application**

2. **Define the Sample Cache for JCache**
12.4.2.1 Modify the Sample JCache Application

The PassThroughCacheConfiguration class is an implementation-specific configuration that provides a JCache interface to a native Coherence cache. The configuration is used instead of the standard MutableConfiguration class.

To configure a cache as a pass-through cache:

1. Open the MyFirstJCacheSample class that you created from Example 12–1.
2. Modify the class to use a PassThroughCacheConfiguration configuration. For example:

   ```java
   ... 
   //set configuration for the cache
   PassThroughCacheConfiguration<String, String> config = new PassThroughCacheConfiguration();
   config.setTypes(String.class, String.class);

   //create and use the cache
   cacheManager.createCache("myCache", config);
   Cache<String, String> cache = cacheManager.getCache("myCache",
   String.class, String.class);
   ...
   ``
3. Save the file.

12.4.2.2 Define the Sample Cache for JCache

For this example, a cache configuration is created that defines a distributed cache that is explicitly mapped to the myCache name.

In the Eclipse environment, the cache configuration for an application which uses the JCache APIs must be stored in the coherence-jcache-cache-config.xml file.

To define the example cache:

1. Obtain the coherence-jcache-cache-config.xml file by using your favorite file compression utility to extract it from the coherence-jcache.jar file. Extract the file to the JCache\appClientModule folder.
2. Right-click the JCache project in the Project Explorer and select Refresh. The coherence-jcache-cache-config.xml file should appear in the list of files under the JCache\appClientModule folder.
3. Double-click the coherence-jcache-cache-config.xml file to open it in the editor.

   Notice that in addition to the namespaces for the XML schema instance and the Coherence cache configuration, the file also contains the definition for the namespace for the JCache namespace (illustrated in bold).

   ```xml
   <cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
     xmlns:jcache="com.tangosol.coherence.jcache.JCacheNamespace"
     xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config coherence-cache-config.xsd">
   ... 
   ```
4. Copy the following distributed cache definition to the file:

   ```xml
   <cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
     xmlns:jcache="com.tangosol.coherence.jcache.JCacheNamespace"
     ... 
   ```
Running a JCache Application in a Cluster

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```xml
<xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>myCache</cache-name>
      <scheme-name>distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <distributed-scheme>
      <scheme-name>distributed</scheme-name>
      <service-name>DistributedCache</service-name>
      <backing-map-scheme>
        <local-scheme/>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

5. Save and close the file.

12.4.3 Start the Example Cache Server

Create a run configuration for the Coherence default cache server.

1. Right click the JCache project in the Eclipse IDE. Select Run As then Run Configurations. In the Run Configurations dialog box, select Oracle Coherence then the New launch configuration icon. Enter DefaultCacheServer as the name for the cache server configuration.

2. Under Project, click Browse and select the name of the JCache project from the Project Selection dialog box.

3. Under Main class, select the Include system libraries when searching for a main class checkbox. Click the Search button and enter DefaultCacheServer in the Select Main Type dialog box. Select com.tangosol.net.DefaultCacheServer and click OK. Click Apply.

4. In the Coherence tab, select the General tab. Click the Browse icon to navigate to the cache configuration file coherence-jcache-cache-config.xml. Select local storage to be Enabled (cache server). Enter a unique value, such as 3155 for the Cluster port. Click Apply.

5. Open the Arguments tab. Enter -showversion in the VM Arguments field. Click Apply.

6. Open the Classpath tab of the dialog box. Click Advanced, then Add Folders to add the JCache\appClientModule folder (which contains the tangosol-coherence-override.xml override file that you configured in Section 12.4.1, "Configure an Example Cluster") to the Bootstrap Entries section of the classpath. Use the Up and Down buttons to position appClientModule before the CoherenceJCache and Coherence12.1.3 libraries. This is because the compiler must encounter the tangosol-coherence-override.xml override file before the coherence.jar library. The Classpath tab should look similar to Figure 12–4.
7. Open the Common tab of the dialog box. Click the Shared file radio button and click Browse to navigate to the project. Click Apply.

8. Click Run to start the cache server. The cache server should start and display output similar to Example 12–3.

**Example 12–3  Output of the DefaultCacheServer**

```
java version '1.7.0_25'
Java(TM) SE Runtime Environment (build 1.7.0_25-b17)
Java HotSpot(TM) 64-Bit Server VM (build 23.25-b01, mixed mode)
...
2014-02-24 15:44:27.381/0.615 Oracle Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Loaded operational overrides from
"file:/C:/home/oracle/workspace/JCache/appClientModule/tangosol-coherence-
override.xml"
...
2014-02-24 15:44:27.710/0.944 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main,
member=n/a): Loaded cache configuration from
"file:/C:/home/oracle/workspace/JCache/appClientModule/coherence-jcache-cache-
config.xml"
...
2014-02-24 15:44:34.557/7.791 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=DistributedCache, member=1): Service DistributedCache joined the cluster
with senior service member 1
2014-02-24 15:44:34.598/7.832 Oracle Coherence GE 12.1.3.0.0 <Info> (thread=main,
member=1):
Services
  ClusterService(Name=Cluster, State=(SERVICE_STARTED, STATE_JOINED), Id=0,
  Version=12.1.3, OldestMemberId=1)
  InvocationService(Name=Management, State=(SERVICE_STARTED), Id=2, Version=12.1.
  3, OldestMemberId=1)
  PartitionedCache(Name=DistributedCache, State=(SERVICE_STARTED),
  LocalStorage=enabled, PartitionCount=257, BackupCount=1, AssignedPartitions=0,
  BackupPartitions=0, CoordinatorId=1)
}
Started DefaultCacheServer...
...
```

**12.4.4 Run the Application**

To create a run configuration for the `MyFirstJCacheSample` class:
1. Right-click the JCache project in the Eclipse IDE. Select Run As then Run Configurations. In the Run Configurations dialog box, select Oracle Coherence then the New launch configuration icon. Enter MyFirstJCacheSample as the name for the cache server configuration. Ensure that JCache appears in the Project field and com.oracle.handson.MyFirstJCacheSample appears in the Main class field. Click Apply.

2. In the Coherence tab, navigate to the coherence-jcache-cache-config.xml JCache cache configuration file in the Cache configuration descriptor field. Select Disabled (cache client) in the Local storage field. Enter a unique value such as 3155 in the Cluster port field.

   **Note:** The value for the Cluster port must match the value you provided for the <port> attribute in the tangosol-coherence-override.xml file.

3. In the Arguments tab, enter the -Dtangosol.coherence.jcache.configuration. uri system property in the VM arguments field to specify the path to the JCache cache configuration file coherence-jcache-cache-config.xml. For example:

   
   ```
   -Dtangosol.coherence.jcache.configuration.
   uri=C:\home\oracle\workspace\JCache\appClientModule\coherence-jcache-cache-config.xml
   ```

4. Open the Classpath tab of the dialog box. Click Advanced, then Add Folders to add the JCache\appClientModule folder (which contains the tangosol-coherence-override.xml override file that you configured in Section 12.4.1, "Configure an Example Cluster") to the Bootstrap Entries section of the classpath. Use the Up and Down buttons to position appClientModule before the CoherenceJCache and Coherence12.1.3 libraries. This is because the Coherence compiler must encounter the tangosol-coherence-override.xml override file before the coherence.jar library. The Classpath tab should look similar to Figure 12–4.

5. Open the Common tab of the dialog box. Click the Shared file radio button and click Browse to navigate to the JCache project. Click Apply.

6. Click Run to start the MyFirstJCacheSample application.

   Notice that the tangosol-coherence-override.xml and coherence-jcache-cache-config.xml files were loaded from the appClientModule folder. The application process connects to the cluster that contains the cache server process and both processes are running the DistributedCache service. The application places the value Gene Smith in the cache, prints it to standard output, then exits the cluster.

*Example 12-4  Output of the MyFirstJCacheSample Application*

```
2014-02-25 11:09:24.145/0.630 Oracle Oracle Coherence GE 12.1.3.0.0 <Info>
(thread=main, member=n/a): Loaded operational overrides from
"file:C:\home\oracle\workspace\JCache\appClientModule\tangosol-coherence-
override.xml"
```

```
2014-02-25 11:09:27.078/3.563 Oracle Coherence GE 12.1.3.0.0 <D5>
(thread=Invocation:Management, member=2): Service Management joined the cluster
with senior service member 1
```

...
12.4.5 Verify the Cache

The cache server in this example is configured, by default, to store the cache's data. The data is available to all members of the cluster and persists even after members leave the cluster. For example, the application exits after it loads and displays a key in the cache. However, the cache and key are still available for all cluster members.

To complete this step, you first save the application to an archive file, then place it on the classpath. You can then use the cache factory command-line tool to connect to the myCache cache and list all items in the cache.

- Create a JAR file for the Application
- Verify the Cache Contents Using a Cache Factory Instance

12.4.5.1 Create a JAR file for the Application

To create a JAR file for the MyFirstJCacheSample application:

1. In the Eclipse project Explorer, right-click the build folder under JCache project and select Export.
2. In the Select screen of the Export wizard, open the General node and select Archive File. Click Next.
3. In the Archive file screen of the Export Wizard, open the build node and navigate down to the handson node. Select the handson node in the left pane and select the MyFirstJCacheSample.class file in the right pane. Enter MyFirstJCacheSample.jar in the To archive file field, as illustrated in Figure 12–5.
12.4.5.2 Verify the Cache Contents Using a Cache Factory Instance

Start a cache factory instance to verify the contents of the cache.

To verify the cache:

1. Create a run configuration for the CacheFactory command line tool. Right click the JCache project in the Eclipse IDE. Select Run As then Run Configurations. In the Run Configurations dialog box, select Oracle Coherence then the New launch configuration icon. Enter CacheFactory as the name for the cache server configuration.

2. Under Project, click Browse and select the name of the JCache project from the Project Selection dialog box.

3. Under Main class, select the Include system libraries when searching for a main class checkbox. Click the Search button and enter CacheFactory in the Select Main Type dialog box. Select com.tangosol.net.CacheFactory and click OK. Click Apply.

4. In the Coherence tab navigate to the coherence-jcache-cache-config.xml file in the Cache configuration descriptor field. Select Disabled (cache client) in the Local storage field. Enter a unique value such as 3155 in the Cluster port field.

5. Open the Classpath tab of the dialog box. Click Advanced, then Add External Jars to add the MyFirstJCacheSample.jar file to the User Entries section of the classpath. Use the Up and Down buttons to position MyFirstJCacheSample.jar file before the JCache project folder. The Classpath tab should look similar to Figure 12–6.

4. Click Finish to create the JAR file.
6. Open the Common tab of the dialog box. Click the Shared file radio button and click Browse to navigate to the JCache project. Click Apply.

7. Click Run to start the cache factory instance.

The cache factory instance starts and becomes a member of the cluster and returns a command prompt for the command-line tool. Use the cache command at the command-line tool command prompt to get the myCache cache, for example:

```
cache myCache
```

At the command-line tool command prompt, use the list command to retrieve the contents of the cache:

```
list
```

The command returns and displays:

```
Name = Gene Smith
```

Example 12–5 displays the output of the cache factory instance.

**Example 12–5  Output of the CacheFactory Instance**

...  
2014-02-24 15:58:26.240/0.610 Oracle Coherence GE 12.1.3.0.0 <Info>  
(thread=main, member=n/a): Loaded operational overrides from  
"file:/C:/home/oracle/workspace/JCache/build/classes/tangosol-coherence-override.xml"  
...  
2014-02-24 15:58:29.303/3.673 Oracle Coherence GE 12.1.3.0.0 <D5>  
(thread=Invocation:Management, member=7): Service Management joined the cluster  
with senior service member 1  
...  
Map (myCache): cache myCache  
2014-02-24 16:03:13.374/287.744 Oracle Coherence GE 12.1.3.0.0 <Info>  
(thread=main, member=7): Loaded cache configuration from  
"file:/C:/home/oracle/workspace/JCache/appClientModule/coherence-jcache-cache-config.xml"  
...  
Map (myCache): list  
Name = Gene Smith  
Map (myCache):  
...
This exercise describes how to cache session information for Web application instances that are deployed across WebLogic Server instances. It highlights the use of managed servers, which allows you to use Coherence data caches and seamlessly incorporate Coherence*Web for session management.

If you do not already have the current WebLogic Server release, you can get it at the following URL:


This chapter has the following sections:

- Introduction
- Caching Session Information for Web Application Instances
- Working with Custom Session Cache Configuration Files

**Introduction**

WebLogic Server includes features that enable deployed applications to use Coherence data caches and seamlessly incorporate Coherence*Web for session management and TopLink Grid as an object-to-relational persistence framework. Collectively, these features are referred to as Managed Coherence Servers.

**About Managed Coherence Servers**

Managed Coherence Servers are employed by applications running on WebLogic Server and provides replicated and distributed caching services that make an application's data available to all servers in a Coherence data cluster. Applications can obtain direct access to data caches either through resource injection or component-based JNDI lookup. You can display, monitor, create, and configure Coherence clusters using the WebLogic Server Administration Console and WLST.

Using Managed Coherence Servers with WebLogic Server instances enable you to create a data tier dedicated to caching application data and storing replicated session state. This is separate from the application tier, where the WebLogic Server instances are dedicated to running the application.

Using Coherence*Web with Managed Coherence Servers enables you to provide Coherence-based HTTP session state persistence to applications. Coherence*Web enables HTTP session sharing and management across different Web applications, domains, and heterogeneous application servers. Session data can be stored in data...
Caching Session Information for Web Application Instances

caches outside of the application server, thus freeing application server heap space and enabling server restarts without losing session data.

Coherence and Coherence*Web are included in the default installation of WebLogic Server. The Coherence and Coherence*Web libraries (coherence.jar and coherence-web.jar) are included in the system classpath of WebLogic Server. These libraries will load application classes with the appropriate classloader in WebLogic Server. This means that you do not have to include the coherence.jar or coherence-web.jar files in the web application’s classpath.

For more information on the integration of Oracle WebLogic Server, Coherence, and Coherence*Web, see Oracle Fusion Middleware Administering HTTP Session Management with Oracle Coherence*Web. For more information on Managed Coherence Servers, see Oracle Fusion Middleware Developing Oracle Coherence Applications for Oracle WebLogic Server.

About Coherence Clusters
Coherence clusters are different than WebLogic Server clusters. They use different clustering protocols and are configured separately. Multiple WebLogic Server clusters can be associated with a Coherence cluster and a WebLogic Server domain can contain only a single Coherence cluster. Managed servers that are configured as Coherence cluster members are referred to as managed Coherence servers.

**Note:** Using multiple Coherence clusters in a single WebLogic Server domain is not recommended.

Managed Coherence servers can be explicitly associated with a Coherence cluster or they can be associated with a WebLogic Server cluster that is associated with a Coherence cluster. Managed Coherence servers are typically setup in tiers based on their type: a data tier for storing data, an application tier for hosting applications, and a proxy tier for allowing access to external clients.

For more information on Coherence clusters in a WebLogic server environment, see "Configuring and Managing Coherence Clusters" in Administering Clusters for Oracle WebLogic Server.

Caching Session Information for Web Application Instances

The following example demonstrates how Managed Coherence Servers and Coherence*Web caches session information for Web application instances that are deployed across WebLogic Server instances. To do this, you will create a Web application and deploy it to two WebLogic Server instances that belong to a Coherence cluster. The application is a simple counter that stores the current count as a session attribute. Coherence*Web automatically serializes and replicates the attribute across both server instances. A browser is used to access each application instance to demonstrate that the same session attribute is used among the instances.

1. Configure and Start WebLogic Server
2. Create the WebLogic Servers
3. Create a Coherence Cluster
4. Enable a Server for Coherence*Web Local Storage
5. Create the Counter Web Application
6. Start the WebLogic Servers
7. Deploy the Application
8. Verify the Example

Configure and Start WebLogic Server

The following instructions assume that you have installed WebLogic Server in the default location: C:\Oracle\Middleware\Oracle_Home.

To configure and start WebLogic Server:

1. Run the Oracle WebLogic Configuration Wizard to create a new WebLogic Server domain.

2. In the Create Domain page, select the Create a new domain option. In the Domain location field, enter C:\Oracle\Middleware\Oracle_Home\user_projects\domains\test_domain as the domain name and location.

3. In the Templates page, ensure that the default Basic WebLogic Server Domain is selected.

4. In the Administrator Account page, enter a password for the domain.

5. In the Domain Mode and JDK and the Advanced Configuration pages, accept the defaults.

6. In the Configuration Summary page click Create.

7. In the final Configuration Success page, select the Start Admin Server check box and click Done. The Configuration Wizard automatically starts the Administration Server.

8. Start the WebLogic Server Administration Console.

   From the browser, log in to the Oracle WebLogic Server Administration Console using the following URL: http://hostname:7001/console. The Console starts and the domain home page displays.

Create a Machine

To create a Machine on which to host WebLogic Server instances:

From the Domain Structure window, select Environment and then Machines. Click New. The Create a New Machine page displays. Enter a name for the Machine (in this case, Test) and click Next. Click Finish on the following page. Figure 13–1 illustrates the Create a New Machine page.
The **Summary of Machines** page should look similar to **Figure 13–2**.
Create the WebLogic Servers

Create two WebLogic server instances associated with the machine. One will be Coherence*Web storage-enabled, the other will be Coherence*Web storage-disabled. The application will be deployed to these servers in a later step.

To create server instances:

1. Click the name of the Machine in the Summary of Machines page to open the Settings for machine page. Click the Servers tab and then click Add to create a server.

2. Select Create a new server and associate it with this machine in the Add a Server to Machine page, and click Next.

3. Provide details about the server in the Create a New Server page.

   Enter ServerA as the Server Name and 8081 as the Server Listen Port. Ensure that No, this is a stand-alone server is selected, as illustrated in Figure 13–3. Click Finish.
4. When you are returned to the Settings for machine page, click Add, and repeat the previous step to create a second server.

Enter ServerB as the Server Name and 8082 as the Server Listen Port. Ensure that No, this is a stand-alone server is selected. Click Finish.

5. Click Servers in the Domain Structure. The Summary of Servers page displays and is similar to Figure 13–4.
Create a Coherence Cluster

A Coherence cluster is a group of Coherence members that share a group address which allows them to communicate. Coherence clusters consist of members formed by applications, modules, or application servers (WebLogic Server instances or cache servers). In this step you create a Coherence cluster and assign the two WebLogic Server instances to it.

To create a Coherence cluster:

1. Click Environment in the domain Structure Window and then click Coherence Clusters. In the Summary of Coherence Clusters page, click New. In the Coherence Cluster Properties page of the Create Coherence Cluster Configuration wizard, enter CoherenceCluster in the Name field, then click Next.

   Figure 13–5 illustrates the Create Coherence Cluster Configuration page.
2. Enter a value such as 8085, in the **Unicast Listen Port** field. Do not change any of the other values and click **Next**.

3. In the **Coherence Cluster Members** page of the Create Coherence Cluster Configuration wizard, select **ServerA** and **ServerB** as the targets. Do not select **AdminServer**. Click **Finish**.
The **Summary of Coherence Clusters** page looks similar to Figure 13–8.

---

**Enable a Server for Coherence*Web Local Storage**

One of the WebLogic servers must be enabled for Coherence*Web local storage. In this step, Coherence*Web local storage will be enabled for **ServerB**.

1. Click **Servers** in the **Domain Structure** tree to open the Summary of Servers.
2. Click ServerB.

3. In Settings for ServerB, click the Configuration tab, then the Coherence tab.

4. Select the Coherence*Web Local Storage Enabled checkbox, as illustrated in Figure 13–9.

5. Click Save.

Figure 13–9  Enabling a Server for Coherence*Web Local Storage

Create the Counter Web Application

The Counter web application is a simple counter implemented as a JSP. The counter is stored as an HTTP session attribute and increments each time the page is accessed.

To create the Counter web application:

1. Create a standard web application folder as follows:

```
/WEB-INF
```

2. Copy the following code to a text file and save it as a file named web.xml in the /WEB-INF folder.
3. Create a weblogic.xml file in the /WEB-INF folder.
   - Reference coherence-web as the persistent store type for the session descriptor.
   - Reference the Coherence cluster in a coherence-cluster-ref stanza.
   Example 13–1 illustrates a sample weblogic.xml file.

   **Example 13–1  Sample weblogic.xml File**

   ```xml
   <weblogic-web-app>
   <session-descriptor>
     <persistent-store-type>coherence-web</persistent-store-type>
   </session-descriptor>
   <coherence-cluster-ref>
     <coherence-cluster-name>CoherenceCluster</coherence-cluster-name>
   </coherence-cluster-ref>
   </weblogic-web-app>
   ``

4. Create a lib subfolder in the WEB-INF folder. Leave it empty.

5. Copy the following code for the counter JSP to a text file and save the file as counter.jsp in the root of the Web application folder.

   ```html
   <html>
   <body>
   <h3>
   Counter :
   <%
   Integer counter = new Integer(1);
   HttpSession httpsession = request.getSession(true);
   if (httpsession.isNew()) {
     httpsession.setAttribute("count", counter);
     out.println(counter);
   } else {
     int count = ((Integer) httpsession.getAttribute("count")).intValue();
     httpsession.setAttribute("count", new Integer(++count));
     out.println(count);
   }
   %>
   </h3>
   </body>
   </html>
   ``


   **Example 13–2  Sample MANIFEST.MF File**

   ```
   Manifest-Version: 1.0
   ```
7. The structure of the web application folder should appear as follows:

```
/counter.jsp
/META-INF/MANIFEST.MF
/WEB-INF/lib/
/WEB-INF/web.xml
/WEB-INF/weblogic.xml
```

8. ZIP or JAR the Web application folder and save the file as `counter.war`.

## Start the WebLogic Servers

Start the managed WebLogic Servers ServerA and ServerB. Because of the tight integration between WebLogic and Coherence, the cache server will start with the managed servers. The managed servers can be started from the command line or from the WebLogic Server Administration Console.

- To Start the WebLogic Servers from the Command Line
- To Start the WebLogic Servers from the WebLogic Server Administration Console

### To Start the WebLogic Servers from the Command Line

The following instructions are for starting the servers from the command line.

1. Open a command prompt from the domain’s bin folder. This example assumes that the bin folder is located in `c:\Oracle\user_projects\domains\base_domain\bin`.

2. Enter the following command to start ServerA:
   
   ```
   startManagedWebLogic.cmd ServerA
   ```
   
   Enter the server’s user name and password when prompted.

3. Open a second command prompt from the domain’s bin folder.

4. Enter the following command to start ServerB:
   
   ```
   startManagedWebLogic.cmd ServerB
   ```
   
   Enter the server’s user name and password when prompted.

When the servers are running, you should see the response similar to Figure 13–10 in the Summary of Servers page in the WebLogic Server Administration Console.
To Start the WebLogic Servers from the WebLogic Server Administration Console

To start WebLogic Servers from the WebLogic Server Administration Console, see "Start Managed Servers from the Administration Console" in the Oracle WebLogic Server Administration Console Online Help.

When the servers are running, you should see the response similar to Figure 13–10 in the Summary of Servers page in the WebLogic Server Administration Console.

Deploy the Application

Deploy the counter.war application to the running managed servers.

To deploy the counter.war application:

1. Open the Summary of Deployments page by clicking Deployments in the Domain Structure menu in the Oracle WebLogic Server Administration Console.
2. Click Install. The Install Application Assistant wizard opens.
3. Navigate to the location of the counter.war file, as illustrated in Figure 13–11. Click Next.
4. Select **Install this deployment as an application** as illustrated in Figure 13–12. Click Next.

5. Target the deployment to **ServerA** and **ServerB**, as illustrated in Figure 13–13.
6. In the Optional Settings page, accept the defaults, as illustrated in Figure 13–14. Click Finish.
The `counter.war` file appears in the table in the Summary of Deployments page. The table indicates that the application is active and running (since the servers are running) on ServerA and ServerB, as illustrated in Figure 13–15.
Verify the Example

To verify the example:

1. Open a browser and access the ServerA counter instance using the following URL:

   http://host:8081/counter/counter.jsp

   The counter page displays and the counter is set to 1 as illustrated in Figure 13–16.

   **Figure 13–16  Counter Page with Counter Set to 1**

2. In a new browser (or new browser tab), access the ServerB counter instance using the following URL:

   http://host:8082/counter/counter.jsp

   The counter page displays and the counter increments to 2 based on the session data as illustrated in Figure 13–17.
If you refresh the page, the counter increments to 3. Return to the original browser (or browser tab), refresh the instance, and the counter displays 4.

**Working with Custom Session Cache Configuration Files**

If you want to use a custom session cache configuration file, you must package it with your application. It must also be stored in a Grid Archive (GAR) file and deployed to the WebLogic Server cluster that is to act as the storage-enabled Coherence cluster members. A detailed discussion of working with custom session cache configuration files is beyond the scope of this document. For more information on creating and deploying a custom session cache configuration file, see "Using a Custom Session Cache Configuration File" in *Oracle Fusion Middleware Administering HTTP Session Management with Oracle Coherence*Web.
The Coherence distribution provides a collection of example code in the `examples.zip` file. These examples demonstrate how to use basic Coherence functionality, security, and events features in all supported languages (Java, .NET, and C++). The examples are organized as collections of code that show how to use one or more features. They also provide a single common way (per language) to build and run all examples.

This appendix has the following sections:

- Examples Provided in the `examples.zip` File
- Obtaining the `examples.zip` File
- How to Build the Examples
- How to Run the Examples
- Coherence Basic Features Examples
- Coherence Security Examples
- Coherence Live Events Examples

There are a number of differences between the examples in the `examples.zip` file described in this appendix and the examples that are presented in the main body of the tutorial:

- The examples in the `examples.zip` file must be built and run from the command line. The tutorial uses an IDE to compile and run the code.
- The examples in the `examples.zip` file demonstrate how to use basic Coherence functionality and security features in all supported languages (Java, .NET, and C++). The tutorial covers only Java implementations.
- The Java examples in the `examples.zip` file are only a subset of the Java examples presented in the tutorial.
- The Java code files in the `examples.zip` file are similar, but not identical to, the files used in the tutorial. In many instances, the code in the tutorial has been simplified for demonstration purposes.

## A.1 Examples Provided in the `examples.zip` File

The Coherence Basic Features Examples include the following:
## Coherence Basic Features Examples

<table>
<thead>
<tr>
<th>Example Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Data Access</td>
<td>&quot;Getting&quot;, &quot;putting&quot; and &quot;removing&quot; data from the Coherence Data Grid. See Section A.5.3, &quot;Basic Data Access Example.&quot;</td>
</tr>
<tr>
<td>Data Loading</td>
<td>Loading example data into the Coherence Data Grid. See Section A.5.4, &quot;Loader Example.&quot;</td>
</tr>
<tr>
<td>Parallel Querying</td>
<td>Querying the Coherence Data Grid including the use of indexes. See Section A.5.5, &quot;Query Example.&quot;</td>
</tr>
<tr>
<td>Observable</td>
<td>Listening for changes to data in the Coherence Data Grid. See Section A.5.6, &quot;Observer Example.&quot;</td>
</tr>
<tr>
<td>Processing</td>
<td>Co-locating data processing with the data itself in the Coherence Data Grid. See Section A.5.7, &quot;Processor Example.&quot;</td>
</tr>
<tr>
<td>Query Language</td>
<td>How to use the Coherence Query Language. See Section A.5.5, &quot;Query Example.&quot;</td>
</tr>
</tbody>
</table>

The Coherence Security Examples include the following:

## Coherence Security Examples

<table>
<thead>
<tr>
<th>Example Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password Example</td>
<td>Requiring a password to access Coherence. See Section A.6.2, &quot;Password Example.&quot;</td>
</tr>
<tr>
<td>Access Control Example</td>
<td>Simplified role based access control. See Section A.6.3, &quot;Access Control Example.&quot;</td>
</tr>
<tr>
<td>Password Identity Transformer</td>
<td>Creates a custom security token that contains the required password and then adds a list of Principal names. See Section A.6.4, &quot;Password Identity Transformer.&quot;</td>
</tr>
<tr>
<td>Password Identity Asserter</td>
<td>Asserts that the security token contains the required password and then constructs a Subject based on a list of Principal names. See Section A.6.5, &quot;Password Identity Asserter.&quot;</td>
</tr>
<tr>
<td>Entitled Cache Service</td>
<td>Wraps a cache service for access control. See Section A.6.6, &quot;Entitled Cache Service.&quot;</td>
</tr>
<tr>
<td>Entitled Invocation Service</td>
<td>Wraps an invocation service for access control. See Section A.6.7, &quot;Entitled Invocation Service.&quot;</td>
</tr>
<tr>
<td>Entitled Named Cache</td>
<td>Wraps a named cache for access control. See Section A.6.8, &quot;Entitled Named Cache.&quot;</td>
</tr>
</tbody>
</table>

The Coherence Live Events Examples are available for the Java platform only. They include the following:

## Coherence Live Events Examples

<table>
<thead>
<tr>
<th>Example Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EventsExamples</td>
<td>Illustrates various features within Live Events, such as providing mean elapsed times split by event type, the different semantics in throwing exceptions in pre-events compared to post-events, and logging of partition movement when enabled. See Section A.7.2, &quot;EventsExamples.&quot;</td>
</tr>
<tr>
<td>TimedTraceInterceptor</td>
<td>Provides timings between pre- and post-commit events for different types of events. See Section A.7.3, &quot;TimedTraceInterceptor.&quot;</td>
</tr>
</tbody>
</table>
A.2 Obtaining the examples.zip File

You can obtain the examples.zip file by performing a full Coherence installation with the coherence_version.jar or wls_version.jar installer file. The Coherence examples appear as an installation option in the Oracle Universal Installer.

If you have already installed Coherence but without the examples, you can obtain the examples.zip file by running the coherence_quick_supp_version.jar supplemental installer file. The supplemental installer contains only API documentation and examples.

Note that the coherence_quick_version.jar quick installer file does not install the examples or API documentation.

Unzip the contents of the examples.zip file into an examples directory.

A.3 How to Build the Examples

Note: You must build and run the Java example even for .NET and C++. This is because the cache server runs in Java.

This section contains the following information:

- How to Build the Java Examples
- How to Build the .NET Examples
- How to Build the C++ Examples

A.3.1 How to Build the Java Examples

This section contains the following information:

- Prerequisites for Java
- Directory Structure for Java
- Build Instructions for Java
A.3.1.1 Prerequisites for Java
To build the example, you must have Coherence version 3.7 or later and a Java development kit (JDK) 1.6 or later. Ensure that the following environment variables are set.

<table>
<thead>
<tr>
<th>Environment Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$COHERENCE_HOME</td>
<td>Make sure that the COHERENCE_HOME environment variable points to the location of the unpacked Coherence 3.7 directory.</td>
</tr>
<tr>
<td>$JAVA_HOME</td>
<td>Make sure that the JAVA_HOME environment variable points to the location of a 1.6 or greater JDK before building the example. A Java runtime 1.6 or greater is needed to run the example.</td>
</tr>
</tbody>
</table>

A.3.1.2 Directory Structure for Java
The directory structure described below is relative to the examples directory.

<table>
<thead>
<tr>
<th>Table A–4 Directory Structure for Java</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directory Name</strong></td>
</tr>
<tr>
<td>java/bin</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>java/src</td>
</tr>
<tr>
<td>java/classes</td>
</tr>
<tr>
<td>java/resource/config</td>
</tr>
<tr>
<td>java/resource/&lt;example name&gt;</td>
</tr>
<tr>
<td>$COHERENCE_HOME/lib</td>
</tr>
</tbody>
</table>

A.3.1.3 Build Instructions for Java
Execute the build script with the name of the example collection, for example: bin/build contacts, bin/build security, or bin/build events.

The script will build the POF package files and then the files for the particular example. On Windows, change directories to the /bin directory then run the scripts.

A.3.2 How to Build the .NET Examples
This section contains the following information:
- Prerequisites for .NET
- Directory Structure for .NET
- Build Instructions for .NET
A.3.2.1 Prerequisites for .NET
To build the example, you must have Coherence version 3.7 or later for .NET and Visual Studio 2008 or later or Visual Studio 2008 Express or later.

To run the example, you will need the Java version of Coherence 3.7 or later and a Java development kit (JDK) 1.6 or greater. The Java version is required because the Coherence*Extend proxy and cache servers require Java. Also, the examples depend on Java example classes that must be built before running the proxy and cache server. See the Java example readme.txt file for instructions on how to build and run. Note that the Java run-proxy script must be executed; the Java run-cache-server is optional because the proxy is storage enabled.

A.3.2.2 Directory Structure for .NET
The directory structure described below is relative to the examples directory.

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dotnet\src</td>
<td>All example source. The examples are in the Tangosol.Examples.&lt;example name&gt; namespace. The classes for objects stored in the cache are in the Tangosol.Examples.Pof namespace. The examples are in the Visual Studio 2008 examples solution. Each example has its own Visual Studio 2008 project in the src directory. For example, src contains projects for the contacts and security examples. The Coherence configuration files required by the example.</td>
</tr>
<tr>
<td>src\pof\config</td>
<td>The common Coherence configuration files required by the examples.</td>
</tr>
<tr>
<td>src&lt;example name&gt;\config</td>
<td>If an example has configuration that is required instead of the common configuration, it will have its own directory. The security example uses configuration files from security\config.</td>
</tr>
</tbody>
</table>

A.3.2.3 Build Instructions for .NET
Open the examples project from the examples\dotnet\src\contacts.csproj directory with Visual Studio.

When installing Coherence 3.7 for the .NET Framework, the installer registers the coherence.dll library with the assembly registry. The included Visual Studio projects have a reference to coherence.dll in the default location. If another version of the library is desired, or it was not installed in the default location, the Coherence reference can be overridden when configuring the reference, be sure to set the local copy attribute to true. This setting will copy and register the correct coherence.dll in the bin\debug directory.

After the desired Coherence 3.7 for .NET is configured, in Visual Studio select Build then Build Solution from the menu, Build Solution (F6), etc., to build the solution.

The build for the contacts example will copy resource\contacts.csv to the build output directory (examples\dotnet\src\bin\Debug).

A.3.3 How to Build the C++ Examples
This section contains the following information:

- Prerequisites for C++
How to Build the Examples

- Directory Structure for C++
- Build Instructions for C++

A.3.3.1 Prerequisites for C++
To run the examples, you will need the Java version of Coherence 3.7 or later and a Java development kit (JDK) 1.6 or greater. The Java version is required because the Coherence*Extend proxy and cache servers require Java. Also, the examples depend on Java example classes that must be built before running the proxy and cache server. See the Java examples readme.txt for instructions on how to build and run. Note that the Java run-proxy script must be executed; the Java run-cache-server is optional because the proxy is storage enabled.

Ensure that the following environment variables are set:

<table>
<thead>
<tr>
<th>Environment Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>%COHERENCE_HOME%</td>
<td>Make sure that the COHERENCE_HOME environment variable points to the location of the unpacked Coherence 3.7 (or later) directory.</td>
</tr>
<tr>
<td>%JAVA_HOME%</td>
<td>Make sure that the JAVA_HOME environment variable points to the location of a 1.6 or greater JDK before building the examples. A Java runtime 1.6 or greater is needed to run the examples.</td>
</tr>
<tr>
<td>%COHERENCE_CPP_HOME%</td>
<td>Make sure that the COHERENCE_CPP_HOME environment variable points to the location of the unpacked C++ development environment. Compiler environments supported.</td>
</tr>
</tbody>
</table>

A.3.3.2 Directory Structure for C++
The directory structure described below is relative to the examples directory.

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cpp\bin</td>
<td>Scripts for building and executing the examples. Scripts with no file extension are bash scripts. Scripts with a .cmd file extension are Windows command scripts. The following description refers to the script names without specifying any file extension.</td>
</tr>
<tr>
<td>cpp</td>
<td>All example source organized under the &lt;example name&gt; (such as contacts and security) and pof directories.</td>
</tr>
<tr>
<td>cpp\contacts</td>
<td>The contacts example source. The examples are in the coherence::examples namespace. The next level of the name after examples represents a related set of example classes. &quot;Driver&quot; in coherence::examples::LoaderExample is the Loader for the contacts example. In other words, the name of the example is the name after coherence::examples.</td>
</tr>
<tr>
<td>cpp\security</td>
<td>The security example source. The examples are in the coherence::examples namespace.</td>
</tr>
<tr>
<td>cpp\pof</td>
<td>The data model is represented in this directory plus any classes that are serialized. The rationale is to show how to utilize an already existing data model and expose it in Coherence. The model classes do not contain any Coherence-specific code to prove this point. However, there is a serializer that is associated with each model type. For example the Contact has a ContactSerializer class whose purpose is to register the model type with Coherence and serialization operations. The generated output will be in the form of a dynamic library.</td>
</tr>
</tbody>
</table>
A.3.3.3 Build Instructions for C++

This section contains the following information:

- **Build Instructions for C++ on Windows**
- **Build Instructions for C++ on Linux/Mac and Solaris**

### Build Instructions for C++ on Windows

Open a development environment command prompt. This should have been installed with Visual Studio or the platform SDK. Go to the C++ examples directory and type `bin\build.cmd <example name>`. This will build both the `pof` (model) and the example executable. For example, `bin\build.cmd contacts` or `bin\build.cmd security`.

The model will put the `pof.lib` and `pof.dll` file under `cpp\pof\out`. These are needed for building and running the contacts and security examples.

The executable `contacts.exe` will be generated in `cpp\contacts\out` directory. The executable `security.exe` will be generated in `cpp\security\out` directory.

To run the contacts example, type `bin\run.cmd contacts` after starting a proxy server, `java\bin\run-proxy`, and an additional cache server `java\bin\run-cache-server`.

As an alternative, in any command window you can `cd` to the C++ bin directory and run `vcvars32.bat` before trying to build the examples. With a default install of Visual Studio, the bin directory is `C:\Program Files\Microsoft Visual Studio 9.0\vc\bin`. Follow the previous instructions for running the build script.

### Build Instructions for C++ on Linux/Mac and Solaris

Open a command shell. Go to the C++ examples directory and type `bin/build <example name>`. This will build both the `pof` (model) and the contacts examples executable.

The model dynamic library and `lib` file will be put in `cpp/pof/out`. These are needed for building and running the contacts and security examples.

The executable `contacts` will be generated in `cpp/contacts/out` or `cpp/security/out`.

---

**Table A-6 (Cont.) Directory Structure for C++**

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>cpp\config</code></td>
<td>The common Coherence configuration files required by the examples.</td>
</tr>
<tr>
<td><code>cpp\config\&lt;example name&gt;</code></td>
<td>If an example has configuration that is required instead of the common configuration, it will have its own directory. The security example uses configuration files from <code>config/security</code>.</td>
</tr>
<tr>
<td><code>cpp\&lt;example name&gt;\out</code></td>
<td>The object files output from a build. This directory will not exist until the build script is executed.</td>
</tr>
<tr>
<td><code>%COHERENCE_CPP_HOME%\include</code></td>
<td>Contains the Coherence header files.</td>
</tr>
<tr>
<td><code>%COHERENCE_CPP_HOME%\lib</code></td>
<td>Contains the Coherence library.</td>
</tr>
</tbody>
</table>
A.4 How to Run the Examples

**Note:** The Coherence examples are distributed as source, so they must first be built. See Section A.3, "How to Build the Examples."

This section contains the following information:

- How to Run the Java Examples
- How to Run the .NET Examples
- How to Run the C++ Examples

A.4.1 How to Run the Java Examples

This section contains the following information:

- Prerequisites for Java
- Directory Structure for Java
- Instructions for Java

A.4.1.1 Prerequisites for Java

To run the examples, you must have Coherence version 3.7 and a Java development kit (JDK) 1.6 or greater.

**Environment Variable** | **Description**
---|---
$COHERENCE_HOME | Make sure that the COHERENCE_HOME environment variable points to the location of the unpacked Coherence 3.7 directory.
$JAVA_HOME | Make sure that the JAVA_HOME environment variable points to the location of a 1.6 or greater JDK before building the examples. A Java runtime 1.6 or greater is needed to run the examples.

A.4.1.2 Directory Structure for Java

The directory structure described below is relative to the examples directory, the directory into which the examples were unzipped.

**Table A–7 Directory Structure for Java**

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>java/bin</td>
<td>Scripts for building and executing examples. There are two sets of scripts. Scripts with no file extension are bash scripts. Scripts with a .cmd file extension are Windows command scripts. The following description refers to the script names without specifying any file extension.</td>
</tr>
<tr>
<td></td>
<td>run—Runs an example collection</td>
</tr>
<tr>
<td></td>
<td>run-cache-server—Runs the cache server used for examples</td>
</tr>
<tr>
<td></td>
<td>run-proxy—Runs a proxy node. Optional for some Java examples; required for .NET and C++. This can only be done after the example has been built</td>
</tr>
<tr>
<td>java/classes</td>
<td>The class files output from a build. This directory will not exist until the build script is executed.</td>
</tr>
</tbody>
</table>
A.4.1.3 Instructions for Java

Execute the run script. There are two parts to running the example.

contacts example
1. Start one or more cache servers: bin/run-cache-server. Each execution will start a cache server cluster node. To add additional nodes, execute the command in a new command shell.

2. In a new command shell, run with the name of the example: bin/run contacts. The Driver.main method will run through the features of the example with output going to the command window (stdout).

Starting with Coherence 3.7, an example of the new Query Language feature was added. This example shows how to configure and use a simple helper class FilterFactory using the Coherence InvocationService.

security example
The security example requires Coherence*Extend, which uses a proxy.

1. Start a proxy: bin/run-proxy security.

   Optionally, start one or more cache servers as described in the contacts example. The proxy is storage-enabled, so it will act as both a proxy and a cache server node.

2. In a new command shell, run with the name of the example: bin/run security. The Driver.main method will run through the features of the example with output going to the command window (stdout).

events example
1. Start one or more cache servers: bin/run-cache-server. Each execution will start a cache server cluster node. To add additional nodes, execute the command in a new command shell.

2. In a new command shell, run with the name of the example: bin/run events. The Driver.main method will run through the features of the example with output going to the command window (stdout).

A.4.2 How to Run the .NET Examples

This section contains the following information:

- Prerequisites for .NET
How to Run the Examples

- Directory Structure for .NET
- Instructions for .NET

A.4.2.1 Prerequisites for .NET
To run the examples, you must have Coherence version 3.7 or later for .NET and Visual Studio 2008 or later. To run the examples, you will also need to build the Java examples. The Java version is required because the Coherence*Extend proxy and cache servers require Java.

Also, the examples depend on Java example classes that must be built before running the proxy and cache server.

A.4.2.2 Directory Structure for .NET
The directory structure described below is relative to the "examples" directory.

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>resource</td>
<td>The data file used for the contacts LoaderExample: contacts.csv.</td>
</tr>
</tbody>
</table>

A.4.2.3 Instructions for .NET
The following sections contain instructions for running the contacts and security examples.

contacts
1. Following the Java instructions, start a proxy server (run-proxy) and zero or more cache servers (run-cache-server).
2. From Visual Studio, start the contacts project without debugging or execute the contacts.exe produced from the build in a command shell. The Driver.Main method will run through the features of the example with the output going to the command window (stdout).

Starting with Coherence 3.7, a new example of the new Query Language feature was integrated. This example shows how configure and use a simple helper class "FilterFactory" using the Coherence InvocationService.

security
1. Following the java readme.txt instructions, start a proxy server (java/bin/run-proxy security) and zero or more cache servers.
2. From Visual Studio, start the security project without debugging or execute the contacts.exe produced from the build in a command shell. The Driver.Main method will run through the features of the example with the output going to the command window (stdout).

A.4.3 How to Run the C++ Examples
This section contains the following information:
- Prerequisites for C++
- Directory Structure for C++
- Instructions for C++
A.4.3.1 Prerequisites for C++

To build the examples, you must have the appropriate C++ library of Coherence version 3.7. Also you must have a C++ development environment. To run the examples, you will also need to build the Java examples. The Java version is required because the Coherence*Extend proxy and cache servers require Java. Also, the examples depend on Java example classes that must be built before running the proxy and cache server.

Environment Variable | Description
--- | ---
$COHERENCE_CPP_HOME | Make sure that the $COHERENCE_CPP_HOME environment variable points to the location of the unpacked Coherence 3.7 C++ installation (or later) directory.

The supported C++ compilers are:

- Windows — Microsoft Visual C++ Express/Studio 2008 or later or the equivalent Platform SDK.
- Linux — g++ 4.0
- Mac — g++ 4.0

A.4.3.2 Directory Structure for C++

The directory structure described below is relative to the examples directory.

<table>
<thead>
<tr>
<th>Directory Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cpp/bin</td>
<td>Scripts for building and executing the examples. Scripts with no file extension are bash scripts. Scripts with a .cmd file extension are Windows command scripts. The following description refers to the script names without specifying any file extension.</td>
</tr>
<tr>
<td></td>
<td>- run — Runs an example, requires that java/bin/run-proxy is started.</td>
</tr>
<tr>
<td>cpp</td>
<td>All example source organized under the contacts and model directories.</td>
</tr>
<tr>
<td>contact/out</td>
<td>The object files output from a build. This directory will not exist until the build script is executed.</td>
</tr>
<tr>
<td>resource</td>
<td>The data file used for the contacts LoaderExample: contacts.csv.</td>
</tr>
<tr>
<td>cpp/contacts</td>
<td>Contains the contacts example sources.</td>
</tr>
<tr>
<td>cpp/security</td>
<td>Contains the security example sources.</td>
</tr>
<tr>
<td>cpp/pof</td>
<td>Contains the datamodel sources and any classes that require serialization.</td>
</tr>
<tr>
<td>$COHERENCE_CPP_HOME/include</td>
<td>Contains the Coherence header files.</td>
</tr>
<tr>
<td>$COHERENCE_CPP_HOME/lib</td>
<td>Contains the Coherence library.</td>
</tr>
</tbody>
</table>

A.4.3.3 Instructions for C++

Execute the run scripts. There are two parts to running the example. From within new command shells:
contacts example
1. Start one proxy server: java/bin/run-proxy contacts.

   Optionally, start one or more cache servers: bin/run-cache-server. Each execution will start a cache server cluster node. To add additional nodes, execute the command in a new command shell.

2. In a new command shell, execute run with the name of the example:

   Running the contacts Example on Windows:
   Type bin\run.cmd contacts

   Running the contacts Example on Linux/Mac and Solaris:
   Type bin/run contacts

   The Driver.main method will run through the features of the example with output going to the command window (stdout).

Starting with Coherence 3.7, an example of the new Query Language feature was added. This example shows how to configure and use a simple helper class FilterFactory using the Coherence InvocationService.

security example
1. Start one proxy server: java/bin/run-proxy security.

   Optionally, start one or more cache servers: bin/run-cache-server. Each execution will start a cache server cluster node. To add additional nodes, execute the command in a new command shell.

2. In a new command shell, execute run with the name of the example:

   Running the security Example on Windows:
   Type bin\run.cmd security

   Running the security Example on Linux/Mac and Solaris:
   Type bin/run security

   The Driver.main method will run through the features of the example with output going to the command window (stdout).

A.5 Coherence Basic Features Examples

The Coherence basic features examples are a collection of examples that show how to use the basic features of Coherence using a simplified contact information tracker and includes:

■ Basic Data Access—"Getting", "putting" and "removing" data from the Coherence Data Grid. See Section A.5.3, "Basic Data Access Example."

■ Data Loading—Loading example data into the Coherence Data Grid. See Section A.5.4, "Loader Example."

■ Parallel Querying —Querying the Coherence Data Grid including the use of indexes. See Section A.5.5, "Query Example."

■ Observable—Listening for changes to data in the Coherence Data Grid. See Section A.5.6, "Observer Example."

■ Processing—Co-locating data processing with the data itself in the Coherence Data Grid. See Section A.5.7, "Processor Example."
Query Language—How to use the new 3.6 Coherence Query Language. See Section A.5.8, "Query Language."

This example set uses example data represented by these Data Model classes.

**Table A–10  Data Model Classes for the Features Examples**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Address information</td>
</tr>
<tr>
<td>Contact</td>
<td>Contact information (includes addresses and phone numbers)</td>
</tr>
<tr>
<td>ContactId</td>
<td>The key (contact name) to the contact information</td>
</tr>
<tr>
<td>PhoneNumber</td>
<td>Phone number</td>
</tr>
</tbody>
</table>

This example set also ships with a contacts.csv file which is a comma-delimited value file containing sample Contacts information.

### A.5.1 Running the Example Set

1. Review the following information:
   - Section A.3, "How to Build the Examples"
   - Section A.4, "How to Run the Examples"

2. Review the information on the Driver implementation found in Section A.5.2, "Understanding the Features Driver File."

### A.5.2 Understanding the Features Driver File

The Driver file has a static `main` method that executes all the Contacts examples in the following order:

1. LoaderExample
2. QueryExample
3. QueryLanguageExample
4. ObserverExample
5. BasicExample
6. ProcessorExample

The Driver file is implemented in each of the three programming languages supported by Coherence.

<table>
<thead>
<tr>
<th>Language</th>
<th>Implementation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Java</td>
<td>com.tangosol.examples.contacts.Driver in java/src</td>
</tr>
<tr>
<td>.NET</td>
<td>Driver in namespace Tangosol.Examples.Contacts in dotnet/src/contacts</td>
</tr>
<tr>
<td>C++</td>
<td>Driver in namespace coherence::examples in cpp/contacts</td>
</tr>
</tbody>
</table>

Please refer to this example set's examples.zip file for more details on each of the examples outlined below.
A.5.3 Basic Data Access Example

This example shows the most basic data access features of Coherence including getting, putting and removing data.

**Java**

Implementation Class: `com.tangosol.examples.contacts.BasicExample` in `java/src`

- Associate a ContactId with a Contact in the cache:
  ```java
  cache.put(contactId, contact);
  ```

- Retrieve the Contact associated with a ContactId from the cache:
  ```java
  contact = (Contact) cache.get(contactId);
  ```

- Remove mapping of ContactId to Contact from the cache:
  ```java
  cache.remove(contactId);
  ```

**.NET**

Implementation Class: `BasicExample` in namespace `Tangosol.Examples.Contacts` in `dotnet/src/contacts`

- Associate a ContactId with a Contact in the cache:
  ```csharp
  cache.Add(contactId, contact);
  ```

- Retrieve the Contact associated with a ContactId from the cache:
  ```csharp
  contact = (Contact)cache[contactId];
  ```

- Remove mapping of ContactId to Contact from the cache:
  ```csharp
  cache.Remove(contactId);
  ```

**C++**

Implementation Class: `BasicExample` in namespace `coherence::examples` in `cpp/contacts`

- Associate a ContactId with a Contact in the cache:
  ```cpp
  hCache->put(vContactId, vContact);
  ```

- Retrieve the Contact associated with a ContactId from the cache:
  ```cpp
  vContact = cast<Managed<Contact>::View>(hCache->get(vContactId));
  ```

- Remove mapping of ContactId to Contact from the cache:
  ```cpp
  hCache->remove(vContactId);
  ```

A.5.3.1 Example Output

The example output (due to "Observer Example"):

**Example A–1 Example Output of the Basic Data Access Example**

entry inserted:
John Nocyefgqo
Addresses
Home: 1500 Boylston St.
A.5.4 Loader Example

This example loads contacts into the cache from a file or stream. It demonstrates the most effective way of inserting data into a cache using bulk inserts. This will allow for minimizing the number of network roundtrips between the application and the cache.

Java
Implementation Class: com.tangosol.examples.contacts.LoaderExample in java/src

cache.putAll(mapBatch);

.NET
Implementation Class: LoaderExample in namespace Tangosol.Examples.Contacts in dotnet/src/contacts

cache.InsertAll(dictBatch);

C++
Implementation Class: LoaderExample in namespace coherence::examples in cpp/contacts

hCache->putAll(hMapBatch);

A.5.4.1 Example Output

Example A–2  Example Output of the LoaderExample

.........Added 10000 entries to cache

A.5.5 Query Example

QueryExample runs sample queries for contacts.
The purpose of this example is to show how to create Extractors on cache data and how to create a KeyExtractor for the cache keys. It also illustrates how to use the indexes to filter the dataset to efficiently create a matching set. Finally, the example demonstrates how to use some of the built-in cache aggregators to do simple computational tasks on the cache data. A subset of the code is shown below.

Java
Implementation Class: com.tangosol.examples.contacts.QueryExample in java/src

- Add an index to make queries more efficient.
  ```java
  cache.addIndex(new ChainedExtractor("getHomeAddress.getState"), /*fOrdered*/
  false, /*comparator*/ null);
  ```

- Find all contacts who live in Massachusetts.
  ```java
  Set setResults = cache.entrySet(new EqualsFilter("getHomeAddress.getState",
  "MA");
  ```

- Count contacts who are older than nAge for the entire cache dataset.
  ```java
  System.out.println("count > " + nAge + ": " + cache.aggregate(new
  GreaterFilter("getAge", nAge), new Count()));
  ```

.NET
Implementation Class: QueryExample in namespace Tangosol.Examples.Contacts in
dotnet/src/contacts

- Add an index to make queries more efficient.
  ```csharp
  cache.AddIndex(new ChainedExtractor("getHomeAddress.getState"),/*fOrdered*/
  false, /*comparator*/ null);
  ```

- Find all contacts who live in Massachusetts.
  ```csharp
  ICacheEntry[] aCacheEntry = cache.GetEntries(new
  EqualsFilter("getHomeAddress.getState", "MA");
  ```

- Count contacts who are older than nAge for the entire cache dataset.
  ```csharp
  Console.WriteLine("count > " + nAge + ": " + cache.Aggregate(new
  GreaterFilter("getAge", nAge), new
  Count()));
  ```

C++
Implementation Class: QueryExample in namespace coherence::examples in
cpp/contacts

- Add an index to make queries more efficient.
  ```cpp
  ValueExtractor::View vHomeStateExtractor = ChainedExtractor::create(
  ChainedExtractor::createExtractors("getHomeAddress.getState"));
  ```

- Find all contacts who live in Massachusetts.
  ```cpp
  Object::View voStateName = String::create("MA");
  Set::View setResults = hCache->entrySet(
  EqualsFilter::create(vHomeStateExtractor, voStateName));
  ```

- Count contacts who are older than nAge for the entire cache dataset.
  ```cpp
  Integer32::View nAge = Integer32::valueOf(58);
  ```
Object::View vResult = hCache->aggregate((Filter::View) GreaterFilter::create(vAgeExtractor, nAge, Count::create()));
std::cout << "count > " << nAge->getValue() << " : " << vResult << std::endl;

A.5.5.1 Example Output
The example output is large due to 10,000 contacts and several queries. A sample of the query for Massachusetts residents:

Example A–3  Example Output of the Query Example
MA Residents
ConverterEntry{Key="John Scqngqda", Value="John Scqngqda
Addresses
Home: 265 Beacon St.
Oaskxm, MA 88259
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover's Mill, OK 95744
US
Phone Numbers
work: +11 88 903 8991283
home: +11 98 553 5878221
Birth Date: 1960-01-03"}

A.5.6 Observer Example
ObserverExample demonstrates how to use a MapListener to monitor cache events such as when cache data has been inserted, updated, and removed. A subset of the code is shown below.

Java
Implementation Class: com.tangosol.examples.contacts.ObserverExample in java/src
- ContactChangeListener is a class that implements the MapListener interface.
  cache.addMapListener(new ContactChangeListener());

.NET
Implementation Class: ObserverExample in namespace Tangosol.Examples.Contacts in dotnet/src/contacts
- ContactChangeListener is a class that implements the ICacheListener interface.
  cache.AddCacheListener(new ContactChangeListener());

C++
Implementation Class: ObserverExample in namespace coherence::examples in cpp/contacts
- ContactChangeListener is a class that extends the MapListener type using Coherence extend macro.
  ContactChangeListener::Handle hListener = ContactChangeListener::create();
  hCache->addFilterListener(hListener);
- Definition of ContactChangeListener:
  class ContactChangeListener
There is no immediate output when this example is run. The registered listener outputs the entry when it is inserted, updated, and deleted. For an update, it outputs both the old value and the new value. The changes to entries are caused by running the "Basic Data Access Example" and the "Processor Example", so the output happens when those examples are run.

A.5.7 Processor Example

ProcessorExample demonstrates how to use a processor to modify a set of data in the cache. In the code sample that follows, all Contacts who live in MA will have their work address updated.

Java

Implementation Class: com.tangosol.examples.contacts.ProcessorExample in java/src

Helper Class: com.tangosol.examples.contacts.OfficeUpdater in java/src

- Apply the OfficeUpdater on all contacts who live in MA. The OfficeUpdater is a class that implements the InvocableMap.EntryProcessor interface by extending AbstractProcessor.

```java
cache.invokeAll(new EqualsFilter("getHomeAddress.getState", "MA"), new OfficeUpdater(addrWork));
```

.NET

Implementation Class: ProcessorExample in namespace Tangosol.Examples.Contacts in dotnet/src/contacts

Helper Class: OfficeUpdater in namespace Tangosol.Examples.Contacts in dotnet/src/contacts

- Apply the OfficeUpdater on all contacts who live in MA. The OfficeUpdater is a class that implements the IEntryProcessor interface by extending AbstractProcessor.

```csharp
cache.InvokeAll(new EqualsFilter("getHomeAddress.getState", "MA"), new OfficeUpdater(addrWork));
```

C++

Implementation Class: ProcessorExample in namespace coherence::examples in cpp/contacts

Helper Class: OfficeUpdater in namespace coherence::examples in cpp/contacts

- The OfficeUpdater is a class that extends the UpdaterProcessor type.

```cpp
class OfficeUpdater : public class_spec<OfficeUpdater,
  extends<UpdaterProcessor>,
  implements<PortableObject> >
```

- Apply the OfficeUpdater on all contacts who live in MA.

```cpp
Filter::View vEqualsFilter = EqualsFilter::create(
  ChainedExtractor::create(ChainedExtractor::createExtractors(
    "getHomeAddress.getState")),
  String::create("MA"));
```
InvocableMap::EntryProcessor::Handle hOffice = OfficeUpdater::create(addrWork);
Map::View vMap = hCache->invokeAll(vEqualsFilter, hOffice);

A.5.7.1 Example Output
The example Output (due to "Observer Example") is large due to the number of contacts. A sample of output:

Example A–4   Example Output of the Processor Example

entry updated
old value:
John Keau
Addresses
Home: 443 Beacon St.
Ophvoww, MA 06539
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover’s Mill, FL 86812
US
Phone Numbers
work: +11 8 919 9456102
home: +11 25 759 588823
Birth Date: 1968-12-31
new value:
John Keau
Addresses
Home: 443 Beacon St.
Ophvoww, MA 06539
US
Work: 200 Newbury St.
Yoyodyne, Ltd.
Boston, MA 02116
US
Phone Numbers
work: +11 8 919 9456102
home: +11 25 759 588823
entry updated
old value:
John Lbggbklk
Addresses
Home: 443 Beacon St.
Ophvoww, MA 06539
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover’s Mill, AZ 19164
US
Phone Numbers
work: +11 60 699 203810
home: +11 34 149 5018157
Birth Date: 1964-01-02
new value:
John Lbggbklk
Addresses
Home: 929 Beacon St.
Trwylbm, MA 50158
US
Work: Yoyodyne Propulsion Systems
330 Lectroid Rd.
Grover’s Mill, AZ 19164
US
Phone Numbers
work: +11 60 699 203810
home: +11 34 149 5018157
Birth Date: 1964-01-02

A.5.8 Query Language

This example shows how to run sample queries for contacts.

**Java**

Implementation Class: `com.tangosol.examples.query.QueryExample` in `java/src`

- Add indexes to make queries more efficient.
  ```java
cache.addIndex(ff.createExtractor("age"), /*fOrdered*/ true, /*comparator*/ null);
cache.addIndex(ff.createExtractor("homeAddress.state"), /*fOrdered*/ false, /*comparator*/ null);
```

- Find all contacts who live in Massachusetts.
  ```java
  Set setResults = cache.entrySet(ff.createFilter("homeAddress.state = 'MA'"));
  ```

- Count contacts who are older than `nAge` for the entire cache dataset.
  ```java
  final int nAge = 58;
  Object[] aEnv = new Object[] {new Integer(nAge)};
  System.out.println("count > " + nAge + ": " +
  cache.aggregate(ff.createFilter("age > ?1", aEnv), new Count()));
  ```

**.NET**

Implementation Class: `SimpleQueryExample` in namespace `Tangosol.Examples.Query` in `dotnet/src/query`

- Add indexes to make queries more efficient.
  ```csharp
  cache.AddIndex(ff.CreateExtractor("age"), /*fOrdered*/ true, /*comparator*/ null);
cache.AddIndex(ff.CreateExtractor("homeAddress.state"), /*fOrdered*/ false, /*comparator*/ null);
  ```

- Find all contacts who live in Massachusetts.
  ```csharp
  ICollection results = cache.GetEntries(ff.CreateFilter("homeAddress.state = 'MA'"));
  ```

- Count contacts who are older than `age` for the entire cache dataset.
  ```csharp
  const int age = 58;
  object[] env = new object[] { age };
  results = cache.GetEntries(ff.CreateFilter("age > ?1", env));
  ```

**C++**

Implementation Class: `SimpleQueryExample` in namespace `coherence::examples` in `cpp/query`

- Add indexes to make queries more efficient.
  ```cpp
  cache.addIndex(ff.createExtractor("age"), /*fOrdered*/ true, /*comparator*/ null);
cache.addIndex(ff.createExtractor("homeAddress.state"), /*fOrdered*/ false, /*comparator*/ null);
  ```

- Find all contacts who live in Massachusetts.
  ```cpp
  ICollection results = cache.GetEntries(ff.createFilter("homeAddress.state = 'MA'"));
  ```

- Count contacts who are older than `age` for the entire cache dataset.
  ```cpp
  const int age = 58;
  object[] env = new object[] { age };
  results = cache.GetEntries(ff.createFilter("age > ?1", env));
  ```
- Add indexes to make queries more efficient.

  ```c
  hCache->addIndex(hff->createExtractor("age"), /*fOrdered*/ true,
  /*vComparator*/ NULL);
  hCache->addIndex(hff->createExtractor("homeAddress.state"), /*fOrdered*/ false,
  /*vComparator*/ NULL);
  ```

- Find all contacts who live in Massachusetts.

  ```c
  Set::View setResults = hCache->entrySet(hff->createFilter("homeAddress.state is 'MA'"));
  ```

- Count contacts who are older than \( nAge \) for the entire cache dataset.

  ```c
  Integer32::View nAge = Integer32::valueOf(58);
  ObjectArray::Handle haEnv = ObjectArray::create(1);
  haEnv[0] = nAge;
  HashMap::Handle hbinds = HashMap::create();
  hbinds->put(String::create("nAge"), nAge);
  setResults = hCache->entrySet(hff->createFilter("age > ?1", haEnv));
  ```

### A.5.8.1 Example Output

The example output (due to "Query Example"):

**Example A–5  Example Output of the Query Language Example**

MA Residents
ConverterCacheEntry(Key="John Wmbltik", Value="John Wmbltik
Addresses
Home: 785 Beacon St.
Vpmji, MA 34400
US
Work: 200 Newbury St.
Yoyodyne, Ltd.
Boston, MA 02116
US
Phone Numbers
work: +1 62 133 6144503
home: +1 17 238 6189757
Birth Date: 1/1/1968 12:00:00 AM"
ConverterCacheEntry(Key="John Dtpx", Value="John Dtpx
Addresses
Home: 673 Beacon St.
Mvblms, MA 25889
US
Work: 200 Newbury St.
Yoyodyne, Ltd.
Boston, MA 02116
US
Phone Numbers
work: +1 89 900 8436918
home: +1 32 686 9582798
Birth Date: 1/3/1960 12:00:00 AM"

. . .
count > 58 : 496
A.5.9 Data Generator

Implementation Class: com.tangosol.examples.contacts.DataGenerator in java/src

The DataGenerator has a static main method that generates random Contact information and stores the results in a comma separated value file. This class was used to generate the contacts.csv that is packaged with the contacts examples and is included in case more sample data is needed.

It is implemented only in Java.

A.6 Coherence Security Examples

The Coherence security examples are a collection of examples that show how to use the security features of Coherence in order to provide access control.

These examples are simplified to show only the security features of Coherence. They are not examples of security best practices:

- "Password Example"—Shows how a Coherence Proxy can require a password to access a cache.
- "Access Control Example"—Shows simplified role based access control.
- "Password Identity Transformer"—Creates a custom security token that contains the required password and then adds a list of Principal names.
- "Password Identity Asserter"—Asserts that the security token contains the required password and then constructs a Subject based on a list of Principal names.
- "Entitled Cache Service"—Wraps a cache service for access control.
- "Entitled Invocation Service"—Wraps an invocation service for access control.
- "Entitled Named Cache"—Wraps a named cache for access control.

A.6.1 This Example Set

- Gets a cache reference that requires a password.
- Attempts cache and invocation service operations that require different roles.

A.6.1.1 Running the Security Example Set

1. Review the following information:
   - Section A.3, "How to Build the Examples"
   - Section A.4, "How to Run the Examples"
2. Review the information on the security Driver implementation found in the next section.

A.6.1.2 Understanding the Security Driver File

Has a static main method that executes all the security examples in the following order:

1. PasswordExample
2. AccessControlExample.accessCache()
3. AccessControlExample.accessInvocationService()

Is implemented in each of the three programming languages supported by Coherence:
A.6.2 Password Example

This example shows how a Coherence Proxy can require a password to get a reference to a cache.

Java
Implementation Class: com.tangosol.examples.security.PasswordExample in java/src

The code logs in to get a Subject, and then tries to get a cache reference running in the context of the Subject.

The **Password Identity Transformer** will generate a security token that contains the password. The **Password Identity Asserter** (running in the proxy) will validate the security token to enforce the password. The token generation and validation occurs automatically when a connection to the proxy is made.

.NET

The code logs in to get a Principal, and then tries to get a cache reference running in the context of the Principal by making the Principal the Thread's current principal.

The **Password Identity Transformer** will generate a security token that contains the password. The **Password Identity Asserter** (running in the proxy) will validate the security token to enforce the password. The token generation and validation occurs automatically when a connection to the proxy is made.

C++
Implementation Class: AccessExample in namespace coherence::examples in cpp/security

The code logs in to get a Subject, and then tries to get a cache reference running in the context of the Subject.

The **Password Identity Transformer** will generate a security token that contains the password. The **Password Identity Asserter** (running in the proxy) will validate the security token to enforce the password. The token generation and validation occurs automatically when a connection to the proxy is made.

The example Output:

**Example A–6 Example Output of the Password Example**

------password example begins------

------password example succeeded------
A.6.3 Access Control Example

This example shows simplified role-based access control.

Java

Implementation Class: com.tangosol.examples.security.AccessControlExample in java/src

The code logs in to get a Subject with a user-id with a particular role, gets a cache reference running in the context of the Subject, and then tries cache operations. Depending on the role granted to the user, the cache operation is allowed or denied.

Someone with a writer role is allowed to put and get. Someone with a reader role can get but not put. Someone with a writer role cannot destroy a cache. Someone with an admin role can destroy a cache.

Then a user with a particular role tries to use the invocation service. A reader is not allowed to invoke, but a writer is allowed.

Note that once the cache or invocation service reference is created in the context of a Subject, that identity is permanently associated with that reference. Any use of that cache or service reference is on behalf of that identity.

The Password Identity Transformer will generate a security token that contains the password, the user-id, and the roles. The Password Identity Asserter (running in the proxy) will validate the security token to enforce the password, and construct a Subject with the proper user-id and roles.

The production and assertion of the security token happens automatically.

See the Entitled Cache Service, Entitled Invocation Service, and Entitled Named Cache code for the implementation of access control.

.NET


The code logs in to get a Principal with a user-id with a particular role, gets a cache reference running in the context of the Principal, and then tries cache operations. Depending on the role granted to the user, the cache operation is allowed or denied.

Someone with a writer role is allowed to put and get. Someone with a reader role can get but not put. Someone with a writer role cannot destroy a cache. Someone with an admin role can destroy a cache.

Then a user with a particular role tries to use the invocation service. A reader is not allowed to invoke, but a writer is allowed.

Note that once the cache or invocation service reference is created in the context of a Principal, that identity is permanently associated with that reference. Any use of that cache or service reference is on behalf of that identity.

The Password Identity Transformer will generate a security token that contains the password, the user-id, and the roles. The Password Identity Asserter (running in the proxy) will validate the security token to enforce the password, and construct a Subject with the proper user-id and roles.

The production and assertion of the security token happens automatically.
See the Entitled Cache Service, Entitled Invocation Service, and Entitled Named Cache code for the implementation of access control.

C++

Implementation Class: AccessControlExample in namespace coherence::examples in cpp/security

The code logs in to get a Subject with a user-id with a particular role, gets a cache reference running in the context of the Subject, and then tries cache operations. Depending on the role granted to the user, the cache operation is allowed or denied.

Someone with a writer role is allowed to put and get. Someone with a reader role can get but not put. Someone with a writer role cannot destroy a cache. Someone with an admin role can destroy a cache.

Then a user with a particular role tries to use the invocation service. A reader is not allowed to invoke, but a writer is allowed.

Note that once the cache or invocation service reference is created in the context of a Subject, that identity is permanently associated with that reference. Any use of that cache or service reference is on behalf of that identity.

The Password Identity Transformer will generate a security token that contains the password, the user-id, and the roles. The Password Identity Asserter (running in the proxy) will validate the security token to enforce the password, and construct a Subject with the proper user-id and roles.

The production and assertion of the security token happens automatically.

See the Entitled Cache Service, Entitled Invocation Service, and Entitled Named Cache code for the implementation of access control.

A.6.3.1 Example Output

The example output:

Example A–7  Example Output of the Access Control Example

-------cache access control example begins-------
Success: read and write allowed
Success: read allowed
Success: Correctly cannot write
Success: Correctly cannot destroy the cache
Success: Correctly allowed to destroy the cache
-------cache access control example completed-------
-------InvocationService access control example begins-------
Success: Correctly allowed to use the invocation service
Success: Correctly unable to use the invocation service
-------InvocationService access control example completed-------

A.6.4 Password Identity Transformer

This example shows how an IdentityTransformer produces a security token from an identity.

Java

Implementation Class:
com.tangosol.examples.security.PasswordIdentityTransformer in java/src
The code produces a security token that is an array of strings. The first string is the password. The second string is the user-id and subsequent strings are the user's roles. Arrays of strings will be serialized by Coherence*Extend without requiring a custom serializer.

This class will be invoked automatically when the Extend client connects to a proxy or a channel is opened in an existing connection.

**.NET**

Implementation Class: PasswordIdentityTransformer in namespace
Tangosol.Example.Security in dotnet/src/security

The code produces a security token that is an array of strings. The first string is the password. The second string is the user-id and subsequent strings are the user's roles. Arrays of strings will be serialized by Coherence*Extend without requiring a custom serializer.

This class will be invoked automatically when the Extend client connects to a proxy or a channel is opened in an existing connection.

**C++**

Implementation Class: PasswordIdentityTransformer in namespace
cohere::examples in cpp/security

The code produces a security token that is an array of strings. The first string is the password. The second string is the user-id and subsequent strings are the user's roles. Arrays of strings will be serialized by Coherence*Extend without requiring a custom serializer.

This class will be invoked automatically when the Extend client connects to a proxy or a channel is opened in an existing connection.

**A.6.5 Password Identity Asserter**

This example shows how an IdentityAsserter validates a security token and produces a Subject from a list of principal names.

**Java**

Implementation Class:
com.tangosol.examples.security.PasswordIdentityAsserter in java/src

The code processes a security token that should be an array of strings. The first string must be the password. Subsequent strings are principals. Any failure processing the token results in a SecurityException that will deny access to the proxy.

**.NET**

Implementation Class: none

The IdentityAsserter runs only on the proxy (in Java), so it does not run in the .NET client. Therefore, there is no PasswordIdentityAsserter for .NET.

**C++**

Implementation Class: none

The PasswordIdentityAsserter runs only on the proxy (in Java), so it does not run in the C++ client. Therefore there is no PasswordIdentityAsserter for C++.
A.6.6 Entitled Cache Service

This example shows how a remote cache service can be wrapped to provide access control.

Java
Implementation Class: com.tangosol.examples.security.EntitledCacheService in java/src

The code instantiates an Entitled Named Cache that provides access control for cache operations. The code also provides access control for the cache service methods release and destroy. The access control check is delegated to the Security Example Helper.

This class will be instantiated automatically when the cache service is started on the proxy.

.NET
There is no .NET implementation. The class runs only on the proxy in Java.

C++
There is no C++ implementation. The class runs only on the proxy in Java.

A.6.7 Entitled Invocation Service

This example shows how a remote invocation service can be wrapped to provide access control.

Java
Implementation Class: com.tangosol.examples.security.EntitledInvocationService in java/src

The code provides access control for the invocation service methods. The access control check is delegated to the Security Example Helper.

This class will be instantiated automatically when the invocation service is started on the proxy.

.NET
There is no .NET implementation. The class runs only on the proxy in Java.

C++
There is no C++ implementation. The class runs only on the proxy in Java.

A.6.8 Entitled Named Cache

This example shows how a remote named cache can be wrapped to provide access control.

Java
Implementation Class: com.tangosol.examples.security.EntitledNamedCache in java/src

The code provides access control for the NamedCache methods. The access control check is delegated to the Security Example Helper.
This class will be instantiated automatically when the cache service is started on the proxy.

**.NET**
There is no .NET implementation. The class runs only on the proxy in Java.

**C++**
There is no C++ implementation. The class runs only on the proxy in Java.

### A.6.9 Security Example Helper

This example is a helper class for authentication and access control.

**Java**

Implementation Class: `com.tangosol.examples.security.SecurityExampleHelper` in `java/src`

The code simulates authentication. For the sake of simplicity, it creates a `Subject`. A real implementation would do platform- and company-specific authentication. The login also does simple mapping of user names to roles.

The `checkAccess` method checks that the operation is allowed by the user's role.

**.NET**


The code simulates authentication. For the sake of simplicity, it creates a `Principal`. A real implementation would do platform- and company-specific authentication. The login also does simple mapping of user names to roles.

**C++**

Implementation Class: `SecurityExampleHelper` in namespace `coherence::examples` in `cpp/security`

The code simulates authentication. For the sake of simplicity, it creates a `Subject`. A real implementation would do platform- and company-specific authentication. The login also does simple mapping of user names to roles.

### A.7 Coherence Live Events Examples

These examples illustrate the various event types in Coherence Live Events and how they can be consumed, including `EntryEvents`, `EntryProcessorEvents` and `TransferEvents`.

The Live Events Examples are available only in the Java programming language, as they are executed on the storage-enabled members of the partitioned service.

- "EventsExamples"—Illustrates various features within Live Events.
- "TimedTraceInterceptor"—Provides timings between pre- and post-commit events for different types of events.
- "CantankerousInterceptor"—Responds with runtime exceptions at either pre- or post-commit time, based on the type of key being inserted.
- "RedistributionInterceptor"—Logs partition events when enabled.
“RedistributionInvocable”—Defines three actionable states that will be executed on various members of the cluster. The states are enable logging performed by the RedistributionInterceptor, disable logging, or terminate the JVM that the invocable (RedistributionInvocable) is executed on.

“LazyProcessor”—Creates a superficial delay between the processing of events.

A.7.1 This Example Set

- Illustrates how to measure the elapsed time between pre- and post-events which are inserted into a results cache.
- Illustrates the semantics of throwing exceptions in pre- and post-commit events.
- Illustrates how partition redistribution events can be logged.

A.7.1.1 Running the Live Events Example Set

1. Review the following information:
   - Section A.3, "How to Build the Examples"
   - Section A.4, "How to Run the Examples"
2. Review the information on the Live Events Driver implementation found in the next section.

A.7.1.2 Understanding the Live Events Driver File

Has a static main method that executes all the Live Events examples in the following order:

1. Timed Events Example
2. Veto Events Example
3. Partition Transfer Events Example

Is implemented only in the Java programming language:

<table>
<thead>
<tr>
<th>Language</th>
<th>Implementation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Java</td>
<td>com.tangosol.examples.events.Driver in java/src</td>
</tr>
</tbody>
</table>

A.7.2 EventsExamples

The EventsExamples class illustrates various features within Live Events. This includes:

- Providing mean elapsed times split by event type.
- Illustrating the different semantics in throwing exceptions in pre-events compared to post-events.
- Illustrating logging of partition movement when enabled.

The EventsExamples class defines these inner classes:

- EventsTimingExample
- VetoEventsExample
- RedistributionEventsExample
A.7.2.1 EventsTimingExample
The EventsTimingExample inner class is a catalyst for action to be performed by TimedTraceInterceptor. This illustrates how the elapsed time between pre- and post-events can be measured which are inserted into a results cache. The entries inserted into the results cache are displayed by using the stdout of the process executing this class.

The example output:

Example A–8  Example Output of the EventsTimingExample
Received stats [memberId=2, eventType=INSERTED, sample=1] = EventStats[name = INSERTED, sampleMean = 0.294040ms, mean = 0.294040ms]
Received stats [memberId=3, eventType=INSERTED, sample=1] = EventStats[name = INSERTED, sampleMean = 0.397855ms, mean = 0.397855ms]
Received stats [memberId=1, eventType=INSERTED, sample=1] = EventStats[name = INSERTED, sampleMean = 0.373270ms, mean = 0.373270ms]
Received stats [memberId=3, eventType=UPDATED, sample=1] = EventStats[name = UPDATED, sampleMean = 0.187132ms, mean = 0.187132ms]
Received stats [memberId=2, eventType=UPDATED, sample=1] = EventStats[name = UPDATED, sampleMean = 0.234314ms, mean = 0.234314ms]
Received stats [memberId=1, eventType=UPDATED, sample=1] = EventStats[name = UPDATED, sampleMean = 0.237622ms, mean = 0.237622ms]

A.7.2.2 VetodEventsExample
The VetodEventsExample inner class is a catalyst for action to be performed by CantankerousInterceptor. This illustrates the semantics of throwing exceptions in pre- and post-events. The exceptions that are expected to only be logged are inserted into a results cache. The entries inserted into the results cache are displayed by using the stdout of the process executing this class.

The example output:

Example A–9  Example Output of the VetodEventsExample
Received event [memberId=3, eventType=NON_VETO, count=1] = Objection falls on deaf ears! value = value: 11
Received event [memberId=3, eventType=NON_VETO, count=2] = Objection falls on deaf ears! value = value: 22
Received event [memberId=3, eventType=NON_VETO, count=3] = Objection falls on deaf ears! value = value: 33
Received event [memberId=3, eventType=NON_VETO, count=4] = Objection falls on deaf ears! value = value: 44

A.7.2.3 RedistributionEventsExample
The RedistributionEventsExample inner class is a catalyst for action to be performed by the RedistributionInterceptor class. This illustrates how partition redistribution events can be logged, by enabling logging in the RedistributionInterceptor and killing a member thus inducing partition redistribution.

The example output:

Example A–10  Output of the RedistributionEventsExample
Choosing to kill member Member(Id=3, Timestamp=2014-01-02 16:38:17.942, Address=10.159.154.103:8092, MachineId=47251, Location=site:,machine:TPFAEFFL-LAP,process:8168, Role=CoherenceServer)
A.7.3 TimedTraceInterceptor

Implementation Class: com.tangosol.examples.events.TimedTraceInterceptor in java/src

The TimedTraceInterceptor class provides timings between pre- and post-commit events for each type of event; that is, inserts, updates, removes, and entry processor execution. These timings are collected and averaged at a sample rate defined by parameter cSample. Additionally they are output to the log at the same time. This implementation does maintain a strong reference to the each binary key however this is removed upon receiving the post-commit event for the same key.

The interceptor implements the EventInterceptor interface. The @Interceptor annotation provides the unique name of the interceptor with the identifier attribute and the order in which it should be executed (Order.HIGH) with the order attribute.

The interceptor also contains a protected EventTimer inner-class. This class times the elapsed time for each event it is notified of. The interceptor tracks the time between a pre- and post-commit event for each entry and the respective event types (INSERT, UPDATE, REMOVE). The timings are sent to the Coherence log in batches displaying sample and cumulative statistics.

As the generic argument is com.tangosol.net.events.partition.cache.Event, you will only get events that are consumers of that event, that is, EntryEvent and EntryProcessorEvent, without specifying any filtering.

A.7.4 CantankerousInterceptor

Implementation Class: com.tangosol.examples.events.CantankerousInterceptor in java/src

The CantankerousInterceptor class is an EventInterceptor implementation that is argumentative in nature, hence the event of inserting certain keys will result in runtime exceptions at either pre- or post-commit phases.

If the exception is thrown at pre-commit time, then a rollback occurs and the exception is propagated to the client. If the exception occurs at post-commit time, then a log event is recorded. The keys used for the exceptions are VETO and NON-VETO. INSERTING and UPDATING are events that can be vetoed, whereas INSERTED and UPDATED events cannot be vetoed.

A.7.5 RedistributionInterceptor

Implementation Class: com.tangosol.examples.events.RedistributionInterceptor in java/src

The RedistributionInterceptor class is an EventInterceptor that logs partition activity when enabled. Logging can be enabled by using setting the RedistributionInvocable.ENABLED constant.

A.7.6 RedistributionInvocable

Implementation Class: com.tangosol.examples.pof.RedistributionInvocable in java/src

The RedistributionInvocable class defines three actionable states that will be executed on various members of the cluster. For this example, define the states as follows:
- DISABLE: Disable the logging performed by the RedistributionInterceptor event interceptor.
- ENABLE: Enable the logging performed by the RedistributionInterceptor event interceptor.
- KILL: Terminate the JVM that this invocable (RedistributionInvocable) is executed on.

A.7.7 LazyProcessor

Implementation Class: com.tangosol.examples.pof.LazyProcessor in java/src

The LazyProcessor class creates a superficial delay between the processing of events. The class specifies the number of milliseconds this processor should sleep between processing events. This class will be used by the EventsTimingExample subclass in the EventsExamples class.