

Oracle® Fusion Middleware

Developing Applications with Oracle Coherence

12c (12.1.3)

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Documentation for Developers and Architects that describes how to develop applications that use Coherence for distributed caching and data grid computing. Includes information for installing Coherence, setting up Coherence clusters, configuring Coherence caches, and performing data grid operations.

Oracle Fusion Middleware Developing Applications with Oracle Coherence, 12c (12.1.3)

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Preface

Welcome to *Developing Applications with Oracle Coherence*. This document provides contextual information, instructions, and examples that are designed to teach developers and architects how to use Coherence and develop Coherence-based applications.

Audience

Developing Applications with Oracle Coherence is intended for the following audiences:

- **Primary Audience** – Application developers who want to understand core Oracle Coherence concepts and want to build applications that leverage an Oracle Coherence data grid.
- **Secondary Audience** – System architects who want to understand core Oracle Coherence concepts and want to build data grid-based solutions.

The audience must be familiar with Java to use this guide. In addition, the examples in this guide require the installation and use of the Oracle Coherence product. The use of an IDE is not required to use this guide, but is recommended to facilitate working through the examples. A database and basic database knowledge is required when using cache store features.

Documentation Accessibility

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

Access to Oracle Support

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

Related Documents

For more information, see the following documents that are included in the Oracle Coherence documentation set:

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

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

Conventions

The following text conventions are used in this document:

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

What's New in This Guide

The following topics introduce the new and changed features of Oracle Coherence and other significant changes that are described in this guide, and provides pointers to additional information. This document is the new edition of the formerly titled *Oracle Coherence Developer's Guide*.

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.

- JCache provider implementation, which provides client applications with a common API for using caching in Java. See [Appendix V, "Using the Coherence JCache Implementation."](#)
- Journal expiry and eviction, which allows entries in a RAM or flash journal to be automatically removed. See ["Using Journal Expiry and Eviction"](#) on page 14-9.
- Asynchronous entry processors, which allows entry processors to be invoked asynchronously. See ["Processing Entries Asynchronously"](#) on page 24-6.

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 the documentation for specifying multicast address. See ["Specifying a Cluster's Multicast Address"](#) on page 7-4.
- Revised the documentation for registering event interceptors. See ["Registering Event Interceptors"](#) on page 27-7.
- Revised the documentation for live events thread model documentation. See ["Understanding Event Threading"](#) on page 27-6.
- Revised the operational configuration reference for all new and changed elements. See [Appendix A, "Operational Configuration Elements."](#)
- Revised the cache configuration reference for all new and changed elements. See [Appendix B, "Cache Configuration Elements."](#)

New and Changed Features for 12c (12.1.2)

Oracle Coherence 12c (12.1.2) includes the following new and changed features for this document.

- Oracle universal installer and patching
 - Complete installer, which provides all installation options and can operate in graphical or silent mode. See ["Running the Coherence Installer"](#) on page 2-2.
 - Quick installer, which provides a silent installer with no API documentation or examples. See ["Running the Coherence Quick Installer"](#) on page 2-4.
 - Supplemental installer, which provides only API documentation and examples. See ["Running the Coherence Supplemental Installer"](#) on page 2-4.
 - Deinstaller, which provides the ability to deinstall a Coherence installation. See ["Deinstalling Coherence"](#) on page 2-8.
- Maven integration, which simplifies and standardize including Coherence in a build process. See ["Integration with Maven"](#) on page 2-8.
- SLF4J integration, which allows SLF4J logging. See ["Using SLF4J for Coherence Logs"](#) on page 5-8.
- Cluster priorities, which are used to assign importance for cluster members, cluster communication components, and threads. See ["Specifying Cluster Priorities"](#) on page 7-16.
- Logical near cache invalidation strategy, which instructs a near cache to listen to all backing map events that are not synthetic deletes. See ["Near Cache Invalidation Strategies"](#) on page 13-12.
- Flash journal high size, which determines when to start removing stale values from the journal and is the basis for automatic tuning. See ["Configuring the Flash Journal Resource Manager"](#) on page 14-11.
- Asynchronous Backup, which allows clients to continue to respond to requests during backup operations. See ["Using Asynchronous Backup"](#) on page 14-12.
- Quorum failover access policy, which moderates client request load during a failover event in order to allow cache servers adequate opportunity to re-establish partition backups. See ["Enabling the Custom Failover Access Policy"](#) on page 17-6.
- Custom XML namespaces and namespace handlers, which allow user-defined XML elements and attributes to be added to a cache configuration file. See [Chapter 19, "Extending Cache Configuration Files"](#).
- POF configuration generator, which automatically creates a POF configuration file that includes user type entries for the classes that contain the `@Portable` annotation. See ["Generating a POF Configuration File"](#) on page 20-11.
- Implicit locks, which allows cache entries in multiple caches to be updated from a single entry processor in a transaction-like manner. See ["Processing Entries in Multiple Caches"](#) on page 24-3.
- Live events, which is an event programming model that allows extensibility within a cluster when performing operations against a data grid. The model uses events to represent observable occurrences of cluster operations. See [Chapter 27, "Using Live Events"](#).
- Partition assignment strategies, which define how partitions are assigned to storage-enabled cluster members. See ["Changing the Partition Distribution Strategy"](#) on page 30-5.
- InfiniBand Message Bus (IMB) provider, which is a native InfiniBand protocol that supports Remote Direct Memory Access (RDMA), zero message copy, kernel bypass, predictive notifications, and custom off-heap buffers. IMB is only available on Oracle Exalogic system. See [Chapter A-71, "unicast-listener Subelements,"](#) and

Chapter B-20, "distributed-scheme Subelements," for details about setting the <reliable-transport> element.

Other Significant Changes in This Document for 12c (12.1.2)

For 12c (12.1.2), this guide has been updated in several ways. Following are the sections that have been added or changed.

- Revised the system requirements. See "[System Requirements](#)" on page 2-1.
- Revised the installation directory structure instructions. See "[Browsing the Installation Directory](#)" on page 2-5.
- Revised the packet buffer configuration instructions. See "[Configuring the Size of the Packet Buffers](#)" on page 10-7 and "[Adjusting the Maximum Size of a Packet](#)" on page 10-9.
- Revised the near cache invalidation strategy section to include new default behavior. See "[Near Cache Invalidation Strategies](#)" on page 13-12.
- Added a section about key serialization that lists considerations when serializing keys. See "[Serializing Keys Using POF](#)" on page 20-16.
- Added a section about deferring key association checks. See "[Deferring the Key Association Check](#)" on page 30-3.
- Added a section about changing the default number of partitions for a distributed cache service. See "[Changing the Number of Partitions](#)" on page 30-4.
- Revised the operational configuration reference for all new and changed elements. See [Appendix A, "Operational Configuration Elements."](#)
- Revised the cache configuration reference for all new and changed elements. See [Appendix B, "Cache Configuration Elements."](#)

Part I

Getting Started

Part I contains the following chapters:

- [Chapter 1, "Introduction to Coherence"](#)
- [Chapter 2, "Installing Oracle Coherence for Java"](#)
- [Chapter 3, "Understanding Configuration"](#)
- [Chapter 4, "Building Your First Coherence Application"](#)
- [Chapter 5, "Debugging in Coherence"](#)

Introduction to Coherence

This chapter provides an introduction to Coherence concepts and features. It outlines product capabilities, usage possibilities, and provides a brief overview of how particular features are implemented. The items discussed in this chapter are detailed throughout this guide.

This chapter includes the following sections:

- [Basic Concepts](#)
- [Read/Write Caching](#)
- [Querying the Cache](#)
- [Invocation Service](#)
- [Event Programming](#)
- [Transactions](#)
- [HTTP Session Management](#)
- [Object-Relational Mapping Integration](#)
- [C++/.NET Integration](#)
- [Management and Monitoring](#)

Basic Concepts

The topics in this section describes fundamental concepts that are associated with Coherence and discusses several important features that are associated with using Coherence to cluster data.

Clustered Data Management

At the core of Coherence is the concept of clustered data management. This implies the following goals:

- A fully coherent, single system image (SSI)
- Scalability for both read and write access
- Fast, transparent failover and failback
- Linear scalability for storage and processing
- No Single-Points-of-Failure (SPOFs)
- Cluster-wide locking and transactions

Built on top of this foundation are the various services that Coherence provides, including database caching, HTTP session management, grid agent invocation and distributed queries. Before going into detail about these features, some basic aspects of Coherence should be discussed.

A single API for the logical layer, XML configuration for the physical layer

Coherence supports many topologies for clustered data management. Each of these topologies has a trade-off in terms of performance and fault-tolerance. By using a single API, the choice of topology can be deferred until deployment if desired. This allows developers to work with a consistent logical view of Coherence, while providing flexibility during tuning or as application needs change.

Caching Strategies

Coherence provides several cache implementations:

- [Understanding Local Caches](#)—Local on-heap caching for non-clustered caching.
- [Understanding Replicated Caches](#)—Perfect for small, read-heavy caches.
- [Understanding Distributed Caches](#)—True linear scalability for both read and write access. Data is automatically, dynamically and transparently partitioned across nodes. The distribution algorithm minimizes network traffic and avoids service pauses by incrementally shifting data.
- [Understanding Near Caches](#)—Provides the performance of local caching with the scalability of distributed caching. Several different near-cache strategies are available and offer a trade-off between performance and synchronization guarantees.

In-process caching provides the highest level of raw performance, since objects are managed within the local JVM. This benefit is most directly realized by the Local, Replicated, Optimistic and Near Cache implementations.

Out-of-process (client/server) caching provides the option of using dedicated cache servers. This can be helpful when you want to partition workloads (to avoid stressing the application servers). This is accomplished by using the Partitioned cache implementation and simply disabling local storage on client nodes through a single command-line option or a one-line entry in the XML configuration.

Tiered caching (using the Near Cache functionality) enables you to couple local caches on the application server with larger, partitioned caches on the cache servers, combining the raw performance of local caching with the scalability of partitioned caching. This is useful for both dedicated cache servers and co-located caching (cache partitions stored within the application server JVMs).

See [Part III, "Using Caches"](#) for detailed information on configuring and using caches.

Data Storage Options

While most customers use on-heap storage combined with dedicated cache servers, Coherence has several options for data storage:

- **On-heap**—The fastest option, though it can affect JVM garbage collection times.
- **Journal**—A combination of RAM storage and disk storage, optimized for solid state disks, that uses a journaling technique. Journal-based storage requires serialization/deserialization.
- **File-based**—Uses a Berkeley Database JE storage system.

Coherence storage is transient: the disk-based storage options are for managing cached data only. For persistent storage, Coherence offers backing maps coupled with a CacheLoader/CacheStore.

See [Chapter 14, "Implementing Storage and Backing Maps,"](#) for detailed information.

Serialization Options

Because serialization is often the most expensive part of clustered data management, Coherence provides the following options for serializing/deserializing data:

- `com.tangosol.io.pof.PofSerializer` – The Portable Object Format (also referred to as POF) is a language agnostic binary format. POF was designed to be incredibly efficient in both space and time and is the recommended serialization option in Coherence. See [Chapter 20, "Using Portable Object Format."](#)
- `java.io.Serializable` – The simplest, but slowest option.
- `java.io.Externalizable` – This requires developers to implement serialization manually, but can provide significant performance benefits. Compared to `java.io.Serializable`, this can cut serialized data size by a factor of two or more (especially helpful with Distributed caches, as they generally cache data in serialized form). Most importantly, CPU usage is dramatically reduced.
- `com.tangosol.io.ExternalizableLite` – This is very similar to `java.io.Externalizable`, but offers better performance and less memory usage by using a more efficient IO stream implementation.
- `com.tangosol.run.xml.XmlBean` – A default implementation of `ExternalizableLite`.

Configurability and Extensibility

Coherence's API provides access to all Coherence functionality. The most commonly used subset of this API is exposed through simple XML options to minimize effort for typical use cases. There is no penalty for mixing direct configuration through the API with the easier XML configuration.

Coherence is designed to allow the replacement of its modules as needed. For example, the local "backing maps" (which provide the actual physical data storage on each node) can be easily replaced as needed. The vast majority of the time, this is not required, but it is there for the situations that require it. The general guideline is that 80% of tasks are easy, and the remaining 20% of tasks (the special cases) require a little more effort, but certainly can be done without significant hardship.

Namespace Hierarchy

Coherence is organized as set of services. At the root is the Cluster service. A cluster is defined as a set of Coherence instances (one instance per JVM, with one or more JVMs on each computer). Under the cluster service are the various services that comprise the Coherence API. These include the various caching services (Replicated, Distributed, and so on) and the Invocation Service (for deploying agents to various nodes of the cluster). Each instance of a service is named, and there is typically a default service instance for each type.

The cache services contain named caches (`com.tangosol.net.NamedCache`), which are analogous to database tables—that is, they typically contain a set of related objects.

See [Chapter 6, "Introduction to Coherence Clusters,"](#) for more information on the cluster service as well the other cluster-based service provided by Coherence.

Read/Write Caching

This section provides an overview of the `NamedCache` API, which is the primary interface used by applications to get and interact with cache instances. This section also includes some insight into the use of the `NamedCache` API.

NamedCache

The following source code returns a reference to a `NamedCache` instance. The underlying cache service is started if necessary. See the *Java API Reference for Oracle Coherence* for details on the `NamedCache` interface.

```
import com.tangosol.net.*;
...
NamedCache cache = CacheFactory.getCache("MyCache");
```

Coherence scans the cache configuration XML file for a name mapping for `MyCache`. This is similar to Servlet name mapping in a web container's `web.xml` file. Coherence's cache configuration file contains (in the simplest case) a set of mappings (from cache name to cache scheme) and a set of cache schemes.

By default, Coherence uses the `coherence-cache-config.xml` file found at the root of `coherence.jar`. This can be overridden on the JVM command-line with `-Dtangosol.coherence.cacheconfig=file.xml`. This argument can reference either a file system path, or a Java resource path.

The `com.tangosol.net.NamedCache` interface extends several other interfaces:

- `java.util.Map`—basic Map methods such as `get()`, `put()`, `remove()`.
- `com.tangosol.util.ObservableMap`—methods for listening to cache events. (See [Chapter 25, "Using Map Events"](#).)
- `com.tangosol.net.cache.CacheMap`—methods for getting a collection of keys (as a `Map`) that are in the cache and for putting objects in the cache. Also supports adding an expiry value when putting an entry in a cache.
- `com.tangosol.util.QueryMap`—methods for querying the cache. (See "Query the Cache" in the *Developing Applications with Oracle Coherence*.)
- `com.tangosol.util.ConcurrentMap`—methods for concurrent access such as `lock()` and `unlock()`.
- `com.tangosol.util.InvocableMap`—methods for server-side processing of cache data.

Requirements for Cached Objects

Cache keys and values must be serializable (for example, `java.io.Serializable`). Furthermore, cache keys must 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 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 `equals()` returns true must serialize identically; most built-in Java types meet this requirement as well.

NamedCache Usage Patterns

There are two general approaches to using a `NamedCache`:

- As a clustered implementation of `java.util.Map` with several added features (queries, concurrency), but with no persistent backing (a "side" cache).
- As a means of decoupling access to external data sources (an "inline" cache). In this case, the application uses the `NamedCache` interface, and the `NamedCache` takes care of managing the underlying database (or other resource).

Typically, an inline cache is used to cache data from:

- **a database**—The most intuitive use of a cache—simply caching database tables (in the form of Java objects).
- **a service**—Mainframe, web service, service bureau—any service that represents an expensive resource to access (either due to computational cost or actual access fees).
- **calculations**—Financial calculations, aggregations, data transformations. Using an inline cache makes it very easy to avoid duplicating calculations. If the calculation is complete, the result is simply pulled from the cache. Since any serializable object can be used as a cache key, it is a simple matter to use an object containing calculation parameters as the cache key.

See [Chapter 15, "Caching Data Sources"](#) for more information on inline caching.

Write-back options:

- **write-through**—Ensures that the external data source always contains up-to-date information. Used when data must be persisted immediately, or when sharing a data source with other applications.
- **write-behind**—Provides better performance by caching writes to the external data source. Not only can writes be buffered to even out the load on the data source, but multiple writes can be combined, further reducing I/O. The trade-off is that data is not immediately persisted to disk; however, it is immediately distributed across the cluster, so the data survives the loss of a server. Furthermore, if the entire data set is cached, this option means that the application can survive a complete failure of the data source temporarily as both cache reads and writes do not require synchronous access the data source.

To implement a read-only inline cache, you simply implement two methods on the `com.tangosol.net.cache.CacheLoader` interface, one for singleton reads, the other for bulk reads. Coherence provides an abstract class

`com.tangosol.net.cache.AbstractCacheLoader` which provides a default implementation of the bulk method, which means that you need only implement a single method: `public Object load(Object oKey)`. This method accepts an arbitrary cache key and returns the appropriate value object.

If you want to implement read/write caching, you must extend `com.tangosol.net.cache.AbstractCacheStore` (or implement the interface `com.tangosol.net.cache.CacheStore`), which adds the following methods:

```
public void erase(Object oKey);
public void eraseAll(Collection colKeys);
public void store(Object oKey, Object oValue);
public void storeAll(Map mapEntries);
```

The method `erase()` should remove the specified key from the external data source. The method `store()` should update the specified item in the data source if it exists, or insert it if it does not presently exist.

After the `CacheLoader/CacheStore` is implemented, it can be connected through the `coherence-cache-config.xml` file.

Querying the Cache

Coherence provides the ability to query cached data. With partitioned caches, the queries are indexed and parallel, which means that adding servers to a partitioned cache not only increases throughput (total queries per second) but also reduces latency, with queries taking less user time. To query against a `NamedCache`, all objects should implement a common interface (or base class). Any field of an object can be queried; indexes are optional, and used to increase performance. With a replicated cache, queries are performed locally, and do not use indexes. See [Chapter 22, "Querying Data In a Cache,"](#) for detailed information.

To add an index to a `NamedCache`, you first need a value extractor (which accepts as input a value object and returns an attribute of that object). Indexes can be added blindly (duplicate indexes are ignored). Indexes can be added at any time, before or after inserting data into the cache.

It should be noted that queries apply only to cached data. For this reason, queries should not be used unless the entire data set has been loaded into the cache, unless additional support is added to manage partially loaded sets.

Developers have the option of implementing additional custom filters for queries, thus taking advantage of query parallel behavior. For particularly performance-sensitive queries, developers may implement index-aware filters, which can access Coherence's internal indexing structures.

Coherence includes a built-in optimizer, and applies indexes in the optimal order. Because of the focused nature of the queries, the optimizer is both effective and efficient. No maintenance is required.

Invocation Service

The Coherence invocation service can deploy computational agents to various nodes within the cluster. These agents can be either execute-style (deploy and asynchronously listen) or query-style (deploy and synchronously listen). See [Chapter 24, "Processing Data In a Cache,"](#) for more information on using the invocation service.

The invocation service is accessed through the `com.tangosol.net.InvocationService` interface and includes the following two methods:

Example 1–1 *Methods in the InvocationService API*

```
public void execute(Invocable task, Set setMembers, InvocationObserver observer);  
public Map query(Invocable task, Set setMembers);
```

An instance of the service can be retrieved from the `com.tangosol.net.CacheFactory` class.

Coherence implements the `WorkManager` API for task-centric processing.

Event Programming

Coherence supports two event programming models that allow applications to receive and react to notifications of cluster operations. Applications observe events as logical concepts regardless of which computer caused the event. Events provide a common

way of extending Coherence with application-specific logic. The event programming models are:

- Live Events – The live event programming model uses user-defined event interceptors that are registered to receive different types of events. Applications decide what action to take based on the event type. Many events that are available through the use of map events are also supported using live events. For details, see [Chapter 27, "Using Live Events."](#)
- Map Events – The map event programming model uses user-defined map listeners that are attached to the underlying map implementation. Map events offer customizable server-based filters and lightweight events that can minimize network traffic and processing. Map listeners follow the JavaBean paradigm and can distinguish between system cache events (for example, eviction) and application cache events (for example, get/put operations). For details, see [Chapter 25, "Using Map Events,"](#) for more detailed information on using events.

Transactions

Coherence provides various transaction options. The options include: basic data concurrency using the `ConcurrentMap` interface and `EntryProcessor` API, partition-level transactions using implicit locking and the `EntryProcessor` API, atomic transactions using the Transaction Framework API, and atomic transactions with full XA support using the Coherence resource adapter. See [Chapter 29, "Performing Transactions"](#) for detailed instructions.

HTTP Session Management

Coherence*Web is an HTTP session-management module with support for a wide range of application servers. See *Administering HTTP Session Management with Oracle Coherence*Web* for more information on Coherence*Web.

Using Coherence session management does not require any changes to the application. Coherence*Web uses the near caching to provide fully fault-tolerant caching, with almost unlimited scalability (to several hundred cluster nodes without issue).

Object-Relational Mapping Integration

Most ORM products support Coherence as an "L2" caching plug-in. These solutions cache entity data inside Coherence, allowing application on multiple servers to share cached data. See *Integrating Oracle Coherence* for more information.

C++/.NET Integration

Coherence provides support for cross-platform clients (over TCP/IP). All clients use the same wire protocol (the servers do not differentiate between client platforms). Also, note that there are no third-party components in any of these clients (such as embedded JVMs or language bridges). The wire protocol supports event feeds and coherent in-process caching for all client platforms. See *Developing Remote Clients for Oracle Coherence* for complete instructions on using Coherence*Extend to support remote C++ and .NET clients.

Management and Monitoring

Coherence offers management and monitoring facilities by using Java Management Extensions (JMX). See *Managing Oracle Coherence* for detailed information on using JMX with Coherence.

Installing Oracle Coherence for Java

This chapter provides instructions for installing and running Oracle Coherence for Java (simply referred to as Coherence). The chapter does not include instructions for installing Coherence*Extend client distributions (C++ and .NET) or Coherence*Web. Refer to the *Developing Remote Clients for Oracle Coherence* and the *Administering HTTP Session Management with Oracle Coherence*Web*, respectively, for instructions on installing these components.

This chapter includes the following sections:

- [System Requirements](#)
- [Performing a Coherence Installation](#)
- [Browsing the Installation Directory](#)
- [Setting Environment Variables](#)
- [Running Coherence for the First Time](#)
- [Integration with Maven](#)
- [Deinstalling Coherence](#)

System Requirements

The following are the minimum requirements for running the Coherence installer:

- 300 MHz CPU
- 512 MB swap space
- 256 color monitor (required for GUI-based installation only)
- Java Development Kit (JDK) 1.6.0_4 or later

The following are the suggested minimum system requirements for running Coherence in a development environment:

- 100 MB disk space for complete installation (includes API documentation and examples)
- 1 GB of RAM (assuming a maximum Java heap size of 512MB) – This amount of RAM can ideally support a maximum cache size of 150MB on a single node that is configured to store a backup of all data (150MB x 2) and leaves more than a 1/3 of the heap available for scratch and JVM tasks. See *Administering Oracle Coherence* for recommendations on calculating cache size.
- JVM (JRE or JDK) 1.7 or later for Cache servers and clients; 1.6 or later for Coherence*Extend clients. A JDK is often used during development and offers

tools for monitoring and troubleshooting Java applications, but a JDK is not required to run Coherence.

- Windows or UNIX-based system that supports the required Java Version
- Network adapter

Performing a Coherence Installation

Coherence is installed using the Oracle Universal Installer. The installer provides both installation and patching services for Oracle products. The following installers are available for Coherence and detailed in this section.

- `fmw_version_coherence.jar` – A full Coherence installation that can be run in either graphical mode or silent mode. See [Running the Coherence Installer](#).
- `fmw_version_coherence_quick.jar` – A minimum Coherence installation that is always run in silent mode. The quick installer provides a smaller footprint and does not include API documentation or examples. See [Running the Coherence Quick Installer](#).
- `fmw_version_coherence_quick_supplemental.jar` – A supplemental installation that is always run in silent mode. The supplemental installer contains only API documentation and examples. See [Running the Coherence Supplemental Installer](#).
- `fmw_version_wls.jar` – A full WebLogic Server installation that includes Coherence. See [Installing Coherence with WebLogic Server](#).

Coherence is always installed to an `ORACLE_HOME/coherence` directory. The complete path to the `coherence` directory is referred to as `COHERENCE_HOME` throughout the Coherence documentation.

Running the Coherence Installer

The Coherence installer is distributed as an executable Java ARchive (JAR) file called `fmw_version_coherence.jar`. Use the `java` command to run the installer on the target computer. The installer supports both a graphical mode and a silent mode. For detailed help on the installer's options, use the `-help` argument when running the installer.

This section includes the following topics:

- [Performing a Coherence Installation In Graphical Mode](#)
- [Performing a Coherence Installation In Silent Mode](#)

Performing a Coherence Installation In Graphical Mode

To perform a Coherence installation in graphical mode:

1. Copy the `fmw_version_coherence.jar` file to the target computer.
2. From a command prompt, change directories to the location of the `coherence_version.jar` file and execute the following command (assuming that `JAVA_HOME/bin` is located on the computer's `PATH`):

```
java -jar fmw_version_coherence.jar
```

The Oracle Coherence installer starts and the Welcome screen displays. On UNIX-based platforms, you are first prompted (prior to the Welcome screen) to select an inventory directory where Oracle product inventory data is written. Follow the on-screen instructions to create an inventory directory.

3. Click **Next**. The Installation Location screen displays. Use the drop-down list to select an existing `ORACLE_HOME` directory to which Coherence will be installed, or enter an absolute path to create a new Coherence `ORACLE_HOME` directory. Click **Browse** to search for a directory if required. The directory cannot contain an existing Coherence installation.
4. Click **Next**. The Installation Type screen displays. Select which options to install.
5. Click **Next**. The Installation Summary screens displays. Verify the installation. Click **Save Response File** if you intend to duplicate this installation on additional computers. A response file is created that can be used to perform a silent install with the exact same installation settings. For details on performing a silent install, see "[Performing a Coherence Installation In Silent Mode](#)" on page 2-3.
6. Click **Install**. The Installation Progress screen displays and shows all tasks that have succeeded and failed.
7. Click **Next**. The Installation Complete screen displays and shows a summary of the installation.
8. Click **Finish** to close the Oracle Coherence installer.

Performing a Coherence Installation In Silent Mode

Silent mode allows Coherence to be installed without using a graphical interface and is ideal for remote installations or when incorporating the installation as part of a script. Silent mode typically uses a response file (`.rsp`) that contains the installation parameters as `name=value` pairs. Create a response file by running the installer in graphical mode and then saving the installation parameters to a response file at the Installation Summary screen. Use the saved file to replicate the installation on other computers or modify the file to change the installation as required.

To perform a Coherence installation in silent mode:

1. Copy the `fmw_version_coherence.jar` file and a response file to the target computer.
2. From a command prompt, change directories to the location of the `coherence_version.jar` file and execute the following command (assuming that `JAVA_HOME/bin` is located on the computer's `PATH`):

```
java -jar fmw_version_coherence.jar -silent -responseFile full_path_to_response_file -waitForCompletion
```

On UNIX-based platforms, the installer requires the location of the `oraInst.loc` inventory directory pointer file if it is not found in the default location (`/etc`). If this is the first time that an Oracle product has been installed on this computer, you can use the `createCentralInventory.sh` script to set up an inventory directory pointer file in the `/etc` directory. The script requires root permissions.

If you want to use a custom location for the `oraInst.loc` file, use the `-invPtrLoc` installer option to specify the location. For example:

```
java -jar fmw_version_coherence.jar -silent -responseFile full_path_to_response_file -waitForCompletion -invPtrLoc /MyDirectory/oraInst.loc
```

The contents of the `oraInst.loc` file contains the location and the ownership group for the inventory directory. For example:

```
inventory_loc=/MyDirectory/oraInventory
inst_group=group
```

Running the Coherence Quick Installer

The quick install is distributed as an executable JAR file called `fmw_version_coherence_quick.jar`. Use the `java` command to run the installer on the target computer. For detailed help on the installer's options, use the `-help` argument when running the installer.

The quick install performs a silent install with no options. The distribution includes less lifecycle tools but does register the Coherence components as part of the Oracle inventory, which allows future lifecycle operations to work. In addition, the installation does not include API documentation or code examples. The result is a faster installation process and a smaller installation footprint than the regular Coherence installer and is an ideal method for installing Coherence as part of a script without user interaction.

To perform a Coherence quick installation:

1. Copy the `fmw_version_coherence_quick.jar` file to a directory on the target computer.
2. From a command prompt, change directories to the location of the `fmw_version_coherence_quick.jar` file and execute the following command (assuming that `JAVA_HOME/bin` is located on the computer's `PATH`):

```
java -jar fmw_version_coherence_quick.jar ORACLE_HOME=/oracle
```

The value of the `ORACLE_HOME` variable specifies the `ORACLE_HOME` directory to which Coherence will be installed. The value must be an absolute path. If the directory already exists, it must be empty or it must be an existing valid `ORACLE_HOME`. The directory cannot contain an existing Coherence installation. If the directory does not exist, the installer creates the directory. You can also start the installation from an empty current working directory and omit the `ORACLE_HOME` variable; the current working directory becomes the `ORACLE_HOME` directory. For example:

```
cd /oracle
java -jar /tmp/fmw_version_coherence_quick.jar
```

On UNIX-based platforms, the quick installer attempts to find the `oraInst.loc` inventory directory pointer file in the `/etc` directory. If the file is not found, the `/tmp` directory is used as the inventory directory. If this is the first time that an Oracle product has been installed on this computer, you can use the `createCentralInventory.sh` script to set up an inventory directory pointer file in the `/etc` directory. The script requires root permissions.

If you want to use a custom location for the `oraInst.loc` file, use the `-invPtrLoc` installer option to specify the location. For example:

```
java -jar fmw_version_coherence_quick.jar -invPtrLoc /MyDirectory/oraInst.loc
```

The contents of the `oraInst.loc` file contains the location and the ownership group for the inventory directory. For example:

```
inventory_loc=/MyDirectory/oraInventory
inst_group=group
```

Running the Coherence Supplemental Installer

The supplemental install is distributed as an executable JAR file called `fmw_version_coherence_quick_supplemental.jar`. The distribution is used to install the API

documentation and code examples to an existing Coherence installation. The supplemental installer performs a silent install with no options. It is typically used together with the quick installer to perform an installation as part of a script without user interaction. If you do not require the API documentation or code examples, then you can skip the supplemental installation.

1. Copy the `fmw_version_coherence_quick_supplemental.jar` file to the `ORACLE_HOME` directory where Coherence is installed.
2. From a command prompt, change directories to the location of the `fmw_version_coherence_quick_supplemental.jar` file and execute the following command (assuming that `JAVA_HOME/bin` is located on the computer's `PATH`):

```
java -jar fmw_version_coherence_quick_supplemental.jar
```

The installation starts and status messages are emitted.

Installing Coherence with WebLogic Server

The WebLogic Server installer includes the Coherence distribution and installs Coherence in the same `ORACLE_HOME` directory as WebLogic Server. WebLogic Server includes a Coherence integration that standardizes how Coherence is managed and deployed within a WebLogic Server domain. The integration makes Coherence a subsystem of WebLogic Server and allows Coherence environments to be administered using WebLogic Server tools and infrastructure, such as Java EE-styled packaging and deployment, remote server management, server clusters, WebLogic Scripting Tool (WLST) automation, and configuration through the Administration Console. For details about installing Coherence with WebLogic Server, see *Installing and Configuring Oracle WebLogic Server and Coherence*.

Browsing the Installation Directory

The following directories are included in `COHERENCE_HOME`:

- `bin` – This directory includes a set of common scripts for performing different tasks, such as: starting a cache server, starting development tools, and performing network tests. The scripts are provided in both Windows (`.cmd`) and UNIX-based (`.sh`) formats.
- `doc` – This directory contains the Coherence Java API Reference and a link to the Coherence documentation on the Oracle Technology Network (OTN). The Coherence Java API Reference is distributed as a JAR file and must be extracted. The JAR can also be imported into an IDE for easy access during development.

To extract the Coherence Java API Reference, execute the following command from the `/api` directory (assuming that `JAVA_HOME/bin` is located on the computer's `PATH`):

```
jar -xvf CoherenceJavaDoc-version.jar
```

- `example` – This directory contains a set of examples that demonstrate many Coherence features and how to use the Coherence API. For detailed instructions on building and running the examples, see *Tutorial for Oracle Coherence*.
- `lib` – This directory includes all delivered libraries. The `coherence.jar` library is the main development and run-time library and is discussed in detail throughout this documentation.
- `plugins` – This directory contains plug-ins for common integrations. Coherence provides a plug-in for Maven and Java VisualVM. The Maven plug-ins are used to

integrate Coherence as part of a Maven build process. For details about the Coherence Maven plugins, see ["Integration with Maven"](#) on page 2-8. The Java VisualVM plug-in used to provide Coherence monitoring. For details about the Java VisualVM plug-in, see *Managing Oracle Coherence*.

Setting Environment Variables

The following system environment variables can be set, but they are not required to run Coherence:

- `JAVA_HOME` – This variable is used when running the scripts that are included in the `COHERENCE_HOME/bin` directory. The value of this variable is the full path to the Java installation directory. If `JAVA_HOME` is not set, the scripts use the computer's default Java installation. Set this variable to ensure that the scripts use a specific Java version.
- `COHERENCE_HOME` – This variable is typically set as a convenience. The value of this variable is the full path to the `ORACLE_HOME/coherence` directory.

Running Coherence for the First Time

The `COHERENCE_HOME/bin` directory includes scripts that are used during development and testing and are provided as a design-time convenience. The `cache-server` script starts a cache server using a default configuration. The `coherence` script starts a cache factory instance using a default configuration. The cache factory instance includes a command-line tool that is used to (among other things) create and interact with a cache.

In this scenario, a basic cluster is created and then the command-line tool is used to create and interact with a cache that is hosted in the cluster.

Create a Basic Cluster

In this step, a basic cluster is created that contains three separate Java processes: a cache server and two cache factory instances. For simplicity, the three processes are collocated on a single computer. The cache server, by default, is configured to store backup data. The two cache factory instances, by default, are configured not to store backup data. As each process is started, they automatically join and become cluster members (also referred to as cluster nodes).

For this example, the Coherence out-of-box default configuration is slightly modified to create a unique cluster which ensures that these cluster members do not attempt to join an existing Coherence cluster that may be running on the network.

Note: The Coherence default behavior is to use multicast to find cluster members. Coherence can be configured to use unicast if a network does not allow the use of multicast. See ["Using Well Known Addresses"](#) on page 7-9 for details.

To create a basic cluster:

1. Using a text editor, open the `COHERENCE_HOME/bin/cache-server` script.
2. Modify the `java_opts` variable to include the `tangosol.coherence.cluster` and the `tangosol.coherence.clusterport` system properties as follows:

```
set java_opts="-Xms%memory% -Xmx%memory% -Dtangosol.coherence.cluster=cluster_
```

```
name -Dtangosol.coherence.clusterport=port"
```

Replace *cluster_name* and *port* with values that are unique for this cluster. For example, use your name for the cluster name and the last four digits of your phone number for the port.

3. Save and close the `cache-server` script.
4. Repeat steps 1 to 3 for the `COHERENCE_HOME/bin/coherence` script.
5. Run the `cache-server` script. The cache server starts and output is emitted that provides information about this cluster member.
6. Run 2 instances of the `coherence` script. As each instance is started, output is emitted that provides information about the respective cluster members. Each instance returns a command prompt for the command-line tool.

Create a Cache

In this step, a cache is created and hosted on the basic cluster. A simple string is entered into the cache using the command-line tool of the first cache factory instance. The string is then retrieved from the cache using the command-line tool of the second cache factory instance. The example is simplistic and not very practical, but it does quickly demonstrate the distributed nature of Coherence caches. Moreover, these steps are typically performed directly using the Coherence API.

To create a cache:

1. At the command prompt for either cache factory instance, create a cache named `Test` using the `cache` command:

```
cache Test
```

2. At the command prompt, use the `put` command to place a simple string in the new cache by entering a key/value pair (separated by a space):

```
put key1 Hello
```

The command returns and displays `null`. The `put` command always returns the previous value for a given key. The `null` value is returned because this is the first value entered for this key.

3. Switch to the other cache factory instance and from the command prompt create the `Test` cache using the `cache` command:

```
cache Test
```

4. From this command prompt, retrieve the string in the cache using the `get` command and entering the key name:

```
get key1
```

The command returns and displays `hello`. Either cache factory process can add or remove cache entries because the processes are part of the same cluster and because the `Test` cache is known to all cluster members. In addition, since the cache server is storing a backup of the cache data, either cache factory process (or both) can be shutdown and the cache data persists.

Integration with Maven

Maven is a build and dependency system that allows the configuration of project dependencies, 3rd party dependencies and definition of a build lifecycle. Software projects often use Maven to simplify and standardize their build process. For details about Maven, see <http://maven.apache.org/>.

Oracle Middleware provides a plug-in that synchronizes an Oracle home directory with a Maven repository and standardizes Maven usage and naming conventions. The plug-in allows Coherence artifacts to be uploaded to a Maven repository, which simplifies how the artifacts are consumed in development projects. For details about setting up Maven and using the synchronization plug-in, see *Developing Applications Using Continuous Integration*.

In addition, the Maven integration includes an archetype and packaging plug-in for a Coherence Grid Archive (GAR). A Coherence GAR is a module type that is typically used to deploy Coherence applications within a WLS domain. The Maven archetype plug-in generates a GAR structure and provides example configuration files. The packaging plug-in generates a GAR based on a project's contents and dependencies and ensures that the dependencies, source, and configuration files are copied into the GAR.

The Maven plug-in and configuration files for Coherence are located in the `COHERENCE_HOME/plugins` directory. The Maven GAR plug-in and archetype are installed in the enterprise repository as part of the synchronization plug-in. For instructions on using the plug-in to incorporate Coherence into a build process, see *Developing Applications Using Continuous Integration*.

Deinstalling Coherence

Coherence is deinstalled using the Oracle Fusion Middleware deinstaller. The deinstaller allows you to select which components in a Coherence `ORACLE_HOME` directory to deinstall and can also be used to completely remove a Coherence `ORACLE_HOME` directory.

To deinstall Coherence using the deinstallation wizard:

1. Start the deinstaller using the Coherence `ORACLE_HOME/oui/bin/deinstall.sh` script on UNIX-based platforms or the Coherence `ORACLE_HOME\oui\bin\deinstall.cmd` script on Windows. A shortcut to the script is available on Windows and is located in the **Oracle** program group on the start menu. The Oracle Fusion Middleware Deinstaller starts and the Welcome screen displays.
2. Click **Next**. The Deinstallation Summary screen displays and lists the features that will be deinstalled.
3. Click **Deinstall**. The Deinstallation Progress screen displays and shows all tasks that have succeeded and failed.
4. Click **Next**. The Deinstallation Complete screen displays and shows a summary of the Deinstallation.
5. Click **Finish** to close the Oracle Fusion Middleware Deinstaller.

Note: Additional files in the `ORACLE_HOME` directory must be manually deleted. On Windows, you must also manually delete the **Oracle** program group on the Start menu.

Understanding Configuration

This chapter describes each of the default configuration files that are distributed with Coherence and details how applications and solutions override these files when creating their own Coherence configurations.

This chapter includes the following sections:

- [Overview of the Default Configuration Files](#)
- [Specifying an Operational Configuration File](#)
- [Specifying a Cache Configuration File](#)
- [Specifying a POF Configuration File](#)
- [Specifying Management Configuration Files](#)
- [Disabling Schema Validation](#)
- [Understanding the XML Override Feature](#)
- [Changing Configuration Using System Properties](#)

Overview of the Default Configuration Files

The Coherence distribution includes a set of default XML configuration files that are included within the `COHERENCE_HOME\lib\coherence.jar` library. The easiest way to inspect these files and their associated schemas is to extract the Coherence library to a directory.

The configuration files provide a default setup that allows Coherence to be used out-of-box with minimal changes. The files are for demonstration purposes only and can be reused or changed as required for a particular application or solution. However, the recommended approach is to provide configuration files that override the default configuration files.

The default configuration files include:

- `tangosol-coherence.xml` – This file provides operational and run-time settings and is used to create and configure cluster, communication, and data management services. This file is typically referred to as the operational deployment descriptor. The schema for this file is the `coherence-operational-config.xsd` file. See [Appendix A, "Operational Configuration Elements,"](#) for a complete reference of the elements in the operational deployment descriptor.
- `tangosol-coherence-override-dev.xml` – This file overrides operational settings in the `tangosol-coherence.xml` file when Coherence is started in developer mode. By default, Coherence is started in developer mode and the settings in this file are used. The settings in this file are suitable for development environments. The

schema file for this override file and the schema for the operational deployment descriptor are the same.

- `tangosol-coherence-override-eval.xml` – This file overrides operational settings in the `tangosol-coherence.xml` file when Coherence is started in evaluation mode. The settings in this file are suitable for evaluating Coherence. The schema file for this override file and the schema for the operational deployment descriptor are the same.
- `tangosol-coherence-override-prod.xml` – This file overrides operational settings in the `tangosol-coherence.xml` file when Coherence is started in production mode. The settings in this file are suitable for production environments. The schema file for this override file and the schema for the operational deployment descriptor are the same.
- `coherence-cache-config.xml` – This file is used to specify the various types of caches which can be used within a cluster. This file is typically referred to as the cache configuration deployment descriptor. The schema for this file is the `coherence-cache-config.xsd` file. See [Appendix B, "Cache Configuration Elements,"](#) for a complete reference of the elements in this file.
- `coherence-pof-config.xml` – This file is used to specify custom data types when using Portable Object Format (POF) to serialize objects. This file is typically referred to as the POF configuration deployment descriptor. The schema for this file is the `coherence-pof-config.xsd` file. See [Appendix C, "POF User Type Configuration Elements,"](#) for a complete reference of the elements in this file.
- Management configuration files – A set of files that are used to configure Coherence management reports. The files are located in the `/reports` directory within `coherence.jar`. The files include a report group configuration files (`report-group.xml`, the default), which refer to any number of report definition files. Each report definition file results in the creation of a report file that displays management information based on a particular set of metrics. The schema for these files are the `coherence-report-config.xsd` file and the `coherence-report-group-config.xsd` file, respectively. See *Managing Oracle Coherence* for detailed information on using reports and a reference for the elements in these configuration files.

Specifying an Operational Configuration File

The `tangosol-coherence.xml` operational deployment descriptor provides operational and run-time settings and is used to create and configure cluster, communication, and data management services. At run time, Coherence uses the first instance of `tangosol-coherence.xml` that is found in the classpath.

The default operational deployment descriptor that is shipped with Coherence is located in the root of the `coherence.jar` library. This file can be changed as required; however, overriding this file is recommended when configuring the operational run time. See ["Understanding the XML Override Feature"](#) on page 3-16 for detailed information about the XML override feature.

This section includes the following topics:

- [Using the Default Operational Override File](#)
- [Specifying an Operational Override File](#)
- [Defining Override Files for Specific Operational Elements](#)
- [Viewing Which Operational Override Files are Loaded](#)

Refer to [Part II, "Using Coherence Clusters"](#) for detailed instructions on configuring the operational run time.

Using the Default Operational Override File

Elements in the default `tangosol-coherence.xml` file are overridden by placing an operational override file named `tangosol-coherence-override.xml` in the classpath at run time. The structure of the override file and the operational deployment descriptor are the same except that all elements are optional. The override file includes only the elements that are being changed. Any missing elements are loaded from the `tangosol-coherence.xml` file.

In general, using the operational override file provides the most comprehensive method of configuring the operational run time and is used in both development and production environments.

To use the default operational override file:

1. Create a file named `tangosol-coherence-override.xml`.
2. Edit the file and add any operational elements that are to be overridden.

The following example configures a cluster name and overrides the default cluster name:

```
<?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 system-property="tangosol.coherence.cluster">
        MyCluster</cluster-name>
      </member-identity>
    </cluster-config>
  </coherence>
```

3. Save and close the file.
4. Make sure the location of the operational override file is located in the classpath at run time.

The following example demonstrates starting a cache server that uses an override file that is located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Tip: When using the `cache-server` and `coherence` scripts during development, add the location of the `tangosol-coherence-override.xml` file to the classpath using the `Java -cp` argument in each of the scripts.

Specifying an Operational Override File

The `tangosol.coherence.override` system property specifies an operational override file to be used instead of the default `tangosol-coherence-override.xml` file. The structure of the specified file and the operational deployment descriptor are the same

except that all elements are optional. Any missing elements are loaded from the `tangosol-coherence.xml` file.

The `tangosol.coherence.override` system property provides an easy way to switch between different operational configurations and is convenient during development and testing.

To specify an operational override file:

1. Create a text file.
2. Edit the file and add any operational elements that are to be overridden.

The following example configures the multicast port number:

```
<?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>
    <multicast-listener>
      <port system-property="tangosol.coherence.clusterport">3059</port>
    </multicast-listener>
  </cluster-config>
</coherence>
```

3. Save the file as an XML file and close the file.
4. Specify the name of the operational override file as a value of the `tangosol.coherence.override` system property. If the file is not located in the classpath, enter the full (or relative) path to the file and the name. The system property also supports the use of a URL when specifying the location of an operational override file.

The following example demonstrates starting a cache server and using an operational override file that is named `cluster.xml` which is located in `COHERENCE_HOME`.

```
java -Dtangosol.coherence.override=cluster.xml -cp COHERENCE_HOME;COHERENCE_
HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer
```

Defining Override Files for Specific Operational Elements

Override files can be created to override the contents of specific operational elements. The override files follow the same structure as the operational deployment descriptor except that their root element must match the element that is to be overridden. See ["Defining Custom Override Files"](#) on page 3-18 for detailed information on defining override files for specific operational elements.

In general, override files for specific operational elements provides fine-grained control over which portions of the operational deployment descriptor may be modified and allows different configurations to be created for different deployment scenarios.

To define override files for specific operational elements:

1. Create a `tangosol-coherence-override.xml` file as described in ["Using the Default Operational Override File"](#) on page 3-3.

2. Add an `xml-override` attribute to an element that is to be overridden. The value of the `xml-override` attribute is the name of an override file.

The following example defines an override file named `cluster-config.xml` that is used to override the `<cluster-config>` element.

```
<?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 xml-override="/cluster-config.xml">
    ...
  </cluster-config>
</coherence>
```

3. Save and close the file.
4. Create a text file.
5. Edit the file and add an XML node that corresponds to the element that is to be overridden. The XML root element must match the element that is to be overridden.

Using the example from step 2, the following node is created to override the `<cluster-config>` element and specifies a multicast join timeout.

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

<cluster-config 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">
  <multicast-listener>
    <join-timeout-milliseconds>4000</join-timeout-milliseconds>
  </multicast-listener>
</cluster-config>
```

6. Save the file as an XML file with the same name used in the `xml-override` attribute.
7. Make sure the location of both override files are located in the classpath at run time.

The following example demonstrates starting a cache server that uses override files that are located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Viewing Which Operational Override Files are Loaded

The output for a Coherence node indicates the location and name of the operational configuration files that are loaded at startup. The operational configuration messages are the first messages to be emitted when starting a process. The output is especially helpful when using multiple override files and is often useful when developing and testing Coherence applications and solutions.

The following example output demonstrates typical messages that are emitted:

```
Loaded operational configuration from resource "jar:file:/D:/coherence/lib/
```

```
coherence.jar!/tangosol-coherence.xml"
Loaded operational overrides from resource "jar:file:/D:/coherence/lib/
coherence.jar!/tangosol-coherence-override-dev.xml"
Loaded operational overrides from resource "file:/D:/coherence/
tangosol-coherence-override.xml"
Optional configuration override "/cluster-config.xml" is not specified
Optional configuration override "/custom-mbeans.xml" is not specified
```

The above output indicates that the operational deployment descriptor included in `coherence.jar` was loaded and that settings in this file are overridden by two loaded override files: `tangosol-coherence-override-dev.xml` and `tangosol-coherence-override.xml`. In addition, two override files were defined for specific operational elements but were not found or loaded at run time.

Specifying a Cache Configuration File

The `coherence-cache-config.xml` cache configuration deployment descriptor file is used to specify the various types of caches that can be used within a cluster. At run time, Coherence uses the first `coherence-cache-config.xml` file that is found in the classpath. A sample `coherence-cache-config.xml` file is included with Coherence and is located in the root of the `coherence.jar` library. The sample file is provided only for demonstration purposes. It can be changed or reused as required; however, it is recommended that a custom cache configuration deployment descriptor be created instead of using the sample file.

Note:

- It is recommended (although not required) that all cache server nodes within a cluster use identical cache configuration descriptors.
 - Coherence requires a cache configuration deployment descriptor to start. If the cache configuration deployment descriptor is not found at run time, an error message indicates that there was a failure loading the configuration resource and also provides the name and location for the file that was not found.
-
-

This section includes the following topics:

- [Using a Default Cache Configuration File](#)
- [Overriding the Default Cache Configuration File](#)
- [Using the Cache Configuration File System Property](#)
- [Viewing Which Cache Configuration File is Loaded](#)

Refer to [Part III, "Using Caches"](#) for detailed instructions on configuring caches.

Using a Default Cache Configuration File

Coherence is configured out-of-box to use the first `coherence-cache-config.xml` file that is found on the classpath. To use a `coherence-cache-config.xml` file, the file must be located on the classpath and must precede the `coherence.jar` library; otherwise, the sample `coherence-cache-config.xml` file that is located in the `coherence.jar` is used.

To use a default cache configuration file:

1. Make a copy of the sample `coherence-cache-config.xml` file that is located in the `coherence.jar` and save it to a different location. The cache definitions that are included in the sample file are for demonstration purposes and are used as a starting point for creating solution-specific cache configurations.
2. Ensure that the location where the `coherence-cache-config.xml` file is saved is in the classpath at run time and that the location precedes the `coherence.jar` file in the classpath.

The following example demonstrates starting a cache server that uses a `coherence-cache-config.xml` cache configuration file that is located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Overriding the Default Cache Configuration File

The default name and location of the cache configuration deployment descriptor is specified in the operational deployment descriptor within the `<configurable-cache-factory-config>` element. This element can be overridden to specify a different name and location to be used for the default cache configuration file.

To override the default cache configuration file:

1. Make a copy of the default `coherence-cache-config.xml` cache configuration file that is located in the `coherence.jar` and save it to a location with a different name.
2. Create a `tangosol-coherence-override.xml` file as described in ["Using the Default Operational Override File"](#) on page 3-3.
3. Edit the operational override file and enter a `<configurable-cache-factory-config>` node that specifies the name of the cache configuration file created in step 1. If the cache configuration file is not located in the classpath, enter the full (or relative) path to the file as well. The element also supports the use of a URL when specifying the location of a cache configuration file.

The following example specifies a cache configuration deployment descriptor called `MyConfig.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">
  <configurable-cache-factory-config>
    <init-params>
      <init-param>
        <param-type>java.lang.String</param-type>
        <param-value system-property="tangosol.coherence.cacheconfig">
          MyConfig.xml</param-value>
        </init-param>
      </init-params>
    </configurable-cache-factory-config>
  </coherence>
```

4. Save and close the file.

5. Ensure that the location of the operational override file is located in the classpath at run time.

The following example demonstrates starting a cache server using an operational override file and a custom cache configuration file that are located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar  
com.tangosol.net.DefaultCacheServer
```

Using the Cache Configuration File System Property

The `tangosol.coherence.cacheconfig` system property is used to specify a custom cache configuration deployment descriptor to be used instead of the configured default cache configuration deployment descriptor. The system property provides an easy way to switch between different configurations and is convenient during development and testing.

To specify a custom cache configuration file, enter the name of the file as a value of the `tangosol.coherence.cacheconfig` system property. This is typically done as a `-D` Java option when starting a Coherence node. If the file is not located in the classpath, enter the full (or relative) path to the file and the name. The system property also supports the use of a URL when specifying the location of a cache configuration file.

The following example starts a cache server and specifies a cache configuration deployment descriptor called `MyConfig.xml` that is located in `COHERENCE_HOME`.

```
java -Dtangosol.coherence.cacheconfig=MyConfig.xml -cp COHERENCE_HOME;COHERENCE_  
HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer
```

Viewing Which Cache Configuration File is Loaded

The output for a Coherence node indicates the location and name of the cache configuration deployment descriptor that is loaded at startup. The configuration message is the first message to display after the Coherence copyright text is emitted. The output is especially helpful when developing and testing Coherence applications and solutions.

The following example output demonstrates a cache configuration message which indicates that a cache configuration deployment descriptor named `Myconfig.xml` was loaded:

```
Loaded cache configuration from resource "file:/D:/coherence/Myconfig.xml"
```

Specifying a POF Configuration File

The `pof-config.xml` POF configuration deployment descriptor file is used to specify custom user types when using Portable Object Format (POF) for serialization. At run time, Coherence uses the first `pof-config.xml` file that is found in the classpath.

Note:

- It is recommended that all nodes within a cluster use identical POF configuration deployment descriptors.
- A POF configuration deployment descriptor is only loaded if the POF serializer is either configured as part of a cache scheme or configured globally for all cache schemes. The default `coherence-cache-config.xml` provides an example cache scheme that defines the POF serializer, but it is commented out by default.

This section includes the following topics:

- [Overriding the Default POF Configuration File](#)
- [Using the POF Configuration File System Property](#)
- [Combining Multiple POF Configuration Files](#)
- [Viewing Which POF Configuration Files are Loaded](#)

Refer to [Chapter 20, "Using Portable Object Format"](#) for detailed instructions on configuring POF user types.

Overriding the Default POF Configuration File

The default `pof-config.xml` POF configuration file is located in the root of the `coherence.jar` library. Coherence is configured out-of-box to use the first `pof-config.xml` file that is found on the classpath. To use a different `pof-config.xml` file, the file must be located on the classpath and must precede the `coherence.jar` library; otherwise, the default `pof-config.xml` file that is located in the `coherence.jar` library is used.

The POF configuration file should be customized for a particular application. The default POF configuration file references the `coherence-pof-config.xml` file. This is where the Coherence specific user types are defined and should always be included when creating a POF configuration file.

To override the Default POF Configuration File:

1. Create an XML file.
2. Edit the file and create a `<pof-config>` node that includes the default Coherence POF user types:

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

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

3. Save the file as `pof-config.xml` and close the file.
4. Ensure that the location of the POF configuration file is located in the classpath at run time.

The following example demonstrates starting a cache server and using a POF configuration file that is located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Using the POF Configuration File System Property

The `tangosol.pof.config` system property is used to specify a custom POF configuration deployment descriptor to be used instead of the default `pof-config.xml` file. The system property provides an easy way to switch between different configurations and is convenient during development and testing.

To specify a custom POF configuration file:

1. Create an XML file.
2. Edit the file and create a `<pof-config>` node that includes the default Coherence POF user types:

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

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

3. Save and close the file.
4. Enter the name of the file as a value of the `tangosol.pof.config` system property. This is typically done as a `-D` Java option when starting a Coherence node. If the file is not located in the classpath, enter the full (or relative) path to the file and the name. The system property also supports the use of a URL when specifying the location of a POF configuration file.

The following example starts a cache server and specifies a POF configuration deployment descriptor called `MyPOF.xml` that is located in `COHERENCE_HOME`.

```
java -Dtangosol.pof.config=MyPOF.xml -cp COHERENCE_HOME;COHERENCE_
HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer
```

Combining Multiple POF Configuration Files

The `<include>` element is used within a POF configuration deployment descriptor to include user types that are defined in different POF configuration deployment descriptors. This allows user types to be organized in meaningful ways, such as by application or development group.

Note: When combining multiple POF configuration files, each user type that is defined must have a unique `<type-id>`. If no type identifier is included, then the type identifiers are based on the order in which the user types appear in the composite configuration file.

To combine multiple POF configuration files:

1. Open an existing POF configuration file that is being loaded at startup.
2. Add an `<include>` element whose value is the name of a POF configuration file. If the file is not located in the classpath, enter the full (or relative) path to the file and the name. A URL can also be used to locate the file.

The following example combines two POF configuration files in addition to the default Coherence POF configuration file:

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

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

3. Save and close the file.
4. If required, ensure that the location of the POF configuration files are located in the classpath at run time.

The following example demonstrates starting a cache server that uses POF configuration files that are located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Viewing Which POF Configuration Files are Loaded

The output for a Coherence node indicates the location and name of the POF configuration deployment descriptors that are loaded at startup. The configuration messages are among the messages that display after the Coherence copyright text is emitted and are associated with the cache service that is configured to use POF. The output is especially helpful when developing and testing Coherence applications and solutions.

The following example output demonstrates POF configuration messages which indicate that four POF configuration deployment descriptors were loaded:

```
Loading POF configuration from resource "file:/D:/coherence/my-pof-config.xml"
Loading POF configuration from resource
"file:/D:/coherence/coherence-pof-config.xml"
Loading POF configuration from resource "file:/D:/coherence/hr-pof-config.xml"
Loading POF configuration from resource "file:/D:/coherence/crm-pof-config.xml"
```

Specifying Management Configuration Files

There are several different configuration files that are used to configure management. These include:

- report group configuration file – A report group configuration file is used to list the name and location of report definition files and the output directory where

reports are written. The name and location of this file is defined in the operational deployment descriptor. By default, the `report-group.xml` file is used and is located in the `/reports` directory of the `coherence.jar`. Additional report group configuration file are provided and custom report group files can be created as required.

- report configuration files – A report configuration file defines a report and results in the creation of a report file that displays management information for a particular set of metrics. Report configuration files must be referenced in a report group configuration file to be used at run time. The default report configuration files are located in the `/reports` directory of the `coherence.jar` and are referenced by the default report group configuration file. Custom report configuration files can be created as required.
- `custom-mbeans.xml` – This file is the default MBean configuration override file and is used to define custom MBeans (that is, application-level MBeans) within the Coherence JMX management and monitoring framework. This allows any application-level MBean to be managed and monitored from any node within the cluster. Custom MBeans can be defined within the operational override file. However, the MBean configuration override file is typically used instead.

This section includes the following topics:

- [Specifying a Custom Report Group Configuration File](#)
- [Specifying an MBean Configuration File](#)
- [Viewing Which Management Configuration Files are Loaded](#)

See *Managing Oracle Coherence* for detailed instructions on managing Coherence.

Specifying a Custom Report Group Configuration File

The name and location of the default report group configuration file is specified in the operational configuration deployment descriptor within the `<management-config>` node. A custom report group configuration file can be specified by either using an operational override file or a system property.

Note: The report group configuration file is only loaded if JMX management is enabled. The examples in this section demonstrate enabling JMX management on nodes that host an MBean server.

Overriding the Default Report Group Configuration File

The name and location of a custom report group configuration file can be specified using an operational override file. This mechanism overrides the default name and location of the report group configuration file.

To override the default report group configuration file:

1. Create an XML file.
2. Edit the file and create a `<report-group>` node as follows. This example configures a single report.

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

<report-group xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-report-group-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/
  coherence-report-group-config coherence-report-group-config.xsd">
```

```

<frequency>1m</frequency>
<output-directory>./</output-directory>
<report-list>
  <report-config>
    <location>reports/report-node.xml</location>
  </report-config>
</report-list>
</report-group>

```

3. Save and close the file.
4. Create a `tangosol-coherence-override.xml` file as described in ["Using the Default Operational Override File"](#) on page 3-3.
5. Edit the file and enter a `<management-config>` node that specifies the name of the report group configuration file. If the report group configuration file is not located in the classpath, enter the full (or relative) path to the file as well. The element also supports the use of a URL when specifying the location of a report group configuration file.

The following example enables JMX management and specifies a report group configuration deployment descriptor called `my-group.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">
  <management-config>
    <managed-nodes system-property="tangosol.coherence.management">
      all</managed-nodes>
    <reporter>
      <configuration system-property="tangosol.coherence.management.report.
        configuration">my-group.xml</configuration>
    </reporter>
  </management-config>
</coherence>

```

6. Save and close the file.
7. Ensure that the location of the operational override file is located in the classpath at run time.

The following example demonstrates starting a cache server using an operational override file and a report group configuration file that are located in `COHERENCE_HOME`.

```

java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer

```

Using the Report Group Configuration File System Property

The `tangosol.coherence.management.report.configuration` system property is used to specify a custom report group configuration file to be used instead of the default `report-group.xml` file. The system property provides an easy way to switch between different configurations and is convenient during development and testing.

To specify a custom report group configuration file, enter the name of the file as a value of the `tangosol.coherence.management.report.configuration` system property. This is typically done as a `-D` Java option when starting a Coherence node. If

the file is not located in the classpath, enter the full (or relative) path to the file and the name. The system property also supports the use of a URL when specifying the location of a report group configuration file.

The following example starts a cache server, enables JMX management, and specifies a report group configuration file that is named `my-group.xml` and is located in `COHERENCE_HOME`.

```
java -Dtangosol.coherence.management=all
-Dtangosol.coherence.management.report.configuration=my-group.xml -cp COHERENCE_
HOME;COHERENCE_HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer
```

Specifying an MBean Configuration File

The `tangosol-coherence.xml` operational deployment descriptor defines an operational override file that is named `custom-mbeans.xml` and is specifically used to define custom MBeans. A name and location of the override file may also be specified using the MBean configuration file system property.

Using the Default MBean Configuration Override File

Custom MBeans are defined within an override file named `custom-mbeans.xml`. At run time, Coherence uses the first instance of `custom-mbeans.xml` that is found in the classpath.

To use the default MBean configuration override file:

1. Create a file named `custom-mbeans.xml`.
2. Edit the file and create an empty `<mbeans>` node as follows:

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

<mbeans 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">
</mbeans>
```

3. Save and close the file.
4. Make sure the location of the custom MBean configuration override file is located in the classpath at run time.

The following example demonstrates starting a cache server that uses a default MBean configuration override file that is located in `COHERENCE_HOME`.

```
java -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Using the MBean Configuration File System Property

The `tangosol.coherence.mbeans` system property specifies an MBean configuration override file to be used instead of the default `custom-mbeans.xml` override file. The system property provides an easy way to switch between different MBean configurations and is convenient during development and testing.

To specify an MBean configuration override file, enter the name of the file as a value of the `tangosol.coherence.mbeans` system property. This is typically done as a `-D` Java option when starting a Coherence node. If the file is not located in the classpath, enter

the full (or relative) path to the file and the name. The system property also supports the use of a URL when specifying the location of an MBean configuration override file.

The following example starts a cache server and specifies an MBean configuration override file that is named `my-mbeans.xml` and is located in `COHERENCE_HOME`.

```
java -Dtangosol.coherence.mbeans=my-mbeans.xml -cp COHERENCE_HOME;COHERENCE_HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer
```

Viewing Which Management Configuration Files are Loaded

The output for a Coherence node indicates the location and name of the report group configuration file and the MBean configuration file that are loaded at startup. The output is especially helpful when developing and testing Coherence applications and solutions.

Report Group Configuration File

The report group configuration messages are among the messages that display after the Coherence copyright text is emitted.

The following example output demonstrates a report group configuration message that indicates the `my-group.xml` file is loaded:

```
Loaded Reporter configuration from "file:/D:/coherence/my-group.xml"
```

MBean Configuration Override File

The MBean configuration message is emitted with the other operational override messages and is among the first messages to be emitted when starting a process. The output is especially helpful when using override files and is often useful when developing and testing Coherence applications and solutions.

The following example output demonstrates an operational override message that indicates the default MBean configuration override file is loaded:

```
Loaded operational overrides from resource "file:/D:/coherence/custom-mbeans.xml"
```

Disabling Schema Validation

Coherence uses schema validation to ensure that configuration files adhere to their respective schema definition. Configuration files that include a schema reference are automatically validated against the schema when the configuration file is loaded. A validation error causes an immediate failure and an error message is emitted that indicates which element caused the error. Schema validation should always be used as a best practice.

Schema validation can be disabled if required. To disable schema validation, remove the `xsi:schemaLocation` attribute from a configuration file. The following example creates a `tangosol-coherence-override.xml` file that does not contain a schema reference and is not validated when loaded:

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

<coherence xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-operational-config">
  ...
</coherence>
```

Note: When schema validation is disabled, Coherence only fails if the XML is malformed. Syntactical errors are ignored and may not be immediately apparent.

Understanding the XML Override Feature

The XML override feature is a configuration mechanism that allows any operational settings to be changed without having to edit the default `tangosol-coherence.xml` operational deployment descriptor that is located in the `coherence.jar`. This mechanism is the preferred way of configuring the Coherence operational run time.

The XML override feature works by associating an XML document, commonly referred to as an override file, with a specific operational XML element. The XML element, and any of its subelements, are then modified as required in the override file. At run time, Coherence loads the override file and its elements replace (or are added to) the elements that are in the `tangosol-coherence.xml` file.

An override file does not have to exist at run time. However, if the override file does exist, then its root element must match the element it overrides. In addition, subelements are optional. If a subelement is not defined in the override file, it is loaded from the `tangosol-coherence.xml` file. Typically, only the subelements that are being changed or added are placed in the override file.

This section includes the following topics:

- [Using the Predefined Override Files](#)
- [Defining Custom Override Files](#)
- [Defining Multiple Override Files for the Same Element](#)

Using the Predefined Override Files

Multiple override files are predefined and can override elements in the operational deployment descriptor. These files must be manually created and saved to a location in the classpath.

- `tangosol-coherence-override.xml` – This override file is defined for the `<coherence>` root element and is used to override any element in the operational deployment descriptor. The root element in this file must be the `<coherence>` element.
- `custom-mbeans.xml` – This override file is defined for the `<mbeans>` element and is used to add custom MBeans to the operational deployment descriptor. The root element in this file must be the `<mbeans>` element.
- `cache-factory-config.xml` – This override file is defined for the `<configurable-cache-factory-config>` element and is used to customize a configurable cache factory. This override file is typically only used to support container integrations. The `<configurable-cache-factory-config>` element is not commonly overridden.
- `cache-factory-builder-config.xml` – This override file is defined for the `<cache-factory-builder-config>` element and is used to customize a cache factory builder. This override file is typically only used to support container integrations. The `<cache-factory-builder-config>` element is not commonly overridden.

The following example demonstrates a `tangosol-coherence-override.xml` file that is used to override the default cluster name. All other operational settings are loaded from the `tangosol-coherence.xml` file.

```
<?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 system-property="tangosol.coherence.cluster">MyCluster
    </cluster-name>
    </member-identity>
  </cluster-config>
</coherence>
```

The following example demonstrates a `tangosol-coherence-override.xml` file that is used to disable local storage for the distributed cache service on this node. Notice the use of an `id` attribute to differentiate an element that can have multiple occurrences. The `id` attribute must match the `id` attribute of the element being overridden.

```
<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="4">
            <param-name>local-storage</param-name>
            <param-value system-property="tangosol.coherence.distributed.
localstorage">>false</param-value>
          </init-param>
        </init-params>
      </service>
    </services>
  </cluster-config>
</coherence>
```

The following example demonstrates a `custom-mbean.xml` file that adds a standard MBean definition to the list of MBeans.

```
<mbeans 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">
  <mbean id="100">
    <mbean-class>com.oracle.customMBeans.Query</mbean-class>
    <mbean-name>type=Query</mbean-name>
    <enabled>>true</enabled>
  </mbean>
</mbeans>
```

Defining Custom Override Files

Any element in the `tangosol-coherence.xml` deployment descriptor can be overridden using the predefined `tangosol-coherence-override.xml` file. However, there may be situations where more fine-grained configuration control is required. For example, a solution may want to allow changes to certain elements, but does not want to allow changes to the complete operational deployment descriptor. As another example, a solution may want to provide different configurations based on different use cases. Custom override files are used to support these types of scenarios.

Using the `xml-override` and `id` attributes

Override files are defined using the `xml-override` attribute and, if required, the `id` attribute. Both of these attributes are optional and are added to the operational element that is to be overridden. See "[Attribute Reference](#)" on page A-100 for a list of the operational elements that support the use of an override file.

The value of the `xml-override` attribute is the name of a document that is accessible to the classes contained in the `coherence.jar` library using the `ClassLoader.getResourceAsStream(String name)` method. In general, the file name contains a `/` prefix and is located in the classpath at run time. The attribute also supports the use of a URL when specifying the location of an override file.

For example, to define an override file named `cluster-config.xml` that is used to override the `<cluster-config>` element, add an `xml-override` attribute to the `<cluster-config>` element in the `tangosol-coherence-override.xml` file as shown below:

```
<?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 xml-override="/cluster-config.xml">
    ...
  </cluster-config>
</coherence>
```

To use this override file, create a document named `cluster-config.xml` and ensure that it and the base document (`tangosol-coherence-override.xml` in this case) are located in a directory that is in the classpath at run time. For this example, the override file's root element must be `<cluster-config>` as shown below.

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

<cluster-config 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">
  <multicast-listener>
    <join-timeout-milliseconds>4000</join-timeout-milliseconds>
  </multicast-listener>
</cluster-config>
```

An `id` attribute is used to distinguish elements that can occur multiple times.

For example, to define a custom override file named `dist-service-config.xml` that is used to override the `<service>` element for the distributed cache service, add an `xml-override` attribute to the `<service>` element whose `id` is number 3 as shown below

```

<?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>
    <services>
      <service id="3" xml-override="/dist-service-config.xml">
      </service>
    </services>
  </cluster-config>
</coherence>

```

To use this override file, create a document named `dist-service-config.xml` and ensure that it is located in a directory that is in the classpath at run time. For this example, the override file's root element must be `<service>` as shown below.

```

<?xml version='1.0'?>

<service id="3" 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">
  <init-params>
    <init-param id="1">
      <param-name>standard-lease-milliseconds</param-name>
      <param-value>2</param-value>
    </init-param>
  </init-params>
</service>

```

Note: If the element's `id` in the override document does not have a match in the base document, the elements are just appended to the base document.

Defining Multiple Override Files for the Same Element

Multiple override files can be defined for the same element to chain operational override files. This is typically done to allow operational configurations based on different deployment scenarios, such as staging and production.

As an example, the `tangosol-coherence.xml` operational deployment descriptor located in `coherence.jar` defines an operational override file for the `<coherence>` element as follows:

```

<?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"
  xml-override="{tangosol.coherence.override/tangosol-coherence-override-
  {mode}.xml}">
  ...
</coherence>

```

The mode-specific override files are also located in `coherence.jar` and are used depending on the Coherence start mode (the value of the `<license-mode>` element).

Each of the mode-specific operational override files, in turn, defines the default operational override file as follows:

```
<?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"
  xml-override="/tangosol-coherence-override.xml">
  ...
</coherence>
```

A fourth override file can be defined for the `<coherence>` element in the `tangosol-coherence-override.xml` file. For example:

```
<?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"
  xml-override="/tangosol-coherence-override-staging.xml">
  ...
</coherence>
```

The chain can continue as required. The files are all loaded at run time if they are placed in a location in the classpath. Files higher up in the chain always override files below in the chain.

Changing Configuration Using System Properties

The command-line override feature allows operational and cache settings to be overridden using system properties. System properties are typically specified on the Java command line using the `Java -D` option. This allows configuration to be customized for each node in a cluster while using the same operational configuration file and cache configuration file across the nodes. System properties are also a convenient and quick way to change settings during development.

This section includes the following topics:

- [Using Preconfigured System Properties](#)
- [Creating Custom System Properties](#)

Using Preconfigured System Properties

Coherence includes many preconfigured system properties that are used to override different operational and cache settings. [Table D-1](#) lists all the preconfigured system properties. The preconfigured system properties are defined within the `tangosol-coherence.xml` and `coherence-cache-config.xml` default deployment descriptors, respectively, using `system-property` attributes.

For example, the preconfigured `tangosol.coherence.log.level` system property is defined in the `tangosol-coherence.xml` file as follows:

```
<logging-config>
  ...
  <severity-level system-property="tangosol.coherence.log.level">5
</severity-level>
```

```
...
</logging-config>
```

To use a preconfigured system property, add the system property as a Java `-D` option at startup. For the above example, the log level system property is specified as follows when starting a cache server:

```
java -Dtangosol.coherence.log.level=3 -cp COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

Note: When using an operational override file and when creating a custom cache configuration file; the preconfigured system properties must always be included along with the element that is to be overridden; otherwise, the property is no longer available.

Creating Custom System Properties

Custom system properties can be created for any operational or cache configuration element. The names of the preconfigured system properties can also be changed as required.

System properties are defined by adding a `system-property` attribute to the element that is to be overridden. The value of the `system-property` attribute can be any user-defined name. Custom system properties are typically defined in an operational override file (such as `tangosol-coherence-override.xml`) and a custom cache configuration file.

Defining a System Property for an Operational Element

The following example defines a system property called `multicast.join.timeout` for the `<join-timeout-milliseconds>` operational element and is added to an operational override file:

```
<?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>
    <multicast-listener>
      <join-timeout-milliseconds system-property="multicast.join.timeout">30000
      </join-timeout-milliseconds>
    </multicast-listener>
  </cluster-config>
</coherence>
```

Defining a System Property for a Cache Configuration element

The following example defines a system property called `cache.name` for a `<cache-name>` element and is added to a custom cache configuration file:

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

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

```
<caching-scheme-mapping>
  <cache-mapping>
    <cache-name system-property="cache.name"></cache-name>
    ...
  </cache-mapping>
</caching-scheme-mapping>
```

Changing a Preconfigured System Property

The following example changes the preconfigured system property name for the <cluster-name> operational element and is added to an operational override file:

```
<?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 system-property="myapp.cluster.name"></cluster-name>
    </member-identity>
  </cluster-config>
</coherence>
```

Note: To remove a system property, delete the system property attribute from the element. If a system property is used at run time and it does not exist, it is disregarded.

Building Your First Coherence Application

This chapter provides step-by-step instructions for building and running a basic Coherence example and demonstrates many fundamental Coherence concepts. The sample application is a simple Hello World application and is implemented both as a standalone Java application and a JSP application. Lastly, a JDeveloper section has been included that provides some basic instructions for setting up JDeveloper when developing with Coherence.

Note: The example in this chapter is basic and is only intended to teach general concepts. For more advanced examples, refer to the examples included with the installation. The examples are also distributed as part of the Coherence supplemental installation. For detailed instructions on building and running the examples, see *Tutorial for Oracle Coherence*.

This chapter includes the following sections:

- [Task 1: Define the Example Cache](#)
- [Task 2: Configure and Start the Example Cluster](#)
- [Task 3: Create and Run a Basic Coherence Standalone Application](#)
- [Task 4: Create and Run a Basic Coherence JavaEE Web Application](#)
- [Using JDeveloper for Coherence Development](#)

Task 1: Define the Example Cache

Caches are defined in a cache configuration deployment descriptor and are referred to by name within an application. This allows configuration changes to be made to a cache without having to change an application's code. The following cache configuration defines a basic distributed cache which is mapped to the cache name `hello-example`.

To define the example cache:

1. Create an XML file named `example-config.xml`.
2. Copy the following distributed cache definition to the file:

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
```

```

coherence-cache-config.xsd">
<キャッシング-scheme-mapping>
  <cache-mapping>
    <cache-name>hello-example</cache-name>
    <scheme-name>distributed</scheme-name>
  </cache-mapping>
</キャッシング-scheme-mapping>

<キャッシング-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>
</キャッシング-schemes>
</cache-config>

```

3. Save and close the file.

Task 2: Configure and Start the Example Cluster

Caches are hosted on a Coherence cluster. At run time, any JVM process that is running Coherence automatically joins the cluster and can access the caches and other services provided by the cluster. When a JVM joins the cluster, it is called a cluster node, or alternatively, a cluster member. For the sample applications in this chapter, two separate Java processes form the cluster: a cache server process and the Hello World application process. For simplicity, the two processes are collocated on a single computer. The cache server, by default, is configured to store cache data.

The example cluster uses 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 two processes do not attempt to join an existing Coherence cluster that may be running on the network. The default configuration is also modified to load the `example-config.xml` cache configuration file instead of the default cache configuration file.

To configure and start the example cluster:

1. Create a file named `tangosol-coherence-override.xml`.
2. Add the following override configuration and replace `cluster_name` and `port` with values that are unique for this cluster. For example, use your name for the cluster name and the last four digits of your phone number for the port.

```

<?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>

<configurable-cache-factory-config>
    <init-params>
        <init-param>
            <param-type>java.lang.String</param-type>
            <param-value system-property="tangosol.coherence.cacheconfig">
                example-config.xml</param-value>
        </init-param>
    </init-params>
</configurable-cache-factory-config>
</coherence>

```

3. Save the file to the same directory where the `example-config.xml` file was saved.
4. From a command prompt, start a cache server instance using the `DefaultCacheServer` class and include the location of the `coherence.jar` library and the configuration files as a Java `-cp` option. For example:

```

java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer

```

Task 3: Create and Run a Basic Coherence Standalone Application

Step 3 is a multi-part step that includes a sample Hello World application and instructions for running and verifying the example. The application is run from the command line and starts a cache node that joins with a cache server. The application puts a key named `k1` with the value `Hello World!` into the `hello-example` cache and then gets and prints out the value of the key before exiting. Lastly, an additional cluster node is started to verify that the key is in the cache.

Create the Sample Standalone Application

Applications use the Coherence API to access and interact with a cache. The `CacheFactory` class is used to get an instance of a cache and the `NamedCache` interface is used to retrieve and store objects in the cache. The Hello World application is very basic, but it does demonstrate using the `CacheFactory` class and the `NamedCache` interface.

Example 4-1 The Sample HelloWorld Standalone Application

```

package com.examples;

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

public class HelloWorld {

    public static void main(String[] args) {

        String key = "k1";
        String value = "Hello World!";

        CacheFactory.ensureCluster();
        NamedCache cache = CacheFactory.getCache("hello-example");
    }
}

```

```
        cache.put(key, value);
        System.out.println((String) cache.get(key));

        CacheFactory.shutdown();
    }
}
```

Run the Sample Standalone Application

To run the standalone application example:

1. From a command prompt, compile the Hello World application. For example:

```
javac -cp COHERENCE_HOME\lib\coherence.jar com\examples\HelloWorld.java
```

2. Run the Hello World application and include the location of the `coherence.jar` library and the configuration files as a Java `-cp` option. In addition, restrict the client from locally storing partitioned data. For example:

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false com.example>HelloWorld
```

The Hello World application starts. The cache factory instance is created and becomes a member of the cluster. The `k1` key with the `Hello World!` value is loaded into the `hello-example` cache. The key is then retrieved from the cache and the value is emitted as part of the output. Lastly, the cache factory is shutdown and leaves the cluster before the Hello World application exits.

Verify the Example 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 Hello World application exits after it loads and displays a key in the cache. However, the cache and key are still available for all cluster members.

This step uses the cache factory command-line tool to connect to the `hello-example` cache and list all items in the cache. It demonstrates both the persistent and distributed nature of Coherence caches.

To verify the cache:

1. From a command prompt, start a standalone cache factory instance using the `CacheFactory` class and include the location of the `coherence.jar` library and the configuration files as a Java `-cp` option. For example:

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false
com.tangosol.net.CacheFactory
```

The cache factory instance starts and becomes a member of the cluster and returns a command prompt for the command-line tool.

2. At the command-line tool command prompt, get the `hello-example` cache using the `cache` command:

```
cache hello-example
```

3. At the command-line tool command prompt, retrieve the contents of the cache using the `list` command.

```
list
```

The command returns and displays:

```
k1 = Hello World!
```

Task 4: Create and Run a Basic Coherence JavaEE Web Application

Step 4 is a multi-part step that includes the Hello World application re-implemented as a JSP page. Instructions are included for packaging the sample as a Web application to be deployed to a JavaEE server. The application runs on the application server and starts a cache node that joins with a cache server. The application puts a key named `k2` with the value `Hello World!` into the `hello-example` cache and then gets and prints out the value of the key before exiting. Lastly, an additional cluster node is started to verify that the key is in the cache.

Note: WebLogic server includes a Coherence integration that standardizes the packaging and deployment of Coherence applications. For Weblogic server instructions about packaging and deploying Coherence applications, see *Administering Oracle Coherence*. The instructions in this section are not specific to, or recommended for, WebLogic Server.

Create the Sample Web Application

To create the sample Web application:

1. Create a basic Web application directory structure as follows:

```
/
/WEB-INF
/WEB-INF/classes
/WEB-INF/lib
```

2. Copy the below JSP to a text file and save the file as `hello.jsp` in the root of the Web application directory.

Example 4-2 The Sample Hello World JSP

```
<html>
<head>
  <title>My First Coherence Cache</title>
</head>
<body>
  <h1>
    <%@ page language="java"
      import="com.tangosol.net.CacheFactory,
            com.tangosol.net.NamedCache"
    %>
    <%
      String key = "k2";
      String value = "Hello World!";

      CacheFactory.ensureCluster();
      NamedCache cache = CacheFactory.getCache("hello-example");

      cache.put(key, value);
```

```
        out.println( (String)cache.get(key) );

        CacheFactory.shutdown();
    %>
</h1>
</body>
</html>
```

3. Copy the following empty Web application deployment descriptor to a text file and save the file as `web.xml` in the `/WEB-INF` directory.

```
<?xml version = '1.0' ?>
  <web-app/>
```

4. Copy the `coherence.jar` file to the `WEB-INF/lib` directory.
5. Copy the `example-config.xml` file and the `tangosol-coherence-override.xml` file to the `WEB-INF/classes` directory.
6. Create a Web ARchive file (WAR) using the `jar` utility and save the file as `hello.war`. For example, issue the following command from a command prompt at the root of the Web application directory:

```
jar -cvf hello.war *
```

The archive should contain the following files

```
/hello.jsp
/WEB-INF/web.xml
/WEB-INF/classes/example-config.xml
/WEB-INF/classes/tangosol-coherence-override.xml
/WEB-INF/lib/coherence.jar
```

Deploy and Run the Sample Web Application

To deploy and run the Web application example:

1. Deploy the `hello.war` file to a JavaEE server.
2. From a browser, run the Hello World application by accessing the `hello.jsp` file using the following URL. Substitute `host` and `port` with values specific to the deployment.

```
http://host:port/hello/hello.jsp
```

The Hello World application starts. The cache factory instance is created and becomes a member of the cluster. The `k2` key with the `Hello World!` value is loaded into the `hello-example` cache. The key is then retrieved from the cache and the value is displayed in the browser. Lastly, the cache factory shuts down and leaves the cluster.

Verify the Example 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 Hello World application exits after it loads and displays a key in the cache. However, the cache and key are still available for all cluster members.

This step uses the cache factory command-line tool to connect to the `hello-example` cache and list all items in the cache. It demonstrates both the persistent and distributed nature of Coherence caches.

To verify the cache:

1. From a command prompt, start a standalone cache factory instance using the `CacheFactory` class and include the location of the `coherence.jar` library and the configuration files as a Java `-cp` option. For example:

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false
com.tangosol.net.CacheFactory
```

The cache factory instance starts and becomes a member of the cluster and returns a command prompt for the command-line tool.

2. At the command-line tool command prompt, get the `hello-example` cache using the `cache` command:

```
cache hello-example
```

3. At the command-line tool command prompt, retrieve the contents of the cache using the `list` command.

```
list
```

The command returns and displays:

```
k2 = Hello World!
```

Using JDeveloper for Coherence Development

This section provides basic instructions on how to setup JDeveloper for Coherence development. The instructions are for running Coherence within the IDE which is a common approach during development. While the instructions are specific to JDeveloper, the same approach should be possible with any IDE. See your IDE's documentation for specific instructions.

- [Running Coherence in JDeveloper](#)
- [Viewing Thread Dumps in JDeveloper](#)
- [Creating Configuration Files in JDeveloper](#)

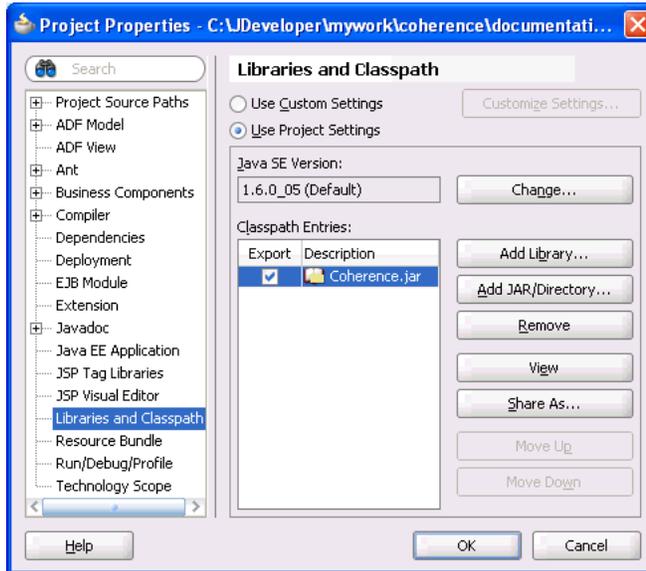
Running Coherence in JDeveloper

JDeveloper can run cache server (`DefaultCacheServer`) and cache (`CacheFactory`) instances. Each instance is started as a separate Java process and emits standard output to the process' log. Input (such as cache commands) can be entered directly in the process as if it were started from the command line. This configuration facilitates development and testing Coherence solutions.

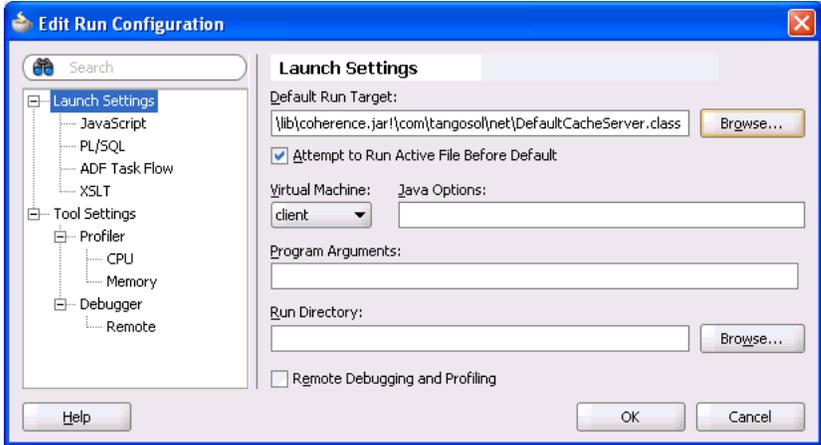
To run Coherence in JDeveloper:

1. In JDeveloper, create a new Generic Application, which includes a single project. If you are new to JDeveloper, consult the Online Help for detailed instructions.
2. In the Application Navigator, double-click the new project. The Project Properties dialog box displays.

3. Select the **Libraries and Classpath** node. The Libraries and Classpath page displays
4. On the Libraries and Classpath page, click **Add JAR/Directory**. The Add Archive or Directory dialog box displays.
5. From the directory tree, select `COHERENCE_HOME\lib\coherence.jar` and click **Select**. The `coherence.jar` library displays in the Classpath Entries list as shown below:

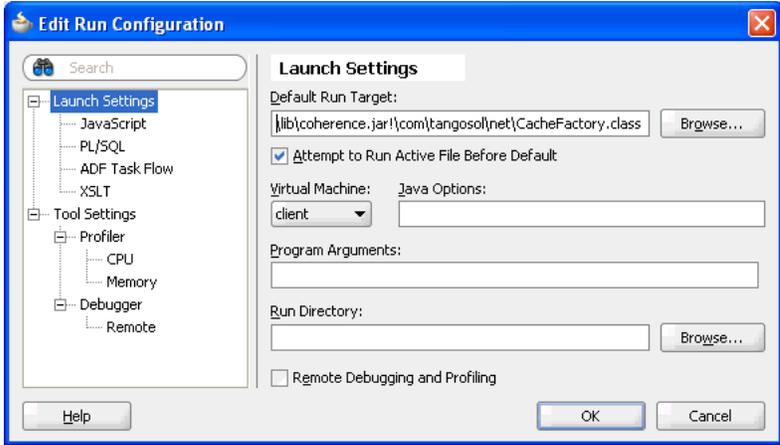


6. From the Project Properties dialog box, select the **Run/Debug/Profile** node. The Run/Debug/Profile page displays.
7. From the Run/Debug/Profile page, click **New**. The Create Run Configuration dialog box displays.
8. In the Name text box, enter a name for the new run configuration. In the Copy Settings From drop-down box, choose **default**. Click **OK**. The new run configuration displays in the Run Configuration list.
9. From the Run Configuration list, select the new Run Configuration and click **Edit**. The Edit Run Configuration dialog box displays and the Launch Settings node is selected.
10. From the Launch Settings page, click **Browse** to select a Default Run Target. The Choose Default Run Target dialog box displays.
11. From the directory tree, select `COHERENCE_HOME\lib\coherence.jar\com\tangosol\net\DefaultCacheServer.class` and click **Open**. The `DefaultCacheServer` class is entered as the default run target as shown below:



Tip: Use the Java Options text box to set Coherence system properties.

- 12. Select the Tool Settings Node. The Tool Settings page displays.
- 13. From the Additional Runner Options section, click the **Allow Program Input** check box. A check mark in the box indicates that the option is selected.
- 14. Click **OK**.
- 15. Repeat Steps 6 through 14 and select `COHERENCE_HOME\lib\coherence.jar\com\tangosol\net\CacheFactory.class` as the default run target as shown below:



- 16. Click **OK** to close the Project Properties dialog box.
- 17. Use the Run button drop-down list to select and start the run configuration for the cache server. A cache server instance is started and output is shown in the process's log tab as shown below:

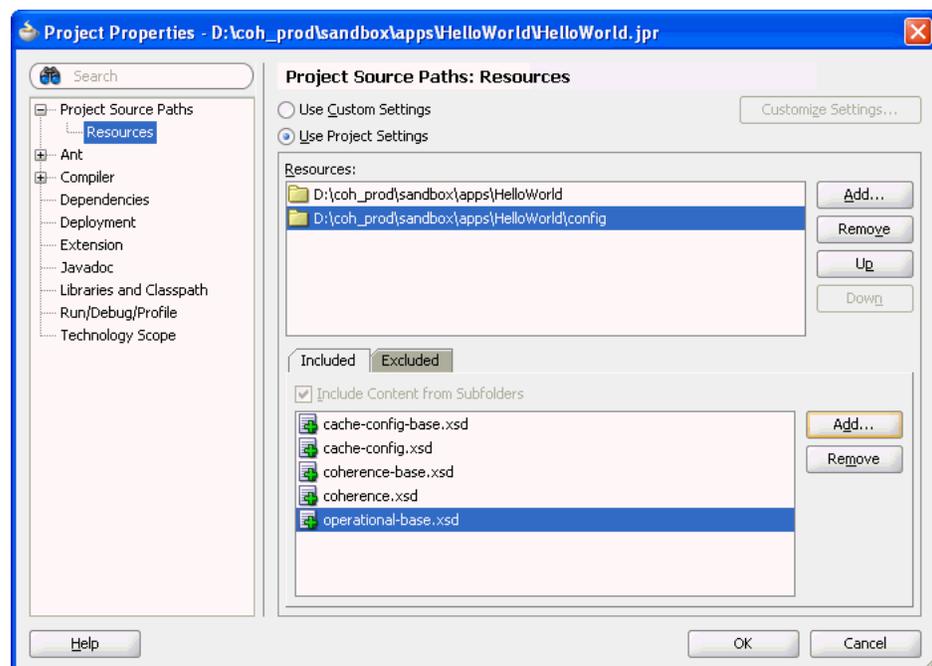
The thread dump is viewable in the process's log in JDeveloper.

Creating Configuration Files in JDeveloper

JDeveloper can create Coherence configuration files. JDeveloper loads the appropriate XSD files and lists all the elements in the Component Palette. In addition, JDeveloper validates configuration files against the XSD and provides XML code completion. The following procedure creates both a cache configuration file and an operational override file. The same procedure can be used for any of the Coherence configuration files.

To create a cache configuration and operation override file in JDeveloper:

1. Extract `coherence-cache-config.xsd`, `coherence-cache-config-base.xsd`, `coherence-operational-config.xsd`, `coherence-operational-config-base.xsd`, and `coherence-config-base.xsd` from the `COHERENCE_HOME\lib\coherence.jar` library to a directory on your computer.
2. In the JDeveloper Application Navigator, double-click your coherence project. The Project Properties dialog box displays.
3. Expand the **Project Source Paths** node and click **Resources**. The Resources page displays.
4. In the Resources section, click **Add** to find and select the directory where you extracted the XSD files.
5. In the Included tab, click **Add** and select the XSD files. Alternatively, you can allow JDeveloper to include all files in this directory and not explicitly add each file.
6. Click **OK**. The XSDs are listed in the Included tab as shown below.



7. Click **OK** to close the Project Properties dialog box. The XSDs are listed in the Application Navigator under the Resources folder for your project.
8. From the File menu, click **New**. The New Gallery dialog box displays.

9. From the Categories section, expand the **General** node and click **XML**.
10. Select **XML Document** and click **OK**. The Create XML File dialog box displays.
11. Enter `coherence-cache-config.xml` as the file name and save it to the same directory where the XSD is located. At run time, this file must be found on the classpath and must be loaded before the `coherence.jar` file.
12. Click **OK**. The cache configuration file is created, opened for editing, and listed in the Application Navigator under the resources folder for your project.
13. Add the following schema reference at the beginning of the file:

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

The Component Palette refreshes and lists all the elements available from the `coherence-cache-config.xsd` file.

14. Save the `coherence-cache-config.xml` file.
15. Repeat steps 8 through 12 to create an operational override file called `tangosol-coherence-override.xml`. At run time, this file must be found on the classpath.
16. Add the following schema references at the beginning of the file:

```
<?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">
```

The Component Palette refreshes and lists all the elements available from the `coherence-operational-config.xsd` file.

17. Save the `tangosol-coherence-override.xml` file.

Debugging in Coherence

This chapter provides instructions for configuring logging and includes general advice for debugging and troubleshooting Coherence applications.

This chapter includes the following sections:

- [Overview of Debugging in Coherence](#)
- [Configuring Logging](#)
- [Performing Remote Debugging](#)
- [Troubleshooting Coherence-Based Applications](#)

Overview of Debugging in Coherence

Coherence applications are typically developed on a single computer. The cache server and application are started within the IDE and the application is debugged as required. This type of development environment is easy to setup, performs well, and is easy to debug. A majority of applications can be created and tested this way. See "[Enabling Single-Server Mode](#)" on page 7-13 for details on configuring Coherence to run on a single server.

Ideally, most errors can be detected during development using logging, enabling JVM debug options, and capturing thread and heap dumps as required. Moreover, IDEs and profiling tools, such as Oracle's Java VisualVM and JConsole, provide features for diagnosing problems. However, Coherence applications must eventually be tested in a more distributed environment. Debugging and troubleshooting in the testing environment is more difficult since data and processes are fully distributed across the cluster and because the network affects the application. Remote debugging with Java Debug Wire Protocol (JDWP) together with Coherence's JMX management and reporting capabilities facilitate debugging and troubleshooting in a distributed environment.

Using Oracle Support

Oracle support can help debug issues and is available through <https://support.oracle.com>. When sending support an issue, always include the following items in a compressed file:

- application code
- configuration files
- log files for all cluster members
- Thread and heap dumps are required under certain circumstances. Thread dumps should be sent if the application is running slow and/or appears to be hung. Heap

dumps should be sent if the application runs out of memory or is consuming more memory than expected.

Configuring Logging

Coherence has its own logging framework and also supports the use of log4j, slf4j, and Java logging to provide a common logging environment for an application. Logging in Coherence occurs on a dedicated and low-priority thread to reduce the impact of logging on the critical portions of the system. Logging is pre-configured and the default settings should be changed as required.

This section includes the following topics:

- [Changing the Log Level](#)
- [Changing the Log Destination](#)
- [Changing the Log Message Format](#)
- [Setting the Logging Character Limit](#)
- [Using JDK Logging for Coherence Logs](#)
- [Using Log4J Logging for Coherence Logs](#)
- [Using SLF4J for Coherence Logs](#)

Changing the Log Level

The logger's log level determines which log messages are emitted. The default log level emits error, warning, informational, and some debug messages. During development, the log level should be raised to its maximum setting to ensure all debug messages are logged. The following log levels are available:

- 0 – This level includes messages that are not associated with a logging level.
- 1 – This level includes the previous level's messages plus error messages.
- 2 – This level includes the previous levels' messages plus warning messages.
- 3 – This level includes the previous levels' messages plus informational messages.
- 4-9 – These levels include the previous levels' messages plus internal debugging messages. More log messages are emitted as the log level is increased. The default log level is 5.
- -1 – No log messages are emitted.

To change the log level, edit the operational override file and add a `<severity-level>` element, within the `<logging-config>` element, that includes the level number. For example:

```
...
<logging-config>
  ...
  <severity-level system-property="tangosol.coherence.log.level">9
</severity-level>
  ...
</logging-config>
...
```

The `tangosol.coherence.log.level` system property is used to specify the log level instead of using the operational override file. For example:

```
-Dtangosol.coherence.log.level=9
```

Changing the Log Destination

The logger can be configured to emit log messages to several destinations. For standard output to the console, both `stdout` and `stderr` (the default) can be used. The logger can also emit messages to a specified file.

Coherence also supports the use of JDK, log4j, and SLF4J to allow an application and Coherence to share a common logging framework. See ["Using JDK Logging for Coherence Logs"](#) on page 5-5, ["Using Log4J Logging for Coherence Logs"](#) on page 5-7, and ["Using SLF4J for Coherence Logs"](#) on page 5-8 for detailed instructions.

To change the log destination, edit the operational override file and add a `<destination>` element, within the `<logging-config>` element, that includes the destination. For example:

```
...
<logging-config>
  <destination system-property="tangosol.coherence.log">stdout</destination>
  ...
</logging-config>
...
```

The `tangosol.coherence.log` system property is used to specify the log destination instead of using the operational override file. For example:

```
-Dtangosol.coherence.log=stdout
```

Sending Log Messages to a File

The logger can be configured to emit log messages to a file by providing a path and file name in the `<destination>` element. The specified path must already exist. Make sure the specified directory can be accessed and has write permissions. Output is appended to the file and there is no size limit. Process cannot share a log file and the log file is replaced when a process is restarted. Sending log messages to a file is typically used during development and testing and is useful if the log messages need to be sent to Oracle support.

The following example demonstrates specifying a log file named `coherence.log` that is written to the `/tmp` directory:

```
...
<logging-config>
  <destination system-property="tangosol.coherence.log"/>/tmp/coherence.log
  </destination>
  ...
</logging-config>
...
```

Changing the Log Message Format

The default format of log messages can be changed depending on the amount of detail that is required. A log message can include static text as well as any of the following parameters that are replaced at run time.

Note: Changing the log message format must be done with caution as critical information (such as member or thread) can be lost which makes issues harder to debug.

Parameter	Description
{date}	This parameter shows the date/time (to a millisecond) when the message was logged.
{uptime}	This parameter shows the amount of time that the cluster members has been operational.
{product}	This parameter shows the product name and license type.
{version}	This parameter shows Coherence version and build details.
{level}	This parameter shows the logging severity level of the message.
{thread}	This parameter shows the thread name that logged the message.
{member}	This parameter shows the cluster member id (if the cluster is currently running).
{location}	This parameter shows the fully cluster member identification: cluster-name, site-name, rack-name, machine-name, process-name and member-name (if the cluster is currently running).
{role}	This parameter shows the specified role of the cluster member.
{text}	This parameter shows the text of the message.
{ecid}	<p>This parameter shows the Execution Context ID (ECID). The ECID is a globally unique ID that is attached to requests between Oracle components. The ECID is an Oracle-specific diagnostic feature and is used to correlate log messages across log files from Oracle components and products and is also used to track log messages pertaining to the same request within a single component when multiple requests are processed in parallel. Coherence clients that want to include the ECID in their logs must have an activated Dynamic Monitoring Service (DMS) execution context when invoking Coherence.</p> <p>Note: If JDK logging is used with an Oracle Diagnostic Logging (ODL) handler, then the {ecid} parameter does not apply because the ECID automatically becomes part of the ODL record form.</p>

To change the log message format, edit the operational override file and add a <message-format> element, within the <logging-config> element, that includes the format. For example:

```

...
<logging-config>
  ...
  <message-format>[{date}] &lt;{level}&gt; (thread={thread}) -->{text}
  </message-format>
  ...
</logging-config>
...

```

Setting the Logging Character Limit

The logging character limit specifies the maximum number of characters that the logger daemon processes from the message queue before discarding all remaining

messages in the queue. The messages that are discarded are summarized by the logging system with a single log entry that details the number of messages that were discarded and their total size. For example:

```
Asynchronous logging character limit exceeded; discarding 5 log messages
(lines=14, chars=968)
```

The truncation is only temporary; when the queue is processed (emptied), the logger is reset so that subsequent messages are logged.

Note: The message that caused the total number of characters to exceed the maximum is never truncated.

The character limit is used to avoid situations where logging prevents recovery from a failing condition. For example, logging can increase already tight timings, which causes additional failures, which produces more logging. This cycle may continue until recovery is not possible. A limit on logging prevents the cycle from occurring.

To set the log character limit, edit the operational override file and add a `<character-limit>` element, within the `<logging-config>` element. The character limit is entered as 0 (`Integer.MAX_VALUE`) or a positive integer. For example:

```
...
<logging-config>
  ...
  <character-limit system-property="tangosol.coherence.log.limit">12288
</character-limit>
</logging-config>
...
```

The `tangosol.coherence.log.limit` system property is used to specify the log character limit instead of using the operational override file. For example:

```
-Dtangosol.coherence.log.limit=12288
```

Using JDK Logging for Coherence Logs

Applications that use the JDK logging framework can configure Coherence to use JDK logging as well. Detailed information about JDK logging is beyond the scope of this documentation. For details on JDK logging, see

<http://download.oracle.com/javase/7/docs/technotes/guides/logging/overview.html>.

To use JDK logging for Coherence logs:

1. Create a `logging.properties` file. The following example configures the JDK logger to emit messages to both the console and to a file. Output to the console and file is configured to use the `FINEST` log level. For the file handler pattern, the specified path must already exist. Also, ensure that the specified directory can be accessed and has write permissions.

```
handlers=java.util.logging.FileHandler, java.util.logging.ConsoleHandler

.level=INFO
Coherence.level=FINEST

java.util.logging.FileHandler.pattern=/tmp/coherence%.log
java.util.logging.FileHandler.limit=50000
```

```
java.util.logging.FileHandler.count=1
java.util.logging.FileHandler.formatter=java.util.logging.SimpleFormatter

java.util.logging.ConsoleHandler.formatter=java.util.logging.SimpleFormatter
```

Note:

- In the above example, Coherence is used as the logger object name and is the default name that is used by the Coherence logging framework. A different name can be used by specifying the name within the <logger-name> element in the operational override file or by specifying the name as the value of the tangosol.coherence.log.logger system property.
 - Set the JDK logging level to `FINEST` and allow the Coherence logging settings to determine which log messages to construct for JDK logging.
-
-

2. Configure Coherence to use JDK logging by specifying `jdk` as the value of the <destination> element in an operational override file. For example:

```
...
<logging-config>
  <destination system-property="tangosol.coherence.log">jdk</destination>
  ...
</logging-config>
...
```

3. Make sure the `logging.properties` file is specified using the `java.util.logging.config.file` system property. For example:

```
-Djava.util.logging.config.file=myfile
```

Mapping JDK Log Levels with Coherence Log Levels

The following table provides a mapping of how JDK log levels are mapped to Coherence log levels.

JDK Log Level	Coherence Log Level
OFF	NONE
FINEST	INTERNAL
SEVERE	ERROR
WARNING	WARNING
INFO	INFO
FINE	LEVEL_D4
FINER	LEVEL_D5
FINEST	LEVEL_D6
FINEST	LEVEL_D7
FINEST	LEVEL_D8
FINEST	LEVEL_D9

JDK Log Level	Coherence Log Level
ALL	ALL

Using Log4J Logging for Coherence Logs

Applications that use the log4j logging framework can configure Coherence to use log4j logging as well. Detailed information about log4j logging is beyond the scope of this documentation. For details on log4j logging, see <http://logging.apache.org/log4j/1.2/manual.html>.

To use log4j logging for Coherence logs:

1. Create a `log4j.properties` file. The following example configures the log4j logger to emit messages to both the console and to a file. Output to the console and file are configured to use the FATAL log level. For the file appender, make sure the specified directory can be accessed and has write permissions.

```
log4j.logger.Coherence=FATAL, stdout, file

log4j.appender.stdout=org.apache.log4j.ConsoleAppender
log4j.appender.stdout.layout=org.apache.log4j.PatternLayout
log4j.appender.stdout.layout.ConversionPattern=%m%n

log4j.appender.file=org.apache.log4j.RollingFileAppender
log4j.appender.file.File=/tmp/coherence.log
log4j.appender.file.MaxFileSize=10MB
log4j.appender.file.layout=org.apache.log4j.PatternLayout
log4j.appender.file.layout.ConversionPattern=%m%n
```

Note:

- In the above example, Coherence is used as the logger object name and is the default name that is used by the Coherence logging framework. A different name can be used by specifying the name within the `<logger-name>` element in the operational override file or by specifying the name as the value of the `tangosol.coherence.log.logger` system property.
 - Set the log4j logging level to FATAL and allow the Coherence logging settings to determine which log messages to construct for log4j logging.
-
-

2. Configure Coherence to use log4j logging by specifying log4j as the value of the `<destination>` element in an operational override file. For example:

```
...
<logging-config>
  <destination system-property="tangosol.coherence.log">log4j</destination>
  ...
</logging-config>
...
```

3. Make sure both the `log4j.jar` file and the `log4j.properties` file are found on the classpath at run time.

Mapping Log4J Log Levels with Coherence Log Levels

The following table provides a mapping of how log4j log levels are mapped to Coherence log levels.

Log4J Log Level	Coherence Log Level
OFF	NONE
DEBUG	INTERNAL
ERROR	ERROR
WARN	WARNING
INFO	INFO
DEBUG	LEVEL_D4
DEBUG	LEVEL_D5
DEBUG	LEVEL_D6
DEBUG	LEVEL_D7
DEBUG	LEVEL_D8
DEBUG	LEVEL_D9
ALL	ALL

Using SLF4J for Coherence Logs

Applications that use SLF4J logging can configure Coherence to use SLF4J logging as well. Detailed information about SLF4J logging is beyond the scope of this documentation. For details on SLF4J logging, see <http://www.slf4j.org/>.

To use SLF4J logging:

1. specify `slf4j` as the value of the `<destination>` element in an operational override file. For example:

```
...
<logging-config>
  <destination system-property="tangosol.coherence.log">slf4j</destination>
  ...
</logging-config>
...
```

2. Make sure both the `slf4j-api.jar` file and the appropriate logging framework SLF4J binding JAR is located on the classpath.

Performing Remote Debugging

Java Debug Wire Protocol (JDWP) provides the ability to debug a JVM remotely. Most IDE tools support JDWP and are used to connect to a remote JVM that has remote debugging enabled. See your IDE's documentation for instructions on how to connect to a remote JVM.

To enable remote debugging on a cache server, start the cache server with the following JVM options. Once the cache server has been started, use the IDE's debugger to connect to the JVM using the port specified (5005 in the example).

```
-Xdebug
-Xrunjdwp:transport=dt_socket,server=y,suspend=n,address=5005
```

Remote debugging a Coherence application can be difficult when the application is no longer on a single node cluster because data is distributed across the members of the cluster. For example, when performing parallel grid operations, the operations are performed on the cluster members where the data is located. Since there are no guarantees on which members the data is located, it is best to constrain a test to use a single cache server.

In addition, the guardian and packet timeout can make cluster debugging difficult. If the debugger pauses the packet publishing, cluster, and service threads, it will cause disruptions across the cluster. In such scenarios, disable the guardian and increase the packet timeout during the debugging session. See "[service-guardian](#)" on page A-82 for details on configuring these settings.

Troubleshooting Coherence-Based Applications

The topics in this section provide general troubleshooting advice. Troubleshooting Coherence-based applications is, for the most part, no different than troubleshooting other Java application. Most IDEs provide features that facilitate the process. In addition, many tools, such as: Java VisualVM, JConsole, and third party tools provide easy ways to monitor and troubleshoot Java applications. See the Troubleshooting Java SE section on OTN for detailed information on troubleshooting Java:

<http://www.oracle.com/technetwork/java/javase/index-138283.html>

Troubleshooting a Coherence application on a single server cluster is typically straight forward. Most Coherence development work is done in such an environment because it facilitates debugging. Troubleshooting an application that is deployed on a distributed cluster can become more challenging.

This section includes the following topics:

- [Using Coherence Logs](#)
- [Using JMX Management and Coherence Reports](#)
- [Using JVM Options to Help Debug](#)
- [Capturing Thread Dumps](#)
- [Capturing Heap Dumps](#)
- [Monitoring the Operating System](#)

Using Coherence Logs

Log messages provide information that is used to monitor and troubleshoot Coherence. Most log messages are explained in the Log Glossary within the *Administering Oracle Coherence*. The glossary provides additional details as well as specific actions that can be taken when a message is encountered.

Configuring logging beyond the default out-of-box configuration is very important when developing and debugging an application. Specifically, use the highest log level (level 9 or ALL when using JDK or log4j logging) to ensure that all log messages are emitted. Also, consider using either JDK or log4j logging. Both of these frameworks support the use of rolling files and console output simultaneously. Lastly, consider placing all log files in a common directory. A common directory makes it easier to review the log files and package them for the Coherence support team. See "[Configuring Logging](#)" on page 5-2 for detailed information on configuring all aspects of logging.

Using JMX Management and Coherence Reports

Coherence management is implemented using Java Management Extensions (JMX). Many MBeans are provided that detail the health and stability of Coherence. The MBeans provide valuable insight and should always be used when moving an application from a development environment to a fully distributed environment. MBeans are accessible using JConsole and VisualVM or any management tool that supports JMX. In addition, Coherence includes reports that gather information from the MBeans over time and provide a historical context that is not possible simply by monitoring the MBeans. The reports are most often used to identify trends that are valuable for troubleshooting. Management and reporting are not enabled by default and must be enabled. See *Managing Oracle Coherence* for detailed instructions on using the management features included with Coherence.

Using JVM Options to Help Debug

Most JVMs include options that facilitate debugging and troubleshooting. These options should be used to get as much information as possible. Consult your JVM vendor's documentation for their available options. The JVM options discussed in this section are Java HotSpot specific. See the Java HotSpot VM Options Web page for detailed information and usage instructions for all JVM options:

<http://www.oracle.com/technetwork/java/javase/tech/vmoptions-jsp-140102.html>

The following JVM options (standard and non standard) can help when debugging and troubleshooting applications:

- `-verbose:gc` or `-Xloggc:file` – These options are used to enable additional logs for each garbage collection event. In a distributed system, a GC pause on a single JVM can affect the performance of many JVMs, so it is essential to monitor garbage collection very closely. The `-Xloggc` option is similar to verbose GC but includes timestamps.
- `-Xprof` and `-Xrunhprof` – These options are used to view JVM profile data and are not intended for production systems.
- `-XX:-PrintGC`, `-XX:-PrintGCDetails`, and `-XX:-PrintGCtimeStamps` – These options are also used print messages at garbage collection.
- `-XX:-HeapDumpOnOutOfMemoryError` and `-XX:HeapDumpPath=./java_pid<pid>.hprof` – These options are used to initiate a heap dump when a `java.lang.OutOfMemoryError` is thrown.
- `-XX:ErrorFile=./hs_err_pid<pid>.log` – This option saves error data to a file.

Capturing Thread Dumps

Thread dumps are used to see detailed thread information, such as thread state, for each thread in the JVM. A thread dump also includes information on each deadlocked thread (if applicable). Thread dumps are useful because of Coherence's multi-threaded and distributed architecture. Thread dumps are often used to troubleshoot an application that is operating slowly or is deadlocked. Make sure to always collect several dumps over a period of time since a thread dump is only snapshot in time. Always include a set of thread dumps when submitting a support issue.

Coherence provides a native `logClusterState` JMX operation that is located on the `ClusterMBean` MBean and a native `logNodeState` JMX operation that is located on the `ClusterNodeMBean` MBean. These operations initiate a thread dump (including outstanding polls) on multiple cluster members or on a single cluster member,

respectively. For a detailed reference of Coherence MBeans, see *Managing Oracle Coherence*.

To perform a thread dump locally on Unix or Linux operating systems, press `Ctrl+\` at the application console. To perform a thread dump on Windows, press `Ctrl+Break` (or `Pause`). Both methods include a heap summary with the thread dump.

Most IDEs provide a thread dump feature that can be used to capture thread dumps while working in the IDE. In addition, Unix and Linux operating systems can use the `kill -3 pid` to cause a remote thread dump in the IDE. On Windows, use a third party tool (such as `SendSignal`) to send a `ctrl+break` signal to a remote Java process and cause a dump in the IDE.

Profiling tools, such as Oracle's Java VirtualVM (`jvisualvm`) and JConsole (`jconsole`) are able to perform thread dumps. These tools are very useful because they provide a single tool for troubleshooting and debugging and display many different types of information in addition to just thread details.

Lastly, the `jstack` tool can be used to capture a thread dump for any process. For example, use `jps` to find a Java process ID and then execute the following from the command line:

```
jstack <pid>
```

The `jstack` tool is unsupported and may or may not be available in future versions of the JDK.

Capturing Heap Dumps

Heap dumps are used to see detailed information for all the objects in a JVM heap. The information includes how many instance of an object are loaded and how much memory is allocated to the objects. Heap information is typically used to find parts of an application that may potentially be wasting resources and causing poor performance. In a fully distributed Coherence environment, heap dumps can be tricky because application processing is occurring across the cluster and problematic objects may not necessarily be local to a JVM. Make sure to always collect several dumps over a period of time since a heap dump is only a snapshot in time. Always include heap dumps when submitting a support issue.

The easiest way to capture a heap dump is to use a profiling tool. Oracle's Java VirtualVM (`jvisualvm`) and JConsole (`jconsole`) provide heap dump features. In addition, most IDEs provide a heap dump feature that can be used to capture heap dumps while working in the IDE.

As an alternative, the `jmap` tool can be used to capture heap dumps, and the `jhat` tool can be used to view heap dumps. For example, use `jps` to find a Java process ID and then execute the following from the command line:

```
jmap -dump:format=b,file=/coherence.bin pid
```

To view the heap dump in a browser, execute the following from the command line and then browse to the returned address. The file can also be loaded into VisualVM for viewing.

```
jhat /coherence.bin
```

The `jmap` and `jhat` tools are unsupported and may or may not be available in future versions of the JDK.

Monitoring the Operating System

Always monitor a cluster member's operating system when troubleshooting and debugging Coherence-based applications. Poorly tuned operating systems can affect the overall performance of the cluster and may have adverse effects on an application. See *Administering Oracle Coherence* for details on performance tuning.

In particular, the following areas are important to monitor:

- CPU – Is the processor running at 100% for extended periods of time?
- Memory/Swapping – Is the available RAM memory being exhausted and causing swap space to be used?
- Network – Is buffer size, the datagram size, and the Maximum Transmission Unit (MTU) size affecting performance and success rates?

To monitor the overall health of the operating system, use tools such as `vmstat` and `top` for Unix/Linux; for Windows, use `perfmon` and tools available from Windows Sysinternals (for example `procexp` and `procmon`). See *Administering Oracle Coherence* for detailed instructions on how to test network performance.

Part II

Using Coherence Clusters

Part II contains the following chapters:

- [Chapter 6, "Introduction to Coherence Clusters"](#)
- [Chapter 7, "Setting Up a Cluster"](#)
- [Chapter 8, "Starting and Stopping Cluster Members"](#)
- [Chapter 9, "Dynamically Managing Cluster Membership"](#)
- [Chapter 10, "Tuning TCMP Behavior"](#)
- [Chapter 11, "Using the Service Guardian"](#)

Introduction to Coherence Clusters

This chapter describes Coherence clusters and how cluster members use the Tangosol Cluster Management Protocol (TCMP) to communicate with each other. Clustered services are also described.

This chapter includes the following sections:

- [Cluster Overview](#)
- [Understanding TCMP](#)
- [Understanding Clustered Services](#)

Cluster Overview

A Coherence cluster is a network of JVM processes that run Coherence. JVMs automatically join together to form a cluster and are called cluster members or cluster nodes. Cluster members communicate using the Tangosol Cluster Management Protocol (TCMP). Cluster members use TCMP for both multicast communication (broadcast) and unicast communication (point-to-point communication).

A cluster contains services that are shared by all cluster members. The services include connectivity services (such as the root Cluster service), cache services (such as the Distributed Cache service), and processing services (such as the Invocation service). Each cluster member can provide and consume such services. The first cluster member is referred to as the senior member and typically starts the core services that are required to create the cluster. If the senior member of the cluster is shutdown, another cluster member assumes the senior member role.

Understanding TCMP

TCMP is an IP-based protocol that is used to discover cluster members, manage the cluster, provision services, and transmit data. TCMP can be configured to use:

- A combination of UDP/IP multicast and UDP/IP unicast. This is the default configuration.
- UDP/IP unicast only (that is, no multicast). See "[Disabling Multicast Communication](#)" on page 7-5. This configuration is used for network environments that do not support multicast or where multicast is not optimally configured.
- TCP/IP only (no UDP/IP multicast or UDP/IP unicast). See "[Using the TCP Socket Provider](#)" on page 10-16. This configuration is used for network environments that favor TCP.

- SDP/IP only (no UDP/IP multicast or UDP/IP unicast). See "[Using the SDP Socket Provider](#)" on page 10-17. This configuration is used for network environments that favor SDP.
- SSL over TCP/IP or SDP/IP. See "[Using the SSL Socket Provider](#)" on page 10-17. This configuration is used for network environments that require highly secure communication between cluster members.

Use of Multicast

Multicast is used as follows:

- Cluster discovery: Multicast is used to discover if there is a cluster running that a new member can join.
- Cluster heartbeat: The most senior member in the cluster issues a periodic heartbeat through multicast; the rate can be configured and defaults to one per second.
- Message delivery: Messages that must be delivered to multiple cluster members are often sent through multicast, instead of unicasting the message one time to each member.

Use of Unicast

Unicast is used as follows:

- Direct member-to-member (point-to-point) communication, including messages, asynchronous acknowledgments (ACKs), asynchronous negative acknowledgments (NACKs) and peer-to-peer heartbeats. A majority of the communication on the cluster is point-to-point.
- Under some circumstances, a message may be sent through unicast even if the message is directed to multiple members. This is done to shape traffic flow and to reduce CPU load in very large clusters.
- All communication is sent using unicast if multicast communication is disabled.

Use of TCP

TCP is used as follows:

- A TCP/IP ring is used as an additional death detection mechanism to differentiate between actual node failure and an unresponsive node (for example, when a JVM conducts a full GC).
- TCMP can be configured to exclusively use TCP for data transfers. Like UDP, the transfers can be configured to use only unicast or both unicast and multicast.

Protocol Reliability

The TCMP protocol provides fully reliable, in-order delivery of all messages. Since the underlying UDP/IP protocol does not provide for either reliable or in-order delivery, TCMP uses a queued, fully asynchronous ACK- and NACK-based mechanism for reliable delivery of messages, with unique integral identity for guaranteed ordering of messages.

Protocol Resource Utilization

The TCMP protocol (as configured by default) requires only three UDP/IP sockets (one multicast, two unicast) and six threads per JVM, regardless of the cluster size. This is a key element in the scalability of Coherence; regardless of the number of

servers, each node in the cluster still communicates either point-to-point or with collections of cluster members without requiring additional network connections.

The optional TCP/IP ring uses a few additional TCP/IP sockets, and an additional thread.

Protocol Tunability

The TCMP protocol is very tunable to take advantage of specific network topologies, or to add tolerance for low-bandwidth and high-latency segments in a geographically distributed cluster. Coherence comes with a pre-set configuration. Some TCMP attributes are dynamically self-configuring at run time, but can also be overridden and locked down for deployment purposes.

Understanding Clustered Services

Coherence functionality is based on the concept of services. Each cluster member can register, provide, and consume services. Multiple services can be running on a cluster member. A cluster member always contains a single root cluster service and can also contain any number of grid services. Grid services have a service name that uniquely identifies the service within the cluster and a service type that defines what the service can do. There may be multiple instances of each service type (other than the root cluster service).

The services are categorized below based on functionality. The categories are used for clarity and do not represent actual components or imply a relationship between services.

Connectivity Services

- **Cluster Service:** This service is automatically started when a cluster node must join the cluster and is often referred to as the root cluster service; each cluster node always has exactly one service of this type running. This service is responsible for the detection of other cluster nodes, for detecting the failure of a cluster node, and for registering the availability of other services in the cluster.
- **Proxy Service:** This service allows connections (using TCP) from clients that run outside the cluster. While many applications are configured so that all clients are also cluster members, there are many use cases where it is desirable to have clients running outside the cluster. Remote clients are especially useful in cases where there are hundreds or thousands of client processes, where the clients are not running on the Java platform, or where a greater degree of de-coupling is desired.

Processing Services

- **Invocation Service:** This service provides clustered invocation and supports grid computing architectures. This services allows applications to invoke agents on any node in the cluster, or any group of nodes, or across the entire cluster. The agent invocations can be request/response, fire and forget, or an asynchronous user-definable model.

Data Services

- **Distributed Cache Service:** This service allows cluster nodes to distribute (partition) data across the cluster so that each piece of data in the cache is managed (held) by only one cluster node. The Distributed Cache Service supports pessimistic locking. Additionally, to support failover without any data loss, the service can be configured so that each piece of data is backed up by one or more other cluster nodes. Lastly, some cluster nodes can be configured to hold no data

at all; this is useful, for example, to limit the Java heap size of an application server process, by setting the application server processes to not hold any distributed data, and by running additional cache server JVMs to provide the distributed cache storage. For more information on distributed caches, see "[Understanding Distributed Caches](#)" on page 12-1.

- **Replicated Cache Service:** This is a synchronized replicated cache service that fully replicates all of its data to all cluster nodes that run the service. Replicated caches support pessimistic locking to ensure that all cluster members receive the update when data is modified. Replicated caches are often used to manage internal application metadata. For more information on replicated caches, see "[Understanding Replicated Caches](#)" on page 12-5.
- **Optimistic Cache Service:** This is an optimistic-concurrency version of the Replicated Cache Service that fully replicates all of its data to all cluster nodes and employs an optimization similar to optimistic database locking to maintain coherency. All servers end up with the same current value even if multiple updates occur at the same exact time from different servers. The Optimistic Cache Service does not support pessimistic locking; so, in general, it should only be used for caching most recently known values for read-only uses. This service is rarely used. For more information on optimistic caches, see "[Understanding Optimistic Caches](#)" on page 12-7.

A clustered service typically uses one daemon thread and optionally has a thread pool that can be configured to provide the service with additional processing bandwidth. For example, the invocation service and the distributed cache service both fully support thread pooling to accelerate database load operations, parallel distributed queries, and agent invocations.

The above services are only the basic cluster services and not the full set of types of caches provided by Coherence. By combining clustered services with cache features, such as backing maps and overflow maps, Coherence provides an extremely flexible and configurable set of options for clustered applications.

Within a cache service, there exists any number of named caches. A named cache provides the standard JCache API, which is based on the Java collections API for key-value pairs, known as `java.util.Map`.

Setting Up a Cluster

This chapter provides instructions for setting up and configuring Coherence clusters and is used to change the default out-of-box cluster settings.

This chapter includes the following sections:

- [Overview of Setting Up Clusters](#)
- [Specifying a Cluster's Name](#)
- [Specifying a Cluster Member's Identity](#)
- [Configuring Multicast Communication](#)
- [Specifying a Cluster Member's Unicast Address](#)
- [Using Well Known Addresses](#)
- [Enabling Single-Server Mode](#)
- [Configuring Death Detection](#)
- [Specifying Cluster Priorities](#)

Overview of Setting Up Clusters

Coherence provides a default out-of-box cluster configuration that is used for demonstration purposes. It allows clusters to be quickly created and often requires little or no configuration changes. However, beyond demonstration, the default setup should not be used. Instead, unique clusters should be set up based on the network environment in which they run and based on the requirements of the applications that use them. A cluster that runs in single-server mode can be configured for unit testing and basic development.

At a minimum, setting up a cluster includes defining the cluster's name and the cluster's multicast address. If multicast is undesirable or unavailable in an environment, then setting up the Well Known Addresses (WKA) feature is required. The rest of the tasks presented in this chapter are typically used when setting up a cluster and are completed when the default settings must be changed.

Clusters are set up within an operational override file (`tangosol-coherence-override.xml`). Each cluster member uses an override file to specify unique values that override the default configuration that is defined in the operational deployment descriptor. See "[Specifying an Operational Configuration File](#)" on page 3-2 for detailed information on using an operational override file. In addition, refer to [Appendix A, "Operational Configuration Elements,"](#) for descriptions and usage information for all the operational elements that are discussed in this chapter.

Specifying a Cluster's Name

A cluster name is a user-defined name that uniquely identifies a cluster from other clusters that run on the network. Cluster members must specify the same cluster name to join and form a cluster. A cluster member does not start if the wrong name is specified when attempting to join an existing cluster. A unique cluster name is often used with a unique multicast port to create distinct clusters on the same network.

Note: A cluster member uses a system generated cluster name if a name is not explicitly specified. Using the system generated name (and the out-of-box multicast defaults) increases the chance of having overlapping cluster configurations on the network. This can lead to cluster members accidentally joining an unexpected cluster.

To specify a cluster name, edit the operational override file and add a `<cluster-name>` element, within the `<member-identity>` element, that includes the cluster name. For example:

```
<?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 system-property="tangosol.coherence.cluster">MyCluster
    </cluster-name>
    </member-identity>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.cluster` system property is used to specify the cluster name instead of using the operational override file. For example:

```
-Dtangosol.coherence.cluster=name
```

Specifying a Cluster Member's Identity

A set of identifiers are used to give a cluster member an identity within the cluster. The identity information is used to differentiate cluster members and conveys the members' role within the cluster. Some identifiers are also used by the cluster service when performing cluster tasks. Lastly, the identity information is valuable when displaying management information (for example, JMX) and facilitates interpreting log entries. The following list describes each of the identifiers:

- **Site Name** – the name of the geographic site that hosts the cluster member. The server's domain name is used if no name is specified. For WAN clustering, this value identifies the datacenter where the member is located. The site name can be used as the basis for intelligent routing, load balancing, and disaster recovery planning (that is, the explicit backing up of data on separate geographic sites). The site name also helps determine where to back up data when using distributed caching and the default partition assignment strategy. Lastly, the name is useful for displaying management information (for example, JMX) and interpreting log entries.

- Rack Name – the name of the location within a geographic site that the member is hosted at and is often a cage, rack, or bladeframe identifier. The rack name can be used as the basis for intelligent routing, load balancing, and disaster recovery planning (that is, the explicit backing up of data on separate bladeframes). The rack name also helps determine where to back up data when using distributed caching and the default partition assignment strategy. Lastly, the name is useful for displaying management information (for example, JMX) and interpreting log entries.
- Machine Name – the name of the server that hosts the cluster member. The server's host name is used if no name is specified. The name is used as the basis for creating an ID. The cluster service uses the ID to ensure that data are backed up on different computers to prevent single points of failure.
- Process Name – the name of the JVM process that hosts the cluster member. The JVM process number is used if no name is specified. The process name makes it possible to easily differentiate among multiple JVMs running on the same computer.
- Member Name – the cluster member's unique name. The name makes it easy to differentiate cluster members especially when multiple members run on the same computer or within the same JVM. Always specify a member name (as a best practice) even though it is not required to do so.
- Role Name – the cluster member's role in the cluster. The role name allows an application to organize cluster members into specialized roles, such as cache servers and cache clients. Default role names (`CoherenceServer` for cache servers and `application_class_name` for cache clients) are used if no role name is specified.

To specify member identity information, edit the operational override file and add the member identity elements within the `<member-identity>` element as demonstrated below:

```
<?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>
      <site-name system-property="tangosol.coherence.site">pa-1</site-name>
      <rack-name system-property="tangosol.coherence.rack">100A</rack-name>
      <machine-name system-property="tangosol.coherence.machine">prod001
      </machine-name>
      <process-name system-property="tangosol.coherence.process">JVM1
      </process-name>
      <member-name system-property="tangosol.coherence.member">C1</member-name>
      <role-name system-property="tangosol.coherence.role">Server</role-name>
    </member-identity>
  </cluster-config>
</coherence>
```

The following system properties are used to specify a cluster member's identity information instead of using the operational override file.

```
-Dtangosol.coherence.site=pa-1 -Dtangosol.coherence.rack=100A
-Dtangosol.coherence.machine=prod001 -Dtangosol.coherence.process=JVM1
-Dtangosol.coherence.member=C1 -Dtangosol.coherence.role=Server
```

Configuring Multicast Communication

Cluster members use multicast communication to discover other cluster members and when a message must be communicated to multiple members of the cluster. The cluster protocol makes very judicious use of multicast and avoids things such as multicast storms. By default, data is only transmitted over multicast if it is intended for more than 25% of the cluster members. The vast majority of traffic is transmitted using unicast even when multicast is enabled. For typical partitioned cache based clusters, most transmissions is point-to-point and only cluster membership and partition ownership is broadcast to the entire cluster.

Multicast communication is configured in an operational override file within the <multicast-listener> node. Many system properties are also available to configure multicast communication when starting a cluster member.

This section includes the following topics:

- [Specifying a Cluster's Multicast Address](#)
- [Disabling Multicast Communication](#)
- [Specifying the Multicast Time-to-Live](#)
- [Specifying the Multicast Join Timeout](#)
- [Changing the Multicast Threshold](#)

Specifying a Cluster's Multicast Address

A multicast address (IP address and port) can be specified for a cluster member. Cluster members must use the same multicast address to join and cluster. A cluster member uses a default multicast address if an address is not explicitly specified. The default value depends on the release version and follows the convention of {build}. {major version}. {minor version}. {patch} for the address and {major version}. {minor version}. {patch} for the port.

Note: Using the default multicast address (and the system generated cluster name) increases the chance of having overlapping cluster configurations on the network. This can lead to cluster members accidentally joining an unexpected cluster.

Distinct clusters that are on the same network must always use unique multicast addresses. Technically, distinct clusters can share either the same IP address or the same port. However, sharing IP addresses or ports can result in increased and un-needed network traffic. The extra network traffic can affect performance and can overload network cards. Therefore, the recommended best practice is to use both a unique IP address and port for each cluster.

Note: On some versions of Linux, distinct clusters on the same network must use both a unique IP address and port.

To specify a cluster multicast address, edit the operational override file and add both an <address> and <port> element and specify the address and port to be used by the cluster member. For example:

```
<?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>
    <multicast-listener>
      <address system-property="tangosol.coherence.clusteraddress">224.3.6.0
      </address>
      <port system-property="tangosol.coherence.clusterport">3059</port>
    </multicast-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.clusteraddress` and `tangosol.coherence.clusterport` system properties are used to specify the cluster multicast address instead of using the operational override file. For example:

```
-Dtangosol.coherence.clusteraddress=224.3.6.0
-Dtangosol.coherence.clusterport=3059
```

Changing the Multicast Socket Interface

The multicast socket is bound to the same network interface (NIC) as the unicast listener IP address. A different NIC for multicast can be configured but, with rare exception, it is strongly discouraged as it can lead to partial failure of the cluster.

With two NICs, the interface (and thus network) used for multicast traffic is different from the interface (and thus network) used for unicast (UDP/IP) and TCP-ring (TCP/IP) traffic. Communication on one interface (or network) continues to succeed even if the other interface has failed; this scenario prolongs failure detection and failover. Since the clustering protocol handles member (and thus interface) failure, it is preferable to have all communication fail so that a failed member is quickly detected and removed from the cluster.

To change the default multicast network interface, edit the operational override file and add an `<interface>` element that specifies the IP address to which the multicast socket binds. For example:

```
<?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>
    <multicast-listener>
      <interface>192.168.0.1</interface>
    </multicast-listener>
  </cluster-config>
</coherence>
```

Disabling Multicast Communication

Multicast traffic may be undesirable or may be disallowed in some network environments. In this case, use the Well Known Addresses feature to prevent Coherence from using multicast. This disables multicast discovery and also disables multicast for all data transfers; unicast (point-to-point) is used instead. Coherence is designed to use point-to-point communication as much as possible, so most

application profiles do not see a substantial performance impact. See ["Using Well Known Addresses"](#) on page 7-9.

Note: Disabling multicast does put a higher strain on the network. However, this only becomes an issue for large clusters with greater than 100 members.

Specifying the Multicast Time-to-Live

The time-to-live value (TTL) setting designates how far multicast UDP/IP packets can travel on a network. The TTL is expressed in terms of how many hops a packet survives; each network interface, router, and managed switch is considered one hop.

The TTL value should be set to the lowest integer value that works. Setting the value too high can use unnecessary bandwidth on other LAN segments and can even cause the operating system or network devices to disable multicast traffic. Typically, setting the TTL value to 1 works on a simple switched backbone. A value of 2 or more may be required on an advanced backbone with intelligent switching. A value of 0 is used for single server clusters that are used for development and testing. See ["Enabling Single-Server Mode"](#) on page 7-13 for more information on single server clusters.

To specify the TTL, edit the operational override file and add a `<time-to-live>` element that includes the TTL value. For example:

```
<?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>
    <multicast-listener>
      <time-to-live system-property="tangosol.coherence.ttl">3</time-to-live>
    </multicast-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.ttl` system property is used to specify the TTL value instead of using the operational override file. For example:

```
-Dtangosol.coherence.ttl=3
```

Specifying the Multicast Join Timeout

The multicast join timeout defines how much time a cluster member waits to join a cluster. If the timeout is reached and an existing cluster is not detected, then the cluster member starts its own cluster and elects itself as the senior cluster member. A short timeout can be specified during development and testing. A timeout of 30 seconds is generally adequate for production environments.

Note: The first member of the cluster waits the full duration of the join timeout before it assumes the role of the senior member. If the cluster startup timeout is less than the join timeout, then the first member of the cluster fails during cluster startup. The cluster member timeout is specified using the packet publisher timeout (`<timeout-milliseconds>`). See ["packet-delivery"](#) on page A-50.

To specify the join timeout, edit the operational override file and add a `<join-timeout-milliseconds>` element that includes the timeout value. For example:

```
<?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>
    <multicast-listener>
      <join-timeout-milliseconds>6000</join-timeout-milliseconds>
    </multicast-listener>
  </cluster-config>
</coherence>
```

Note: The `<join-timeout-milliseconds>` setting will be used for both multicast and unicast communication.

Changing the Multicast Threshold

Cluster members use both multicast and unicast communication when sending cluster packets. The multicast threshold value is used to determine whether to use multicast for packet delivery or unicast. Setting the threshold higher or lower can force a cluster to favor one style of communication over the other. The threshold setting is not used if multicast communication is disabled.

The multicast threshold is a percentage value and is in the range of 1% to 100%. In a cluster of n members, a cluster member that is sending a packet to a set of destination nodes (not counting itself) of size d (in the range of 0 to $n-1$) sends a packet using multicast only if the following hold true:

- The packet is being sent over the network to multiple nodes ($d > 1$).
- The number of nodes is greater than the specified threshold ($d > (n-1) * (threshold/100)$).

For example, in a 25 member cluster with a multicast threshold of 25%, a cluster member only uses multicast if the packet is destined for 6 or more members ($24 * .25 = 6$).

Setting this value to 1 allows the cluster to use multicast for basically all multi-point traffic. Setting this value to 100 forces the cluster to use unicast for all multi-point traffic except for explicit broadcast traffic (for example, cluster heartbeat and discovery) because the 100% threshold is never exceeded. With the setting of 25 (the default) a cluster member sends the packet using unicast if it is destined for less than one-fourth of all nodes, and sends the packet using multicast if it is destined for one-fourth or more of all nodes.

To specify the multicast threshold, edit the operational override file and add a `<multicast-threshold-percent>` element that includes the threshold value. For example:

```
<?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>
  <multicast-listener>
    <multicast-threshold-percent>40</multicast-threshold-percent>
  </multicast-listener>
</cluster-config>
</coherence>

```

Specifying a Cluster Member's Unicast Address

Cluster members use unicast for direct member-to-member (point-to-point) communication, which makes up the majority of communication on the cluster. A default unicast address (IP address and ports) is used or an explicit address can be specified as required within the `<unicast-listener>` element. The multicast socket binds to the same interface as defined by the unicast address. See ["Changing the Multicast Socket Interface"](#) on page 7-5.

The unicast listener is configured as follows:

- `<address>` – A cluster member attempts to obtain the IP to bind to using the `java.net.InetAddress.getLocalHost()` call. The use of `localhost` may not work on systems that define `localhost` as the loopback address; in that case, the computer name or a specific IP address must be specified. An address must also be explicitly specified when a computer has multiple IPs or NICs.

The `<address>` element supports Classless Inter-Domain Routing (CIDR) notation, which uses a subnet and mask pattern for a local IP address to bind to instead of specifying an exact IP address. CIDR simplifies configuration by allowing a single address configuration to be shared across computers on the same subnet. Each cluster member specifies the same CIDR address block and a local NIC on each computer is automatically found that matches the address pattern. For example, to specify a unicast address for multiple multi-NIC computers that are located on the same network and that will run a cluster on their `192.168.1.*` address, specify an address such as `192.168.1.0/24` and each node finds a local NIC that matches the pattern. The `/24` prefix size matches up to 256 available addresses: from `192.168.1.0` to `192.168.1.255`.

- `<port>` – A cluster member uses two unicast UDP ports. The default behavior is to attempt to use port 8088 for the first port (`port1`). If port 8088 is not available, automatic port adjustment is used to select the next available port. The second port (`port2`) is automatically opened and defaults to the next available port after `port1` (`port1 + 1` if available). Automatic port adjustment can be disabled. In this case, `port1` must be available and the second port is always `port1 + 1`.

Two UDP ports are used because:

- It reduces contention between inbound and outbound traffic and avoids doing both heavy transmits and receives on the same port
- It allows for coherence members to communicate at the optimal packet size based on the Maximum Transmission Unit (MTU) of the operating system. One UDP port is used for large packets, and the other port is for packets with sizes at or under the network MTU. The separation allows for separate packet buffers based on size.
- It allows for large clusters (> 500 members) to be run without artificially increasing the size of the socket buffers

To specify a cluster member's unicast address, edit the operational override file and add both an `<address>` and `<port>` element (and optionally a `<port-auto-adjust>`

element) and specify the address and port to be used by the cluster member. For example:

```
<?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>
    <unicast-listener>
      <address system-property="tangosol.coherence.localhost">192.168.0.1
      </address>
      <port system-property="tangosol.coherence.localport">8090</port>
      <port-auto-adjust system-property="tangosol.coherence.localport.adjust">
        true
      </port-auto-adjust>
    </unicast-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.localhost`, `tangosol.coherence.localport`, and `tangosol.coherence.localport.adjust` system properties are used to specify the unicast address instead of using the operational override file. For example:

```
-Dtangosol.coherence.localhost=192.168.0.1 -Dtangosol.coherence.localport=8090
-Dtangosol.coherence.localport.adjust=true
```

Using Well Known Addresses

The Well Known Addresses (WKA) feature is a mechanism that allows cluster members to discover and join a cluster using unicast instead of multicast. WKA is most often used when multicast networking is undesirable or unavailable in an environment or when an environment is not properly configured to support multicast. All cluster multicast communication is disabled if WKA is enabled.

WKA is enabled by specifying a small subset of cluster members (referred to as WKA members) that are able to start a cluster. The optimal number of WKA members varies based on the cluster size. Generally, WKA members should be about 10% of the cluster. One or two WKA members for each switch is recommended.

WKA members are expected to remain available over the lifetime of the cluster but are not required to be simultaneously active at any point in time. Only one WKA member must be operational for cluster members to discover and join the cluster. In addition, after a cluster member has joined the cluster, it receives the addresses of all cluster members and then broadcasts are performed by individually sending messages to each cluster member. This allows a cluster to operate even if all WKA members are stopped. However, new cluster members are not able to join the cluster unless they themselves are a WKA member or until a WKA member is started. In this case, the senior-most member of the cluster polls the WKA member list and allows the WKA member to rejoin the existing cluster.

There are two ways to specify WKA members. The first method explicitly defines a list of addresses. The second method uses an address provider implementation to get a list of WKA addresses. Both methods are configured in an operational override file within the `<well-known-addresses>` subelement of the `<unicast-listener>` element.

This section includes the following topics:

- [Specifying WKA Member Addresses](#)
- [Specifying a WKA Address Provider](#)

Specifying WKA Member Addresses

WKA members are explicitly specified within the `<socket-address>` element. Any number of `<socket-address>` elements can be specified and each must define both the address and port of a WKA member by using the `<address>` and `<port>` elements. If a cluster member specifies its own address, then the cluster member is a WKA member when it is started. The list of WKA members must be the same on every cluster member to ensure that different cluster members do not operate independently from the rest of the cluster. The following example specifies two WKA members:

```
<?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>
    <unicast-listener>
      <well-known-addresses>
        <socket-address id="1">
          <address>192.168.0.100</address>
          <port>8088</port>
        </socket-address>
        <socket-address id="2">
          <address>192.168.0.101</address>
          <port>8088</port>
        </socket-address>
      </well-known-addresses>
    </unicast-listener>
  </cluster-config>
</coherence>
```

Note: When setting up a WKA member, the port value must match the port value that is specified for the member's unicast listener port. See "[Specifying a Cluster Member's Unicast Address](#)" on page 7-8 for more information on setting the unicast port.

Using WKA System Properties

A single WKA member can be specified using the `tangosol.coherence.wka` and `tangosol.coherence.wka.port` system properties instead of specifying the address in an operational override file. The system properties are intended for demonstration and testing scenarios to quickly specify a single WKA member. For example:

```
-Dtangosol.coherence.wka=192.168.0.100 -Dtangosol.coherence.wka.port=8088
```

To create additional system properties to specify multiple WKA member addresses, an operational override file must be used to define multiple WKA member addresses and a `system-property` attribute must be defined for each WKA member address element. The attributes must include the system property names to be used to override the elements. The below example defines two addresses including system properties:

Note: Defining additional system properties to specify a list of WKA members can be used during testing or in controlled production environments. However, the best practice is to exclusively use an operational override file to specify WKA members in production environments. This ensure the same list of WKA members exists on each cluster member.

```
<?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>
    <unicast-listener>
      <well-known-addresses>
        <socket-address id="1">
          <address system-property="tangosol.coherence.wka"></address>
          <port system-property="tangosol.coherence.wka.port"></port>
        </socket-address>
        <socket-address id="2">
          <address system-property="tangosol.coherence.wka2"></address>
          <port system-property="tangosol.coherence.wka2.port"></port>
        </socket-address>
      </well-known-addresses>
    </unicast-listener>
  </cluster-config>
</coherence>
```

For the above example, the WKA member addresses are specified using the system properties as follows:

```
-Dtangosol.coherence.wka=192.168.0.102 -Dtangosol.coherence.wka.port=8090
-Dtangosol.coherence.wka2=192.168.0.103 -Dtangosol.coherence.wka2.port=8094
```

See "[Creating Custom System Properties](#)" on page 3-21 for more information on defining system properties.

Specifying a WKA Address Provider

A WKA address provider offers a programmatic way to define WKA members. A WKA address provider must implement the `com.tangosol.net.AddressProvider` interface. Implementations may be as simple as a static list or as complex as using dynamic discovery protocols. The address provider must return a terminating null address to indicate that all available addresses have been returned. The address provider implementation is called when the cluster member starts.

Note: implementations must exercise extreme caution since any delay with returned or unhandled exceptions causes a discovery delay and may cause a complete shutdown of the cluster service on the member. Implementations that involve more expensive operations (for example, network fetch) may choose to do so asynchronously by extending the `com.tangosol.net.RefreshableAddressProvider` class.

To use a WKA address provider implementation, add an `<address-provider>` element and specify the fully qualified name of the implementation class within the `<class-name>` element. For example:

```
<?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>
    <unicast-listener>
      <well-known-addresses>
        <address-provider>
          <class-name>package.MyAddressProvider</class-name>
        </address-provider>
      </well-known-addresses>
    </unicast-listener>
  </cluster-config>
</coherence>
```

As an alternative, the `<address-provider>` element supports the use of a `<class-factory-name>` element that is used to specify a factory class for creating `AddressProvider` instances, and a `<method-name>` element to specify the static factory method on the factory class that performs object instantiation. The following example gets an address provider instance using the `getAddressProvider` method on the `MyAddressProviderFactory` class.

```
<?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>
    <unicast-listener>
      <well-known-addresses>
        <address-provider>
          <class-factory-name>package.MyAddressProviderFactory
          </class-factory-name>
          <method-name>getAddressProvider</method-name>
        </address-provider>
      </well-known-addresses>
    </unicast-listener>
  </cluster-config>
</coherence>
```

Any initialization parameters that are required for a class or class factory implementation can be specified using the `<init-params>` element. Initialization parameters are accessible by implementations that include a public constructor with a matching signature. The following example sets the `iMaxTime` parameter to 2000.

```
<?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>
    <unicast-listener>
```

```

    <well-known-addresses>
      <address-provider>
        <class-name>package.MyAddressProvider</class-name>
        <init-params>
          <init-param>
            <param-name>iMaxTime</param-name>
            <param-value>2000</param-value>
          </init-param>
        </init-params>
      </address-provider>
    </well-known-addresses>
  </unicast-listener>
</cluster-config>
</coherence>

```

Enabling Single-Server Mode

Single-Server mode is a cluster that is constrained to run on a single computer and does not access the network. Single-Server mode offers a quick way to start and stop a cluster for development and unit testing.

To enable single-server mode, edit the operational override file and add a `<time-to-live>` element that is set to 0 and a unicast `<address>` element that is set to an address that is routed to loopback. On most computers, setting the address to 127.0.0.1 works. For example:

```

<?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>
    <unicast-listener>
      <address system-property="tangosol.coherence.localhost">127.0.0.1
      </address>
    </unicast-listener>
    <multicast-listener>
      <time-to-live system-property="tangosol.coherence.ttl">0</time-to-live>
    </multicast-listener>
  </cluster-config>
</coherence>

```

The `tangosol.coherence.ttl` and `tangosol.coherence.localhost` system properties are used to enable single-server mode instead of using the operational override file. For example:

```
-Dtangosol.coherence.ttl=0 -Dtangosol.coherence.localhost=127.0.0.1
```

On some UNIX operating systems, including some versions of Linux and Mac OS X, setting the TTL to zero may not be enough to isolate a cluster to a single computer. In such cases, a unique cluster name must also be configured. A cluster member cannot join an existing cluster if it uses a different cluster name. See ["Specifying a Cluster's Name"](#) on page 7-2 for details on configuring a cluster name.

Lastly, on some versions of Mac OS X and Linux, a loopback route for `localhost` is not configured and results in the cluster failing to start. For such scenarios, use the WKA feature to ensure the discovery of cluster members. For example:

```
-Dtangosol.coherence.localhost=127.0.0.1 -Dtangosol.coherence.ttl=0  
-Dtangosol.coherence.wka=127.0.0.1
```

See ["Using Well Known Addresses"](#) on page 7-9 for details on configuring WKA.

Configuring Death Detection

Death detection is a cluster mechanism that quickly detects when a cluster member has failed. Failed cluster members are removed from the cluster and all other cluster members are notified about the departed member. Death detection allows the cluster to differentiate between actual member failure and an unresponsive member, such as the case when a JVM conducts a full garbage collection.

Death detection identifies both process failures (TcpRing component) and hardware failure (IpMonitor component). Process failure is detected using a ring of TCP connections opened on the same port that is used for cluster UDP communication. Each cluster member issues a unicast heartbeat, and the most senior cluster member issues the cluster heartbeat, which is a broadcast message. Hardware failure is detected using the Java `InetAddress.isReachable` method which either issues a trace ICMP ping, or a pseudo ping and uses TCP port 7. Death detection is enabled by default and is configured within the `<tcp-ring-listener>` element.

This section includes the following topics:

- [Changing TCP-Ring Settings](#)
- [Changing the Heartbeat Interval](#)
- [Disabling Death Detection](#)

Changing TCP-Ring Settings

Several settings are used to change the default behavior of the TCP-ring listener. This includes changing the amount of attempts and time before determining that a computer that is hosting cluster members has become unreachable. These default to 3 and 15 seconds, respectively. The TCP/IP server socket backlog queue can also be set and defaults to the value used by the operating system.

To change the TCP-ring settings, edit the operational override file and add the following TCP-Ring elements:

Note: The values of the `<ip-timeout>` and `<ip-attempts>` elements should be high enough to insulate against allowable temporary network outages.

```
<?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>  
    <tcp-ring-listener>  
      <ip-timeout system-property="tangosol.coherence.ipmonitor.pingtimeout">  
        25s</ip-timeout>  
      <ip-attempts>5</ip-attempts>  
      <listen-backlog>10</listen-backlog>  
    </tcp-ring-listener>
```

```

    </cluster-config>
</coherence>

```

The `tangosol.coherence.ipmonitor.pingtimeout` system property is used to specify a timeout instead of using the operational override file. For example:

```
-Dtangosol.coherence.ipmonitor.pingtimeout=20s
```

Changing the Heartbeat Interval

The death detection heartbeat interval can be changed. A higher interval may alleviate minimal network traffic but may also prolongs detection of failed members. The default heartbeat value is 1 second.

Note: The heartbeat setting technically controls how often to evaluate whether or not a heartbeat needs to be emitted. The actual heartbeat interval may or may not be emitted within the specified interval depending on the evaluation process.

To change the death detection heartbeat interval, edit the operational override file and add a `<heartbeat-milliseconds>` element that includes the heartbeat value. For example:

```

<?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>
    <packet-publisher>
      <packet-delivery>
        <heartbeat-milliseconds>5000</heartbeat-milliseconds>
      </packet-delivery>
    </packet-publisher>
  </cluster-config>
</coherence>

```

Disabling Death Detection

Death detection is enabled by default and must be explicitly disabled. Disabling death detection alleviates only minimal network traffic and prolongs the detection of failed members. If disabled, a cluster member uses the packet publisher's resend timeout interval to determine that another member has stopped responding to UDP packets. By default, the timeout interval is set to 5 minutes. See ["Changing the Packet Resend Timeout"](#) on page 10-6 for more details.

Note: Using the packet publisher's resend timeout to detect a failed cluster member is error prone and can produce false positives due to high garbage collection intervals.

To disable death detection, edit the operational override file and add an `<enabled>` element that is set to `false`. For example:

```
<?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>
    <tcp-ring-listener>
      <enabled>false</enabled>
    </tcp-ring-listener>
  </cluster-config>
</coherence>
```

Specifying Cluster Priorities

The cluster priority mechanism allows a priority value to be assigned to a cluster member and to different threads running within a member.

This section includes the following topics:

- [Specifying a Cluster Member's Priority](#)
- [Specifying Communication Thread Priorities](#)
- [Specifying Thread Priorities for Services](#)

Specifying a Cluster Member's Priority

A cluster member's priority is used as the basis for determining tie-breakers between members. If a condition occurs in which one of two members is ejected from the cluster, and in the rare case that it is not possible to objectively determine which of the two is at fault and should be ejected, then the member with the lower priority is ejected.

To specify a cluster member's priority, edit the operational override file and add a `<priority>` element, within the `<member-identity>` node, that includes a priority value between 1 and 10 where 10 is the highest priority. For example:

```
<?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>
      <priority system-property="tangosol.coherence.priority">1</priority>
    </member-identity>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.priority` system property can also be used to specify a cluster member's priority instead of using the operational override file. For example:

```
-Dtangosol.coherence.priority=1
```

Specifying Communication Thread Priorities

Multiple cluster components support thread priority. The priority is used as the basis for determining Java thread execution importance. The components include: the

multicast listener, the unicast listener, the TCP ring listener, the packet speaker, the packet publisher, and the incoming message handler. The default priority setup gives the packet publisher the highest priority followed by the incoming message handler followed by the remaining components.

Thread priority is specified within each component's configuration element (<unicast-listener>, <multicast-listener>, <packet-speaker>, <packet-publisher>, <tcp-ring-listener>, and <incoming-message-handler> elements, respectively). For example, to specify a thread priority for the unicast listener, edit the operational override file and add a <priority> element, within the <unicast-listener> node, that includes a priority value between 1 and 10 where 10 is the highest priority:

```
<?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>
    <unicast-listener>
      <priority>5</priority>
    </unicast-listener>
  </cluster-config>
</coherence>
```

Specifying Thread Priorities for Services

Cluster services support thread priority. The priority is used as the basis for determining Java thread execution importance and indicates which threads of a service are considered critical. There are three types of threads that can have a priority: service threads, event dispatcher threads, and worker threads. The default setup gives service and event dispatcher threads precedence followed by worker threads.

Thread priorities for services can be changed for all services in a cluster by overriding the <service> element in an operational override file. However, a better practice is to configure thread priorities for a service instance within in a cache configuration file when defining a cache scheme. See ["Defining Cache Schemes"](#) on page 13-3 for more information on how to define caches. Use the <service-priority>, <event-dispatcher-priority>, and <worker-priority> subelements, respectively and enter a value between 1 and 10 where 10 is the highest priority. For example:

```
...
<distributed-scheme>
  <scheme-name>distributed</scheme-name>
  <service-name>MyDistributedService</service-name>
  <service-priority>10</service-priority>
  <event-dispatcher-priority>10</event-dispatcher-priority>
  <worker-priority>5</worker-priority>
  ...
</distributed-scheme>
...
```

Starting and Stopping Cluster Members

This chapter provides basic instructions for starting and stopping cache servers and cache clients. If you are having difficulties establishing a cluster when using multicast, see *Administering Oracle Coherence* for instructions on performing a multicast connectivity test.

This chapter includes the following sections:

- [Starting Cache Servers](#)
- [Starting Cache Clients](#)
- [Stopping Cluster Members](#)
- [Performing a Rolling Restart](#)

Starting Cache Servers

Cache servers are cluster members that are responsible for storing cached data. A cluster may be comprised of many cache servers. Each cache server runs in its own JVM.

This section includes the following topics:

- [Overview of the DefaultCacheServer Class](#)
- [Starting Cache Servers From the Command Line](#)
- [Starting Cache Servers Programmatically](#)

Overview of the DefaultCacheServer Class

The `com.tangosol.net.DefaultCacheServer` class is used to start a cache server. A cache server can be started from the command line or can be started programmatically. The following arguments are used when starting a cache server:

- the name of a cache configuration file that is found on the classpath or the path to a Grid ARchive (GAR). If both are provided, the GAR takes precedence. A GAR includes the artifacts that comprise a Coherence application and adheres to a specific directory structure. A GAR can be left as a directory or can be archived with a `.gar` extension. For details about creating a GAR, see *Administering Oracle Coherence*.
- An optional application name for the GAR. If no name is provided, the archive name is used (the directory name or the file name without the `.gar` extension). The name provides an application scope that is used to separate applications on a cluster.

- the number of seconds between checks for stopped services. Stopped services are only automatically started if they are set to be automatically started (as configured by an `<autostart>` element in the cache configuration file). The default value if no argument is provided is 5 seconds.

Starting Cache Servers From the Command Line

Cache servers are typically started from the command line. Use the Java `-cp` option to indicate the location of the `coherence.jar` file and the location where the `tangosol-coherence-override.xml` and `coherence-cache-config.xml` files are located. The location of the configuration files must precede the `coherence.jar` file on the classpath; otherwise, the default configuration files that are located in the `coherence.jar` file are used to start the cache server instance. See [Chapter 3, "Understanding Configuration,"](#) for detailed information on configuration files.

The following example starts a cache server member, uses any configuration files that are placed in the `COHERENCE_HOME\config` directory, and checks for service restarts every 2 seconds.

```
java -server -Xms512m -Xmx512m -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer 2
```

The following example starts a cache server member and uses the Coherence application artifacts that are packaged in the `MyGar.jar` file. The default name (`MyGAR`) is used as the application name.

```
java -server -Xms512m -Xmx512m -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar com.tangosol.net.DefaultCacheServer D:\example\MyGAR.jar
```

Note: The cache configuration file that is packaged in a GAR file takes precedence over a cache configuration file that is located on the classpath.

The `COHERENCE_HOME\bin\cache-server` script is provided as a convenience and can start a cache server instance. The script sets up a basic environment and then runs the `DefaultCacheServer` class. There is a script for both the Windows and UNIX-based platforms. The scripts are typically modified as required for a particular cluster.

Tip: During testing, it is sometimes useful to create multiple scripts with different names that uniquely identify each cache server. For example: `cahe-server-a`, `cache-server-b`, and so on.

Starting Cache Servers Programmatically

An application can use or extend the `DefaultCacheServer` class as required when starting a cache server. For example, an application may want to do some application-specific setup or processing before starting a cache server and its services.

The following example starts a cache server using the `main` method:

```
String[] args = new String[]{"my-cache-config.xml", "5"};
DefaultCacheServer.main(args);
```

The `DefaultCacheServer(ConfigurableCacheFactory)` constructor uses a factory class to create a cache server instance that uses a specified cache configuration file. The following example uses the `ExtensibleConfigurableCacheFactory` implementation

and creates a `DefaultCacheServer` instance and also uses the `startAndMonitor(long)` method to start a cache server as in the previous example:

```
ExtensibleConfigurableCacheFactory factory;
factory = new ExtensibleConfigurableCacheFactory("my-cache-config.xml");

DefaultCacheServer dcs = new DefaultCacheServer(factory);
dcs.startAndMonitor(5000);
```

The static method `startDaemon()` method starts a cache server on a dedicated daemon thread and is intended for use within managed containers.

Two additional static start methods (`start()` and `start(ConfigurableCacheFactory)`) are also available to start a cache server and return control. However, the cache factory class is typically used instead of these methods, which remain for backward compatibility.

Applications that require even more fine-grained control can subclass the `DefaultCacheServer` class and override its methods to perform any custom processing as required. See *Java API Reference for Oracle Coherence* for detailed information on the `DefaultCacheServer` class.

Starting Cache Clients

Cache clients are cluster members that join the cluster to interact with the cluster's services. Cache clients can be as simple as an application that gets and puts data in a cache or can be as complex as a data grid compute application that processes data that is in a cache. The main difference between a cache client and a cache server is that cache clients are generally not responsible for cluster storage.

This section includes the following topics:

- [Disabling Local Storage](#)
- [Using the CacheFactory Class to Start a Cache Client](#)

Disabling Local Storage

Cache clients that use the partition cache service (distributed caches) should not maintain any partitioned data. Cache clients that have storage disabled perform better and use less resources. Partitioned data should only be distributed among cache server instances.

Local storage is disabled on a per-process basis using the `tangosol.coherence.distributed.localstorage` system property. This allows cache clients and servers to use the same configuration descriptors. For example:

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false com.MyApp
```

Using the CacheFactory Class to Start a Cache Client

Applications that use the `com.tangosol.net.CacheFactory` class to get an instance of a cache become cluster members and are considered cache clients. The following example demonstrates the most common way of starting a cache client:

```
CacheFactory.ensureCluster();
NamedCache cache = CacheFactory.getCache("cache_name");
```

When starting an application that is a cache client, use the Java `-cp` option to indicate the location of the `coherence.jar` file and the location where the `tangosol-coherence-override.xml` and `coherence-cache-config.xml` files are located. The location of the configuration files must precede the `coherence.jar` file on the classpath; otherwise, the default configuration files that are located in the `coherence.jar` file are used to start the cache server instance. See [Chapter 3, "Understanding Configuration,"](#) for detailed information on configuration files.

The following example starts an application that is a cache client, uses any configuration files that are placed in the `COHERENCE_HOME\config` directory, and disables storage on the member.

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false com.MyApp
```

The `COHERENCE_HOME\bin\coherence` script is provided for testing purposes and can start a cache client instance. The script sets up a basic environment, sets storage to be disabled, and then runs the `CacheFactory` class, which returns a prompt. The prompt is used to enter commands for interacting with a cache and a cluster. There is a script for both the Windows and UNIX-based platforms. The scripts are typically modified as required for a particular cluster. The class can also be started directly from the command line instead of using the script. For example:

```
java -cp COHERENCE_HOME\config;COHERENCE_HOME\lib\coherence.jar
-Dtangosol.coherence.distributed.localstorage=false com.tangosol.net.CacheFactory
```

If a Coherence application is packaged as a GAR, the GAR can be loaded by the `CacheFactory` instance using the `server` command at the prompt after the client member starts.

```
server [<path-to-gar>] [<app-name>]
```

The following example loads the Coherence application artifacts that are packaged in the `MyGar.gar` file. The default name (`MyGAR`) is used as the application name.

```
Map (?) server D:\example\MyGAR.gar
```

Stopping Cluster Members

This section includes the following topics:

- [Stopping Cluster Members From the Command Line](#)
- [Stopping Cache Servers Programmatically](#)

Stopping Cluster Members From the Command Line

Cluster members are most often shutdown using the `kill` command when on the UNIX platform and `Ctrl+c` when on the Windows platform. These commands initiate the standard JVM shutdown hook which is invoked upon normal JVM termination.

Note: Issuing the `kill -9` command triggers an abnormal JVM termination and the shutdown hook does not run. However, a graceful shutdown is generally not required if a service is known to be node-safe (as seen using JMX management) before termination.

The action a cluster member takes when receiving a shutdown command is configured in the operational override file within the `<shutdown-listener>` element. The following options are available:

- `none` — perform no explicit shutdown actions. This is the suggested value for production unless testing has verified that the behavior on external shutdown is exactly what is desired.
- `force` — (default) perform a hard-stop on the node by calling `Cluster.stop()`. This is the default out-of-box action.
- `graceful` — perform a normal shutdown by calling `Cluster.shutdown()`
- `true` — same as `force`
- `false` — same as `none`

The following example sets the shutdown hook to `none`.

```
<?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>
    <shutdown-listener>
      <enabled system-property="tangosol.coherence.shutdownhook">none</enabled>
    </shutdown-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.shutdownhook` system property is used to specify the shutdown hook behavior instead of using the operational override file. For example:

```
-Dtangosol.coherence.shutdownhook=none
```

Stopping Cache Servers Programmatically

The `DefaultCacheServer` class provides two methods that are used to shutdown a cache server:

Note: Shutdown is supposed to be called in a standalone application where it shuts down the instance which the `DefaultCacheServer` class itself maintains as a static member.

- `shutdown()` – This is a static method that is used to shut down a cache server that was started on a different thread using the `DefaultCacheServer.main()` or `DefaultCacheServer.start()` methods.
- `shutdownServer()` – This method is called on a `DefaultCacheServer` instance which an application keeps hold of.

Performing a Rolling Restart

A rolling restart is a technique for restarting cache servers in a cluster that ensures no data is lost during the restart. A rolling restart allows the data on a cache server to be redistributed to other cache servers on the cluster while the cache server is restarted.

Each cache server in the cluster can be restarted in turn to effectively restart the whole cluster.

Rolling restarts are commonly performed when a cache server or its host computer must be updated or when upgrading a cache server to a new point release. However, the technique can be used whenever you want to restart a cache server that is currently managing a portion of cached data.

Note: When upgrading a cluster, a rolling restart can only be used to upgrade patch set or patch set updates, but not major or minor releases. For details about Oracle Fusion Middleware release numbers, see *Administering Oracle Fusion Middleware*.

Prerequisites to Performing a Rolling Restart

A rolling restart requires initial consideration and setup prior to starting a cluster. A rolling restart cannot be performed on a cluster that does not meet the following prerequisites:

- The cache servers in a cluster must provide enough capacity to handle the shutdown of a single cache server (n minus 1 where n is the number of cache servers in the cluster). An out-of-memory exception can occur during a redistribution of data if cache servers are running at capacity. For details on capacity planning see, *Administering Oracle Coherence*.
- Remote JMX management must be enabled on all cache servers and at least two cache servers must contain an operational MBean server. Ensure that you can connect to the MBean servers using an MBean browser such as JConsole. For details on configuring JMX management and connecting to an MBean server instance, see *Managing Oracle Coherence*.

Restarting Cache Servers for a Rolling Restart

Use these instructions to restart a cache server. If you are restarting the host computer, then make sure all cache server processes are shutdown before shutting down the computer.

To restart a cache server:

1. Connect to a Coherence MBean server using an MBean browser. Ensure that the MBean server is not hosted on the cache server that is being restarted.
2. From the Coherence Service MBean, select a cluster service that corresponds to a cache that is configured in the cache configuration file.
3. Check the `StatusHA` attribute for any cluster member to ensure that the attribute's value is `MACHINE-SAFE`. The `MACHINE-SAFE` state indicates that all the cache servers running on any given computer could be stopped without data loss. If the attribute is not `MACHINE-SAFE`, then additional cache servers, possibly on different computers, must be started before performing a restart. For details on the `StatusHA` attribute, see *Managing Oracle Coherence*.
4. Shutdown the cache server.
5. From the MBean browser, recheck the `StatusHA` attribute and wait for the state to return to `MACHINE-SAFE`.
6. Restart the cache server.

7. From the MBean browser, recheck the `StatusHA` attribute and wait for the state to return to `MACHINE-SAFE`.
8. Repeat steps 4 to 7 for additional cache servers that are to be restarted.

Dynamically Managing Cluster Membership

This chapter provides instructions for programmatically managing members and services in a cluster and listening to member and service events.

This chapter includes the following sections:

- [Overview of Managing Cluster Membership](#)
- [Using the Cluster and Service Objects](#)
- [Using the Member Object](#)
- [Listening to Member Events](#)

Overview of Managing Cluster Membership

Coherence manages cluster membership by automatically adding new servers to the cluster when they start and automatically detecting their departure when they are shut down or fail. Applications have full access to this information and can sign up to receive event notifications when members join and leave the cluster. Coherence also tracks all the services that each member is providing and consuming. This information is used to, among other things, plan for service resiliency in case of server failure and to load-balance data management across all members of the cluster.

Using the Cluster and Service Objects

From any cache, the application can obtain a reference to the local representation of a cache's service. From any service, the application can obtain a reference to the local representation of the cluster.

```
CacheService service = cache.getCacheService();
Cluster        cluster = service.getCluster();
```

From the `Cluster` object, the application can determine the set of services that run in the cluster. This is illustrated in [Example 9-1](#).

Example 9-1 *Determining Services Running in the Cluster*

```
...
for (Enumeration enum = cluster.getServiceNames(); enum.hasMoreElements(); )
{
    String sName = (String) enum.nextElement();
    ServiceInfo info = cluster.getServiceInfo(sName);
    // ...
}
...

```

The `ServiceInfo` object provides information about the service, including its name, type, version and membership.

For more information on this feature, see the API documentation for `NamedCache`, `CacheService`, `Service`, `ServiceInfo` and `Cluster`.

Using the Member Object

The primary information that an application can determine about each member in the cluster is:

- The Member's IP address
- What date/time the Member joined the cluster

As an example, if there are four servers in the cluster with each server running one copy ("instance") of the application and all four instances of the application are clustered, then the cluster is composed of four Members. From the `Cluster` object, the application can determine what the local Member is:

```
Member memberThis = cluster.getLocalMember();
```

From the `Cluster` object, the application can also determine the entire set of cluster members:

```
Set setMembers = cluster.getMemberSet();
```

From the `ServiceInfo` object, the application can determine the set of cluster members that are participating in that service:

```
ServiceInfo info = cluster.getServiceInfo(sName);  
Set setMembers = info.getMemberSet();
```

For more information on this feature, see the API documentation for `Member`.

Listening to Member Events

Applications must create a class that implements the `MemberListener` interface (see [Example 9-2](#)) to listen for cluster and service membership changes. The listener class is then added on a service by either using the service's `addMemberListener` method or by adding a `<member-listener>` element to a cache scheme definition.

There are two advantages to using the configuration approach versus the programmatic approach. First, programmatically, listeners can only be added to a service that is running. As such, the first `MEMBER_JOINED` event is missed. Secondly, the `addMemberListener` call must be issued on each and every cluster node that runs the corresponding service. The configuration approach solves both of these issues.

The following example adds a listener implementation named `MyMemberListener` to a service using the `addMemberListener` method:

```
Service service = cache.getCacheService();  
service.addMemberListener(package.MyMemberListener);
```

The service can also be looked up by its name:

```
Service service = cluster.getService(sName);  
service.addMemberListener(package.MyMemberListener);
```

The following example adds a listener implementation named `MyMemberListener` to a service named `DistributedCache` by adding the `<member-listener>` element to a distributed cache scheme definition:

```
<distributed-scheme>
  <scheme-name>example-distributed</scheme-name>
  <service-name>DistributedCache</service-name>
  <member-listener>
    <class-name>package.MyMemberListener</class-name>
  </member-listener>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>example-binary-backing-map</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>
```

The `<member-listener>` element can be used within the `<distributed-scheme>`, `<replicated-scheme>`, `<optimistic-scheme>`, `<invocation-scheme>`, and `<proxy-scheme>` elements. See [Appendix B, "Cache Configuration Elements"](#) for a reference of valid cache configuration elements.

Note: A `MemberListener` implementation must have a public default constructor when using the `<member-listener>` element to add a listener to a service.

[Example 9–2](#) demonstrates a `MemberListener` implementation that prints out all the membership events that it receives:

Example 9–2 A Sample `MemberListener` Implementation

```
public class MemberEventPrinter
    extends Base
    implements MemberListener
{
    public void memberJoined(MemberEvent evt)
    {
        out(evt);
    }

    public void memberLeaving(MemberEvent evt)
    {
        out(evt);
    }

    public void memberLeft(MemberEvent evt)
    {
        out(evt);
    }
}
```

The `MemberEvent` object carries information about the event type (either `MEMBER_JOINED`, `MEMBER_LEAVING`, or `MEMBER_LEFT`), the member that generated the event, and the service that acts as the source of the event. Additionally, the event provides a method, `isLocal()`, that indicates to the application that it is *this* member that is joining or leaving the cluster. This is useful for recognizing soft restarts in which an application automatically rejoins a cluster after a failure occurs.

Note: Calling the `CacheFactory.shutdown()` method unregisters all listeners. In this case, both the `MEMBER_LEAVING` and `MEMBER_LEFT` events are sent. If a member terminates for any other reason, only the `MEMBER_LEFT` event is sent.

[Example 9-3](#) illustrates how information encapsulated in a `MemberEvent` object can be used.

Example 9-3 Using Event Type Information in a `MemberEvent` Object

```
public class RejoinEventPrinter
    extends Base
    implements MemberListener
{
    public void memberJoined(MemberEvent evt)
    {
        if (evt.isLocal())
        {
            out("this member just rejoined the cluster: " + evt);
        }
    }

    public void memberLeaving(MemberEvent evt)
    {
    }

    public void memberLeft(MemberEvent evt)
    {
    }
}
```

For more information on these feature, see the API documentation for `Service`, `MemberListener` and `MemberEvent`.

Tuning TCMP Behavior

This chapter provides instructions for changing default TCMP settings. A brief overview of TCMP is also provided. See "[Understanding TCMP](#)" on page 6-1 for additional details on TCMP. Also, see *Administering Oracle Coherence* which includes many tuning recommendations and instructions.

This chapter includes the following sections:

- [Overview of TCMP Data Transmission](#)
- [Throttling Data Transmission](#)
- [Bundling Packets to Reduce Load](#)
- [Changing Packet Retransmission Behavior](#)
- [Configuring the Size of the Packet Buffers](#)
- [Adjusting the Maximum Size of a Packet](#)
- [Changing the Packet Speaker Volume Threshold](#)
- [Configuring the Incoming Message Handler](#)
- [Using Network Filters](#)
- [Changing the TCMP Socket Provider Implementation](#)

Overview of TCMP Data Transmission

Cluster members communicate using Tangosol Cluster Management Protocol (TCMP). TCMP is an IP-based protocol that is used to discover cluster members, manage the cluster, provision services, and transmit data. TCMP is an asynchronous protocol; communication is never blocking even when many threads on a server are communicating at the same time. Asynchronous communication also means that the latency of the network (for example, on a routed network between two different sites) does not affect cluster throughput, although it affects the speed of certain operations.

The TCMP protocol is very tunable to take advantage of specific network topologies, or to add tolerance for low-bandwidth and high-latency segments in a geographically distributed cluster. Coherence comes with a pre-set configuration. Some TCMP attributes are dynamically self-configuring at run time, but can also be overridden and locked down for deployment purposes. TCMP behavior should always be changed based on performance testing. Coherence includes a datagram test that is used to evaluate TCMP data transmission performance over the network. See *Administering Oracle Coherence* for instructions on using the datagram test utility to test network performance.

TCMP data transmission behavior is configured within the `tangosol-coherence-override.xml` file using the `<packet-publisher>`, `<packet-speaker>`, `<incoming-message-handler>`, and `<outgoing-message-handler>` elements. See [Appendix A, "Operational Configuration Elements,"](#) for a reference of all TCMP-related elements that are discussed in this chapter.

Throttling Data Transmission

The speed at which data is transmitted is controlled using the `<flow-control>` and `<traffic-jam>` elements. These elements can help achieve the greatest throughput with the least amount of packet failure. The throttling settings discussed in this section are typically changed when dealing with slow networks, or small packet buffers.

This section includes the following topics:

- [Adjusting Packet Flow Control Behavior](#)
- [Disabling Packet Flow Control](#)
- [Adjusting Packet Traffic Jam Behavior](#)

Adjusting Packet Flow Control Behavior

Flow control is used to dynamically throttle the rate of packet transmission to a given cluster member based on point-to-point transmission statistics which measure the cluster member's responsiveness. Flow control stops a cluster member from being flooded with packets while it is incapable of responding.

Flow control is configured within the `<flow-control>` element. There are two settings that are used to adjust flow control behavior:

- `<pause-detection>` – This setting controls the maximum number of packets that are resent to an unresponsive cluster member before determining that the member is paused. When a cluster member is marked as paused, packets addressed to it are sent at a lower rate until the member resumes responding. Pauses are typically due to long garbage collection intervals. The value is specified using the `<maximum-packets>` element and defaults to 16 packets. A value of 0 disables pause detection.
- `<outstanding-packets>` – This setting is used to define the number of unconfirmed packets that are sent to a cluster member before packets addressed to that member are deferred. The value may be specified as either an explicit number by using the `<maximum-packets>` element, or as a range by using both a `<maximum-packets>` and `<minimum-packets>` elements. When a range is specified, this setting is dynamically adjusted based on network statistics. The maximum value should always be greater than 256 packets and defaults to 4096 packets. The minimum range should always be greater than 16 packets and defaults to 64 packets.

To adjust flow control behavior, edit the operational override file and add the `<pause-detection>` and `<outstanding-packets>` elements as follows:

```
<?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>
    <packet-publisher>
```

```

    <packet-delivery>
      <flow-control>
        <pause-detection>
          <maximum-packets>32</maximum-packets>
        </pause-detection>
        <outstanding-packets>
          <maximum-packets>2048</maximum-packets>
          <minimum-packets>128</minimum-packets>
        </outstanding-packets>
      </flow-control>
    </packet-delivery>
  </packet-publisher>
</cluster-config>
</coherence>

```

Disabling Packet Flow Control

To disable flow control, edit the operational override file and add an `<enabled>` element, within the `<flow-control>` element, that is set to `false`. For example

```

<?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>
    <packet-publisher>
      <packet-delivery>
        <flow-control>
          <enabled>false</enabled>
        </flow-control>
      </packet-delivery>
    </packet-publisher>
  </cluster-config>
</coherence>

```

Adjusting Packet Traffic Jam Behavior

A packet traffic jam is when the number of pending packets that are enqueued by client threads for the packet publisher to transmit on the network grows to a level that the packet publisher considers intolerable. Traffic jam behavior is configured within the `<traffic-jam>` element. There are two settings that are used to adjust traffic jam behavior:

- `<maximum-packets>` – This setting controls the maximum number of pending packets that the packet publisher tolerates before determining that it is clogged and must slow down client requests (requests from local non-system threads). When the configured maximum packets limit is exceeded, client threads are forced to pause until the number of outstanding packets drops below the specified limit. This setting prevents most unexpected out-of-memory conditions by limiting the size of the resend queue. A value of 0 means no limit. The default value is 8192.
- `<pause-milliseconds>` – This setting controls the number of milliseconds that the publisher pauses a client thread that is trying to send a message when the publisher is clogged. The publisher does not allow the message to go through until

the clog is gone, and repeatedly sleeps the thread for the duration specified by this property. The default value is 10.

Specifying a packet limit which is too low, or a pause which is too long, may result in the publisher transmitting all pending packets and being left without packets to send. A warning is periodically logged if this condition is detected. Ideal values ensure that the publisher is never left without work to do, but at the same time prevent the queue from growing uncontrollably. The pause should be set short (10ms or under) and the limit on the number of packets be set high (that is, greater than 5000).

When the `<traffic-jam>` element is used with the `<flow-control>` element, the setting operates in a point-to-point mode, only blocking a send if the recipient has too many packets outstanding. It is recommended that the `<traffic-jam>` element's `<maximum-packets>` subelement value be greater than the `<maximum-packets>` value for the `<outstanding-packets>` element. When `<flow-control>` is disabled, the `<traffic-jam>` setting takes all outstanding packets into account.

To adjust the enqueue rate behavior, edit the operational override file and add the `<maximum-packets>` and `<pause-milliseconds>` elements as follows:

```
<?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>
    <packet-publisher>
      <traffic-jam>
        <maximum-packets>8192</maximum-packets>
        <pause-milliseconds>10</pause-milliseconds>
      </traffic-jam>
    </packet-publisher>
  </cluster-config>
</coherence>
```

Bundling Packets to Reduce Load

Multiple small packets can be bundled into a single larger packet to reduce the load on the network switching infrastructure. Packet bundling is configured within the `<packet-bundling>` element and includes the following settings:

- `<maximum-deferral-time>` – This setting specifies the maximum amount of time to defer a packet while waiting for additional packets to bundle. A value of zero results in the algorithm not waiting, and only bundling the readily accessible packets. A value greater than zero causes some transmission deferral while waiting for additional packets to become available. This value is typically set below 250 microseconds to avoid a detrimental throughput impact. If the units are not specified, nanoseconds are assumed. The default value is 1us (microsecond).
- `<aggression-factor>` – This setting specifies the aggressiveness of the packet deferral algorithm. Where as the `<maximum-deferral-time>` element defines the upper limit on the deferral time, the `<aggression-factor>` influences the average deferral time. The higher the aggression value, the longer the publisher may wait for additional packets. The factor may be expressed as a real number, and often times values between 0.0 and 1.0 allows for high packet utilization while keeping latency to a minimum. The default value is 0.

The default packet-bundling settings are minimally aggressive allowing for bundling to occur without adding a measurable delay. The benefits of more aggressive bundling is based on the network infrastructure and the application object's typical data sizes and access patterns.

To adjust packet bundling behavior, edit the operational override file and add the `<maximum-deferral-time>` and `<aggression-factor>` elements as follows:

```
<?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>
    <packet-publisher>
      <packet-delivery>
        <packet-bundling>
          <maximum-deferral-time>1us</maximum-deferral-time>
          <aggression-factor>0</aggression-factor>
        </packet-bundling>
      </packet-delivery>
    </packet-publisher>
  </cluster-config>
</coherence>
```

Changing Packet Retransmission Behavior

TCMP utilizes notification packets to acknowledge the receipt of packets which require confirmation. A positive acknowledgment (ACK) packet indicates that a packet was received correctly and that the packet must not be resent. Multiple ACKs for a given sender are batched into a single ACK packet to avoid wasting network bandwidth with many small ACK packets. Packets that have not been acknowledged are retransmitted based on the packet publisher's configured resend interval.

A negative acknowledgment (NACK) packet indicates that the packet was received incorrectly and causes the packet to be retransmitted. Negative acknowledgment is determined by inspecting packet ordering for packet loss. Negative acknowledgment causes a packet to be resent much quicker than relying on the publisher's resend interval. See "[Disabling Negative Acknowledgments](#)" on page 10-11 to disable negative acknowledgments.

This section includes the following topics:

- [Changing the Packet Resend Interval](#)
- [Changing the Packet Resend Timeout](#)
- [Configuring Packet Acknowledgment Delays](#)

Changing the Packet Resend Interval

The packet resend interval specifies the minimum amount of time, in milliseconds, that the packet publisher waits for a corresponding ACK packet, before resending a packet. The default resend interval is 200 milliseconds.

To change the packet resend interval, edit the operational override file and add a `<resend-milliseconds>` element as follows:

```
<?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>
    <packet-publisher>
      <packet-delivery>
        <resend-milliseconds>400</resend-milliseconds>
      </packet-delivery>
    </packet-publisher>
  </cluster-config>
</coherence>

```

Changing the Packet Resend Timeout

The packet resend timeout interval specifies the maximum amount of time, in milliseconds, that a packet continues to be resent if no ACK packet is received. After this timeout expires, a determination is made if the recipient is to be considered terminated. This determination takes additional data into account, such as if other nodes are still able to communicate with the recipient. The default value is 300000 milliseconds. For production environments, the recommended value is the greater of 300000 and two times the maximum expected full GC duration.

Note: The default death detection mechanism is the TCP-ring listener, which detects failed cluster members before the resend timeout interval is ever reached. See "[Configuring Death Detection](#)" on page 7-14 for more information on death detection.

To change the packet resend timeout interval, edit the operational override file and add a `<timeout-milliseconds>` element as follows:

```

<?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>
    <packet-publisher>
      <packet-delivery>
        <timeout-milliseconds>420000</timeout-milliseconds>
      </packet-delivery>
    </packet-publisher>
  </cluster-config>
</coherence>

```

Configuring Packet Acknowledgment Delays

The amount of time the packet publisher waits before sending ACK and NACK packets can be changed as required. The ACK and NACK packet delay intervals are configured within the `<notification-queueing>` element using the following settings:

- `<ack-delay-milliseconds>` – This element specifies the maximum number of milliseconds that the packet publisher delays before sending an ACK packet. The

ACK packet may be transmitted earlier if multiple batched acknowledgments fills the ACK packet. This value should be set substantially lower than the remote member's packet delivery resend timeout to allow ample time for the ACK to be received and processed before the resend timeout expires. The default value is 16.

- `<nack-delay-milliseconds>` – This element specifies the number of milliseconds that the packet publisher delays before sending a NACK packet. The default value is 1.

To change the ACK and NACK delay intervals, edit the operational override file and add the `<ack-delay-milliseconds>` and `<nack-delay-milliseconds>` elements as follows:

```
<?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>
    <packet-publisher>
      <notification-queueing>
        <ack-delay-milliseconds>32</ack-delay-milliseconds>
        <nack-delay-milliseconds>1</nack-delay-milliseconds>
      </notification-queueing>
    </packet-publisher>
  </cluster-config>
</coherence>
```

Configuring the Size of the Packet Buffers

Packet buffers are operating system buffers used by datagram sockets (also referred to as socket buffers). Packet buffers can be configured to control how many packets the operating system is requested to buffer. Packet buffers are used by unicast and multicast listeners (inbound buffers) and by the packet publisher (outbound buffer).

This section includes the following topics:

- [Understanding Packet Buffer Sizing](#)
- [Configuring the Outbound Packet Buffer Size](#)
- [Configuring the Inbound Packet Buffer Size](#)

Understanding Packet Buffer Sizing

Packet buffer size can be configured based on either the number of packets or based on bytes using the following settings:

- `<maximum-packets>` – This setting specifies the number of packets (based on the configured packet size) that the datagram socket is asked to size itself to buffer. See `java.net.SocketOptions#SO_SNDBUF` and `java.net.SocketOptions#SO_RCVBUF` properties for additional details. Actual buffer sizes may be smaller if the underlying socket implementation cannot support more than a certain size. For details on configuring the packet size, see "[Adjusting the Maximum Size of a Packet](#)" on page 10-9.
- `<size>` – Specifies the requested size of the underlying socket buffer in bytes.

The operating system only treats the specified packet buffer size as a hint and is not required to allocate the specified amount. In the event that less space is allocated than requested, Coherence issues a warning and continues to operate with the constrained buffer, which may degrade performance. See *Administering Oracle Coherence* for details on configuring your operating system to allow larger buffers.

Large inbound buffers can help insulate the Coherence network layer from JVM pauses that are caused by the Java Garbage Collector. While the JVM is paused, Coherence cannot dequeue packets from any inbound socket. If the pause is long enough to cause the packet buffer to overflow, the packet reception is delayed as the originating node must detect the packet loss and retransmit the packet(s).

Configuring the Outbound Packet Buffer Size

The outbound packet buffer is used by the packet publisher when transmitting packets. When making changes to the buffer size, performance should be evaluated both in terms of throughput and latency. A large buffer size may allow for increased throughput, while a smaller buffer size may allow for decreased latency.

To configure the outbound packet buffer size, edit the operational override file and add a `<packet-buffer>` element within the `<packet-publisher>` node and specify the packet buffer size using either the `<size>` element (for bytes) or the `<maximum-packets>` element (for packets). The default value is 32 packets. The following example demonstrates specifying the packet buffer size based on the number of packets:

```
<?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>
    <packet-publisher>
      <packet-buffer>
        <maximum-packets>64</maximum-packets>
      </packet-buffer>
    </packet-publisher>
  </cluster-config>
</coherence>
```

Configuring the Inbound Packet Buffer Size

The multicast listener and unicast listener each have their own inbound packet buffer. To configure an inbound packet buffer size, edit the operational override file and add a `<packet-buffer>` element (within either a `<multicast-listener>` or `<unicast-listener>` node, respectively) and specify the packet buffer size using either the `<size>` element (for bytes) or the `<maximum-packets>` element (for packets). The default value is 64 packets for the multicast listener and 1428 packets for the unicast listener.

The following example specifies the packet buffer size for the unicast listener and is entered using bytes:

```
<?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>
  <unicast-listener>
    <packet-buffer>
      <size>1500000</size>
    </packet-buffer>
  </unicast-listener>
</cluster-config>
</coherence>
```

The following example specifies the packet buffer size for the multicast listener and is entered using packets:

```
<?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>
  <packet-publisher>
    <packet-buffer>
      <maximum-packets>128</maximum-packets>
    </packet-buffer>
  </packet-publisher>
</cluster-config>
</coherence>
```

Adjusting the Maximum Size of a Packet

The maximum and preferred UDP packet sizes can be adjusted to optimize the efficiency and throughput of cluster communication. All cluster nodes must use identical maximum packet sizes. For optimal network utilization, this value should be 32 bytes less than the network maximum transmission unit (MTU).

Note: When specifying a UDP packet size larger than 1024 bytes on Microsoft Windows a registry setting must be adjusted to allow for optimal transmission rates. The `COHERENCE_HOME/bin/optimize.reg` registration file contains the registry settings. See *Administering Oracle Coherence* for details on setting the Datagram size on Windows.

Packet size is configured within the `<packet-size>` element and includes the following settings:

- `<maximum-length>` – Specifies the packet size, in bytes, which all cluster members can safely support. This value must be the same for all members in the cluster. A low value can artificially limit the maximum size of the cluster. This value should be at least 512. The default value is 64KB.
- `<preferred-length>` – Specifies the preferred size, in bytes, of the `DatagramPacket` objects that are sent and received on the unicast and multicast sockets.

This value can be larger or smaller than the `<maximum-length>` value, and need not be the same for all cluster members. The ideal value is one which fits within the network MTU, leaving enough space for either the UDP or TCP packet headers, which are 32 and 52 bytes respectively.

This value should be at least 512. A default value is automatically calculated based on the local nodes MTU. An MTU of 1500 is used if the MTU cannot be obtained and is adjusted for the packet headers (1468 for UDP and 1448 for TCP).

To adjust the packet size, edit the operational override file and add the `<maximum-length>` and `<preferred-length>` elements as follows:

```
<?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>
    <packet-publisher>
      <packet-size>
        <maximum-length>49152</maximum-length>
        <preferred-length>1500</preferred-length>
      </packet-size>
    </packet-publisher>
  </cluster-config>
</coherence>
```

Changing the Packet Speaker Volume Threshold

The packet speaker is responsible for sending packets on the network when the packet-publisher detects that a network send operation is likely to block. This allows the packet publisher to avoid blocking on I/O and continue to prepare outgoing packets. The packet publisher dynamically chooses whether to use the speaker as the packet load changes.

When the packet load is relatively low it may be more efficient for the speaker's operations to be performed on the publisher's thread. When the packet load is high using the speaker allows the publisher to continue preparing packets while the speaker transmits them on the network.

The packet speaker is configured using the `<volume-threshold>` element to specify the minimum number of packets which must be ready to be sent for the speaker daemon to be activated. If the value is unspecified (the default), it is set to match the packet buffer.

To specify the packet speaker volume threshold, edit the operational override file and add the `<volume-threshold>` element as follows:

```
<?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>
    <packet-speaker>
      <enabled>true</enabled>
      <volume-threshold>
        <minimum-packets>32</minimum-packets>
      </volume-threshold>
    </packet-speaker>
  </cluster-config>
</coherence>
```

Configuring the Incoming Message Handler

The incoming message handler assembles UDP packets into logical messages and dispatches them to the appropriate Coherence service for processing. The incoming message handler is configured within the `<incoming-message-handler>` element.

This section includes the following topics:

- [Changing the Time Variance](#)
- [Disabling Negative Acknowledgments](#)

Changing the Time Variance

The `<maximum-time-variance>` element specifies the maximum time variance between sending and receiving broadcast messages when trying to determine the difference between a new cluster member's system time and the cluster time. The smaller the variance, the more certain one can be that the cluster time is closer between multiple systems running in the cluster; however, the process of joining the cluster is extended until an exchange of messages can occur within the specified variance. Normally, a value as small as 20 milliseconds is sufficient; but, with heavily loaded clusters and multiple network hops, a larger value may be necessary. The default value is 16.

To change the maximum time variance, edit the operational override file and add the `<maximum-time-variance>` element as follows:

```
<?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>
    <incoming-message-handler>
      <maximum-time-variance>16</maximum-time-variance>
    </incoming-message-handler>
  </cluster-config>
</coherence>
```

Disabling Negative Acknowledgments

Negative acknowledgments can be disabled for the incoming message handler. When disabled, the handler does not notify the packet sender if packets were received incorrectly. In this case, the packet sender waits the specified resend timeout interval before resending the packet. See "[Changing Packet Retransmission Behavior](#)" on page 10-5 for more information on packet acknowledgments.

To disable negative acknowledgment, edit the operational override file and add a `<use-nack-packets>` element that is set to false. For example:

```
<?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>
    <incoming-message-handler>
      <use-nack-packets>>false</use-nack-packets>
    </incoming-message-handler>
  </cluster-config>
</coherence>
```

```
</cluster-config>  
</coherence>
```

Using Network Filters

A network filter is a mechanism for plugging into the low-level TCMP stream protocol. Every message that is sent across the network by Coherence is streamed through this protocol. Coherence includes a predefined compression filter and also supports custom filters as required.

This section includes the following topics:

- [Using the Compression Filter](#)
- [Using Custom Network Filters](#)

Filters are defined in the operational deployment descriptor and must be explicitly enabled within a `tangosol-coherence-override.xml` file.

Note: Use filters in an all-or-nothing manner: if one cluster member is using a filter and another is not, the messaging protocol fails. Stop the entire cluster before configuring filters.

Using the Compression Filter

The compression filter is based on the `java.util.zip` package and compresses message contents to reduce network load. This filter is useful when there is ample CPU available but insufficient network bandwidth. The compression filter is defined in the `com.tangosol.net.CompressionFilter` class and declared in the operational deployment descriptor within the `<filters>` node. The compression filter's configured name is `gzip`, which is used when enabling the filter for specific services or when enabling the filter for all services.

The following topics are included in this section:

- [Enabling the Compression Filter for Specific Services](#)
- [Enabling the Compression Filter for All Services](#)
- [Configuring the Compression Filter](#)

Enabling the Compression Filter for Specific Services

To enable the compression filter for a specific service, include the `<use-filters>` element within the service's definition and add a `<filter-name>` subelement that is set to `gzip`. The following example configures the Distributed Cache service definition to enable the compression filter. All services that are instances of this service automatically use the filter.

```
<?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>  
    <services>  
      <service id="3">  
        <service-type>DistributedCache</service-type>
```

```

        <service-component>PartitionedService.PartitionedCache
        </service-component>
        <use-filters>
            <filter-name>gzip</filter-name>
        </use-filters>
    </service>
</services>
</cluster-config>
</coherence>

```

Enabling the Compression Filter for All Services

To enable the compression filter for all services, add the `<use-filters>` element within the `<outgoing-message-handler>` element and add a `<filter-name>` subelement that is set to `gzip`. For example:

```

<?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>
    <outgoing-message-handler>
      <use-filters>
        <filter-name>gzip</filter-name>
      </use-filters>
    </outgoing-message-handler>
  </cluster-config>
</coherence>

```

Configuring the Compression Filter

The compression filter includes parameters that can configure the filter's behavior. [Table 10-1](#) describes each of the parameters that are available. See `java.util.zip.Deflater` for additional details.

The following example demonstrates configuring the compression filter and changes the default compression strategy and level:

```

<?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>
    <filters>
      <filter id="1">
        <filter-name>gzip</filter-name>
        <filter-class>com.tangosol.net.CompressionFilter</filter-class>
        <init-params>
          <init-param id="1">
            <param-name>strategy</param-name>
            <param-value>huffman-only</param-value>
          </init-param>
          <init-param id="2">
            <param-name>level</param-name>
            <param-value>speed</param-value>
          </init-param>
        </init-params>
      </filter>
    </filters>
  </cluster-config>
</coherence>

```

```

        </init-param>
    </init-params>
</filter>
</filters>
</cluster-config>
</coherence>

```

Table 10–1 Compression Filter Parameters

Parameter Name	Description
buffer-length	Specifies compression buffer length in bytes. Legal values are positive integers or zero. The default value is 0.
level	Specifies the compression level. Legal values are: <ul style="list-style-type: none"> ▪ default (default) ▪ compression ▪ speed ▪ none
strategy	Specifies the compressions strategy. Legal values are: <ul style="list-style-type: none"> ▪ gzip (default) ▪ huffman-only ▪ filtered ▪ default

Using Custom Network Filters

Custom network filters can be created as required. Custom filters must implement the `com.tangosol.io WrapperStreamFactory` interface. The `WrapperStreamFactory` interface provides the stream to be wrapped ("filtered") on input (received message) or output (sending message) and expects a stream back that wraps the original stream. These methods are called for each incoming and outgoing message. See *Java API Reference for Oracle Coherence* for details on these APIs.

The following topics are included in this section:

- [Declaring a Custom Filter](#)
- [Enabling a Custom Filter for Specific Services](#)
- [Enabling a Custom Filter for All Services](#)

Declaring a Custom Filter

Custom filters are declared within the `<filters>` element in the `tangosol-coherence-override.xml` file. The following example demonstrates defining a custom filter named `MyFilter`. When declaring a custom filter, the filter id must be greater than 3 because there are three predefined filters that are declared in the operational deployment descriptor.

```

<?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>
    <filters>

```

```

    <filter id="4">
      <filter-name>MyFilter</filter-name>
      <filter-class>package.MyFilter</filter-class>
      <init-params>
        <init-param id="1">
          <param-name>foo</param-name>
          <param-value>bar</param-value>
        </init-param>
      </init-params>
    </filter>
  </filters>
</cluster-config>
</coherence>

```

Enabling a Custom Filter for Specific Services

To enable a custom filter for a specific service, include the `<use-filters>` element within the service's definition and add a `<filter-name>` subelement that is set to the filter's name. The following example enables a custom filter called `MyFilter` for the Distributed Cache service. All caches that are derived from this service automatically use the filter. Coherence instantiates the filter when the service starts and holds it until the service stops.

```

<?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>
    <services>
      <service id="3">
        <service-type>DistributedCache</service-type>
        <service-component>PartitionedService.PartitionedCache
        </service-component>
        <use-filters>
          <filter-name>MyFilter</filter-name>
        </use-filters>
      </service>
    </services>
  </cluster-config>
</coherence>

```

Enabling a Custom Filter for All Services

To enable a custom filter globally for all services, add the `<use-filters>` element within the `<outgoing-message-handler>` element and add a `<filter-name>` subelement that is set to the filter name. The following example enables a custom filter called `MyFilter` for all services. Coherence instantiates the filter on startup and holds it until the cluster stops.

```

<?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>
    <outgoing-message-handler>
      <use-filters>

```

```
        <filter-name>MyFilter</filter-name>
    </use-filters>
</outgoing-message-handler>
</cluster-config>
</coherence>
```

Changing the TCMP Socket Provider Implementation

Coherence provides multiple underlying socket provider implementations (besides the default system socket provider) for use by TCMP. Socket providers for use by TCMP are configured for the unicast listener within the `<unicast-listener>` element.

This section includes the following topics:

- [Using the TCP Socket Provider](#)
- [Using the SDP Socket Provider](#)
- [Using the SSL Socket Provider](#)

Using the TCP Socket Provider

The TCP socket provider is a socket provider which, whenever possible, produces TCP-based sockets. This socket provider creates `DatagramSocket` instances which are backed by TCP. When used with the WKA feature (multicast disabled), TCMP functions entirely over TCP without the need for UDP.

Note: if this socket provider is used without the WKA feature (multicast enabled), TCP is used for all unicast communications; while, multicast is utilized for group based communications.

The TCP socket provider uses up to two TCP connections between each pair of cluster members. No additional threads are added to manage the TCP traffic as it is all done using nonblocking NIO based sockets. Therefore, the existing TCMP threads handle all the connections. The connections are brought up on demand and are automatically reopened as needed if they get disconnected for any reason. Two connections are utilized because it reduces send/receive contention and noticeably improves performance. TCMP is largely unaware that it is using a reliable protocol and as such still manages guaranteed delivery and flow control.

To specify the TCP socket provider, edit the operational override file and add a `<socket-provider>` element that includes the `tcp` value. For example:

```
<?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>
    <unicast-listener>
      <socket-provider system-property="tangosol.coherence.socketprovider">tcp
    </socket-provider>
    </unicast-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.socketprovider` system property is used to specify the socket provider instead of using the operational override file. For example:

```
-Dtangosol.coherence.socketprovider=tcp
```

Using the SDP Socket Provider

The SDP socket provider is a socket provider which, whenever possible, produces SDP-based sockets provided that the JVM and underlying network stack supports SDP. This socket provider creates `DatagramSocket` instances which are backed by SDP. When used with the WKA feature (multicast disabled), TCMP functions entirely over SDP without the need for UDP.

Note: if this socket provider is used without the WKA feature (multicast enabled), SDP is used for all unicast communications; while, multicast is utilized for group based communications.

To specify the SDP socket provider, edit the operational override file and add a `<socket-provider>` element that includes the `sdp` value. For example:

```
<?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>
    <unicast-listener>
      <socket-provider system-property="tangosol.coherence.socketprovider">sdp
    </socket-provider>
    </unicast-listener>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.socketprovider` system property is used to specify the socket provider instead of using the operational override file. For example:

```
-Dtangosol.coherence.socketprovider=sdp
```

Using the SSL Socket Provider

The SSL socket provider is a socket provider which only produces SSL protected sockets. This socket provider creates `DatagramSocket` instances which are backed by SSL/TCP or SSL/SDP. SSL is not supported for multicast sockets; therefore, the WKA feature (multicast disabled) must be used for TCMP to function with this provider.

The default SSL configuration allows for easy configuration of two-way SSL connections, based on peer trust where every trusted peer resides within a single JKS keystore. More elaborate configuration can be defined with alternate identity and trust managers to allow for Certificate Authority trust validation. See *Securing Oracle Coherence* for detailed instructions on configuring and using SSL with TCMP.

Using the Service Guardian

This chapter provides instructions for using and configuring the service guardian to detect and resolve deadlocked service threads and includes instructions for implementing custom failure policies.

This chapter includes the following sections:

- [Overview](#)
- [Configuring the Service Guardian](#)
- [Issuing Manual Guardian Heartbeats](#)

Overview

The service guardian is a mechanism that detects and attempts to resolve deadlocks in Coherence threads. Deadlocked threads on a member may result in many undesirable behaviors that are visible to the rest of the cluster, such as the inability to add new nodes to the cluster and the inability to service requests by nodes currently in the cluster.

The service guardian receives periodic heartbeats that are issued by Coherence-owned and created threads. Should a thread fail to issue a heartbeat before the configured timeout, the service guardian takes corrective action. Both the timeout and corrective action (recovery) can be configured as required.

Note: The term deadlock does not necessarily indicate a true deadlock; a thread that does not issue a timely heartbeat may be executing a long running process or waiting on a slow resource. The service guardian does not have the ability to distinguish a deadlocked thread from a slow one.

Interfaces That Are Executed By Coherence

Implementations of the following interfaces are executed by Coherence-owned threads. Any processing in an implementation that exceeds the configured guardian timeout results in the service guardian attempting to recover the thread. The list is not exhaustive and only provides the most common interfaces that are implemented by end users.

```
com.tangosol.net.Invocable  
com.tangosol.net.cache.CacheStore  
com.tangosol.util.Filter  
com.tangosol.util.InvocableMap.EntryAggregator  
com.tangosol.util.InvocableMap.EntryProcessor
```

```
com.tangosol.util.MapListener  
com.tangosol.util.MapTrigger
```

Understanding Recovery

The service guardian's recovery mechanism uses a series of steps to determine if a thread is deadlocked. Corrective action is taken if the service guardian concludes that the thread is deadlocked. The action to take can be configured and custom actions can be created if required. The recovery mechanism is outlined below:

- **Soft Timeout** – The recovery mechanism first attempts to interrupt the thread just before the configured timeout is reached. The following example log message demonstrates a soft timeout message:

```
<Error> (thread=DistributedCache, member=1): Attempting recovery (due to soft  
timeout) of Daemon{Thread="Thread[WriteBehindThread:CacheStoreWrapper (com.  
tangosol.examples.rwbm.TimeoutTest), 5,WriteBehindThread:CacheStoreWrapper (com.  
tangosol.examples.rwbm.TimeoutTest)]", State=Running}
```

If the thread can be interrupted and it results in a heartbeat, normal processing resumes.

- **Hard Timeout** – The recovery mechanism attempts to stop a thread after the configured timeout is reached. The following example log message demonstrates a hard timeout message:

```
<Error> (thread=DistributedCache, member=1): Terminating guarded execution (due  
to hard timeout) of Daemon{Thread="Thread[WriteBehindThread:CacheStoreWrapper  
(com.tangosol.examples.rwbm.TimeoutTest), 5,WriteBehindThread:CacheStoreWrapper  
(com.tangosol.examples.rwbm.TimeoutTest)]", State=Running}
```

- Lastly, if the thread cannot be stopped, the recovery mechanism performs an action based on the configured failure policy. Actions that can be performed include: shutting down the cluster service, shutting down the JVM, and performing a custom action. The following example log message demonstrates an action taken by the recovery mechanism:

```
<Error> (thread=Termination Thread, member=1): Write-behind thread timed out;  
stopping the cache service
```

Configuring the Service Guardian

The service guardian is enabled out-of-the box and has two configured items: the timeout value and the failure policy. The timeout value is the length of time the service guardian waits to receive a heartbeat from a thread before starting recovery. The failure policy is the corrective action that the service guardian takes after it concludes that the thread is deadlocked.

Setting the Guardian Timeout

The service guardian timeout can be set in three different ways based on the level of granularity that is required:

- **All threads** – This option allows a single timeout value to be applied to all Coherence-owned threads on a cluster node. This is the out-of-box configuration and is set at 305000 milliseconds by default.
- **Threads per service type** – This option allows different timeout values to be set for specific service types. The timeout value is applied to the threads of all service

instances. If a timeout is not specified for a particular service type, then the timeout defaults to the timeout that is set for all threads.

- **Threads per service instance** – This option allows different timeout values to be set for specific service instances. If a timeout is not set for a specific service instance, then the service's timeout value, if specified, is used; otherwise, the timeout that is set for all threads is used.

Setting the timeout value to 0 stops threads from being guarded. In general, the service guardian timeout value should be set equal to or greater than the timeout value for packet delivery.

Note: The guardian timeout can also be used for cache store implementations that are configured with a read-write-backing-map scheme. In this case, the `<cachestore-timeout>` element is set to 0, which defaults the timeout to the guardian timeout. See ["read-write-backing-map-scheme"](#) on page B-104.

Setting the Guardian Timeout for All Threads

To set the guardian timeout for all threads in a cluster node, add a `<timeout-milliseconds>` element to an operational override file within the `<service-guardian>` element. The following example sets the timeout value to 120000 milliseconds:

```
<?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>
    <service-guardian>
      <timeout-milliseconds>120000</timeout-milliseconds>
    </service-guardian>
  </cluster-config>
</coherence>
```

The `<timeout-milliseconds>` value can also be set using the `tangosol.coherence.guard.timeout` system property.

Setting the Guardian Timeout Per Service Type

To set the guardian timeout per service type, override the service's `guardian-timeout` initialization parameter in an operational override file. The following example sets the guardian timeout for the DistributedCache service to 120000 milliseconds:

```
<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="17">
            <param-name>guardian-timeout</param-name>
```

```

        <param-value>120000</param-value>
    </init-param>
</init-params>
</service>
</services>
</cluster-config>
</coherence>

```

The `guardian-timeout` initialization parameter can be set for the `DistributedCache`, `ReplicatedCache`, `OptimisticCache`, `Invocation`, and `Proxy` services. Refer to the `tangosol-coherence.xml` file that is located in the `coherence.jar` file for the correct service ID and initialization parameter ID to use when overriding the `guardian-timeout` parameter for a service.

Each service also has a system property that sets the guardian timeout, respectively:

```

tangosol.coherence.distributed.guard.timeout
tangosol.coherence.replicated.guard.timeout
tangosol.coherence.optimistic.guard.timeout
tangosol.coherence.invocation.guard.timeout
tangosol.coherence.proxy.guard.timeout

```

Setting the Guardian Timeout Per Service Instance

To set the guardian timeout per service instance, add a `<guardian-timeout>` element to a cache scheme definition in the cache configuration file. The following example sets the guardian timeout for a distributed cache scheme to 120000 milliseconds.

```

<distributed-scheme>
  <scheme-name>example-distributed</scheme-name>
  <service-name>DistributedCache</service-name>
  <guardian-timeout>120000</guardian-timeout>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>example-binary-backing-map</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>

```

The `<guardian-timeout>` element can be used in the following schemes: `<distributed-scheme>`, `<replicated-scheme>`, `<optimistic-scheme>`, `<transaction-scheme>`, `<invocation-scheme>`, and `<proxy-scheme>`.

Using the Timeout Value From the `PriorityTask` API

Custom implementations of the `Invocable`, `EntryProcessor`, and `EntryAggregator` interface can implement the `com.tangosol.net.PriorityTask` interface. In this case, the service guardian attempts recovery after the task has been executing for longer than the value returned by `getExecutionTimeoutMillis()`. See [Chapter 31, "Managing Thread Execution,"](#) for more information on using the API.

The execution timeout can be set using the `<task-timeout>` element within an `<invocation-scheme>` element defined in the cache configuration file. For the `Invocation` service, the `<task-timeout>` element specifies the timeout value for `Invocable` tasks that implement the `PriorityTask` interface, but do not explicitly specify the execution timeout value; that is, the `getExecutionTimeoutMillis()` method returns 0.

If the `<task-timeout>` element is set to 0, the default guardian timeout is used. See [Appendix B, "Cache Configuration Elements"](#) for more information on the different cache schemes that support the use of the `<task-timeout>` element.

Setting the Guardian Service Failure Policy

The service failure policy determines the corrective action that the service guardian takes after it concludes that a thread is deadlocked. The following policies are available:

- `exit-cluster` – This policy attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. This is the default policy if no policy is specified.
- `exit-process` – This policy attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly.
- `logging` – This policy logs any detected problems but takes no corrective action.
- `custom` – the name of a Java class that provides an implementation for the `com.tangosol.net.ServiceFailurePolicy` interface. See ["Enabling a Custom Guardian Failure Policy"](#) on page 11-6.

The service guardian failure policy can be set three different ways based on the level of granularity that is required:

- `All threads` – This option allows a single failure policy to be applied to all Coherence-owned threads on a cluster node. This is the out-of-box configuration.
- `Threads per service type` – This option allows different failure policies to be set for specific service types. The policy is applied to the threads of all service instances. If a policy is not specified for a particular service type, then the timeout defaults to the timeout that is set for all threads.
- `Threads per service instance` – This option allows different failure policies to be set for specific service instances. If a policy is not set for a specific service instance, then the service's policy, if specified, is used; otherwise, the policy that is set for all threads is used.

Setting the Guardian Failure Policy for All Threads

To set a guardian failure policy, add a `<service-failure-policy>` element to an operational override file within the `<service-guardian>` element. The following example sets the failure policy to `exit-process`:

```
<?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>
    <service-guardian>
      <service-failure-policy>exit-process</service-failure-policy>
    </service-guardian>
  </cluster-config>
</coherence>
```

Setting the Guardian Failure Policy Per Service Type

To set the failure policy per service type, override the service's `service-failure-policy` initialization parameter in an operational override file. The following example sets the failure policy for the `DistributedCache` service to the logging policy:

```
<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="18">
            <param-name>service-failure-policy</param-name>
            <param-value>logging</param-value>
          </init-param>
        </init-params>
      </service>
    </services>
  </cluster-config>
</coherence>
```

The `service-failure-policy` initialization parameter can be set for the `DistributedCache`, `ReplicatedCache`, `OptimisticCache`, `Invocation`, and `Proxy` services. Refer to the `tangosol-coherence.xml` file that is located in the `coherence.jar` file for the correct service ID and initialization parameter ID to use when overriding the `service-failure-policy` parameter for a service.

Setting the Guardian Failure Policy Per Service Instance

To set the failure policy per service instance, add a `<service-failure-policy>` element to a cache scheme definition in the cache configuration file. The following example sets the failure policy to logging for a distributed cache scheme:

```
<distributed-scheme>
  <scheme-name>example-distributed</scheme-name>
  <service-name>DistributedCache</service-name>
  <guardian-timeout>120000</guardian-timeout>
  <service-failure-policy>logging</service-failure-policy>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>example-binary-backing-map</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>
```

The `<service-failure-policy>` element can be used in the following schemes: `<distributed-scheme>`, `<replicated-scheme>`, `<optimistic-scheme>`, `<transaction-scheme>`, `<invocation-scheme>`, and `<proxy-scheme>`.

Enabling a Custom Guardian Failure Policy

To use a custom failure policy, include an `<instance>` subelement and provide a fully qualified class name that implements the `ServiceFailurePolicy` interface. See ["instance"](#) on page A-30 for detailed instructions on using the `<instance>` element. The

following example enables a custom failure policy that is implemented in the `MyFailurePolicy` class. Custom failure policies can be enabled for all threads (as shown below) or can be enabled per service instance within a cache scheme definition.

```
<?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>
    <service-guardian>
      <service-failure-policy>
        <instance>
          <class-name>package.MyFailurePolicy</class-name>
        </instance>
      </service-failure-policy>
    </service-guardian>
  </cluster-config>
</coherence>
```

As an alternative, the `<instance>` element supports the use of a `<class-factory-name>` element to use a factory class that is responsible for creating `ServiceFailurePolicy` instances, and a `<method-name>` element to specify the static factory method on the factory class that performs object instantiation. The following example gets a custom failure policy instance using the `getPolicy` method on the `MyPolicyFactory` class.

```
<?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>
    <service-guardian>
      <service-failure-policy>
        <instance>
          <class-factory-name>package.MyPolicyFactory</class-factory-name>
          <method-name>getPolicy</method-name>
        </instance>
      </service-failure-policy>
    </service-guardian>
  </cluster-config>
</coherence>
```

Any initialization parameters that are required for an implementation can be specified using the `<init-params>` element. The following example sets the `iMaxTime` parameter to 2000.

```
<?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>
    <service-guardian>
      <service-failure-policy>
        <instance>
          <class-name>package.MyFailurePolicy</class-name>
```

```
        <init-params>
          <init-param>
            <param-name>iMaxTime</param-name>
            <param-value>2000</param-value>
          </init-param>
        </init-params>
      </instance>
    </service-failure-policy>
  </service-guardian>
</cluster-config>
</coherence>
```

Issuing Manual Guardian Heartbeats

The `com.tangosol.net.GuardSupport` class provides heartbeat methods that applications can use to manually issue heartbeats to the guardian:

```
GuardSupport.heartbeat();
```

For known long running operations, the heartbeat can be issued with the number of milliseconds that should pass before the operation is considered "stuck:"

```
GuardSupport.heartbeat(long cMillis);
```

Part III

Using Caches

Part III contains the following chapters:

- [Chapter 12, "Introduction to Coherence Caches"](#)
- [Chapter 13, "Configuring Caches"](#)
- [Chapter 14, "Implementing Storage and Backing Maps"](#)
- [Chapter 15, "Caching Data Sources"](#)
- [Chapter 16, "Serialization Paged Cache"](#)
- [Chapter 17, "Using Quorum"](#)
- [Chapter 18, "Cache Configurations by Example"](#)

Introduction to Coherence Caches

This chapter provides an overview and comparison of basic cache types offered by Coherence.

This chapter includes the following sections:

- [Understanding Distributed Caches](#)
- [Understanding Replicated Caches](#)
- [Understanding Optimistic Caches](#)
- [Understanding Near Caches](#)
- [Understanding Local Caches](#)
- [Understanding Remote Caches](#)
- [Summary of Cache Types](#)

Understanding Distributed Caches

A distributed, or partitioned, cache is a clustered, fault-tolerant cache that has linear scalability. Data is partitioned among all storage members of the cluster. For fault-tolerance, partitioned caches can be configured to keep each piece of data on one or more unique computers within a cluster. Distributed caches are the most commonly used caches in Coherence.

Coherence defines a distributed cache as a collection of data that is distributed across any number of cluster nodes such that exactly one node in the cluster is responsible for each piece of data in the cache, and the responsibility is distributed (or, load-balanced) among the cluster nodes.

There are several key points to consider about a distributed cache:

- **Partitioned:** The data in a distributed cache is spread out over all the servers in such a way that no two servers are responsible for the same piece of cached data. The size of the cache and the processing power associated with the management of the cache can grow linearly with the size of the cluster. Also, it means that read operations against data in the cache can be accomplished with a "single hop," in other words, involving at most one other server. Write operations are "single hop" if no backups are configured.
- **Load-Balanced:** Since the data is spread out evenly over the servers, the responsibility for managing the data is automatically load-balanced across the cluster.
- **Location Transparency:** Although the data is spread out across cluster nodes, the exact same API is used to access the data, and the same behavior is provided by

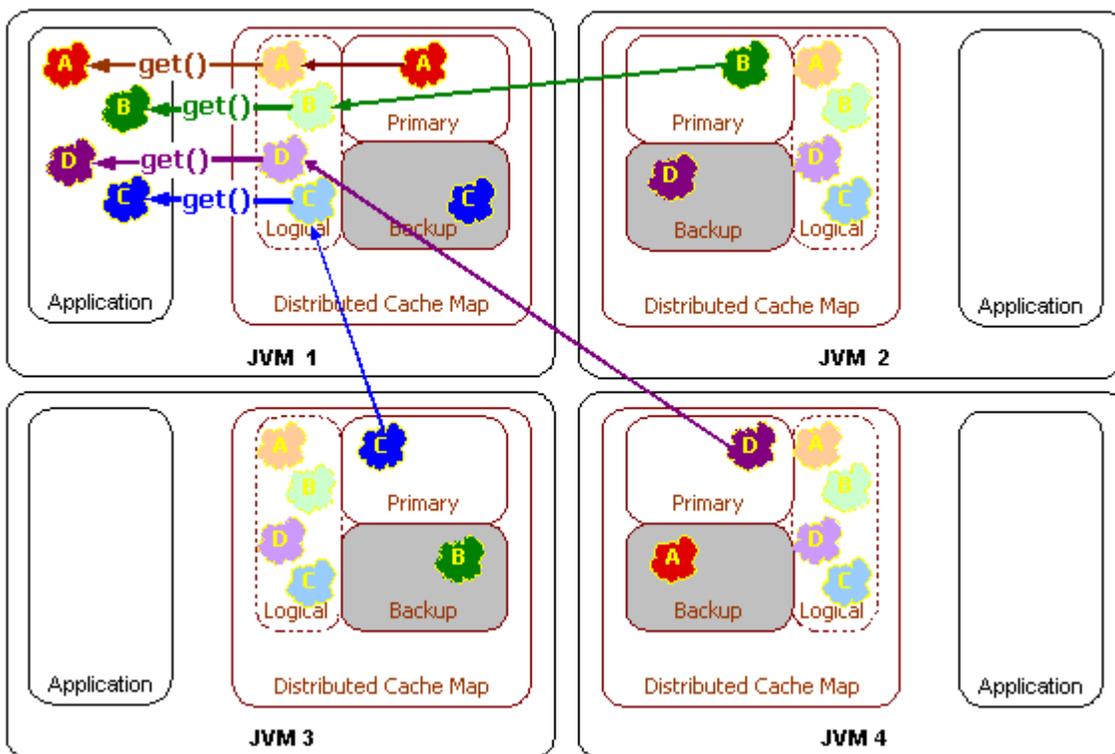
each of the API methods. This is called location transparency, which means that the developer does not have to code based on the topology of the cache, since the API and its behavior is the same with a local JCache, a replicated cache, or a distributed cache.

- Failover:** All Coherence services provide failover and failback without any data loss, and that includes the distributed cache service. The distributed cache service allows the number of backups to be configured; if the number of backups is one or higher, any cluster node can fail without the loss of data.

Access to the distributed cache often must go over the network to another cluster node. All other things equals, if there are n cluster nodes, $(n - 1) / n$ operations go over the network:

Figure 12-1 provides a conceptual view of a distributed cache during get operations.

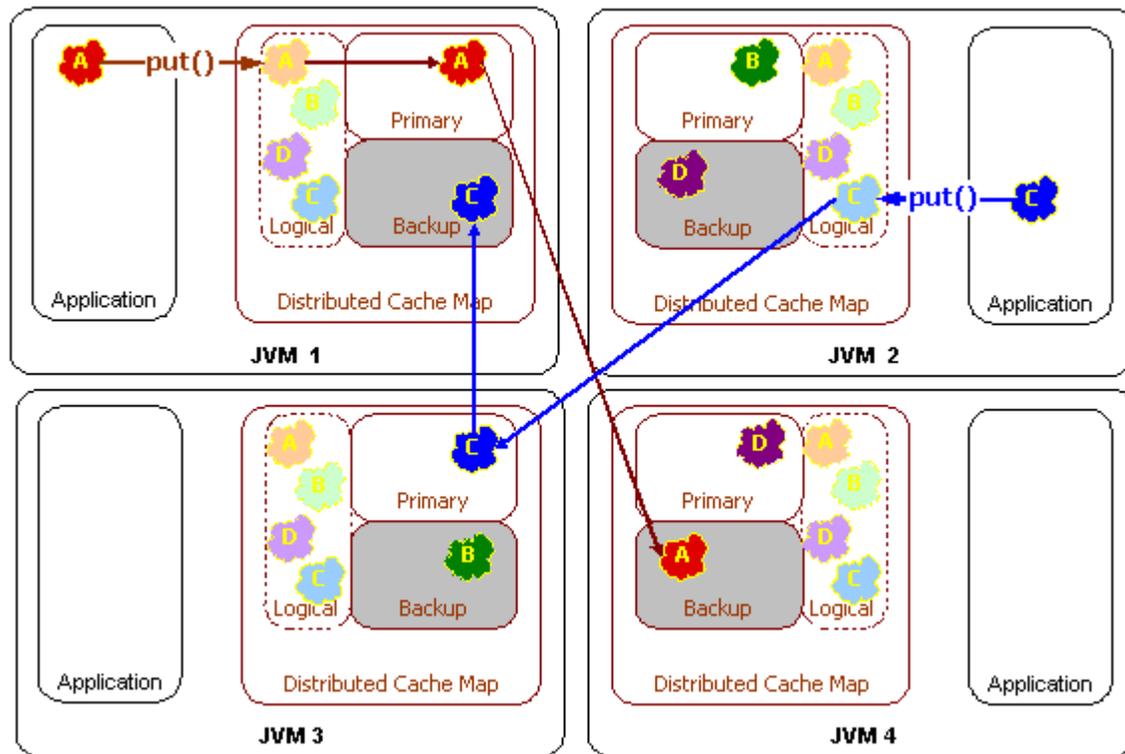
Figure 12-1 Get Operations in a Distributed Cache



Since each piece of data is managed by only one cluster node, read operations over the network are only "single hop" operations. This type of access is extremely scalable, since it can use point-to-point communication and thus take optimal advantage of a switched network.

Figure 12-2 provides a conceptual view of a distributed cache during put operations.

Figure 12–2 Put Operations in a distributed Cache Environment



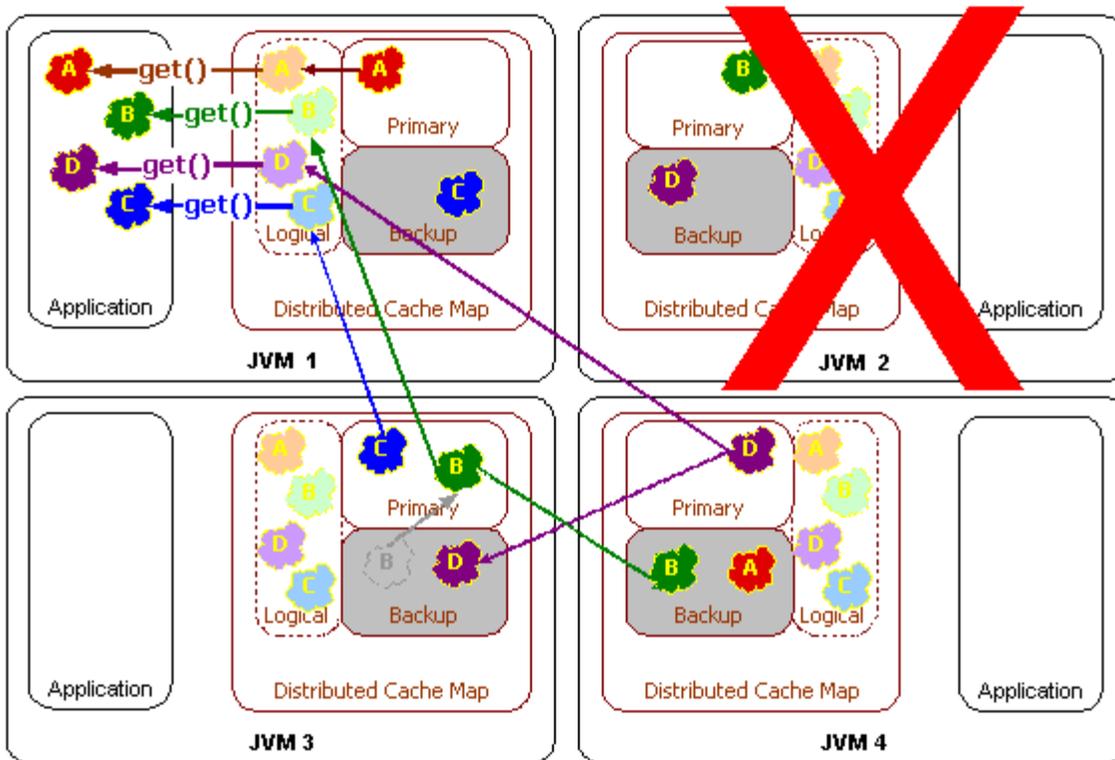
In the figure above, the data is being sent to a primary cluster node and a backup cluster node. This is for failover purposes, and corresponds to a backup count of one. (The default backup count setting is one.) If the cache data were not critical, which is to say that it could be re-loaded from disk, the backup count could be set to zero, which would allow some portion of the distributed cache data to be lost if a cluster node fails. If the cache were extremely critical, a higher backup count, such as two, could be used. The backup count only affects the performance of cache modifications, such as those made by adding, changing or removing cache entries.

Modifications to the cache are not considered complete until all backups have acknowledged receipt of the modification. There is a slight performance penalty for cache modifications when using the distributed cache backups; however it guarantees that if a cluster node were to unexpectedly fail, that data consistency is maintained and no data is lost.

Failover of a distributed cache involves promoting backup data to be primary storage. When a cluster node fails, all remaining cluster nodes determine what data each holds in backup that the failed cluster node had primary responsible for when it died. Those data becomes the responsibility of whatever cluster node was the backup for the data.

Figure 12–3 provides a conceptual view of a distributed cache during failover.

Figure 12-3 Failover in a Distributed Cache

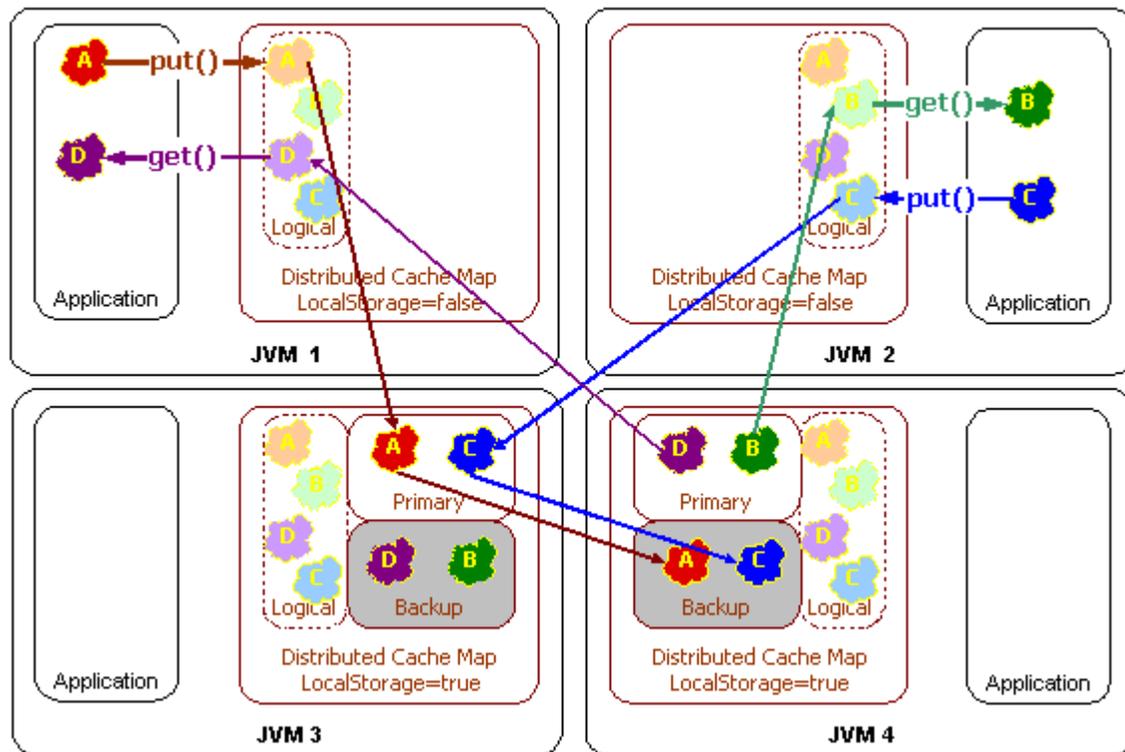


If there are multiple levels of backup, the first backup becomes responsible for the data; the second backup becomes the new first backup, and so on. Just as with the replicated cache service, lock information is also retained with server failure; the sole exception is when the locks for the failed cluster node are automatically released.

The distributed cache service also allows certain cluster nodes to be configured to store data, and others to be configured to not store data. The name of this setting is *local storage enabled*. Cluster nodes that are configured with the local storage enabled option provides the cache storage and the backup storage for the distributed cache. Regardless of this setting, all cluster nodes have the same exact view of the data, due to location transparency.

Figure 12-4 provides a conceptual view of local storage in a distributed cache during get and put operations.

Figure 12-4 Local Storage in a Distributed Cache



There are several benefits to the local storage enabled option:

- The Java heap size of the cluster nodes that have turned off local storage enabled are not affected at all by the amount of data in the cache, because that data is cached on other cluster nodes. This is particularly useful for application server processes running on older JVM versions with large Java heaps, because those processes often suffer from garbage collection pauses that grow exponentially with the size of the heap.
- Coherence allows each cluster node to run any supported version of the JVM. That means that cluster nodes with local storage enabled turned on could be running a newer JVM version that supports larger heap sizes, or Coherence's off-heap storage using elastic data. Different JVM versions are fine between storage enabled and disabled nodes, but all storage enabled nodes should use the same JVM version.
- The local storage enabled option allows some cluster nodes to be used just for storing the cache data; such cluster nodes are called Coherence cache servers. Cache servers are commonly used to scale up Coherence's distributed query functionality.

Understanding Replicated Caches

A replicated cache is a clustered, fault tolerant cache where data is fully replicated to every member in the cluster. This cache offers the fastest read performance with linear performance scalability for reads but poor scalability for writes (as writes must be processed by every member in the cluster). Adding servers does not increase aggregate cache capacity because data is replicated to all servers. Replicated caches are typically used for small data sets that are read-only.

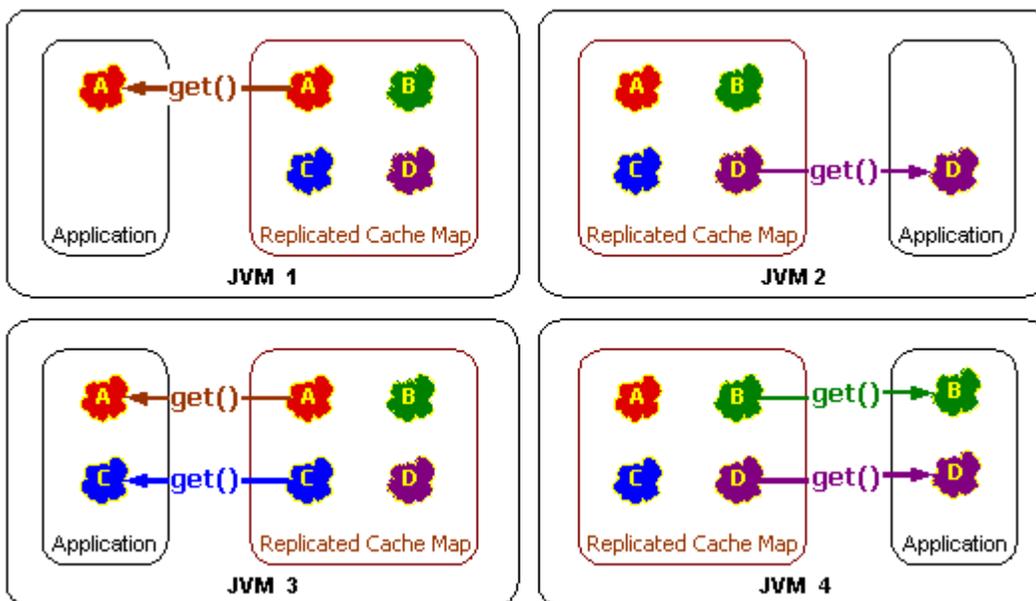
Note: Unlike distributed caches, replicated caches do not differentiate between storage-enabled and storage-disabled cluster members.

Replicated caches have very high access speeds since the data is replicated to each cluster node (JVM), which accesses the data from its own memory. This type of access is often referred to as zero latency access and is perfect for situations in which an application requires the highest possible speed in its data access. However, it is important to remember that zero latency access only occurs after the data has been accessed for the first time. That is, replicated caches store data in serialized form until the data is accessed, at which time the data must be deserialized. Each cluster node where the data is accessed must perform the initial deserialization step as well (even on the node where the data was originally created). The deserialization step adds a performance cost that must be considered when using replicated caches.

There are several challenges to building a reliable replicated cache. The first is how to get it to scale and perform well. Updates to the cache have to be sent to all cluster nodes, and all cluster nodes have to end up with the same data, even if multiple updates to the same piece of data occur at the same time. Also, if a cluster node requests a lock, it should not have to get all cluster nodes to agree on the lock, otherwise it scales extremely poorly; yet with cluster node failure, all of the data and lock information must be kept safely. Coherence handles all of these scenarios transparently and provides a scalable and highly available replicated cache implementation.

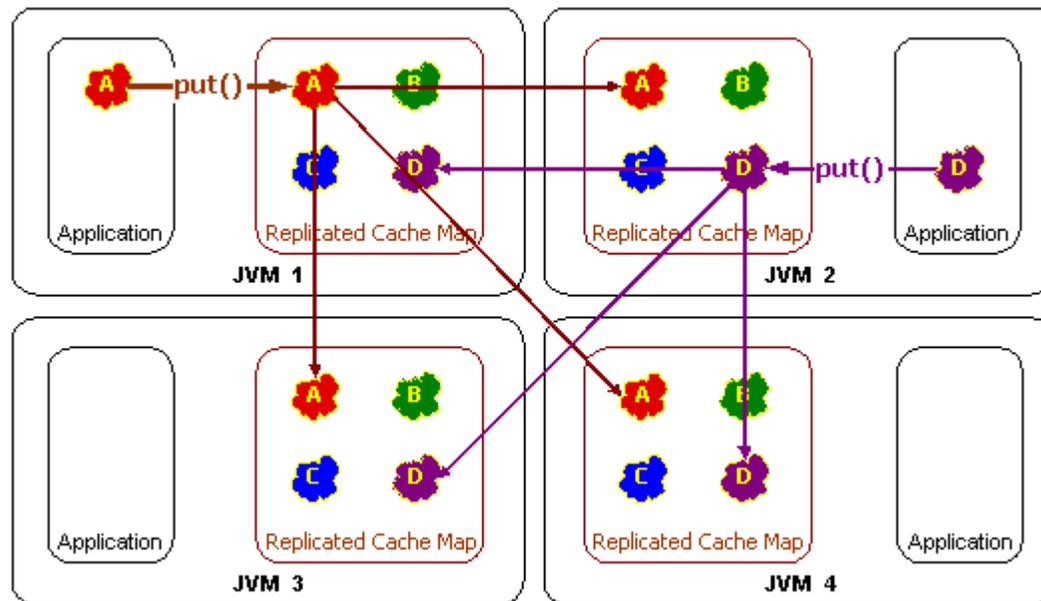
Figure 12-5 provides a conceptual view of replicated caches during a get operations.

Figure 12-5 Get Operation in a Replicated Cache



For put operations, updating a replicated cache requires pushing the new version of the data to all other cluster nodes. Figure 12-6 provides a conceptual view of replicated caches during a put operations.

Figure 12–6 Put Operation in a Replicated Cache



Coherence implements its replicated cache service in such a way that all read-only operations occur locally, all concurrency control operations involve at most one other cluster node, and only update operations require communicating with all other cluster nodes. The result is excellent scalable performance, and as with all of the Coherence services, the replicated cache service provides transparent and complete failover and failback.

The limitations of the replicated cache service should also be carefully considered:

- Data is managed by the replicated cache service on every cluster node that has joined the service. Therefore, memory utilization (the Java heap size) is increased for each cluster node and can impact performance.
- Replicated caches that have a high incidence of updates do not scale linearly as the cluster grows. The cluster suffers diminishing returns as cluster nodes are added.
- Replicated caches do not support per-entry expiration. Expiry needs to be set at the cache level. Expiry and eviction are enforced locally by the backing map, so data may expire independently on each node. Entries may expire at slightly different times and may be available slightly longer on different nodes. When using expiry and eviction, an application must be designed to accommodate a partial data set. If a system of record (such as a database) is used, then it should be irrelevant to an application whether an item has been expired or evicted.

Understanding Optimistic Caches

An optimistic cache is a clustered cache implementation similar to the replicated cache implementation but without any concurrency control. This implementation offers higher write throughput than a replicated cache. It also allows an alternative underlying store for the cached data (for example, a MRU/MFU-based cache). However, if two cluster members are independently pruning or purging the underlying local stores, the stored content held by each member may be different.

Understanding Near Caches

A near cache is a hybrid cache; it typically fronts a distributed cache or a remote cache with a local cache. Near cache invalidates front cache entries, using a configured invalidation strategy, and provides excellent performance and synchronization. Near cache backed by a partitioned cache offers zero-millisecond local access for repeat data access, while enabling concurrency and ensuring coherency and fail over, effectively combining the best attributes of replicated and partitioned caches.

The objective of a near cache is to provide the best of both worlds between the extreme performance of replicated caches and the extreme scalability of distributed caches by providing fast read access to Most Recently Used (MRU) and Most Frequently Used (MFU) data. Therefore, a near cache is an implementation that wraps two caches: a "front cache" and a "back cache" that automatically and transparently communicate with each other by using a read-through/write-through approach.

The "front cache" provides local cache access. It is assumed to be inexpensive, in that it is fast, and is limited in terms of size. The "back cache" can be a centralized or multitiered cache that can load-on-demand in case of local cache misses. The "back cache" is assumed to be complete and correct in that it has much higher capacity, but more expensive in terms of access speed.

This design allows near caches to configure cache coherency, from the most basic expiry-based caches and invalidation-based caches, up to advanced caches that version data and provide guaranteed coherency. The result is a tunable balance between the preservation of local memory resources and the performance benefits of truly local caches.

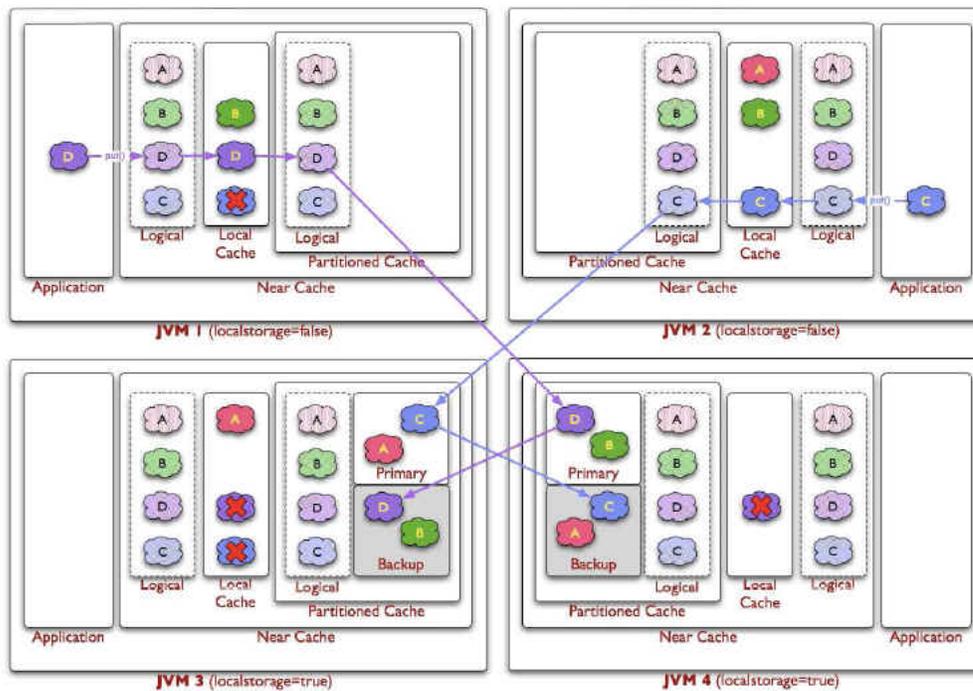
The typical deployment uses a local cache for the "front cache". A local cache is a reasonable choice because it is thread safe, highly concurrent, size-limited, auto-expiring, and stores the data in object form. For the "back cache", a partitioned cache is used.

The following figure illustrates the data flow in a near cache. If the client writes an object D into the grid, the object is placed in the local cache inside the local JVM and in the partitioned cache which is backing it (including a backup copy). If the client requests the object, it can be obtained from the local, or "front cache", in object form with no latency.

Note: Because entries are stored in object form in the front of the near cache, the application must take care of synchronizing access by multiple threads in the same JVM. For example, if a thread mutates an entry that has been retrieved from the front of a near cache, the change is immediately visible to other threads in the same JVM.

[Figure 12–7](#) provides a conceptual view of a near cache during put operations.

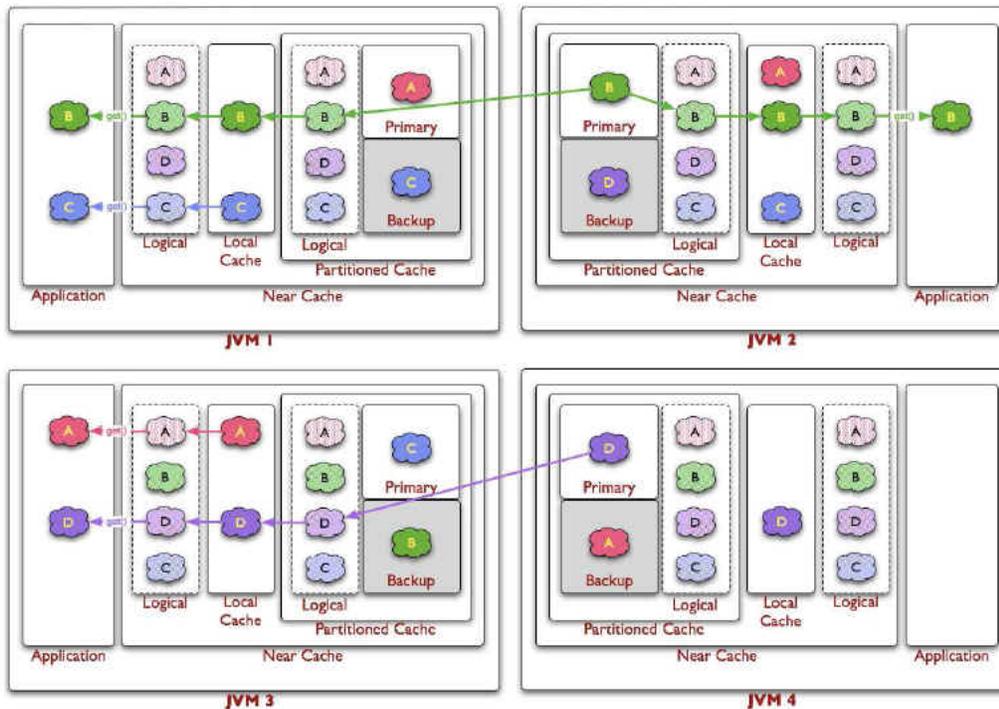
Figure 12-7 Put Operations in a Near Cache



If the client requests an object that has been expired or invalidated from the "front cache", then Coherence automatically retrieves the object from the partitioned cache. The "front cache" stores the object before the object is delivered to the client.

Figure 12-8 provides a conceptual view of a near cache during get operations.

Figure 12–8 Get Operations in a Near Cache



Understanding Local Caches

While it is not a clustered service, the local cache implementation is often used in combination with various clustered cache services as part of a near cache.

Note: Applications that use a local cache as part of a near cache must make sure that keys are immutable. Keys that are mutable can cause threads to hang and deadlocks to occur.

In particular, the near cache implementation uses key objects to synchronize the local cache (front map), and the key may also be cached in an internal map. Therefore, a key object passed to the `get()` method is used as a lock. If the key object is modified while a thread holds the lock, then the thread may fail to unlock the key. In addition, if there are other threads waiting for the locked key object to be freed, or if there are threads who attempt to acquire a lock to the modified key, then threads may hang and deadlocks can occur. For details on the use of keys, see the `java.util.Map` API documentation.

A local cache is completely contained within a particular cluster node. There are several attributes of the local cache that are particularly interesting:

- The local cache implements the same standard collections interface that the clustered caches implement, meaning that there is no programming difference between using a local or a clustered cache. Just like the clustered caches, the local cache is tracking to the JCache API, which itself is based on the same standard collections API that the local cache is based on.

- The local cache can be size-limited. The local cache can restrict the number of entries that it caches, and automatically evict entries when the cache becomes full. Furthermore, both the sizing of entries and the eviction policies can be customized. For example, the cache can be size-limited based on the memory used by the cached entries. The default eviction policy uses a combination of Most Frequently Used (MFU) and Most Recently Used (MRU) information, scaled on a logarithmic curve, to determine what cache items to evict. This algorithm is the best general-purpose eviction algorithm because it works well for short duration and long duration caches, and it balances frequency versus recentness to avoid cache thrashing. The pure LRU and pure LFU algorithms are also supported, and the ability to plug in custom eviction policies.
- The local cache supports automatic expiration of cached entries, meaning that each cache entry can be assigned a time to live in the cache.
- The local cache is thread safe and highly concurrent, allowing many threads to simultaneously access and update entries in the local cache.
- The local cache supports cache notifications. These notifications are provided for additions (entries that are put by the client, or automatically loaded into the cache), modifications (entries that are put by the client, or automatically reloaded), and deletions (entries that are removed by the client, or automatically expired, flushed, or evicted.) These are the same cache events supported by the clustered caches.
- The local cache maintains hit and miss statistics. These run-time statistics can accurately project the effectiveness of the cache, and adjust its size-limiting and auto-expiring settings accordingly while the cache is running.

The local cache is important to the clustered cache services for several reasons, including as part of Coherence's near cache technology, and with the modular backing map architecture.

Understanding Remote Caches

A remote cache describes any out-of-process cache accessed by a Coherence*Extend client. All cache requests are sent to a Coherence proxy where they are delegated to a cache (Replicated, Optimistic, Partitioned). See *Developing Remote Clients for Oracle Coherence* for more information on using remote caches.

Summary of Cache Types

Numerical Terms:

- **JVMs** = number of JVMs
- **DataSize** = total size of cached data (measured without redundancy)
- **Redundancy** = number of copies of data maintained
- **LocalCache** = size of local cache (for near caches)

Table 12–1 Summary of Cache Types and Characteristics

	Replicated Cache	Optimistic Cache	Partitioned Cache	Near Cache backed by partitioned cache	LocalCache not clustered
Topology	Replicated	Replicated	Partitioned Cache	Local Caches + Partitioned Cache	Local Cache
Read Performance	Instant 5	Instant 5	Locally cached: instant 5 Remote: network speed 1	Locally cached: instant 5 Remote: network speed 1	Instant 5
Fault Tolerance	Extremely High	Extremely High	Configurable 4 Zero to Extremely High	Configurable 4 Zero to Extremely High	Zero
Write Performance	Fast 2	Fast 2	Extremely fast 3	Extremely fast 3	Instant 5
Memory Usage (Per JVM)	DataSize	DataSize	DataSize/JVMs x Redundancy	LocalCache + [DataSize / JVMs]	DataSize
Coherency	fully coherent	fully coherent	fully coherent	fully coherent 6	n/a
Memory Usage (Total)	JVMs x DataSize	JVMs x DataSize	Redundancy x DataSize	[Redundancy x DataSize] + [JVMs x LocalCache]	n/a
Locking	fully transactional	none	fully transactional	fully transactional	fully transactional
Typical Uses	Metadata	n/a (see Near Cache)	Read-write caches	Read-heavy caches w/ access affinity	Local data

Notes:

1. As a rough estimate, with 100mb Ethernet, network reads typically require ~20ms for a 100KB object. With gigabit Ethernet, network reads for 1KB objects are typically sub-millisecond.
2. Requires UDP multicast or a few UDP unicast operations, depending on JVM count.
3. Requires a few UDP unicast operations, depending on level of redundancy.
4. Partitioned caches can be configured with as many levels of backup as desired, or zero if desired. Most installations use one backup copy (two copies total)
5. Limited by local CPU/memory performance, with negligible processing required (typically sub-millisecond performance).
6. Listener-based Near caches are coherent; expiry-based near caches are partially coherent for non-transactional reads and coherent for transactional access.

Configuring Caches

This chapter provides detailed instructions on how use the Coherence cache configuration deployment descriptor to define and configure caches for use by an application. Refer to [Appendix B, "Cache Configuration Elements,"](#) for a complete reference of all the elements available in the cache configuration deployment descriptor. In addition, see [Chapter 18, "Cache Configurations by Example,"](#) for various sample cache configurations.

This chapter includes the following sections:

- [Overview](#)
- [Defining Cache Mappings](#)
- [Defining Cache Schemes](#)
- [Using Scheme Inheritance](#)
- [Using Cache Scheme Properties](#)
- [Using Parameter Macros](#)

Overview

Caches are configured in a Coherence cache configuration deployment descriptor. By default, the first `coherence-cache-config.xml` deployment descriptor file that is found on the classpath is loaded. Coherence includes a sample `coherence-cache-config.xml` file in the `coherence.jar` library. To use a different `coherence-cache-config.xml` file, the file must be located on the classpath and must be loaded before the `coherence.jar` library; otherwise, the sample cache configuration deployment descriptor is used. See "[Specifying a Cache Configuration File](#)" on page 3-6 for alternate methods that are available for specifying a cache configuration deployment descriptor.

The cache configuration descriptor allows caches to be defined independently from the application code. At run time, applications get an instance of a cache by referring to a cache using the name that is defined in the descriptor. This allows application code to be written independent of the cache definition. Based on this approach, cache definitions can be modified without making any changes to the application code. This approach also maximizes cache definition reuse.

The schema definition of the cache configuration descriptor is the `coherence-cache-config.xsd` file, which imports the `coherence-cache-config-base.xsd` file, which, in turn, implicitly imports the `coherence-config-base.xsd` file. This file is located in the root of the `coherence.jar` file. A cache configuration deployment descriptor consists of two primary elements that are detailed in this chapter: the `<caching-scheme-mapping>` element and the

<cache-mappings> element. These elements are used to define cache schemes and to define cache names that map to the cache schemes.

Defining Cache Mappings

Cache mappings map a cache name to a cache scheme definition. The mappings provide a level of separation between applications and the underlying cache definitions. The separation allows cache implementations to be changed as required without having to change application code. Cache mappings can also be used to set initialization parameters that are applied to the underlying cache scheme definition.

Cache mappings are defined using a <cache-mapping> element within the <cache-scheme-mapping> node. Any number of cache mappings can be created. The cache mapping must include the cache name and the scheme name to which the cache name is mapped. See "[cache-mapping](#)" on page B-23 for a detailed reference of the <cache-mappings> element.

Using Exact Cache Mappings

Exact cache mappings map a specific cache name to a cache scheme definition. An applications must provide the exact name as specified in the mapping to use a cache. [Example 13-1](#) creates a single cache mapping that maps the cache name `example` to a distributed cache scheme definition with the scheme name `distributed`.

Example 13-1 Sample Exact Cache Mapping

```
<?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">
  <cache-mapping>
    <cache-name>example</cache-name>
    <scheme-name>distributed</scheme-name>
  </cache-mapping>
</cache-mapping>

  <cache-schemes>
    <distributed-scheme>
      <scheme-name>distributed</scheme-name>
    </distributed-scheme>
  </cache-schemes>
</cache-config>
```

Using Name Pattern Cache Mappings

Name pattern cache mappings allow applications to use patterns when specifying a cache name. Patterns use the asterisk (*) wildcard. Name patterns alleviate an application from having to know the exact name of a cache. [Example 13-2](#) creates two cache mappings. The first mapping uses the wildcard (*) to map any cache name to a distributed cache scheme definition with the scheme name `distributed`. The second mapping maps the name pattern `account-*` to the cache scheme definition with the scheme name `account-distributed`.

Example 13–2 Sample Cache Name Pattern Mapping

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>*/</cache-name>
      <scheme-name>distributed</scheme-name>
    </cache-mapping>
    <cache-mapping>
      <cache-name>account-*/</cache-name>
      <scheme-name>account-distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <distributed-scheme>
      <scheme-name>distributed</scheme-name>
    </distributed-scheme>
    <distributed-scheme>
      <scheme-name>account-distributed</scheme-name>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

For the first mapping, an application can use any name when creating a cache and the name is mapped to the cache scheme definition with the scheme name `distributed`. The second mapping requires an application to use a pattern when specifying a cache name. In this case, an application must use the prefix `account-` before the name. For example, an application that specifies `account-overdue` as the cache name uses the cache scheme definition with the scheme name `account-distributed`.

As shown in [Example 13–2](#), it is possible to have a cache name (for example `account-overdue`) that can be matched to multiple cache mappings. In such cases, if an exact cache mapping is defined, then it is always selected over any wildcard matches. Among multiple wildcard matches, the last matching wildcard mapping (based on the order in which they are defined in the file) is selected. Therefore, it is common to define less specific wildcard patterns earlier in the file that can be overridden by more specific wildcard patterns later in the file.

Defining Cache Schemes

Cache schemes are used to define the caches that are available to an application. Cache schemes provide a declarative mechanism that allows caches to be defined independent of the applications that use them. This removes the responsibility of defining caches from the application and allows caches to change without having to change an application's code. Cache schemes also promote cache definition reuse by allowing many applications to use the same cache definition.

Cache schemes are defined within the `<caching-schemes>` element. Each cache type (distributed, replicated, and so on) has a corresponding scheme element and properties that are used to define a cache of that type. Cache schemes can also be nested to allow further customized and composite caches such as near caches. See ["caching-schemes"](#) on page B-27 for a detailed reference of the `<caching-schemes>` element.

This section describes how to define cache schemes for the most often used cache types and does not represent the full set of cache types provided by Coherence. Instructions for defining cache schemes for additional cache types are found throughout this guide and are discussed as part of the features that they support. This section includes the following topics:

- [Defining Distributed Cache Schemes](#)
- [Defining Replicated Cache Schemes](#)
- [Defining Optimistic Cache Schemes](#)
- [Defining Local Cache Schemes](#)
- [Defining Near Cache Schemes](#)

Defining Distributed Cache Schemes

The `<distributed-scheme>` element is used to define distributed caches. A distributed cache utilizes a distributed (partitioned) cache service instance. Any number of distributed caches can be defined in a cache configuration file. See ["distributed-scheme"](#) on page B-32 for a detailed reference of the `<distributed-scheme>` element.

Example 13-3 defines a basic distributed cache that uses `distributed` as the scheme name and is mapped to the cache name `example`. The `<autostart>` element is set to `true` to start the service on a cache server node.

Example 13-3 Sample Distributed Cache Definition

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>example</cache-name>
      <scheme-name>distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <distributed-scheme>
      <scheme-name>distributed</scheme-name>
      <backing-map-scheme>
        <local-scheme/>
      </backing-map-scheme>
      <autostart>true</autostart>
    </distributed-scheme>
  </caching-schemes>
</cache-config>
```

In the example, the distributed cache defines a local cache to be used as the backing map. See [Chapter 14, "Implementing Storage and Backing Maps"](#) for more information on configuring backing maps.

Defining Replicated Cache Schemes

The `<replicated-scheme>` element is used to define replicated caches. A replicated cache utilizes a replicated cache service instance. Any number of replicated caches can be defined in a cache configuration file. See ["replicated-scheme"](#) on page B-112 for a detailed reference of the `<replicated-scheme>` element.

[Example 13-4](#) defines a basic replicated cache that uses `replicated` as the scheme name and is mapped to the cache name `example`. The `<autostart>` element is set to `true` to start the service on a cache server node.

Example 13-4 Sample Replicated Cache Definition

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>example</cache-name>
      <scheme-name>replicated</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <replicated-scheme>
      <scheme-name>replicated</scheme-name>
      <backing-map-scheme>
        <local-scheme/>
      </backing-map-scheme>
      <autostart>true</autostart>
    </replicated-scheme>
  </caching-schemes>
</cache-config>
```

In the example, the replicated cache defines a local cache to be used as the backing map. See [Chapter 14, "Implementing Storage and Backing Maps"](#) for more information on configuring backing maps.

Defining Optimistic Cache Schemes

The `<optimistic-scheme>` element is used to define optimistic caches. An optimistic cache utilizes an optimistic cache service instance. Any number of optimistic caches can be defined in a cache configuration file. See ["optimistic-scheme"](#) on page B-80 for a detailed reference of the `<optimistic-scheme>` element.

[Example 13-5](#) defines a basic optimistic cache that uses `optimistic` as the scheme name and is mapped to the cache name `example`. The `<autostart>` element is set to `true` to start the service on a cache server node.

Example 13-5 Sample Optimistic Cache Definition

```
<?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">
```

```
<キャッシング-scheme-mapping>
  <cache-mapping>
    <cache-name>example</cache-name>
    <scheme-name>optimistic</scheme-name>
  </cache-mapping>
</キャッシング-scheme-mapping>

<キャッシング-schemes>
  <optimistic-scheme>
    <scheme-name>optimistic</scheme-name>
    <backing-map-scheme>
      <local-scheme/>
    </backing-map-scheme>
    <autostart>true</autostart>
  </optimistic-scheme>
</キャッシング-schemes>
</cache-config>
```

In the example, the optimistic cache defines a local cache to be used as the backing map. See [Chapter 14, "Implementing Storage and Backing Maps"](#) for more information on configuring backing maps.

Defining Local Cache Schemes

The `<local-scheme>` element is used to define local caches. Local caches are generally nested within other cache schemes, for instance as the front-tier of a near cache. Thus, this element can appear as a sub-element of any of the following elements:

`<キャッシング-schemes>`, `<distributed-scheme>`, `<replicated-scheme>`, `<optimistic-scheme>`, `<near-scheme>`, `<overflow-scheme>`, `<read-write-backing-map-scheme>`, and `<backing-map-scheme>`. See ["local-scheme"](#) on page B-67 for a detailed reference of the `<local-scheme>` element.

Example 13-6 defines a local cache that uses `local` as the scheme name and is mapped to the cache name `example`.

Note: A local cache is not typically used as a standalone cache on a cache server; moreover, a clustering cache server distribution does not start if the only cache definition in the cache configuration file is a local cache.

Example 13-6 Sample Local Cache Definition

```
<?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">
  <キャッシング-scheme-mapping>
    <cache-mapping>
      <cache-name>example</cache-name>
      <scheme-name>local</scheme-name>
    </cache-mapping>
  </キャッシング-scheme-mapping>

  <キャッシング-schemes>
    <local-scheme>
      <scheme-name>local</scheme-name>
```

```

    <eviction-policy>LRU</eviction-policy>
    <high-units>32000</high-units>
    <low-units>10</low-units>
    <unit-calculator>FIXED</unit-calculator>
    <expiry-delay>10ms</expiry-delay>
  </local-scheme>
</caching-schemes>
</cache-config>

```

See "Defining a Local Cache for C++ Clients" and "Configuring a Local Cache for .NET Clients" in the *Developing Remote Clients for Oracle Coherence* when using Coherence*Extend.

Controlling the Growth of a Local Cache

As shown in Table 13–6, the `<local-scheme>` provides several optional sub-elements that control the growth of the cache. For example, the `<low-units>` and `<high-units>` sub-elements limit the cache in terms of size. When the cache reaches its maximum allowable size it prunes itself back to a specified smaller size, choosing which entries to evict according to a specified eviction-policy (`<eviction-policy>`). The entries and size limitations are measured in terms of units as calculated by the scheme's unit-calculator (`<unit-calculator>`).

Local caches use the `<expiry-delay>` cache configuration element to configure the amount of time that items may remain in the cache before they expire. Client threads initiate these actions while accessing the cache. Therefore, the `<expiry-delay>` may be reached, but not initiated until a client thread accesses the cache. For example, if the `<expiry-delay>` value is set at 10 seconds (10s) and a client accesses the cache after 15 seconds, then expiry occurs after 15 seconds.

Note: The client thread performs the evictions, not a background thread. In addition, the expiry delay parameter (`cExpiryMillis`) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed `Integer.MAX_VALUE` (2147483647) milliseconds or approximately 24 days.

Specifying a Custom Eviction Policy

The `LocalCache` class is used for size-limited caches. It is used both for caching on-heap objects (as in a local cache or the front portion of a near cache) and as the backing map for a partitioned cache. Applications can provide custom eviction policies for use with a `LocalCache`.

Coherence's default eviction policy is very effective for most workloads; the majority of applications do not have to provide a custom policy. Generally, it is best to restrict the use of eviction policies to scenarios where the evicted data is present in a backing system (that is, the back portion of a near cache or a database). Eviction should be treated as a physical operation (freeing memory) and not a logical operation (deleting an entity).

Example 13–7 shows the implementation of a simple custom eviction policy:

Example 13–7 Implementing a Custom Eviction Policy

```

package com.tangosol.examples.eviction;

import com.tangosol.net.cache.AbstractEvictionPolicy;
import com.tangosol.net.cache.ConfigurableCacheMap;

```

```
import com.tangosol.net.cache.LocalCache;
import com.tangosol.net.BackingMapManagerContext;
import com.tangosol.util.ConverterCollections;
import java.util.Iterator;
import java.util.Map;

/**
 * Custom eviction policy that evicts items randomly (or more specifically,
 * based on the natural order provided by the map's iterator.)
 * This example may be used in cases where fast eviction is required
 * with as little processing as possible.
 */
public class SimpleEvictionPolicy
    extends AbstractEvictionPolicy
    {
    /**
     * Default constructor; typically used with local caches or the front
     * parts of near caches.
     */
    public SimpleEvictionPolicy()
        {
        }

    /**
     * Constructor that accepts {@link BackingMapManagerContext}; should
     * be used with partitioned cache backing maps.
     *
     * @param ctx backing map context
     */
    public SimpleEvictionPolicy(BackingMapManagerContext ctx)
        {
        m_ctx = ctx;
        }

    /**
     * {@inheritDoc}
     */
    public void entryUpdated(ConfigurableCacheMap.Entry entry)
        {
        }

    /**
     * {@inheritDoc}
     */
    public void entryTouched(ConfigurableCacheMap.Entry entry)
        {
        }

    /**
     * {@inheritDoc}
     */
    public void requestEviction(int cMaximum)
        {
        ConfigurableCacheMap cache = getCache();
        Iterator iter = cache.entrySet().iterator();

        for (int i = 0, c = cache.getUnits() - cMaximum; i < c && iter.hasNext();
            i++)
            {
            ConfigurableCacheMap.Entry entry = (ConfigurableCacheMap.Entry)

```

```

        iter.next();
        StringBuffer                buffer = new StringBuffer();

        // If the contents of the entry (for example the key/value) need
        // to be examined, invoke convertEntry(entry) in case
        // the entry must be deserialized
        Map.Entry convertedEntry = convertEntry(entry);
        buffer.append("Entry: ").append(convertedEntry);

        // Here's how to get metadata about creation/last touched
        // timestamps for entries. This information might be used
        // in determining what gets evicted.
        if (entry instanceof LocalCache.Entry)
        {
            buffer.append(", create millis=");
            buffer.append(((LocalCache.Entry) entry).getCreatedMillis());
        }
        buffer.append(", last touch millis=");
        buffer.append(entry.getLastTouchMillis());

        // This output is for illustrative purposes; this may generate
        // excessive output in a production system
        System.out.println(buffer);

        // iterate and remove items
        // from the cache until below the maximum. Note that
        // the non converted entry key is passed to the evict method
        cache.evict(entry.getKey());
    }
}

/**
 * If a {@link BackingMapManagerContext} is configured, wrap the
 * Entry with {@link ConverterCollections.ConverterEntry} in order
 * to deserialize the entry.
 *
 * @see ConverterCollections.ConverterEntry
 * @see BackingMapManagerContext
 *
 * @param entry  entry to convert if necessary
 *
 * @return an entry that deserializes its key and value if necessary
 */
protected Map.Entry convertEntry(Map.Entry entry)
{
    BackingMapManagerContext ctx = m_ctx;
    return ctx == null ? entry :
        new ConverterCollections.ConverterEntry(entry,
            ctx.getKeyFromInternalConverter(),
            ctx.getValueFromInternalConverter(),
            ctx.getValueToInternalConverter());
}

private BackingMapManagerContext m_ctx;
}

```

[Example 13-8](#) illustrates a Coherence cache configuration file with an eviction policy:

Example 13–8 Custom Eviction Policy in a coherence-cache-config.xml File

```

<?xml version="1.0"?>

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>*</cache-name>
      <scheme-name>example-near</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <near-scheme>
      <scheme-name>example-near</scheme-name>
      <front-scheme>
        <local-scheme>
          <eviction-policy>
            <class-scheme>
              <class-name>
                com.tangosol.examples.eviction.SimpleEvictionPolicy
              </class-name>
            </class-scheme>
          </eviction-policy>
          <high-units>1000</high-units>
        </local-scheme>
      </front-scheme>
      <back-scheme>
        <distributed-scheme>
          <scheme-ref>example-distributed</scheme-ref>
        </distributed-scheme>
      </back-scheme>
      <invalidation-strategy>all</invalidation-strategy>
      <autostart>true</autostart>
    </near-scheme>

    <distributed-scheme>
      <scheme-name>example-distributed</scheme-name>
      <service-name>DistributedCache</service-name>
      <backing-map-scheme>
        <local-scheme>
          <eviction-policy>
            <class-scheme>
              <class-name>
                com.tangosol.examples.eviction.SimpleEvictionPolicy
              </class-name>
              <init-params>
                <!--
                Passing the BackingMapManagerContext to the eviction policy;
                this is required for deserializing entries
                -->
                <init-param>
                  <param-type>
                    com.tangosol.net.BackingMapManagerContext</param-type>
                  <param-value>{manager-context}</param-value>
                </init-param>
              </init-params>
            </class-scheme>
          </eviction-policy>
        </local-scheme>
      </backing-map-scheme>
    </distributed-scheme>
  </caching-schemes>
</cache-config>

```

```

        </eviction-policy>
        <high-units>20</high-units>
        <unit-calculator>binary</unit-calculator>
    </local-scheme>
</backing-map-scheme>
    <autostart>true</autostart>
</distributed-scheme>
</caching-schemes>
</cache-config>

```

Defining Near Cache Schemes

The `<near-scheme>` element is used to define a near cache. A near cache is a composite cache because it contains two caches: the `<front-scheme>` element is used to define a local (front-tier) cache and the `<back-scheme>` element is used to define a (back-tier) cache. Typically, a local cache is used for the front-tier, however, the front-tier can also use schemes based on Java Objects (using the `<class-scheme>`) and non-JVM heap-based caches (using `<external-scheme>` or `<paged-external-scheme>`). The back-tier cache is described by the `<back-scheme>` element. A back-tier cache can be any clustered cache type and any of the standalone cache types. See ["near-scheme"](#) on page B-73 for a detailed reference of the `<near-scheme>` element.

[Example 13-9](#) defines of a near cache that uses `near` as the scheme name and is mapped to the cache name `example`. The front-tier is a local cache and the back-tier is a distributed cache.

Note: Near caches are used for cache clients and are not typically used on a cache server; moreover, a cache server does not start if the only cache definition in the cache configuration file is a near cache.

Example 13-9 Sample Near Cache Definition

```

<?xml version="1.0"?>

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>example</cache-name>
      <scheme-name>near</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <near-scheme>
      <scheme-name>near</scheme-name>
      <front-scheme>
        <local-scheme/>
      </front-scheme>
      <back-scheme>
        <distributed-scheme>
          <scheme-name>near-distributed</scheme-name>
          <backing-map-scheme>
            <local-scheme/>
          </backing-map-scheme>
          <autostart>true</autostart>
        </distributed-scheme>
      </back-scheme>
    </near-scheme>
  </caching-schemes>
</cache-config>

```

```

        </distributed-scheme>
    </back-scheme>
</near-scheme>
</caching-schemes>
</cache-config>

```

See "Defining a Near Cache for C++ Clients" and "Defining a Near Cache for .NET Clients" in the *Developing Remote Clients for Oracle Coherence* when using Coherence*Extend.

Near Cache Invalidation Strategies

The `<invalidation-strategy>` is an optional subelement for a near cache. An invalidation strategy is used to specify how the front-tier and back-tier objects are kept synchronous. A near cache can be configured to listen to certain events in the back cache and automatically update or invalidate entries in the front cache. Depending on the interface that the back cache implements, the near cache provides five different strategies of invalidating the front cache entries that have changed by other processes in the back cache.

Note: When using an invalidation strategy of `all`, cache operations that modify a large number of entries (for example, a clear operation) can cause a flood of events that may saturate the network.

Table 13–1 describes the invalidation strategies. You can find more information on the invalidation strategies and the read-through/write-through approach in [Chapter 15](#), "Caching Data Sources."

Table 13–1 Near Cache Invalidation Strategies

Strategy Name	Description
auto	The default strategy if no strategy is specified. This strategy is identical to the <code>present</code> strategy.
present	This strategy instructs a near cache to listen to the back cache events related only to the items currently present in the front cache. This strategy works best when each instance of a front cache contains distinct subset of data relative to the other front cache instances (for example, sticky data access patterns).
all	This strategy instructs a near cache to listen to all back cache events. This strategy is optimal for read-heavy tiered access patterns where there is significant overlap between the different instances of front caches.
logical	This strategy instructs a near cache to listen to all backing map events that are not synthetic deletes. A synthetic delete event could be emitted as a result of eviction or expiration. With this invalidation strategy, it is possible for the front map to contain cache entries that have been synthetically removed from the backing map. Any subsequent re-insertion of the entries to the backing map causes the corresponding entries in the front map to be invalidated.
none	This strategy instructs the cache not to listen for invalidation events at all. This is the best choice for raw performance and scalability when business requirements permit the use of data which might not be absolutely current. Freshness of data can be guaranteed by use of a sufficiently brief eviction policy for the front cache.

Using Scheme Inheritance

Scheme inheritance allows cache schemes to be created by inheriting another scheme and selectively overriding the inherited scheme's properties as required. This flexibility enables cache schemes to be easily maintained and promotes cache scheme reuse. The `<scheme-ref>` element is used within a cache scheme definition and specifies the name of the cache scheme from which to inherit.

[Example 13–10](#) creates two distributed cache schemes that are equivalent. The first explicitly configures a local scheme to be used for the backing map. The second definition use the `<scheme-ref>` element to inherit a local scheme named `LocalSizeLimited`:

Example 13–10 Using Cache Scheme References

```
<distributed-scheme>
  <scheme-name>DistributedInMemoryCache</scheme-name>
  <service-name>DistributedCache</service-name>
  <backing-map-scheme>
    <local-scheme>
      <eviction-policy>LRU</eviction-policy>
      <high-units>1000</high-units>
      <expiry-delay>1h</expiry-delay>
    </local-scheme>
  </backing-map-scheme>
</distributed-scheme>

<distributed-scheme>
  <scheme-name>DistributedInMemoryCache</scheme-name>
  <service-name>DistributedCache</service-name>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>LocalSizeLimited</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
</distributed-scheme>

<local-scheme>
  <scheme-name>LocalSizeLimited</scheme-name>
  <eviction-policy>LRU</eviction-policy>
  <high-units>1000</high-units>
  <expiry-delay>1h</expiry-delay>
</local-scheme>
```

In [Example 13–10](#), the first distributed scheme definition is more compact; however, the second definition offers the ability to easily reuse the `LocalSizeLimited` scheme within multiple schemes. [Example 13–11](#) demonstrates multiple schemes reusing the same `LocalSizeLimited` base definition and overriding the `expiry-delay` property.

Example 13–11 Multiple Cache Schemes Using Scheme Inheritance

```
<distributed-scheme>
  <scheme-name>DistributedInMemoryCache</scheme-name>
  <service-name>DistributedCache</service-name>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>LocalSizeLimited</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
</distributed-scheme>
```

```

<replicated-scheme>
  <scheme-name>ReplicatedInMemoryCache</scheme-name>
  <service-name>ReplicatedCache</service-name>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>LocalSizeLimited</scheme-ref>
      <expiry-delay>10m</expiry-delay>
    </local-scheme>
  </backing-map-scheme>
</replicated-scheme>

<local-scheme>
  <scheme-name>LocalSizeLimited</scheme-name>
  <eviction-policy>LRU</eviction-policy>
  <high-units>1000</high-units>
  <expiry-delay>1h</expiry-delay>
</local-scheme>

```

Using Cache Scheme Properties

Cache scheme properties modify cache behavior as required for a particular application. Each cache scheme type contains its own set of properties that are valid for the cache. Cache properties are set within a cache scheme definition using their respective elements. See [Appendix B, "Cache Configuration Elements,"](#) for a reference of all the properties that are supported for each cache scheme type.

Many cache properties use default values unless a different value is explicitly given within the cache scheme definition. The clustered caches (distributed, replicated and optimistic) use the default values as specified by their respective cache service definition. Cache services are defined in the operational deployment descriptor. While it is possible to change property values using an operational override file, cache properties are most often set within the cache scheme definition.

[Example 13–12](#) creates a basic distributed cache scheme that sets the service thread count property and the request timeout property. In addition, the local scheme that is used for the backing map sets properties to limit the size of the local cache. Instructions for using cache scheme properties are found throughout this guide and are discussed as part of the features that they support.

Example 13–12 Setting Cache Properties

```

<?xml version="1.0"?>

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>example</cache-name>
      <scheme-name>DistributedInMemoryCache</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <distributed-scheme>
      <scheme-name>DistributedInMemoryCache</scheme-name>

```

```

    <service-name>DistributedCache</service-name>
    <thread-count>4</thread-count>
    <request-timeout>60s</request-timeout>
    <backing-map-scheme>
      <local-scheme>
        <scheme-ref>LocalSizeLimited</scheme-ref>
      </local-scheme>
    </backing-map-scheme>
  </distributed-scheme>

  <local-scheme>
    <scheme-name>LocalSizeLimited</scheme-name>
    <eviction-policy>LRU</eviction-policy>
    <high-units>1000</high-units>
    <expiry-delay>1h</expiry-delay>
  </local-scheme>
</caching-schemes>
</cache-config>

```

Using Parameter Macros

The cache configuration deployment descriptor supports the use of parameter macros. Parameter macros are literal strings that are replaced with an actual value at runtime. Coherence includes predefined macros and also allows user-defined macros. This section includes the following topics:

- [Using User-Defined Parameter Macros](#)
- [Using Predefined Parameter Macros](#)

Using User-Defined Parameter Macros

User-defined parameter macros allow property values in a scheme to be replaced at runtime by values that are configured within cache mapping initialization parameters. User-defined parameter macros maximize the reuse of cache scheme definitions and can significantly reduce the size of a cache configuration file.

Note: Parameter macros should not be used for service-scoped (shared by all caches in the same service) items, such as thread count, partition count, and service name. Parameter macros should only be used for cache-scoped items, such as expiry, high units, or cachec stores to name a few.

To define a user-defined parameter macro, place a literal string within curly braces as the value of a property. A parameter macro can also include an optional default value by placing the value after the string preceded by a space. The form of a user-defined macro is as follows:

```
{user-defined-name default_value}
```

The following example creates a user-defined macro that is called `back-size-limit`. The macro is used for the `<high-units>` property of a backing map and allows the property value to be replaced at runtime. The macro specifies a default value of 500 for the `<high-units>` property.

```

<caching-schemes>
  <distributed-scheme>

```

```

    <scheme-name>distributed</scheme-name>
    <backing-map-scheme>
      <local-scheme>
        <high-units>{back-size-limit 500}</high-units>
      </local-scheme>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>
</caching-schemes>

```

At runtime, the `<high-units>` value can be replaced by using an initialization parameter that is defined within a cache mapping definition. The following example overrides the default value of 500 with 1000 by using an `<init-param>` element and setting the `<param-name>` element to `back-size-limit` and the `<param-value>` element to 1000. See ["init-param"](#) on page B-52 for a detailed reference of the `<init-param>` element.

```

<caching-scheme-mapping>
  <cache-mapping>
    <cache-name>example</cache-name>
    <scheme-name>distributed</scheme-name>
    <init-params>
      <init-param>
        <param-name>back-size-limit</param-name>
        <param-value>1000</param-value>
      </init-param>
    </init-params>
  </cache-mapping>
</caching-scheme-mapping>

<caching-schemes>
  <distributed-scheme>
    <scheme-name>distributed</scheme-name>
    <backing-map-scheme>
      <local-scheme>
        <high-units>{back-size-limit 500}</high-units>
      </local-scheme>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>
</caching-schemes>

```

The benefit of using user-defined parameter macros is that multiple cache mappings can use the same cache scheme and set different property values as required.

[Example 13-13](#) demonstrates two cache mappings that reuse the same cache scheme. However, the mappings result in caches with different values for the `<high-units>` element.

Example 13-13 *Overriding User-Defined Macros From a Cache Mapping*

```

...
<caching-scheme-mapping>
  <cache-mapping>
    <cache-name>*</cache-name>
    <scheme-name>distributed</scheme-name>
  </cache-mapping>
  <cache-mapping>
    <cache-name>example</cache-name>
    <scheme-name>distributed</scheme-name>
    <init-params>

```

```
        <init-param>
            <param-name>back-size-limit</param-name>
            <param-value>1000</param-value>
        </init-param>
    </init-params>
</cache-mapping>
<cache-mapping>

<cache-schemes>
    <distributed-scheme>
        <scheme-name>distributed</scheme-name>
        <backing-map-scheme>
            <local-scheme>
                <high-units>{back-size-limit 500}</high-units>
            </local-scheme>
        </backing-map-scheme>
        <autostart>true</autostart>
    </distributed-scheme>
</cache-schemes>
```

Using Predefined Parameter Macros

Coherence includes predefined parameter macros that minimize custom coding and enable the specification of commonly used attributes when configuring class constructor parameters. The macros must be entered within curly braces and are specific to either the `param-type` or `param-value` elements.

[Table 13–2](#) describes the predefined parameter macros that may be specified.

Table 13–2 *Predefined Parameter Macros for Cache Configuration*

<param-type>	<param-value>	Description
java.lang.String	{cache-name}	<p>Used to pass the current cache name as a constructor parameter. For example:</p> <pre> <class-name>com.mycompany.cache.CustomCacheLoader </class-name> <init-params> <init-param> <param-type>java.lang.String</param-type> <param-value>{cache-name}</param-value> </init-param> </init-params> </pre>
java.lang.ClassLoader	{class-loader}	<p>Used to pass the current classloader as a constructor parameter. For example:</p> <pre> <class-name>com.mycompany.cache.CustomCacheLoader </class-name> <init-params> <init-param> <param-type>java.lang.ClassLoader</param-type> <param-value>{class-loader}</param-value> </init-param> </init-params> </pre>

Table 13–2 (Cont.) Predefined Parameter Macros for Cache Configuration

<param-type>	<param-value>	Description
com.tangosol.net.BackingMapManagerContext	{manager-context}	<p>Used to pass the current BackingMapManagerContext object as a constructor parameter. For example:</p> <pre data-bbox="787 327 1390 611"> <class-name>com.mycompany.cache.CustomCacheLoader </class-name> <init-params> <init-param> <param-type> com.tangosol.net.BackingMapManagerContext </param-type> <param-value>{manager-context}</param-value> </init-param> </init-params> </pre>
{scheme-ref}	local-scheme	<p>Instantiates an object defined by the <class-scheme>, <local-scheme> or <file-scheme> with the specified <scheme-name> value and uses it as a constructor parameter. For example:</p> <pre data-bbox="787 758 1442 1856"> <class-scheme> <scheme-name>dbconnection</scheme-name> <class-name>com.mycompany.dbConnection</class-name> <init-params> <init-param> <param-name>driver</param-name> <param-type>String</param-type> <param-value>org.gjt.mm.mysql.Driver </param-value> </init-param> <init-param> <param-name>url</param-name> <param-type>String</param-type> <param-value> jdbc:mysql://dbserver:3306/companydb </param-value> </init-param> <init-param> <param-name>user</param-name> <param-type>String</param-type> <param-value>default</param-value> </init-param> <init-param> <param-name>password</param-name> <param-type>String</param-type> <param-value>default</param-value> </init-param> </init-params> </class-scheme> ... <class-name>com.mycompany.cache.CustomCacheLoader </class-name> <init-params> <init-param> <param-type>{scheme-ref}</param-type> <param-value>dbconnection</param-value> </init-param> </init-params> </pre>

Table 13–2 (Cont.) Predefined Parameter Macros for Cache Configuration

<param-type>	<param-value>	Description
{cache-ref}	cache name	<p>Used to obtain a NamedCache reference for the specified cache name. Consider the following configuration example:</p> <pre data-bbox="708 331 1373 1696"> <cache-config> <caching-scheme-mapping> <cache-mapping> <cache-name>boston-*/</cache-name> <scheme-name>wrapper</scheme-name> <init-params> <init-param> <param-name>delegate-cache-name</param-name> <param-value>london-*/</param-value> </init-param> </init-params> </cache-mapping> </caching-scheme-mapping> <cache-mapping> <cache-name>london-*/</cache-name> <scheme-name>partitioned</scheme-name> </cache-mapping> </caching-schemes> <class-scheme> <scheme-name>wrapper</scheme-name> <class-name> com.tangosol.net.cache WrapperNamedCache </class-name> <init-params> <init-param> <param-type>{cache-ref}</param-type> <param-value>{delegate-cache-name}</param-value> </init-param> <init-param> <param-type>string</param-type> <param-value>{cache-name}</param-value> </init-param> </init-params> </class-scheme> <distributed-scheme> <scheme-name>partitioned</scheme-name> <service-name>partitioned</service-name> <backing-map-scheme> <local-scheme> <unit-calculator>BINARY</unit-calculator> </local-scheme> </backing-map-scheme> <autostart>true</autostart> </distributed-scheme> </caching-schemes> </cache-config> </pre> <p>The CacheFactory.getCache("london-test") call would result in a standard partitioned cache reference. Conversely, the CacheFactory.getCache("boston-test") call would resolve the value of the delegate-cache-name parameter to london-test and would construct an instance of the WrapperNamedCache delegating to the NamedCache returned by the CacheFactory.getCache("london-test") call.</p>

Implementing Storage and Backing Maps

This chapter describes how storage is implemented in Coherence and includes instructions for configuring Coherence backing maps.

This chapter includes the following sections:

- [Cache Layers](#)
- [Local Storage](#)
- [Operations](#)
- [Capacity Planning](#)
- [Using Partitioned Backing Maps](#)
- [Using the Elastic Data Feature to Store Data](#)
- [Using Asynchronous Backup](#)
- [Using Delta Backup](#)

Cache Layers

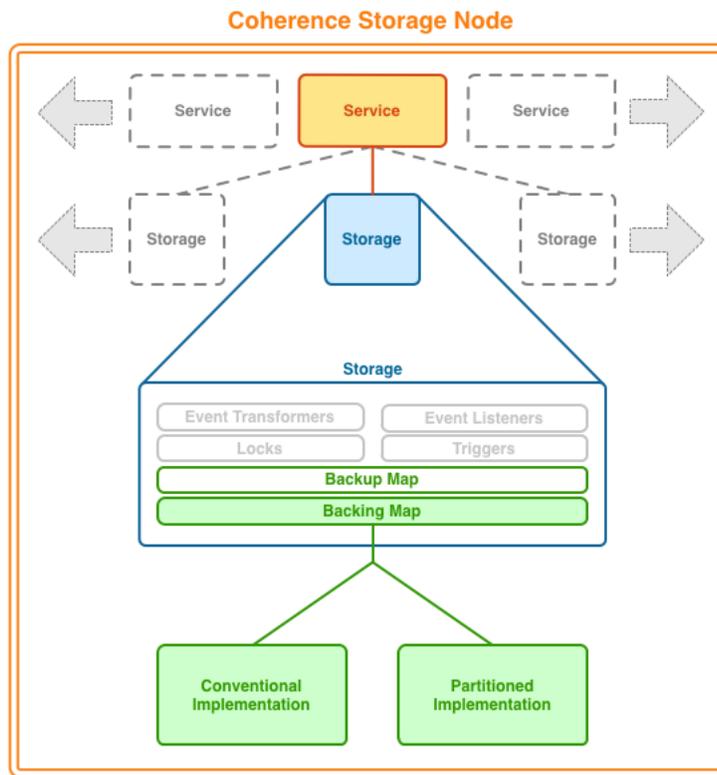
Partitioned (Distributed) cache service in Coherence has three distinct layers:

- **Client View** – The client view represents a virtual layer that provides access to the underlying partitioned data. Access to this tier is provided using the `NamedCache` interface. In this layer you can also create synthetic data structures such as `NearCache` or `ContinuousQueryCache`.
- **Storage Manager** – The storage manager is the server-side tier that is responsible for processing cache-related requests from the client tier. It manages the data structures that hold the actual cache data (primary and backup copies) and information about locks, event listeners, map triggers, and so on.
- **Backing Map** – The Backing Map is the server-side data structure that holds actual data.

Coherence allows users to configure out-of-the-box and custom backing map implementations. The only constraint for a Map implementation is the understanding that the Storage Manager provides all keys and values in internal (Binary) format. To deal with conversions of that internal data to and from an Object format, the Storage Manager can supply Backing Map implementations with a `BackingMapManagerContext` reference.

[Figure 14–1](#) shows a conceptual view of backing maps.

Figure 14–1 Backing Map Storage



Local Storage

Local storage refers to the data structures that actually store or cache the data that is managed by Coherence. For an object to provide local storage, it must support the same standard collections interface, `java.util.Map`. When a local storage implementation is used by Coherence to store replicated or distributed data, it is called a backing map because Coherence is actually backed by that local storage implementation. The other common uses of local storage is in front of a distributed cache and as a backup behind the distributed cache.

Caution: Be careful when using any backing map that does not store data on heap, especially if storing more data than can actually fit on heap. Certain cache operations (for example, unindexed queries) can potentially traverse a large number of entries that force the backing map to bring those entries onto the heap. Also, partition transfers (for example, restoring from backup or transferring partition ownership when a new member joins) force the backing map to bring lots of entries onto the heap. This can cause GC problems and potentially lead to `OutOfMemory` errors.

Coherence supports the following local storage implementations:

- Safe HashMap:** This is the default lossless implementation. A lossless implementation is one, like the `Java Hashtable` class, that is neither size-limited nor auto-expiring. In other words, it is an implementation that never evicts ("loses") cache items on its own. This particular `HashMap` implementation is optimized for extremely high thread-level concurrency. For the default

implementation, use class `com.tangosol.util.SafeHashMap`; when an implementation is required that provides cache events, use `com.tangosol.util.ObservableHashMap`. These implementations are thread-safe.

- **Local Cache:** This is the default size-limiting and auto-expiring implementation. See "[Capacity Planning](#)" on page 14-4, for details on configuration. A local cache limits the size of the cache and automatically expires cache items after a certain period. For the default implementation, use `com.tangosol.net.cache.LocalCache`; this implementation is thread safe and supports cache events, `com.tangosol.net.CacheLoader`, `CacheStore` and configurable/pluggable eviction policies.
- **Read/Write Backing Map:** This is the default backing map implementation for caches that load from a backing store (such as a database) on a cache miss. It can be configured as a read-only cache (consumer model) or as either a write-through or a write-behind cache (for the consumer/producer model). The write-through and write-behind modes are intended only for use with the distributed cache service. If used with a near cache and the near cache must be kept synchronous with the distributed cache, it is possible to combine the use of this backing map with a Seppuku-based near cache (for near cache invalidation purposes). For the default implementation, use class `com.tangosol.net.cache.ReadWriteBackingMap`.
- **Binary Map (Java NIO):** This is a backing map implementation that can store its information in memory but outside of the Java heap, or even in memory-mapped files, which means that it does not affect the Java heap size and the related JVM garbage-collection performance that can be responsible for application pauses. This implementation is also available for distributed cache backups, which is particularly useful for read-mostly and read-only caches that require backup for high availability purposes, because it means that the backup does not affect the Java heap size yet it is immediately available in case of failover.
- **Serialization Map:** This is a backing map implementation that translates its data to a form that can be stored on disk, referred to as a serialized form. It requires a separate `com.tangosol.io.BinaryStore` object into which it stores the serialized form of the data. `SerializationMap` supports any custom implementation of `BinaryStore`. For the default implementation of `SerializationMap`, use `com.tangosol.net.cache.SerializationMap`.
- **Serialization Cache:** This is an extension of the `SerializationMap` that supports an LRU eviction policy. For example, a serialization cache can limit the size of disk files. For the default implementation of `SerializationCache`, use `com.tangosol.net.cache.SerializationCache`.
- **Journal:** This is a backing map implementation that stores data to either RAM, disk, or both RAM and disk. Journaling use the `com.tangosol.io.journal.JournalBinaryStore` class. For details about using journals, see "[Using the Elastic Data Feature to Store Data](#)" on page 14-7.
- **Overflow Map:** An overflow map does not actually provide storage, but it deserves mention in this section because it can combine two local storage implementations so that when the first one fills up, it overflows into the second. For the default implementation of `OverflowMap`, use `com.tangosol.net.cache.OverflowMap`.

Operations

There are number of operation types performed against the Backing Map:

- Natural access and update operations caused by the application usage. For example, `NamedCache.get()` call naturally causes a `Map.get()` call on a corresponding Backing Map; the `NamedCache.invoke()` call may cause a sequence of `Map.get()` followed by the `Map.put()`; the `NamedCache.keySet(filter)` call may cause an `Map.entrySet().iterator()` loop, and so on.
- Remove operations caused by the time-based expiry or the size-based eviction. For example, a `NamedCache.get()` or `NamedCache.size()` call from the client tier could cause a `Map.remove()` call due to an entry expiry timeout; or `NamedCache.put()` call causing some `Map.remove()` calls (for different keys) caused by the total amount data in a backing map reaching the configured high water-mark value.
- Insert operations caused by a `CacheStore.load()` operation (for backing maps configured with read-through or read-ahead features)
- Synthetic access and updates caused by the partition distribution (which in turn could be caused by cluster nodes fail over or fail back). In this case, without any application tier call, some entries could be inserted or removed from the backing map.

Capacity Planning

Depending on the actual implementation, the Backing Map stores the cache data in the following ways:

- on-heap memory
- off-heap memory
- disk (memory-mapped files or in-process DB)
- solid state device (journal files)
- combination of any of the above

Keeping data in memory naturally provides dramatically smaller access and update latencies and is most commonly used.

More often than not, applications must ensure that the total amount of data placed into the data grid does not exceed some predetermined amount of memory. It could be done either directly by the application tier logic or automatically using size- or expiry-based eviction. The total amount of data held in a Coherence cache equals the sum of data volume in all corresponding backing maps (one per each cluster node that runs the corresponding partitioned cache service in a storage enabled mode).

Consider following cache configuration excerpts:

```
<backing-map-scheme>
  <local-scheme/>
</backing-map-scheme>
```

The backing map above is an instance of `com.tangosol.net.cache.LocalCache` and does not have any pre-determined size constraints and has to be controlled explicitly. Failure to do so could cause the JVM to go out-of-memory. The following example configures size constraints on the backing map:

```
<backing-map-scheme>
  <local-scheme>
    <eviction-policy>LRU</eviction-policy>
    <high-units>100</high-units>
    <unit-calculator>BINARY</unit-calculator>
    <unit-factor>1048576</unit-factor>
```

```

    </local-scheme>
</backing-map-scheme>

```

This backing map above is also a `com.tangosol.net.cache.LocalCache` and has a capacity limit of 100MB. As the total amount of data held by this backing map exceeds that high watermark, some entries are removed from the backing map, bringing the volume down to the low watermark value (`<low-units>` configuration element, which defaults to 80% of the `<high-units>`). The choice of the removed entries is based on the LRU (Least Recently Used) eviction policy. Other options are LFU (Least Frequently Used) and Hybrid (a combination of the LRU and LFU). The value of `<high-units>` is limited to `Integer.MAX_VALUE` (or approximately 2GB). To overcome that limitation (but maintain backward compatibility) Coherence uses the `<unit-factor>` element. For example, the `<high-units>` value of 8192 with a `<unit-factor>` of 1048576 results in a high watermark value of 8GB.

The following backing map automatically evicts any entries that have not been updated for more than an hour. Note, that the eviction is "lazy" and can happen any time after an hour since the last update happens; the only guarantee Coherence provides is that entries that exceed one hour are not returned to a caller.

```

<backing-map-scheme>
  <local-scheme>
    <expiry-delay>1h</expiry-delay>
  </local-scheme>
</backing-map-scheme>

```

The following backing map is an instance of `com.tangosol.net.cache.SerializationCache` which stores values in the extended (nio) memory and has a capacity limit of 100MB (100*1048576).

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See ["Using the Elastic Data Feature to Store Data"](#) on page 14-7.

```

<backing-map-scheme>
  <external-scheme>
    <nio-memory-manager>
      <initial-size>1MB</initial-size>
      <maximum-size>100MB</maximum-size>
    </nio-memory-manager>
    <high-units>100</high-units>
    <unit-calculator>BINARY</unit-calculator>
    <unit-factor>1048576</unit-factor>
  </external-scheme>
</backing-map-scheme>

```

Configure a backup storage for this cache being off-heap (or file-mapped):

```

<backup-storage>
  <type>off-heap</type>
  <initial-size>1MB</initial-size>
  <maximum-size>100MB</maximum-size>
</backup-storage>

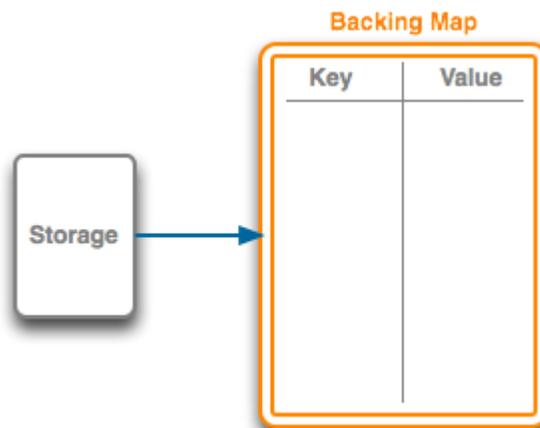
```

Using Partitioned Backing Maps

The conventional backing map implementation contained entries for all partitions owned by the corresponding node. (During partition transfer, it could also hold "in flight" entries that from the clients' perspective are temporarily not owned by anyone).

Figure 14–2 shows a conceptual view of the conventional backing map implementation.

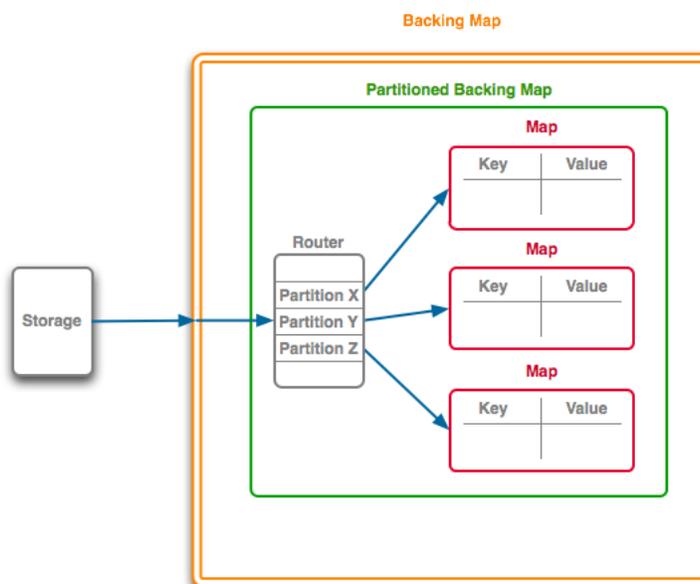
Figure 14–2 Conventional Backing Map Implementation



A partitioned backing map is basically a multiplexer of actual Map implementations, each of which would contain only entries that belong to the same partition.

Figure 14–3 shows a conceptual view of the partitioned backing map implementation.

Figure 14–3 Partitioned Backing Map Implementation



To configure a partitioned backing map, add a `<partitioned>` element with a value of `true`. For example:

```
<backing-map-scheme>
```

```

<partitioned>>true</partitioned>
<external-scheme>
  <nio-memory-manager>
    <initial-size>1MB</initial-size>
    <maximum-size>50MB</maximum-size>
  </nio-memory-manager>
  <high-units>8192</high-units>
  <unit-calculator>BINARY</unit-calculator>
  <unit-factor>1048576</unit-factor>
</external-scheme>
</backing-map-scheme>

```

This backing map is an instance of `com.tangosol.net.partition.PartitionSplittingBackingMap`, with individual partition holding maps being instances of `com.tangosol.net.cache.SerializationCache` that each store values in the extended (nio) memory. The individual nio buffers have a limit of 50MB, while the backing map as whole has a capacity limit of 8GB (8192*1048576).

Using the Elastic Data Feature to Store Data

The Elastic Data feature is used to seamlessly store data across memory and disk-based devices. This feature is especially tuned to take advantage of fast disk-based devices such as Solid State Disks (SSD) and enables near memory speed while storing and reading data from SSDs. The Elastic Data feature uses a technique called journaling to optimize the storage across memory and disk.

Elastic data contains two distinct components: the RAM journal for storing data in-memory and the flash journal for storing data to disk-based devices. These can be combined in different combinations and are typically used for backing maps and backup storage but can also be used with composite caches (for example, a near cache). The RAM journal always works with the flash journal to enable seamless overflow to disk.

Caches that use RAM and flash journals are configured as part of a cache scheme definition within a cache configuration file. Journaling behavior is configured, as required, by using an operational override file to override the out-of-box configuration.

This section includes the following topics:

- [Journaling Overview](#)
- [Defining Journal Schemes](#)
- [Changing Journaling Behavior](#)

Journaling Overview

Journaling refers to the technique of recording state changes in a sequence of modifications called a journal. As changes occur, the journal records each value for a specific key and a tree structure that is stored in memory keeps track of which journal entry contains the current value for a particular key. To find the value for an entry, you find the key in the tree which includes a pointer to the journal entry that contains the latest value.

As changes in the journal become obsolete due to new values being written for a key, stale values accumulate in the journal. At regular intervals, the stale values are evacuated making room for new values to be written in the journal.

The Elastic Data feature includes a RAM journal implementation and a Flash journal implementation that work seamlessly with each other. If for example the RAM Journal runs out of memory, the Flash Journal automatically accepts the overflow from the RAM Journal, allowing for caches to expand far beyond the size of RAM.

Note: Elastic data is ideal when performing key-based operations and typically not recommend for large filter-based operations. When journaling is enabled, additional capacity planning is required if you are performing data grid operations (such as queries and aggregations) on large result sets. See *Administering Oracle Coherence* for details.

A resource manager controls journaling. The resource manager creates and utilizes a binary store to perform operations on the journal. The binary store is implemented by the `JournalBinaryStore` class. All reads and writes through the binary store are handled by the resource manager. There is a resource manager for RAM journals (`RamJournalRM`) and one for flash journals (`FlashJournalRM`). For details about these APIs, see *Java API Reference for Oracle Coherence*.

Defining Journal Schemes

The `<ramjournal-scheme>` and `<flashjournal-scheme>` elements are used to configure RAM and Flash journals (respectively) in a cache configuration file. See the "[ramjournal-scheme](#)" on page B-101 and the "[flashjournal-scheme](#)" on page B-44 for detailed configuration options for these scheme types.

This section includes the following topics:

- [Configuring a RAM Journal Backing Map](#)
- [Configuring a Flash Journal Backing Map](#)
- [Referencing a Journal Scheme](#)
- [Using Journal Expiry and Eviction](#)
- [Using a Journal Scheme for Backup Storage](#)
- [Enabling a Custom Map Implementation for a Journal Scheme](#)

Configuring a RAM Journal Backing Map

To configure a RAM journal backing map, add the `<ramjournal-scheme>` element within the `<backing-map-scheme>` element of a cache definition. The following example creates a distributed cache that uses a RAM journal for the backing map. The RAM journal automatically delegates to a flash journal when the RAM journal exceeds the configured memory size. See "[Changing Journaling Behavior](#)" on page 14-10 to change memory settings.

```
<distributed-scheme>
  <scheme-name>distributed-journal</scheme-name>
  <service-name>DistributedCacheRAMJournal</service-name>
  <backing-map-scheme>
    <ramjournal-scheme/>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>
```

Configuring a Flash Journal Backing Map

To configure a flash journal backing map, add the `<flashjournal-scheme>` element within the `<backing-map-scheme>` element of a cache definition. The following example creates a distributed scheme that uses a flash journal for the backing map.

```
<distributed-scheme>
  <scheme-name>distributed-journal</scheme-name>
  <service-name>DistributedCacheFlashJournal</service-name>
  <backing-map-scheme>
    <flashjournal-scheme/>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>
```

Referencing a Journal Scheme

The RAM and flash journal schemes both support the use of scheme references to reuse scheme definitions. The following example creates a distributed cache and configures a RAM journal backing map by referencing the RAM scheme definition called `default-ram`.

```
<caching-schemes>
  <distributed-scheme>
    <scheme-name>distributed-journal</scheme-name>
    <service-name>DistributedCacheJournal</service-name>
    <backing-map-scheme>
      <ramjournal-scheme>
        <scheme-ref>default-ram</scheme-ref>
      </ramjournal-scheme>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>

  <ramjournal-scheme>
    <scheme-name>default-ram</scheme-name>
  </ramjournal-scheme>
</caching-schemes>
```

Using Journal Expiry and Eviction

The RAM and flash journal can be size-limited. They can restrict the number of entries to store and automatically evict entries when the journal becomes full. Furthermore, both the sizing of entries and the eviction policies can be customized. The following example defines expiry and eviction settings for a RAM journal:

```
<distributed-scheme>
  <scheme-name>distributed-journal</scheme-name>
  <service-name>DistributedCacheFlashJournal</service-name>
  <backing-map-scheme>
    <ramjournal-scheme>
      <eviction-policy>LFU</eviction-policy>
      <high-units>100</high-units>
      <low-units>80</low-units>
      <unit-calculator>Binary</unit-calculator>
      <unit-factor>1</unit-factor>
      <expiry-delay>0</expiry-delay>
    </ramjournal-scheme>
  </backing-map-scheme>
  <autostart>true</autostart>
```

```
</distributed-scheme>
```

Using a Journal Scheme for Backup Storage

Journal schemes are used for backup storage as well as for backing maps. By default, Flash Journal is used as the backup storage. This default behavior can be modified by explicitly specifying the storage type within the `<backup-storage>` element. The following configuration uses a RAM journal for the backing map and explicitly configures a RAM journal for backup storage:

```
<キャッシング-schemes>
  <distributed-scheme>
    <scheme-name>default-distributed-journal</scheme-name>
    <service-name>DistributedCacheJournal</service-name>
    <backup-storage>
      <type>scheme</type>
      <scheme-name>example-ram</scheme-name>
    </backup-storage>
    <backing-map-scheme>
      <ramjournal-scheme/>
    </backing-map-scheme>
    <autostart>true</autostart>
  </distributed-scheme>

  <ramjournal-scheme>
    <scheme-name>example-ram</scheme-name>
  </ramjournal-scheme>
</キャッシング-schemes>
```

Enabling a Custom Map Implementation for a Journal Scheme

Journal schemes can be configured to use a custom backing map as required. Custom map implementations must extend the `CompactSerializationCache` class and declare the exact same set of public constructors. For details about this API, see *Java API Reference for Oracle Coherence*.

To enable a custom implementation, add a `<class-scheme>` element whose value is the fully qualified name of the custom class. Any parameters that are required by the custom class can be defined using the `<init-params>` element. The following example enables a custom map implementation called `MyCompactSerializationCache`.

```
<flashjournal-scheme>
  <scheme-name>example-flash</scheme-name>
  <class-name>package.MyCompactSerializationCache</class-name>
</flashjournal-scheme>
```

Changing Journaling Behavior

A resource manager controls journaling behavior. There is a resource manager for RAM journals (`RamJournalRM`) and a resource manager for Flash journals (`FlashJournalRM`). The resource managers are configured for a cluster in the `tangosol-coherence-override.xml` operational override file. The resource managers' default out-of-box settings are used if no configuration overrides are set.

This section includes the following topics:

- [Configuring the RAM Journal Resource Manager](#)
- [Configuring the Flash Journal Resource Manager](#)

Configuring the RAM Journal Resource Manager

The `<ramjournal-manager>` element is used to configure RAM journal behavior. The following list summarizes the default characteristics of a RAM journal. See ["ramjournal-manager"](#) on page A-56 for details on all settings that are available and their defaults.

- Binary values are limited by default to 64KB (and a maximum of 4MB). A flash journal is automatically used if a binary value exceeds the configured limit.
- An individual buffer (a journal file) is limited by default to 2MB (and a maximum of 2GB). The maximum file size should not be changed.
- A journal is composed of up to 512 files. 511 files are usable files and one file is reserved for depleted states.
- The total memory used by the journal is limited to 1GB by default (and a maximum of 64GB). A flash journal is automatically used if the total memory of the journal exceeds the configured limit.

To configure a RAM journal resource manager, add a `<ramjournal-manager>` element within a `<journaling-config>` element and define any subelements that are to be overridden. The following example demonstrates overriding RAM journal subelements:

```
<?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>
    <journaling-config>
      <ramjournal-manager>
        <maximum-value-size>64K</maximum-value-size>
        <maximum-size system-property="tangosol.coherence.ramjournal.size">
          2G</maximum-size>
      </ramjournal-manager>
    </journaling-config>
  </cluster-config>
</coherence>
```

Configuring the Flash Journal Resource Manager

The `<flashjournal-manager>` element is used to configure flash journal behavior. The following list summarizes the default characteristics of a flash journal. See ["flashjournal-manager"](#) on page A-20 for details on all settings that are available and their defaults.

- Binary values are limited by default to 64MB.
- An individual buffer (a journal file) is limited by default to 2GB (and maximum 4GB).
- A journal is composed of up to 512 files. 511 files are usable files and one file is reserved for depleted states. A journal is limited by default to 1TB, with a theoretical maximum of 2TB.
- A journal has a high journal size of 11GB by default. The high size determines when to start removing stale values from the journal. This is not a hard limit on the journal size, which can still grow to the maximum file count (512).

- Keys remain in memory in a compressed format. For values, only the unwritten data (being queued or asynchronously written) remains in memory. When sizing the heap, a reasonable estimate is to allow 50 bytes for each entry to hold key data (this is true for both RAM and Flash journals) and include additional space for the buffers (16MB). The entry size is increased if expiry or eviction is configured.

To configure a flash journal resource manager, add a `<flashjournal-manager>` element within a `<journaling-config>` element and define any subelements that are to be overridden. The following example demonstrates overriding flash journal subelements:

```
<?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>
    <journaling-config>
      <flashjournal-manager>
        <maximum-value-size>64K</maximum-value-size>
        <maximum-file-size>8M</maximum-file-size>
        <block-size>512K</block-size>
        <maximum-pool-size>32M</maximum-pool-size>
        <directory>/coherence_storage</directory>
        <async-limit>32M</async-limit>
        <high-journal-size
          system-property="tangosol.coherence.flashjournal.highjournal.size">
          11GB</high-journal-size>
        </flashjournal-manager>
      </journaling-config>
    </cluster-config>
  </coherence>
```

Note: The directory specified for storing journal files must exist. If the directory does not exist, a warning is logged and the default temporary file directory, as designated by the JVM, is used.

Using Asynchronous Backup

Distributed caches support both synchronous and asynchronous backup. With synchronous backup, clients are blocked until a backup operation completes. With asynchronous backup, clients continue to respond to requests during backup operations. Backups are performed synchronously unless asynchronous backup is explicitly enabled.

Asynchronous backup is typically used to increase client performance. However, applications that use asynchronous backup must handle the possible effects on data integrity. Specifically, cache operations may complete before backup operations complete (successfully or unsuccessfully) and backup operations may complete in any order. Consider using asynchronous backup if an application does not require backups (that is, data can be restored from a system of record if lost) but the application still wants to offer fast recovery in the event of a node failure.

To enable asynchronous backup for a distributed cache, add an `<async-backup>` element, within a `<distributed-scheme>` element, that is set to `true`. For example:

```
<distributed-scheme>
```

```

...
<async-backup>true</async-backup>
...
</distributed-scheme>

```

To enable asynchronous backup for all instances of the distributed cache service type, override the partitioned cache service's `async-backup` initialization parameter in an operational override file. For example:

```

<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="27">
            <param-name>async-backup</param-name>
            <param-value
              system-property="tangosol.coherence.distributed.asyncbackup">
              false
            </param-value>
          </init-param>
        </init-params>
      </service>
    </services>
  </cluster-config>
</coherence>

```

The `tangosol.coherence.distributed.asyncbackup` system property is used to enable asynchronous backup for all instances of the distributed cache service type instead of using the operational override file. For example:

```
-Dtangosol.coherence.distributed.asyncbackup=true
```

Using Delta Backup

Delta backup is a technique that is used to apply changes to a backup binary entry rather than replacing the whole entry when the primary entry changes. Delta backup is ideal in situations where the entry being updated is large but only small changes are being made. In such cases, the cost for changing only a small portion of the entry is often less than the cost associated with rewriting the whole entry and results in better performance. However, entries that change by more than 50% typically demonstrate little or no performance gain. In this case, the use of delta backup should only be used if no adverse effect on performance is observed.

Delta backup uses a compressor that compares two in-memory buffers containing an old and a new value and produces a result (called a delta) that can be applied to the old value to create the new value. Coherence provides standard delta compressors for POF and non-POF formats. Custom compressors can also be created and configured as required.

Enabling Delta Backup

Delta backup is only available for distributed caches and is disabled by default. Delta backup is enabled either individually for each distributed cache or for all instances of the distributed cache service type.

To enable delta backup for a distributed cache, add a `<compressor>` element, within a `<distributed-scheme>` element, that is set to `standard`. For example:

```
<distributed-scheme>
  ...
  <compressor>standard</compressor>
  ...
</distributed-scheme>
```

To enable delta backup for all instances of the distributed cache service type, override the partitioned cache service's `compressor` initialization parameter in an operational override file. For example:

```
<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="22">
            <param-name>compressor</param-name>
            <param-value
              system-property="tangosol.coherence.distributed.compressor">
              standard</param-value>
          </init-param>
        </init-params>
      </service>
    </services>
  </cluster-config>
</coherence>
```

The `tangosol.coherence.distributed.compressor` system property is used to enable delta backup for all instances of the distributed cache service type instead of using the operational override file. For example:

```
-Dtangosol.coherence.distributed.compressor=standard
```

Enabling a Custom Delta Backup Compressor

To use a custom compressor for performing delta backup, include an `<instance>` subelement and provide a fully qualified class name that implements the `DeltaCompressor` interface. See ["instance"](#) on page B-54 for detailed instructions on using the `<instance>` element. The following example enables a custom compressor that is implemented in the `MyDeltaCompressor` class.

```
<distributed-scheme>
  ...
  <compressor>
    <instance>
      <class-name>package.MyDeltaCompressor</class-name>
```

```

        </instance>
    </compressor>
    ...
</distributed-scheme>

```

As an alternative, the `<instance>` element supports the use of a `<class-factory-name>` element to use a factory class that is responsible for creating `DeltaCompressor` instances, and a `<method-name>` element to specify the static factory method on the factory class that performs object instantiation. The following example gets a custom compressor instance using the `getCompressor` method on the `MyCompressorFactory` class.

```

<distributed-scheme>
    ...
    <compressor>
        <instance>
            <class-factory-name>package.MyCompressorFactory</class-factory-name>
            <method-name>getCompressor</method-name>
        </instance>
    </compressor>
    ...
</distributed-scheme>

```

Any initialization parameters that are required for an implementation can be specified using the `<init-params>` element. The following example sets the `iMaxTime` parameter to 2000.

```

<distributed-scheme>
    ...
    <compressor>
        <instance>
            <class-name>package.MyDeltaCompressor</class-name>
            <init-params>
                <init-param>
                    <param-name>iMaxTime</param-name>
                    <param-value>2000</param-value>
                </init-param>
            </init-params>
        </instance>
    </compressor>
    ...
</distributed-scheme>

```

Caching Data Sources

This chapter provides instructions for caching data sources and using Coherence as a temporary system-of-record. The chapter includes samples and implementation considerations.

This chapter includes the following sections:

- [Overview of Caching Data Sources](#)
- [Selecting a Cache Strategy](#)
- [Creating a Cache Store Implementation](#)
- [Plugging in a Cache Store Implementation](#)
- [Sample Cache Store Implementation](#)
- [Sample Controllable Cache Store Implementation](#)
- [Implementation Considerations](#)

Overview of Caching Data Sources

Coherence supports transparent read/write caching of any data source, including databases, web services, packaged applications and file systems; however, databases are the most common use case. As shorthand, "database" is used to describe any back-end data source. Effective caches must support both intensive read-only **and** read/write operations, and for read/write operations, the cache and database must be kept fully synchronized. To accomplish caching of data sources, Coherence supports **Read-Through, Write-Through, Refresh-Ahead and Write-Behind** caching.

Note: Read-through/write-through caching (and variants) are intended for use only with the Partitioned (Distributed) cache topology (and by extension, Near cache). Local caches support a subset of this functionality. Replicated and Optimistic caches should not be used.

The following topics are include in this section:

- [Pluggable Cache Store](#)
- [Read-Through Caching](#)
- [Write-Through Caching](#)
- [Write-Behind Caching](#)
- [Refresh-Ahead Caching](#)

Pluggable Cache Store

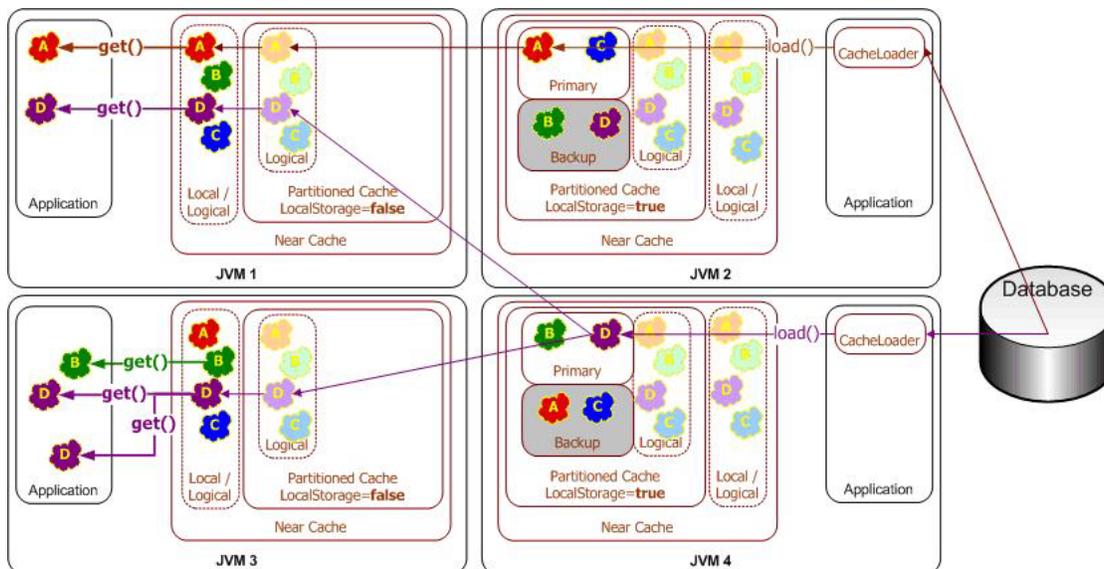
A cache store is an application-specific adapter used to connect a cache to a underlying data source. The cache store implementation accesses the data source by using a data access mechanism (for example, *Hibernate*, *Toplink*, *JPA*, application-specific JDBC calls, another application, mainframe, another cache, and so on). The cache store understands how to build a Java object using data retrieved from the data source, map and write an object to the data source, and erase an object from the data source.

Both the data source connection strategy and the data source-to-application-object mapping information are specific to the data source schema, application class layout, and operating environment. Therefore, this mapping information must be provided by the application developer in the cache store implementation. See "[Creating a Cache Store Implementation](#)" on page 15-6 for more information.

Read-Through Caching

When an application asks the cache for an entry, for example the key *X*, and *X* is not in the cache, Coherence automatically delegates to the *CacheStore* and asks it to load *X* from the underlying data source. If *X* exists in the data source, the *CacheStore* loads it, returns it to Coherence, then Coherence places it in the cache for future use and finally returns *X* to the application code that requested it. This is called **Read-Through** caching. Refresh-Ahead Cache functionality may further improve read performance (by reducing perceived latency). See "[Refresh-Ahead Caching](#)" on page 15-5 for more information.

Figure 15-1 Read-Through Caching

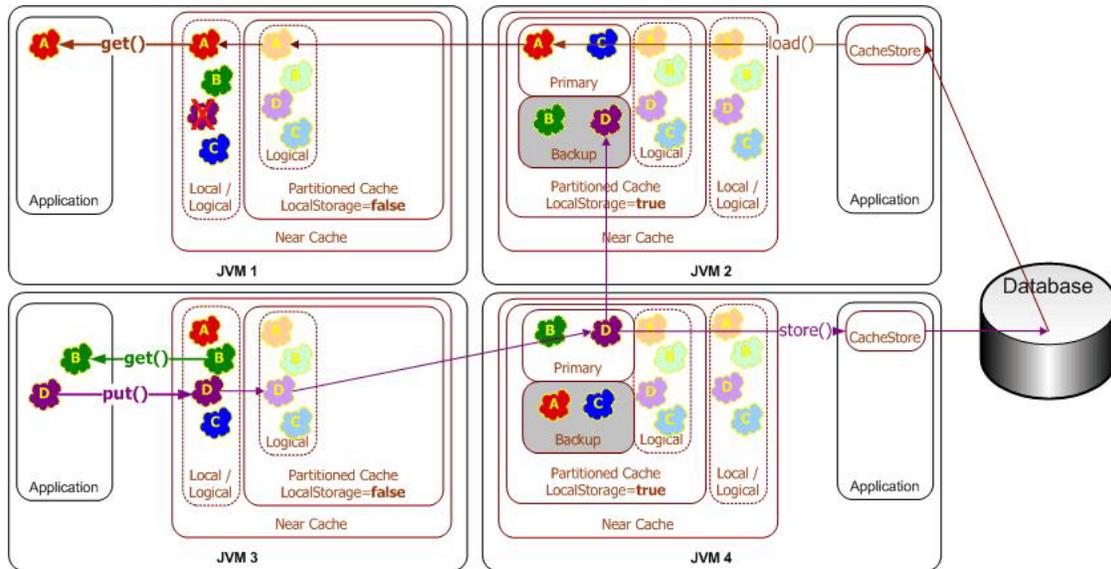


Write-Through Caching

Coherence can handle updates to the data source in two distinct ways, the first being **Write-Through**. In this case, when the application updates a piece of data in the cache (that is, calls `put(...)` to change a cache entry,) the operation does not complete (that is, the `put` does not return) until Coherence has gone through the cache store and successfully stored the data to the underlying data source. This does not improve write performance at all, since you are still dealing with the latency of the write to the data

source. Improving the write performance is the purpose for the *Write-Behind Cache* functionality. See "[Write-Behind Caching](#)" on page 15-3 for more information.

Figure 15–2 Write-Through Caching



Write-Behind Caching

In the **Write-Behind** scenario, modified cache entries are asynchronously written to the data source after a configured delay, whether after 10 seconds, 20 minutes, a day, a week or even longer. Note that this only applies to cache inserts and updates - cache entries are removed synchronously from the data source. For **Write-Behind** caching, Coherence maintains a write-behind queue of the data that must be updated in the data source. When the application updates *x* in the cache, *x* is added to the write-behind queue (if it is not there; otherwise, it is replaced), and after the specified write-behind delay Coherence calls the CacheStore to update the underlying data source with the latest state of *x*. Note that the write-behind delay is relative to the first of a series of modifications—in other words, the data in the data source never lags behind the cache by more than the write-behind delay.

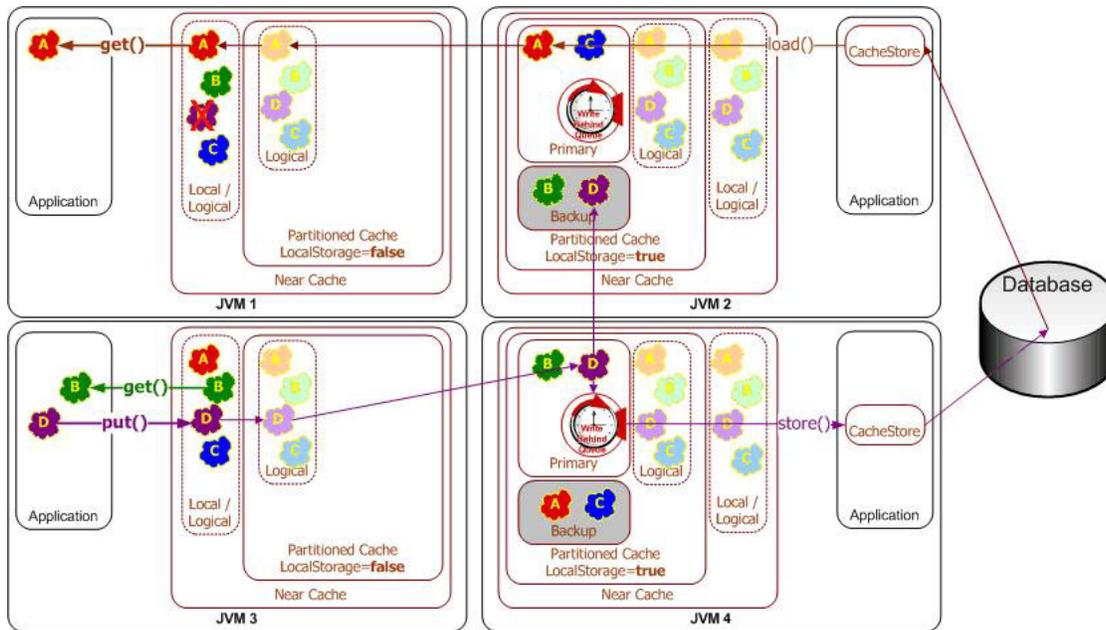
The result is a "read-once and write at a configured interval" (that is, much less often) scenario. There are four main benefits to this type of architecture:

- The application improves in performance, because the user does not have to wait for data to be written to the underlying data source. (The data is written later, and by a different execution thread.)
- The application experiences drastically reduced database load: Since the amount of both read and write operations is reduced, so is the database load. The reads are reduced by caching, as with any other caching approach. The writes, which are typically much more expensive operations, are often reduced because multiple changes to the same object within the write-behind interval are "coalesced" and only written once to the underlying data source ("write-coalescing"). Additionally, writes to multiple cache entries may be combined into a single database transaction ("write-combining") by using the `CacheStore.storeAll()` method.
- The application is somewhat insulated from database failures: the **Write-Behind** feature can be configured in such a way that a write failure results in the object being re-queued for write. If the data that the application is using is in the

Coherence cache, the application can continue operation without the database being up. This is easily attainable when using the Coherence Partitioned Cache, which partitions the entire cache across all participating cluster nodes (with local-storage enabled), thus allowing for enormous caches.

- Linear Scalability:** For an application to handle more concurrent users you need only increase the number of nodes in the cluster; the effect on the database in terms of load can be tuned by increasing the write-behind interval.

Figure 15–3 Write-Behind Caching



Write-Behind Requirements

While enabling write-behind caching is simply a matter of adjusting one configuration setting, ensuring that write-behind works as expected is more involved. Specifically, application design must address several design issues up-front.

The most direct implication of write-behind caching is that database updates occur outside of the cache transaction; that is, the cache transaction usually completes before the database transaction(s) begin. This implies that the database transactions must never fail; if this cannot be guaranteed, then rollbacks must be accommodated.

As write-behind may re-order database updates, referential integrity constraints must allow out-of-order updates. Conceptually, this is similar to using the database as ISAM-style storage (primary-key based access with a guarantee of no conflicting updates). If other applications share the database, this introduces a new challenge—there is no way to guarantee that a write-behind transaction does not conflict with an external update. This implies that write-behind conflicts must be handled heuristically or escalated for manual adjustment by a human operator.

As a rule of thumb, mapping each cache entry update to a logical database transaction is ideal, as this guarantees the simplest database transactions.

Because write-behind effectively makes the cache the system-of-record (until the write-behind queue has been written to disk), business regulations must allow cluster-durable (rather than disk-durable) storage of data and transactions.

Refresh-Ahead Caching

In the **Refresh-Ahead** scenario, Coherence allows a developer to configure a cache to automatically and asynchronously reload (refresh) any recently accessed cache entry from the cache loader before its expiration. The result is that after a frequently accessed entry has entered the cache, the application does not feel the impact of a read against a potentially slow cache store when the entry is reloaded due to expiration. The asynchronous refresh is only triggered when an object that is sufficiently close to its expiration time is accessed—if the object is accessed after its expiration time, Coherence performs a synchronous read from the cache store to refresh its value.

The refresh-ahead time is expressed as a percentage of the entry's expiration time. For example, assume that the expiration time for entries in the cache is set to 60 seconds and the refresh-ahead factor is set to 0.5. If the cached object is accessed after 60 seconds, Coherence performs a *synchronous* read from the cache store to refresh its value. However, if a request is performed for an entry that is more than 30 but less than 60 seconds old, the current value in the cache is returned and Coherence schedules an *asynchronous* reload from the cache store.

Refresh-ahead is especially useful if objects are being accessed by a large number of users. Values remain fresh in the cache and the latency that could result from excessive reloads from the cache store is avoided.

The value of the refresh-ahead factor is specified by the `<refresh-ahead-factor>` subelement of the `<read-write-backing-map-scheme>` element in the `coherence-cache-config.xml` file. Refresh-ahead assumes that you have also set an expiration time (`<expiry-delay>`) for entries in the cache.

Example 15–1 configures a refresh-ahead factor of 0.5 and an expiration time of 20 seconds for entries in the local cache. If an entry is accessed within 10 seconds of its expiration time, it is scheduled for an asynchronous reload from the cache store.

Example 15–1 Specifying a Refresh-Ahead Factor

```
<distributed-scheme>
  <scheme-name>categories-cache-all-scheme</scheme-name>
  <service-name>DistributedCache</service-name>
  <backing-map-scheme>

    <read-write-backing-map-scheme>
      <scheme-name>categoriesLoaderScheme</scheme-name>
      <internal-cache-scheme>
        <local-scheme>
          <scheme-ref>categories-eviction</scheme-ref>
        </local-scheme>
      </internal-cache-scheme>

      <cachestore-scheme>
        <class-scheme>
          <class-name>
            com.demo.cache.coherence.categories.CategoryCacheLoader
          </class-name>
        </class-scheme>
      </cachestore-scheme>
      <refresh-ahead-factor>0.5</refresh-ahead-factor>
    </read-write-backing-map-scheme>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>
<local-scheme>
```

```
<scheme-name>categories-eviction</scheme-name>  
<expiry-delay>20s</expiry-delay>  
</local-scheme>
```

Selecting a Cache Strategy

This section compares and contrasts the benefits of several caching strategies.

- [Read-Through/Write-Through versus Cache-Aside](#)
- [Refresh-Ahead versus Read-Through](#)
- [Write-Behind versus Write-Through](#)

Read-Through/Write-Through versus Cache-Aside

There are two common approaches to the cache-aside pattern in a clustered environment. One involves checking for a cache miss, then querying the database, populating the cache, and continuing application processing. This can result in multiple database visits if different application threads perform this processing at the same time. Alternatively, applications may perform double-checked locking (which works since the check is atomic for the cache entry). This, however, results in a substantial amount of overhead on a cache miss or a database update (a clustered lock, additional read, and clustered unlock - up to 10 additional network hops, or 6-8ms on a typical gigabit Ethernet connection, plus additional processing overhead and an increase in the "lock duration" for a cache entry).

By using inline caching, the entry is locked only for the 2 network hops (while the data is copied to the backup server for fault-tolerance). Additionally, the locks are maintained locally on the partition owner. Furthermore, application code is fully managed on the cache server, meaning that only a controlled subset of nodes directly accesses the database (resulting in more predictable load and security). Additionally, this decouples cache clients from database logic.

Refresh-Ahead versus Read-Through

Refresh-ahead offers reduced latency compared to read-through, but only if the cache can accurately predict which cache items are likely to be needed in the future. With full accuracy in these predictions, refresh-ahead offers reduced latency and no added overhead. The higher the rate of inaccurate prediction, the greater the impact is on throughput (as more unnecessary requests are sent to the database) - potentially even having a negative impact on latency should the database start to fall behind on request processing.

Write-Behind versus Write-Through

If the requirements for write-behind caching can be satisfied, write-behind caching may deliver considerably higher throughput and reduced latency compared to write-through caching. Additionally write-behind caching lowers the load on the database (fewer writes), and on the cache server (reduced cache value deserialization).

Creating a Cache Store Implementation

Cache store implementations are pluggable and depending on the cache's usage of the data source must implement one of the following interfaces:

- CacheLoader – read-only caches
- CacheStore – read/write caches
- BinaryEntryStore – read/write for binary entry objects.

These interfaces are located in the `com.tangosol.net.cache` package. The CacheLoader interface has two main methods: `load(Object key)` and `loadAll(Collection keys)`, and the CacheStore interface adds the methods `store(Object key, Object value)`, `storeAll(Map mapEntries)`, `erase(Object key)`, and `eraseAll(Collection colKeys)`. The BinaryEntryStore interface provides the same methods as the other interfaces, but it works directly on binary objects.

See ["Sample Cache Store Implementation"](#) on page 15-8 and ["Sample Controllable Cache Store Implementation"](#) on page 15-13 for example CacheStore implementations.

Plugging in a Cache Store Implementation

To plug in a cache store implementation, specify the implementation class name within the `distributed-scheme`, `backing-map-scheme`, `cachestore-scheme`, or `read-write-backing-map-scheme` cache configuration element.

The `read-write-backing-map-scheme` configures a `com.tangosol.net.cache.ReadWriteBackingMap`. This backing map is composed of two key elements: an internal map that actually caches the data (see `internal-cache-scheme`), and a cache store implementation that interacts with the database (see `cachestore-scheme`).

[Example 15-2](#) illustrates a cache configuration that specifies a cache store implementation. The `<init-params>` element contains an ordered list of parameters that is passed into the constructor. The `{cache-name}` configuration macro is used to pass the cache name into the implementation, allowing it to be mapped to a database table. For a complete list of available macros, see ["Using Parameter Macros"](#) on page 13-15.

For more detailed information on configuring write-behind and refresh-ahead, see the `read-write-backing-map-scheme`, taking note of the `write-batch-factor`, `refresh-ahead-factor`, `write-requeue-threshold`, and `rollback-cachestore-failures` elements.

Example 15-2 Example Cachestore Module

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>com.company.dto.*</cache-name>
      <scheme-name>distributed-rwbm</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <distributed-scheme>
      <scheme-name>distributed-rwbm</scheme-name>
      <backing-map-scheme>
        <read-write-backing-map-scheme>
```

```

<internal-cache-scheme>
  <local-scheme/>
</internal-cache-scheme>

<cachestore-scheme>
  <class-scheme>
    <class-name>com.example.MyCacheStore</class-name>
    <init-params>
      <init-param>
        <param-type>java.lang.String</param-type>
        <param-value>{cache-name}</param-value>
      </init-param>
    </init-params>
  </class-scheme>
</cachestore-scheme>
</read-write-backing-map-scheme>
</backing-map-scheme>
</distributed-scheme>
</caching-schemes>
</cache-config>

```

Note: The use of a cache store implementation substantially increases the consumption of cache service threads (even the fastest database select is orders of magnitude slower than updating an in-memory structure). Consequently, the cache service thread count must be increased (typically in the range 10-100). The most noticeable symptom of an insufficient thread pool is increased latency for cache requests (without corresponding behavior in the backing database).

Sample Cache Store Implementation

This section provides a very basic implementation of the `com.tangosol.net.cache.CacheStore` interface. The implementation in [Example 15-3](#) uses a single database connection by using JDBC, and does not use bulk operations. A complete implementation would use a connection pool, and, if write-behind is used, implement `CacheStore.storeAll()` for bulk JDBC inserts and updates. "[Cache of a Database](#)" on page 18-4 provides an example of a database cache configuration.

Tip: Save processing effort by bulk loading the cache. The following example use the `put` method to write values to the cache store. Often, performing bulk loads with the `putAll` method results in a savings in processing effort and network traffic. For more information on bulk loading, see [Chapter 21, "Pre-Loading a Cache."](#)

Example 15-3 Implementation of the `CacheStore` Interface

```

package com.tangosol.examples.coherence;

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;

```

```

import java.sql.SQLException;

import java.util.Collection;
import java.util.Iterator;
import java.util.LinkedList;
import java.util.List;
import java.util.Map;

/**
 * An example implementation of CacheStore
 * interface.
 *
 * @author erm 2003.05.01
 */
public class DBCacheStore
    extends Base
    implements CacheStore
{
    // ---- constructors -----
    /**
     * Constructs DBCacheStore for a given database table.
     *
     * @param sTableName the db table name
     */
    public DBCacheStore(String sTableName)
    {
        m_sTableName = sTableName;
        configureConnection();
    }

    /**
     * Set up the DB connection.
     */
    protected void configureConnection()
    {
        try
        {
            Class.forName("org.gjt.mm.mysql.Driver");
            m_con = DriverManager.getConnection(DB_URL, DB_USERNAME,
DB_PASSWORD);

            m_con.setAutoCommit(true);
        }
        catch (Exception e)
        {
            throw ensureRuntimeException(e, "Connection failed");
        }
    }

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

    /**
     * Obtain the name of the table this CacheStore is persisting to.
     *
     * @return the name of the table this CacheStore is persisting to
     */
    public String getTableName()
    {
        return m_sTableName;
    }
}

```

```

    }

/**
 * Obtain the connection being used to connect to the database.
 *
 * @return the connection used to connect to the database
 */
public Connection getConnection()
{
    return m_con;
}

// ----- CacheStore Interface -----

/**
 * Return the value associated with the specified key, or null if the
 * key does not have an associated value in the underlying store.
 *
 * @param oKey key whose associated value is to be returned
 *
 * @return the value associated with the specified key, or
 *         <tt>null</tt> if no value is available for that key
 */
public Object load(Object oKey)
{
    Object    oValue = null;
    Connection con    = getConnection();
    String    sSQL    = "SELECT id, value FROM " + getTableName()
        + " WHERE id = ?";

    try
    {
        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;
}

/**
 * Store the specified value under the specific key in the underlying
 * store. This method is intended to support both key/value creation
 * and value update for a specific key.
 *
 * @param oKey key to store the value under

```

```

* @param oValue value to be stored
*
* @throws UnsupportedOperationException if this implementation or the
*       underlying store is read-only
*/
public void store(Object oKey, Object oValue)
{
    Connection con    = getConnection();
    String      sTable = getTableName();
    String      sSQL;

    // the following is very inefficient; it is recommended to use DB
    // specific functionality that is, REPLACE for MySQL or MERGE for Oracle
    if (load(oKey) != null)
    {
        // key exists - update
        sSQL = "UPDATE " + sTable + " SET value = ? where id = ?";
    }
    else
    {
        // new key - insert
        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);
    }
}

/**
* Remove the specified key from the underlying store if present.
*
* @param oKey key whose mapping is to be removed from the map
*
* @throws UnsupportedOperationException if this implementation or the
*       underlying store is read-only
*/
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));
        stmt.executeUpdate();
        stmt.close();
    }
    catch (SQLException e)
    {

```

```
        throw ensureRuntimeException(e, "Erase failed: key=" + oKey);
    }
}

/**
 * Remove the specified keys from the underlying store if present.
 *
 * @param colKeys keys whose mappings are being removed from the cache
 *
 * @throws UnsupportedOperationException if this implementation or the
 *         underlying store is read-only
 */
public void eraseAll(Collection colKeys)
{
    throw new UnsupportedOperationException();
}

/**
 * Return the values associated with each the specified keys in the
 * passed collection. If a key does not have an associated value in
 * the underlying store, then the return map does not have an entry
 * for that key.
 *
 * @param colKeys a collection of keys to load
 *
 * @return a Map of keys to associated values for the specified keys
 */
public Map loadAll(Collection colKeys)
{
    throw new UnsupportedOperationException();
}

/**
 * Store the specified values under the specified keys in the underlying
 * store. This method is intended to support both key/value creation
 * and value update for the specified keys.
 *
 * @param mapEntries a Map of any number of keys and values to store
 *
 * @throws UnsupportedOperationException if this implementation or the
 *         underlying store is read-only
 */
public void storeAll(Map mapEntries)
{
    throw new UnsupportedOperationException();
}

/**
 * Iterate all keys in the underlying store.
 *
 * @return a read-only iterator of the keys in the underlying store
 */
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();
}

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

/**
 * The connection.
 */
protected Connection m_con;

/**
 * The db table name.
 */
protected String m_sTableName;

/**
 * Driver class name.
 */
private static final String DB_DRIVER = "org.gjt.mm.mysql.Driver";

/**
 * Connection URL.
 */
private static final String DB_URL = "jdbc:mysql://localhost:3306/CacheStore";

/**
 * User name.
 */
private static final String DB_USERNAME = "root";

/**
 * Password.
 */
private static final String DB_PASSWORD = null;
}

```

Sample Controllable Cache Store Implementation

This section illustrates the implementation of a controllable cache store. In this scenario, the application can control when it writes updated values to the data store. The most common use case for this scenario is during the initial population of the cache from the data store at startup. At startup, there is no requirement to write values in the cache back to the data store. Any attempt to do so would be a waste of resources.

The `Main.java` file in [Example 15-4](#) illustrates two different approaches to interacting with a controllable cache store:

- Use a controllable cache (note that it must be on a different service) to enable or disable the cache store. This is illustrated by the `ControllableCacheStore1` class.
- Use the `CacheStoreAware` interface to indicate that objects added to the cache do not require storage. This is illustrated by the `ControllableCacheStore2` class.

Both `ControllableCacheStore1` and `ControllableCacheStore2` extend the `com.tangosol.net.cache.AbstractCacheStore` class. This helper class provides unoptimized implementations of the `storeAll` and `eraseAll` operations.

The `CacheStoreAware` interface can be used to indicate that an object added to the cache should not be stored in the database.

See "[Cache of a Database](#)" on page 18-4 for a sample cache configurations.

[Example 15-4](#) provides a listing of the `Main.java` interface.

Example 15-4 Main.java - Interacting with a Controllable CacheStore

```
import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.net.cache.AbstractCacheStore;
import com.tangosol.util.Base;

import java.io.Serializable;
import java.util.Date;

public class Main extends Base
{
    /**
     * A cache controlled CacheStore implementation
     */
    public static class ControllableCacheStore1 extends AbstractCacheStore
    {
        public static final String CONTROL_CACHE = "cachestorecontrol";

        String m_sName;

        public static void enable(String sName)
        {
            CacheFactory.getCache(CONTROL_CACHE).put(sName, Boolean.TRUE);
        }

        public static void disable(String sName)
        {
            CacheFactory.getCache(CONTROL_CACHE).put(sName, Boolean.FALSE);
        }

        public void store(Object oKey, Object oValue)
        {
            Boolean isEnabled = (Boolean) CacheFactory.getCache(CONTROL_
CACHE).get(m_sName);
            if (isEnabled != null && isEnabled.booleanValue())
            {
                log("controllablecachestore1: enabled " + oKey + " = " + oValue);
            }
            else
            {

```

```

        log("controllablecachestore1: disabled " + oKey + " = " + oValue);
    }
}

public Object load(Object oKey)
{
    log("controllablecachestore1: load:" + oKey);
    return new MyValue1(oKey);
}

public ControllableCacheStore1(String sName)
{
    m_sName = sName;
}

}

/**
 * a valued controlled CacheStore implementation that
 * implements the CacheStoreAware interface
 */
public static class ControllableCacheStore2 extends AbstractCacheStore
{
    public void store(Object oKey, Object oValue)
    {
        boolean isEnabled = oValue instanceof CacheStoreAware ?
!((CacheStoreAware) oValue).isSkipStore() : true;
        if (isEnabled)
        {
            log("controllablecachestore2: enabled " + oKey + " = " + oValue);
        }
        else
        {
            log("controllablecachestore2: disabled " + oKey + " = " + oValue);
        }
    }

    public Object load(Object oKey)
    {
        log("controllablecachestore2: load:" + oKey);
        return new MyValue2(oKey);
    }

}

public static class MyValue1 implements Serializable
{
    String m_sValue;

    public String getValue()
    {
        return m_sValue;
    }

    public String toString()
    {
        return "MyValue1[" + getValue() + "]";
    }
}

```

```
public MyValue1(Object obj)
{
    m_sValue = "value:" + obj;
}

public static class MyValue2 extends MyValue1 implements CacheStoreAware
{
    boolean m_isSkipStore = false;

    public boolean isSkipStore()
    {
        return m_isSkipStore;
    }

    public void skipStore()
    {
        m_isSkipStore = true;
    }

    public String toString()
    {
        return "MyValue2[" + getValue() + "];"
    }

    public MyValue2(Object obj)
    {
        super(obj);
    }
}

public static void main(String[] args)
{
    try
    {
        // example 1

        NamedCache cache1 = CacheFactory.getCache("cache1");

        // disable cachestore
        ControllableCacheStore1.disable("cache1");
        for(int i = 0; i < 5; i++)
        {
            cache1.put(new Integer(i), new MyValue1(new Date()));
        }

        // enable cachestore
        ControllableCacheStore1.enable("cache1");
        for(int i = 0; i < 5; i++)
        {
            cache1.put(new Integer(i), new MyValue1(new Date()));
        }

        // example 2

        NamedCache cache2 = CacheFactory.getCache("cache2");

        // add some values with cachestore disabled
```

```

        for(int i = 0; i < 5; i++)
        {
            MyValue2 value = new MyValue2(new Date());
            value.skipStore();
            cache2.put(new Integer(i), value);
        }

        // add some values with cachestore enabled
        for(int i = 0; i < 5; i++)
        {
            cache2.put(new Integer(i), new MyValue2(new Date()));
        }

    }

    catch(Throwable oops)
    {
        err(oops);
    }
    finally
    {
        CacheFactory.shutdown();
    }
}
}

```

Implementation Considerations

Please keep the following in mind when creating a cache store implementation.

Idempotency

All operations should be designed to be idempotent (that is, repeatable without unwanted side-effects). For write-through and write-behind caches, this allows Coherence to provide low-cost fault-tolerance for partial updates by re-trying the database portion of a cache update during failover processing. For write-behind caching, idempotency also allows Coherence to combine multiple cache updates into a single invocation without affecting data integrity.

Applications that have a requirement for write-behind caching but which must avoid write-combining (for example, for auditing reasons), should create a "versioned" cache key (for example, by combining the natural primary key with a sequence id).

Write-Through Limitations

Coherence does not support two-phase operations across multiple cache store instances. In other words, if two cache entries are updated, triggering calls to cache store implementations that are on separate cache servers, it is possible for one database update to succeed and for the other to fail. In this case, it may be preferable to use a cache-aside architecture (updating the cache and database as two separate components of a single transaction) with the application server transaction manager. In many cases it is possible to design the database schema to prevent logical commit failures (but obviously not server failures). Write-behind caching avoids this issue as "puts" are not affected by database behavior (as the underlying issues have been addressed earlier in the design process).

Cache Queries

Cache queries only operate on data stored in the cache and do not trigger a cache store implementation to load any missing (or potentially missing) data. Therefore, applications that query cache store-backed caches should ensure that all necessary data required for the queries has been pre-loaded. For efficiency, most bulk load operations should be done at application startup by streaming the data set directly from the database into the cache (batching blocks of data into the cache by using `NamedCache.putAll()`). The loader process must use a "Controllable Cachestore" pattern to disable circular updates back to the database. The cache store may be controlled by using an Invocation service (sending agents across the cluster to modify a local flag in each JVM) or by setting the value in a Replicated cache (a different cache service) and reading it in every cache store implementation method invocation (minimal overhead compared to the typical database operation). A custom MBean can also be used, a simple task with Coherence's clustered JMX facilities.

Re-entrant Calls

The cache store implementation must not call back into the hosting cache service. This includes ORM solutions that may internally reference Coherence cache services. Note that calling into another cache service instance is allowed, though care should be taken to avoid deeply nested calls (as each call consumes a cache service thread and could result in deadlock if a cache service thread pool is exhausted).

Cache Server Classpath

The classes for cache entries (also known as Value Objects, Data Transfer Objects, and so on) must be in the cache server classpath (as the cache server must serialize-deserialize cache entries to interact with the cache store).

CacheStore Collection Operations

The `CacheStore.storeAll` method is most likely to be used if the cache is configured as write-behind and the `<write-batch-factor>` is configured. The `CacheLoader.loadAll` method is also used by Coherence. For similar reasons, its first use likely requires refresh-ahead to be enabled.

Connection Pools

Database connections should be retrieved from the container connection pool (or a third party connection pool) or by using a thread-local lazy-initialization pattern. As dedicated cache servers are often deployed without a managing container, the latter may be the most attractive option (though the cache service thread-pool size should be constrained to avoid excessive simultaneous database connections).

Serialization Paged Cache

This chapter provides general information about caching large amounts of binary data off-heap.

This chapter includes the following sections:

- [Understanding Serialization Paged Cache](#)
- [Configuring Serialization Paged Cache](#)
- [Optimizing a Partitioned Cache Service](#)
- [Configuring for High Availability](#)
- [Configuring Load Balancing and Failover](#)
- [Supporting Huge Caches](#)

Understanding Serialization Paged Cache

Coherence provides explicit support for efficient caching of huge amounts of automatically-expiring data using potentially high-latency storage mechanisms such as disk files. The benefits include supporting much larger data sets than can be managed in memory, while retaining an efficient expiry mechanism for timing out the management (and automatically freeing the resources related to the management) of that data. Optimal usage scenarios include the ability to store many large objects, XML documents or content that are rarely accessed, or whose accesses tolerates a higher latency if the cached data has been paged to disk. See [Chapter 14, "Implementing Storage and Backing Maps."](#)

Serialization Paged Cache is defined as follows:

- *Serialization* implies that objects stored in the cache are serialized and stored in a *Binary Store*; refer to the existing features *Serialization Map* and *Serialization Cache*.
- *Paged* implies that the objects stored in the cache are segmented for efficiency of management.
- *Cache* implies that there can be limits specified to the size of the cache; in this case, the limit is the maximum number of concurrent pages that the cache manages before expiring pages, starting with the oldest page.

The result is a feature that organizes data in the cache based on the time that the data was placed in the cache, and then can efficiently expire that data from the cache, an entire page at a time, and typically without having to reload any data from disk.

Configuring Serialization Paged Cache

The primary configuration for the Serialization Paged Cache is composed of two parameters: The number of pages that the cache manages, and the length of time a page is active. For example, to cache data for one day, the cache can be configured as 24 pages of one hour each, or 96 pages of 15 minutes each, and so on.

Each page of data in the cache is managed by a separate Binary Store. The cache requires a *Binary Store Manager*, which provides the means to create and destroy these Binary Stores. Coherence provides Binary Store Managers for all of the built-in Binary Store implementations, including Berkley DB (referred to as "BDB").

Serialization paged caches are configured within the `<external-scheme>` and `<paged-external-scheme>` element in the cache configuration file. See ["external-scheme"](#) on page B-40 and ["paged-external-scheme"](#) on page B-89 for details.

Optimizing a Partitioned Cache Service

Coherence provides an optimization for the partitioned cache service, since - when it is used to back a partitioned cache—the data being stored in any of the Serialization Maps and Caches is entirely binary in form. This is called the Binary Map optimization, and when it is enabled, it gives the Serialization Map, the Serialization Cache and the Serialization Paged Cache permission to assume that all data being stored in the cache is binary. The result of this optimization is a lower CPU and memory utilization, and also slightly higher performance. See the ["external-scheme"](#) and ["paged-external-scheme"](#) cache configuration elements.

Configuring for High Availability

Explicit support is also provided in the Serialization Paged Cache for the high-availability features of the partitioned cache service, by providing a configuration that can be used for the primary storage of the data and a configuration that is optimized for the backup storage of the data. The configuration for the backup storage is known as a passive model, because it does not actively expire data from its storage, but rather reflects the expiration that is occurring on the primary cache storage. When using the high-availability data feature (a backup count of one or greater; the default value is one) for a partitioned cache service, and using the Serialization Paged Cache as the primary backing storage for the service, it is a best practice to also use the Serialization Paged Cache as the backup store, and configure the backup with the passive option. See the ["paged-external-scheme"](#) cache configuration elements.

Configuring Load Balancing and Failover

When used with the distributed cache service, special considerations should be made for load balancing and failover purposes. The `partition-count` parameter of the distributed cache service should be set higher than normal if the amount of cache data is very large. A high partition count breaks up the overall cache into smaller chunks for load-balancing and recovery processing due to failover. For example, if the cache is expected to be one terabyte, twenty thousand partitions breaks the cache up into units averaging about 50MB. If a unit (the size of a partition) is too large, it causes an out-of-memory condition when load-balancing the cache. (Remember to ensure that the partition count is a prime number; see <http://primes.utm.edu/lists/small/> for lists of prime numbers that you can use.)

Supporting Huge Caches

To support huge caches (for example, terabytes) of expiring data, the expiration processing is performed concurrently on a daemon thread with no interruption to the cache processing. The result is that many thousands or millions of objects can exist in a single cache page, and they can be expired asynchronously, thus avoiding any interruption of service. The daemon thread is an option that is enabled by default, but it can be disabled. See the `<external-scheme>` and `<paged-external-scheme>` cache configuration elements.

When the cache is used for large amounts of data, the pages are typically disk-backed. Since the cache eventually expires each page, thus releasing the disk resources, the cache uses a virtual erase optimization by default. Data that is explicitly removed or expired from the cache is not actually removed from the underlying Binary Store, but when a page (a Binary Store) is completely emptied, it is erased in its entirety. This reduces I/O by a considerable margin, particularly during expiry processing and during operations such as load-balancing that have to redistribute large amounts of data within the cluster. The cost of this optimization is that the disk files (if a disk-based Binary Store option is used) tends to be larger than the data that they are managing would otherwise imply; since disk space is considered to be inexpensive compared to other factors such as response times, the virtual erase optimization is enabled by default, but it can be disabled. Note that the disk space is typically allocated locally to each server, and thus a terabyte cache partitioned over one hundred servers would only use about 20GB of disk space per server (10GB for the primary store and 10GB for the backup store, assuming one level of backup.)

Using Quorum

This chapter provides instructions for using and configuring quorum policies to control when specific service actions are allowed in a cluster in order to ensure that a cluster is adequately provisioned.

This chapter includes the following sections:

- [Overview of Using Quorum](#)
- [Using the Cluster Quorum](#)
- [Using the Partitioned Cache Quorums](#)
- [Using the Proxy Quorum](#)
- [Using Custom Action Policies](#)

Overview of Using Quorum

A quorum, in Coherence, refers to the minimum number of service members that are required in a cluster before a service action is allowed or disallowed. Quorums are beneficial because they automatically provide assurances that a cluster behaves in an expected way when member thresholds are reached. For example, a partitioned cache backup quorum might require at least 5 storage-enabled members before the partitioned cache service is allowed to back up partitions.

Quorums are service-specific and defined within a quorum policy; there is a cluster quorum policy for the Cluster service, a partitioned quorum policy for the Partitioned Cache service, and a proxy quorum policy for the Proxy service. Quorum thresholds are set on the policy using a cache configuration file.

Each quorum provides benefits for its particular service. However, in general, quorums:

- control service behavior at different service member levels
- mandate the minimum service member levels that are required for service operations
- ensure an optimal cluster and cache environment for a particular application or solution

Using the Cluster Quorum

The cluster quorum policy defines a single quorum (the timeout survivor quorum) for the Cluster Service. The timeout survivor quorum mandates the minimum number of cluster members that must remain in the cluster when the cluster service is

terminating suspect members. A member is considered suspect if it has not responded to network communications and is in imminent danger of being disconnected from the cluster. The quorum can be specified generically across all members or constrained to members that have a specific role in the cluster, such as client or server members. See the `<role-name>` element in "[member-identity](#)" on page A-41 for more information on defining role names for cluster members.

This quorum is typically used in environments where network performance varies. For example, intermittent network outages may cause a high number of cluster members to be removed from the cluster. Using this quorum, a certain number of members are maintained during the outage and are available when the network recovers. This behavior also minimizes the manual intervention required to restart members. Naturally, requests that require cooperation by the nodes that are not responding are not able to complete and are either blocked for the duration of the outage or are timed out.

Configuring the Cluster Quorum Policy

The timeout survivor quorum threshold is configured in an operational override file using the `<timeout-survivor-quorum>` element and optionally the `role` attribute. This element must be used within a `<cluster-quorum-policy>` element. The following example demonstrates configuring the timeout survivor quorum threshold to ensure that 5 cluster members with the `server` role are always kept in the cluster while removing suspect members:

```
<cluster-config>
  <member-identity>
    <role-name>server</role-name>
  </member-identity>
  <cluster-quorum-policy>
    <timeout-survivor-quorum role="Server">5</timeout-survivor-quorum>
  </cluster-quorum-policy>
</cluster-config>
```

Using the Partitioned Cache Quorums

The partitioned cache quorum policy defines four quorums for the partitioned cache service (DistributedCache) that mandate how many service members are required before different partitioned cache service operations can be performed:

- **Distribution Quorum** – This quorum mandates the minimum number of storage-enabled members of a partitioned cache service that must be present before the partitioned cache service is allowed to perform partition distribution.
- **Restore Quorum** – This quorum mandates the minimum number of storage-enabled members of a partitioned cache service that must be present before the partitioned cache service is allowed to restore lost primary partitions from backup.
- **Read Quorum** – This quorum mandates the minimum number of storage-enabled members of a partitioned cache service that must be present to process read requests. A read request is any request that does not mutate the state or contents of a cache.
- **Write Quorum** – This quorum mandates the minimum number of storage-enabled members of a partitioned cache service that must be present to process write requests. A write request is any request that may mutate the state or contents of a cache.

These quorums are typically used to indicate at what service member levels different service operations are best performed given the intended use and requirements of a distributed cache. For example, a small distributed cache may only require three storage-enabled members to adequately store data and handle projected request volumes. While; a large distributed cache may require 10, or more, storage-enabled members to adequately store data and handle projected request volumes. Optimal member levels are tested during development and then set accordingly to ensure that the minimum service member levels are provisioned in a production environment.

If the number of storage-enabled nodes running the service drops below the configured level of read or write quorum, the corresponding client operation are rejected by throwing the `com.tangosol.net.RequestPolicyException`. If the number of storage-enabled nodes drops below the configured level of distribution quorum, some data may become "endangered" (no backup) until the quorum is reached. Dropping below the restore quorum may cause some operation to be blocked until the quorum is reached or to be timed out.

Configuring the Partitioned Cache Quorum Policy

Partitioned cache quorums are configured in a cache configuration file within the `<partitioned-quorum-policy-scheme>` element. The element must be used within a `<distributed-scheme>` element. The following example demonstrates configuring thresholds for the partitioned cache quorums. Ideally, the threshold values would indicate the minimum amount of service members that are required to perform the operation.

```
<distributed-scheme>
  <scheme-name>partitioned-cache-with-quorum</scheme-name>
  <service-name>PartitionedCacheWithQuorum</service-name>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <partitioned-quorum-policy-scheme>
    <distribution-quorum>4</distribution-quorum>
    <restore-quorum>3</restore-quorum>
    <read-quorum>3</read-quorum>
    <write-quorum>5</write-quorum>
  </partitioned-quorum-policy-scheme>
  <autostart>true</autostart>
</distributed-scheme>
```

The `<partitioned-quorum-policy-scheme>` element also supports the use of scheme references. In the below example, a `<partitioned-quorum-policy-scheme>`, with the name `partitioned-cache-quorum`, is referenced from within the `<distributed-scheme>` element:

```
<distributed-scheme>
  <scheme-name>partitioned-cache-with-quorum</scheme-name>
  <service-name>PartitionedCacheWithQuorum</service-name>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <partitioned-quorum-policy-scheme>
    <scheme-ref>partitioned-cache-quorum</scheme-ref>
  </partitioned-quorum-policy-scheme>
  <autostart>true</autostart>
</distributed-scheme>

<distributed-scheme>
```

```
<scheme-name>dist-example</scheme-name>
<service-name>DistributedCache</service-name>
<backing-map-scheme>
  <local-scheme/>
</backing-map-scheme>
<partitioned-quorum-policy-scheme>
  <scheme-name>partitioned-cache-quorum</scheme-name>
  <distribution-quorum>4</distribution-quorum>
  <restore-quorum>3</restore-quorum>
  <read-quorum>3</read-quorum>
  <write-quorum>5</write-quorum>
</partitioned-quorum-policy-scheme>
<autostart>true</autostart>
</distributed-scheme>
```

Using the Proxy Quorum

The proxy quorum policy defines a single quorum (the connection quorum) for the proxy service. The connection quorum mandates the minimum number of proxy service members that must be available before the proxy service can allow client connections.

This quorum is typically used to ensure enough proxy service members are available to optimally support a given set of TCP clients. For example, a small number of clients may efficiently connect to a cluster using two proxy services. While, a large number of clients may require 3 or more proxy services to efficiently connect to a cluster. Optimal levels are tested during development and then set accordingly to ensure that the minimum service member levels are provisioned in a production environment.

Configuring the Proxy Quorum Policy

The connection quorum threshold is configured in a cache configuration file within the `<proxy-quorum-policy-scheme>` element. The element must be used within a `<proxy-scheme>` element. The following example demonstrates configuring the connection quorum threshold to ensure that 3 proxy service members are present in the cluster before the proxy service is allowed to accept TCP client connections:

```
<proxy-scheme>
  <scheme-name>proxy-with-quorum</scheme-name>
  <service-name>TcpProxyService</service-name>
  <acceptor-config>
    <tcp-acceptor>
      <local-address>
        <address>localhost</address>
        <port>32000</port>
      </local-address>
    </tcp-acceptor>
  </acceptor-config>
  <proxy-quorum-policy-scheme>
    <connect-quorum>3</connect-quorum>
  </proxy-quorum-policy-scheme>
  <autostart>true</autostart>
</proxy-scheme>
```

The `<proxy-quorum-policy-scheme>` element also supports the use of scheme references. In the below example, a `<proxy-quorum-policy-scheme>`, with the name `proxy-quorum`, is referenced from within the `<proxy-scheme>` element:

```

<proxy-scheme>
  <scheme-name>proxy-with-quorum</scheme-name>
  <service-name>TcpProxyService</service-name>
  ...
  <proxy-quorum-policy-scheme>
    <scheme-ref>proxy-quorum</scheme-ref>
  </proxy-quorum-policy-scheme>
  <autostart>true</autostart>
</proxy-scheme>
<proxy-scheme>
  <scheme-name>proxy-example</scheme-name>
  <service-name>TcpProxyService</service-name>
  ...
  <proxy-quorum-policy-scheme>
    <scheme-name>proxy-quorum</scheme-name>
    <connect-quorum>3</connect-quorum>
  </proxy-quorum-policy-scheme>
  <autostart>true</autostart>
</proxy-scheme>

```

Using Custom Action Policies

Custom action policies can be used instead of the default quorum policies for the Cluster service, Partitioned Cache service, and Proxy service. Custom action policies must implement the `com.tangosol.net.ActionPolicy` interface.

This section includes the following topics:

- [Enabling Custom Action Policies](#)
- [Enabling the Custom Failover Access Policy](#)

Enabling Custom Action Policies

To enable a custom policy, add a `<class-name>` element within a quorum policy scheme element that contains the fully qualified name of the implementation class. The following example adds a custom action policy to the partitioned quorum policy for a distributed cache scheme definition:

```

<distributed-scheme>
  <scheme-name>partitioned-cache-with-quorum</scheme-name>
  <service-name>PartitionedCacheWithQuorum</service-name>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <partitioned-quorum-policy-scheme>
    <class-name>package.MyCustomAction</class-name>
  </partitioned-quorum-policy-scheme>
  <autostart>true</autostart>
</distributed-scheme>

```

As an alternative, a factory class can create custom action policy instances. To define a factory class, use the `<class-factory-name>` element to enter the fully qualified class name and the `<method-name>` element to specify the name of a static factory method on the factory class which performs object instantiation. For example.

```

<distributed-scheme>
  <scheme-name>partitioned-cache-with-quorum</scheme-name>
  <service-name>PartitionedCacheWithQuorum</service-name>

```

```

<backing-map-scheme>
  <local-scheme/>
</backing-map-scheme>
<partitioned-quorum-policy-scheme>
  <class-factory-name>package.Myfactory</class-factory-name>
  <method-name>createPolicy</method-name>
</partitioned-quorum-policy-scheme>
<autostart>>true</autostart>
</distributed-scheme>

```

Enabling the Custom Failover Access Policy

Coherence provides a pre-defined custom action policy that moderates client request load during a failover event in order to allow cache servers adequate opportunity to re-establish partition backups. Use this policy in situations where a heavy load of high-latency requests may prevent, or significantly delay, cache servers from successfully acquiring exclusive access to partitions needing to be transferred or backed up.

To enable the custom failover access policy, add a `<class-name>` element within a `<partition-quorum-policy-scheme>` element that contains the fully qualified name of the failover access policy (`com.tangosol.net.partition.FailoverAccessPolicy`). The policy accepts the following parameters:

- `cThresholdMillis` – Specifies the delay before the policy should start holding requests (after becoming endangered). The default value is 5000 milliseconds.
- `cLimitMillis` – Specifies the delay before the policy makes a maximal effort to hold requests (after becoming endangered). The default values is 60000 milliseconds.
- `cMaxDelayMillis` – Specifies the maximum amount of time to hold a request. The default value is 5000 milliseconds.

The following example enables the custom failover access policy and sets each of the parameters:

```

<distributed-scheme>
  <scheme-name>partitioned-cache-with-quorum</scheme-name>
  <service-name>PartitionedCacheWithQuorum</service-name>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <partitioned-quorum-policy-scheme>
    <class-name>com.tangosol.net.partition.FailoverAccessPolicy</class-name>
    <init-params>
      <init-param>
        <param-name>cThresholdMillis</param-name>
        <param-value>7000</param-value>
      </init-param>
      <init-param>
        <param-name>cLimitMillis</param-name>
        <param-value>30000</param-value>
      </init-param>
      <init-param>
        <param-name>cMaxDelayMillis</param-name>
        <param-value>2000</param-value>
      </init-param>
    </init-params>
  </partitioned-quorum-policy-scheme>
<autostart>>true</autostart>

```

</distributed-scheme>

Cache Configurations by Example

This chapter provides a series of basic cache scheme definitions that can be used or modified as required. See [Chapter 13, "Configuring Caches,"](#) for detailed instructions on how to configure caches. In addition, the samples in this chapter build upon one another and often use a `<scheme-ref>` element to reuse other samples as nested schemes. See ["Using Scheme Inheritance"](#) on page 13-13 for details on using the `<scheme-ref>` element. Lastly, these samples only specify a minimum number of settings, follow the embedded links to a scheme's documentation to see the full set of options.

This chapter contains the following sections:

- [Local Caches \(accessible from a single JVM\)](#)
- [Clustered Caches \(accessible from multiple JVMs\)](#)

Local Caches (accessible from a single JVM)

This section defines a series of local cache schemes. In this context "local" means that the cache is only directly accessible by a single JVM. Later in this document local caches are used as building blocks for clustered caches. See ["Clustered Caches \(accessible from multiple JVMs\)"](#) on page 18-5.

This section contains the following topics:

- [In-memory Cache](#)
- [Size Limited In-memory Cache](#)
- [In-memory Cache with Expiring Entries](#)
- [In-memory Cache with Disk Based Overflow](#)
- [NIO In-memory Cache](#)
- [Cache on Disk](#)
- [Size Limited Cache on Disk](#)
- [Persistent Cache on Disk](#)
- [Cache of a Database](#)

In-memory Cache

[Example 18-1](#) uses a `local-scheme` to define an in-memory cache. The cache stores as much as the JVM heap allows.

Example 18–1 Configuration for a Local, In-memory Cache

```
<local-scheme>
  <scheme-name>SampleMemoryScheme</scheme-name>
</local-scheme>
```

Size Limited In-memory Cache

Adding a `<high-units>` sub element to `<local-scheme>` limits the size of the cache. Here the cache is size limited to one thousand entries. When the limit is exceeded, the scheme's `<eviction-policy>` determines which elements to evict from the cache.

Example 18–2 Configuration for a Size Limited, In-memory, Local Cache

```
<local-scheme>
  <scheme-name>SampleMemoryLimitedScheme</scheme-name>
  <high-units>1000</high-units>
</local-scheme>
```

In-memory Cache with Expiring Entries

Adding an `<expiry-delay>` subelement to `<local-scheme>` causes cache entries to automatically expire if they are not updated for a given time interval. When expired the cache invalidates the entry, and remove it from the cache.

Example 18–3 Configuration for an In-memory Cache with Expiring Entries

```
<local-scheme>
  <scheme-name>SampleMemoryExpirationScheme</scheme-name>
  <expiry-delay>5m</expiry-delay>
</local-scheme>
```

In-memory Cache with Disk Based Overflow

[Example 18–4](#) uses an `overflow-scheme` to define a size limited in-memory cache, when the in-memory (`<front-scheme>`) size limit is reached, a portion of the cache contents are moved to the on disk (`<back-scheme>`). The front-scheme's `<eviction-policy>` determines which elements to move from the front to the back.

Note that this example reuses the examples in "[Size Limited Cache on Disk](#)" and "[Cache on Disk](#)" on page 18-3. to implement the front and back of the cache.

Example 18–4 Configuration for In-memory Cache with Disk Based Overflow

```
<overflow-scheme>
  <scheme-name>SampleOverflowScheme</scheme-name>
  <front-scheme>
    <local-scheme>
      <scheme-ref>SampleMemoryLimitedScheme</scheme-ref>
    </local-scheme>
  </front-scheme>
  <back-scheme>
    <external-scheme>
      <scheme-ref>SampleDiskScheme</scheme-ref>
    </external-scheme>
  </back-scheme>
</overflow-scheme>
```

NIO In-memory Cache

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See ["Using the Elastic Data Feature to Store Data"](#) on page 14-7.

[Example 18-5](#) uses an [external-scheme](#) to define an in-memory cache using an [nio-memory-manager](#). The advantage of an NIO memory based cache is that it allows for large in-memory cache storage while not negatively impacting the JVM's GC times. The size of the cache is limited by the maximum size of the NIO memory region. See the `<maximum-size>` subelement of [nio-memory-manager](#).

Example 18-5 Configuration for a NIO In-memory Cache

```
<external-scheme>
  <scheme-name>SampleNioMemoryScheme</scheme-name>
  <nio-memory-manager/>
</external-scheme>
```

Cache on Disk

[Example 18-6](#) uses an [external-scheme](#) to define an on disk cache.

Note: This example uses the [bdb-store-manager](#) (Berkeley Database) for its on disk storage implementation. See [external-scheme](#) for additional external storage options.

Example 18-6 Configuration to Define a Cache on Disk

```
<external-scheme>
  <scheme-name>SampleDiskScheme</scheme-name>
  <bdb-store-manager/>
</external-scheme>
```

Size Limited Cache on Disk

Adding a `<high-units>` sub-element to [external-scheme](#) limits the size of the cache. The cache is size limited to one million entries. When the limit is exceeded, LRU eviction is used determine which elements to evict from the cache. Refer to ["paged-external-scheme"](#) on page B-89 for an alternate size limited external caching approach.

Example 18-7 Configuration for a Size Limited Cache on Disk

```
<external-scheme>
  <scheme-name>SampleDiskLimitedScheme</scheme-name>
  <bdb-store-manager/>
  <high-units>1000000</high-units>
</external-scheme>
```

Persistent Cache on Disk

[Example 18-8](#) uses an [external-scheme](#) to implement a cache suitable for use as long-term storage for a single JVM.

External caches are generally used for temporary storage of large data sets, and are automatically deleted on JVM shutdown. An external-cache can be used for long term storage (see "[Persistence \(long-term storage\)](#)" on page B-41) in non-clustered caches when using either the [bdb-store-manager](#) storage managers. For clustered persistence see the "[Partitioned Cache of a Database](#)" on page 18-6 sample.

The {cache-name} macro is used to specify the name of the file the data is stored in. See "[Using Parameter Macros](#)" on page 13-15 for more information on this macro.

Example 18-8 Configuration for Persistent cache on disk with Berkeley DB

```
<external-scheme>
  <scheme-name>SampleDiskPersistentScheme</scheme-name>
  <bdb-store-manager>
    <directory>/my/storage/directory</directory>
    <store-name>{cache-name}.store</store-name>
  </bdb-store-manager>
</external-scheme>
```

Cache of a Database

[Example 18-9](#) uses a [read-write-backing-map-scheme](#) to define a cache of a database. This scheme maintains local cache of a portion of the database contents. Cache misses are read-through to the database, and cache writes are written back to the database.

The [cachestore-scheme](#) element is configured with a custom class implementing either the `com.tangosol.net.cache.CacheLoader` or `com.tangosol.net.cache.CacheStore` interface. This class is responsible for all operations against the database, such as reading and writing cache entries. See "[Sample Cache Store Implementation](#)" on page 15-8 implementations for examples of writing a cache store.

The {cache-name} macro is used to inform the cache store implementation of the name of the cache it backs. See "[Using Parameter Macros](#)" on page 13-15 for more information on this macro.

Example 18-9 Configuration for the Cache of a Database

```
<read-write-backing-map-scheme>
  <scheme-name>SampleDatabaseScheme</scheme-name>
  <internal-cache-scheme>
    <local-scheme>
      <scheme-ref>SampleMemoryScheme</scheme-ref>
    </local-scheme>
  </internal-cache-scheme>
  <cachestore-scheme>
    <class-scheme>
      <class-name>com.tangosol.examples.coherence.DBCacheStore</class-name>
      <init-params>
        <init-param>
          <param-type>java.lang.String</param-type>
          <param-value>{cache-name}</param-value>
        </init-param>
      </init-params>
    </class-scheme>
```

```
</cachestore-scheme>
</read-write-backing-map-scheme>
```

Clustered Caches (accessible from multiple JVMs)

This section defines a series of clustered cache examples. Clustered caches are accessible from multiple JVMs (any cluster node running the same cache service). The internal cache storage (backing-map) on each cluster node is defined using local caches (see "[Local Caches \(accessible from a single JVM\)](#)" on page 18-1). The cache service provides the capability to access local caches from other cluster nodes.

This section contains the following topics:

- [Partitioned Cache](#)
- [Partitioned Cache with Overflow](#)
- [Partitioned Cache with Journal Storage](#)
- [Partitioned Cache of a Database](#)
- [Partitioned Cache with a Serializer](#)
- [Near Cache](#)
- [Replicated Cache](#)
- [Replicated Cache with Overflow](#)

Partitioned Cache

[Example 18–10](#) uses the [distributed-scheme](#) to define a clustered cache in which cache storage is partitioned across all cluster nodes.

The "[In-memory Cache](#)" on page 18-1 is used to define the cache storage on each cluster node. The total storage capacity of the cache is the sum of all storage enabled cluster nodes running the partitioned cache service. See the `<local-storage>` subelement of "[distributed-scheme](#)" on page B-32.

Example 18–10 Configuration for a Partitioned Cache

```
<distributed-scheme>
  <scheme-name>SamplePartitionedScheme</scheme-name>
  <backing-map-scheme>
    <local-scheme>
      <scheme-ref>SampleMemoryScheme</scheme-ref>
    </local-scheme>
  </backing-map-scheme>
</distributed-scheme>
```

Partitioned Cache with Overflow

The `backing-map-scheme` element can use a scheme reference to specify any of the other local cache samples. For instance if it had used the "[In-memory Cache with Disk Based Overflow](#)" on page 18-2, each storage-enabled cluster node would have a local overflow cache allowing for much greater storage capacity. Note that the cache's backup storage also uses the same overflow scheme which allows for backup data to be overflowed to disk.

Example 18–11 Configuration for a Partitioned Cache with Overflow

```

<distributed-scheme>
  <scheme-name>SamplePartitionedOverflowScheme</scheme-name>
  <backing-map-scheme>
    <overflow-scheme>
      <scheme-ref>SampleOverflowScheme</scheme-ref>
    </overflow-scheme>
  </backing-map-scheme>
  <backup-storage>
    <type>scheme</type>
    <scheme-name>SampleOverflowScheme</scheme-name>
  </backup-storage>
</distributed-scheme>

```

Partitioned Cache with Journal Storage

[Example 18–12](#) uses the `backing-map-scheme` element to define a partitioned cache that uses a RAM journal for the backing map. The RAM journal automatically delegates to a flash journal when the RAM journal exceeds a configured memory size. For details about configuring RAM journals and flash journals, see ["Defining Journal Schemes"](#) on page 14-8.

Example 18–12 Configuration for a Partitioned Cache with RAM Journaling

```

<distributed-scheme>
  <scheme-name>SamplePartitionedJournalScheme</scheme-name>
  <backing-map-scheme>
    <ramjournal-scheme/>
  </backing-map-scheme>
  <autostart>>true</autostart>
</distributed-scheme>

```

[Example 18–13](#) define a partitioned cache that directly uses a flash journal for the backing map.

Example 18–13 Configuration for a Partitioned Cache with Flash Journaling

```

<distributed-scheme>
  <scheme-name>SamplePartitionedJournalScheme</scheme-name>
  <backing-map-scheme>
    <flashjournal-scheme/>
  </backing-map-scheme>
  <autostart>>true</autostart>
</distributed-scheme>

```

Partitioned Cache of a Database

Switching the `backing-map-scheme` element to use a [read-write-backing-map-scheme](#) allows the cache to load and store entries against an external source such as a database.

[Example 18–14](#) reuses the ["Cache of a Database"](#) on page 18-4 to define the database access.

Example 18–14 Configuration for a Partitioned Cache of a Database

```

<distributed-scheme>

```

```

<scheme-name>SamplePartitionedDatabaseScheme</scheme-name>
<backing-map-scheme>
  <read-write-backing-map-scheme>
    <scheme-ref>SampleDatabaseScheme</scheme-ref>
    <internal-cache-scheme>
      <local-scheme>
        <scheme-ref>SampleMemoryScheme</scheme-ref>
      </local-scheme>
    </internal-cache-scheme>
  </read-write-backing-map-scheme>
</backing-map-scheme>
</distributed-scheme>

```

Partitioned Cache with a Serializer

Example 18–15 uses the `serializer` element in `distributed-scheme` to define a serializer that is used to serialize and deserialize user types. In this case, the partitioned cache uses POF (`ConfigurablePofContext`) as its serialization format. Note that if you use POF and your application uses any custom user type classes, then you must also define a custom POF configuration for them. See [Appendix C, "POF User Type Configuration Elements"](#) for more information on POF elements.

Example 18–15 Configuration for a Partitioned Cache with a Serializer

```

<distributed-scheme>
  <scheme-name>SamplePartitionedPofScheme</scheme-name>
  <service-name>PartitionedPofCache</service-name>
  <serializer>
    <instance>
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
    </instance>
  </serializer>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>

```

Serializers that are defined in the `tangosol-coherence.xml` deployment descriptor can also be referenced.

Example 18–16 Partitioned Cache that References a Serializer

```

<distributed-scheme>
  <scheme-name>SamplePartitionedPofScheme</scheme-name>
  <service-name>PartitionedPofCache</service-name>
  <serializer>pof</serializer>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <autostart>true</autostart>
</distributed-scheme>

```

Lastly a default serializer can be defined for all cache schemes and alleviates having to explicitly include a `serializer` element in each cache scheme definition. The global serializer definitions can also reference serializers that are defined in the `tangosol-coherence.xml` deployment descriptor

Example 18–17 Defining a Default Serializer

```
<?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>
  ...
```

Near Cache

[Example 18–18](#) uses the [near-scheme](#) to define a local in-memory cache of a subset of a partitioned cache. The result is that any cluster node accessing the partitioned cache maintains a local copy of the elements it frequently accesses. This offers read performance close to the [replicated-scheme](#)-based caches, while offering the high scalability of a [distributed-scheme](#)-based cache.

The "Size Limited In-memory Cache" on page 18-2 sample is reused to define the "near" (<front-scheme>) cache, while the "Partitioned Cache" on page 18-5 sample is reused to define the [near-scheme](#).

Note that the size limited configuration of the front-scheme specifies the limit on how much of the back-scheme cache is locally cached.

Example 18–18 Configuration for a Local Cache of a Partitioned Cache

```
<near-scheme>
  <scheme-name>SampleNearScheme</scheme-name>
  <front-scheme>
    <local-scheme>
      <scheme-ref>SampleLimitedMemoryScheme</scheme-ref>
    </local-scheme>
  </front-scheme>
  <back-scheme>
    <distributed-scheme>
      <scheme-ref>SamplePartitionedScheme</scheme-ref>
    </distributed-scheme>
  </back-scheme>
</near-scheme>
```

Replicated Cache

[Example 18–19](#) uses the [replicated-scheme](#) element to define a clustered cache in which a copy of each cache entry is stored on all cluster nodes.

The sample in "In-memory Cache" on page 18-1 is used to define the cache storage on each cluster node. The size of the cache is only limited by the cluster node with the smallest JVM heap.

Example 18–19 Configuration for a Replicated Cache

```
<replicated-scheme>
  <scheme-name>SampleReplicatedScheme</scheme-name>
  <backing-map-scheme>
```

```
<local-scheme>
  <scheme-ref>SampleMemoryScheme</scheme-ref>
</local-scheme>
</backing-map-scheme>
</replicated-scheme>
```

Replicated Cache with Overflow

The `backing-map-scheme` element could just as easily specify any of the other local cache samples. For instance, if it had used the ["In-memory Cache with Disk Based Overflow"](#) on page 18-2, each cluster node would have a local overflow cache allowing for much greater storage capacity.

Example 18–20 Configuration for a Replicated Cache with Overflow

```
<replicated-scheme>
  <scheme-name>SampleReplicatedOverflowScheme</scheme-name>
  <backing-map-scheme>
    <overflow-scheme>
      <scheme-ref>SampleOverflowScheme</scheme-ref>
    </overflow-scheme>
  </backing-map-scheme>
</replicated-scheme>
```

Extending Cache Configuration Files

This chapter provides detailed instructions for extending Coherence cache configuration files using XML namespaces and namespace handler classes. The instructions in this chapter assume a general understanding of XML namespaces and XML processing.

This chapter includes the following sections:

- [Introduction to Extending Cache Configuration Files](#)
- [Declaring XML Namespaces](#)
- [Creating Namespace Handlers](#)
- [Example: the JNDI Resource Namespace Handler](#)

Introduction to Extending Cache Configuration Files

Cache configuration files can include user-defined XML elements and attributes. The elements and attributes are declared within an XML namespace and are processed by a namespace handler at runtime. The namespace handler allows application logic to be executed based on the processing of the elements and attributes.

The following example extends a cache configuration file by declaring a `run` namespace that is associated with a `RunNamespaceHandler` namespace handler class. At runtime, the handler class processes the `<run:runnable>` element and its attributes and executes any logic on the cluster member as required.

```
<?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"
              xmlns:run="class://com.examples.RunNamespaceHandler">
  <run:runnable classname="MyRunnable" every="10m"/>
  ...
</cache-config>
```

Cache configuration files are typically extended to allow applications to perform custom initialization, background tasks, or perform monitoring and maintenance of caches in a cluster. For example, an application can:

- establish domain-specific cache entry indexes
- preload cached information
- load configuration into a cluster
- run or schedule background tasks against the cluster

- integrate with external systems

Extending cache configuration files offers applications a common and consolidated place for configuration. In addition, application logic is embedded and managed in a cluster, which is a high-availability and scalable environment that can provide automated recovery of failed application logic if required.

Declaring XML Namespaces

Namespaces are declared in a cache configuration file by using a namespace declaration. The use of XML namespaces must adhere to the XML specification. At runtime, the XML syntax and XML namespaces are validated and checks are performed to ensure that the namespace prefixes have a corresponding `xmlns` declaration. Errors that are encountered in the cache configuration file results in the Coherence member failing to start. The following example declares a namespace that uses the prefix `ex`:

```
<?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"
  xmlns:ex="URI">
  ...
```

The URI value for a namespace must be in the format `class://FullyQualifiedClassName`. If an incorrect format is provided, then a failure occurs and the Coherence member fails to start. The handler class provided in the declaration must be a class that implements the `NamespaceHandler` interface. For details about creating handler classes, see ["Creating Namespace Handlers"](#) on page 19-3.

The handler class must be able to process the associated XML elements and attributes as they occur within the cache configuration file. More specifically, during the processing of the XML DOM for the cache configuration, all XML elements and attributes that occur within a namespace are passed to the associated handler instance for processing. The following example uses the `MyNamespaceHandler` to process all elements that use the `ex` namespace prefix.

```
<?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"
  xmlns:ex="class://MyNamespaceHandler">

  <ex:myelement/>
  ...
```

Guidelines for Declaring an XML Namespace

Use the following guidelines when declaring an XML namespace:

- A URI class must implement the `NamespaceHandler` interface; otherwise, the processing of the cache configuration file fails.

- XML elements and attributes must not use an undeclared namespace prefix; otherwise, the processing of the cache configuration file fails.
- The default handler that is used for Coherence elements and attributes cannot be overridden; otherwise, the processing of the cache configuration file fails. The default namespace is reserved for Coherence.

Creating Namespace Handlers

Namespace handlers are used to process XML elements and attributes that belong to a specific XML namespace. Each unique namespace that is used in a cache configuration file requires a namespace handler. Namespace handlers must implement the `NamespaceHandler` interface. Typically, namespace handlers extend the base `AbstractNamespaceHandler` implementation class, which provides convenience methods that can simplify the processing of complex namespaces. Both of these APIs are discussed in this section and are included in the `com.tangosol.config.xml` package. For details about the APIs, see *Java API Reference for Oracle Coherence*.

This section includes the following topics:

- [Implementing the Namespace Handler Interface](#)
- [Extending the Namespace Handler Abstract Class](#)

Implementing the Namespace Handler Interface

Namespace handlers process the elements and attributes that are used within an XML namespace. Namespace handlers can directly implement the `NamespaceHandler` interface. The interface relies on the `DocumentPreprocessor`, `ElementProcessor`, and `AttributeProcessor` interfaces. XML processing is performed within a processing context as defined by the `ProcessingContext` interface.

Elements and attributes that are encountered in a namespace must be processed by a processor implementation. Element and attribute processors are responsible for processing, parsing, and type conversion logic. Document preprocessors are used to mutate elements, if required, before they are processed.

[Example 19–1](#) provides a basic `NamespaceHandler` implementation. The `GreetingNamespaceHandler` implementation processes a `<message>` element using an `ElementProcessor` implementation (`MessageProcessor`), which is included as an inner class. For the example, the following XML is assumed:

```
<?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"
  xmlns:ex="class://com.examples.GreetingNamespaceHandler">

  <ex:message>hello</ex:message>
  ...
```

Example 19–1 Handler Implementation Using the NamespaceHandler Interface

```
import com.tangosol.config.ConfigurationException;
import com.tangosol.config.xml.AttributeProcessor;
import com.tangosol.config.xml.DocumentPreprocessor;
import com.tangosol.config.xml.ElementProcessor;
import com.tangosol.config.xml.NamespaceHandler;
```

```
import com.tangosol.config.xml.ProcessingContext;
import com.tangosol.run.xml.XmlAttribute;
import com.tangosol.run.xml.XmlElement;
import java.net.URI;

public class GreetingNamespaceHandler implements NamespaceHandler
{
    public AttributeProcessor getAttributeProcessor(XmlAttribute xmlAttribute)
    {
        return null;
    }

    public DocumentPreprocessor getDocumentPreprocessor()
    {
        return null;
    }

    public ElementProcessor getElementProcessor(XmlElement xmlElement)
    {
        if (xmlElement.getName().equals("ex:message"))
        {
            MessageProcessor mp = new MessageProcessor();
            return mp;
        }
        else
        {
            throw new RuntimeException("Unknown element type " +
                xmlElement.getQualifiedName());
        }
    }

    public void onEndNamespace(ProcessingContext processingContext,
        XmlElement xmlElement, String string, URI uRI)
    {
    }

    public void onStartNamespace(ProcessingContext processingContext,
        XmlElement xmlElement, String string, URI uRI)
    {
    }

    public class MessageProcessor implements ElementProcessor
    {
        public Object process(ProcessingContext processingContext,
            XmlElement xmlElement) throws ConfigurationException
        {
            System.out.println("Greeting is: " + xmlElement.getString());
            return null;
        }
    }
}
```

The above class handles the `<ex:message>` element content. However, it does not distinguish between the different types of elements that may occur. All elements that occur within the default XML namespace are provided to the same `process` method. In order to process each type of XML element, conditional statements are required within the `process` method. This technique may be sufficient for trivial XML content; however, more complex XML content may require many conditional statements and can become overly complicated. A more declarative approach is provided with the `AbstractNamespaceHandler` class.

Namespace Handler Callback Methods

The `NamespaceHandler` interface provides the `onStartNamespace` and the `onEndNamespace` callback methods. These methods allow additional processing to be performed on the first and last encounter of a namespace in a cache configuration file.

Extending the Namespace Handler Abstract Class

The `AbstractNamespaceHandler` class provides a useful and extensible base implementation of the `NamespaceHandler`, `ElementProcessor` and `AttributeProcessor` interfaces together with mechanisms to register processor for specifically named elements and attributes. The class simplifies the processing of elements and attributes and can, in most cases, remove the requirement to directly implement the element and attribute processor interfaces.

This section contains the following topics:

- [Registering Processors](#)
- [Using Injection to Process Element Content](#)

Registering Processors

The `AbstractNamespaceHandler` class provides methods for declaratively registering element and attribute processors. The methods alleviate the need to check element names and types. There are two registration mechanisms: explicit registration and implicit registration.

Explicit Processor Registration

To use explicit processor registration, call the `registerProcessor` method within a sub-class constructor and manually register both element and attribute processors. [Example 19–2](#) re-implements [Example 19–1](#) and uses the `registerProcessor` method to register the `MessageProcessor` element processor.

Example 19–2 *AbstractNamespaceHandler Implementation with Explicit Registration*

```
import com.tangosol.config.ConfigurationException;
import com.tangosol.config.xml.AbstractNamespaceHandler;
import com.tangosol.config.xml.ElementProcessor;
import com.tangosol.config.xml.ProcessingContext;
import com.tangosol.run.xml.XmlElement;

public class GreetingNamespaceHandler extends AbstractNamespaceHandler
{
    public GreetingNamespaceHandler()
    {
        registerProcessor("message", new MessageProcessor());
    }

    public class MessageProcessor implements ElementProcessor
    {
        public Object process(ProcessingContext processingContext,
            XmlElement xmlElement) throws ConfigurationException
        {
            System.out.println("Greeting is: " + xmlElement.getString());
            return null;
        }
    }
}
```

Implicit Processor Registration

To use implicit processor registration, annotate processor classes with the `@XmlSimpleName` annotation. The processors are automatically registered for use within the associated namespace. The `@XmlSimpleName` annotation is used to determine which of the processor implementations are appropriate to handle XML content encountered during XML DOM processing. If an XML element or attribute is encountered for which there is no defined processor, then the `onUnknownElement` or `onUnknownAttribute` methods are called, respectively. The methods allow corrective action to be taken if possible. By default, a `ConfigurationException` exception is raised if unknown XML content is discovered during processing.

Example 19-3 re-implements **Example 19-1** and uses the `@XmlSimpleName` annotation to register the `MessageProcessor` element processor.

Example 19-3 AbstractNamespaceHandler Implementation with Implicit Registration

```
import com.tangosol.config.ConfigurationException;
import com.tangosol.config.xml.AbstractNamespaceHandler;
import com.tangosol.config.xml.ElementProcessor;
import com.tangosol.config.xml.ProcessingContext;
import com.tangosol.config.xml.XmlSimpleName;
import com.tangosol.run.xml.XmlElement;

public class GreetingNamespaceHandler extends AbstractNamespaceHandler
{
    public GreetingNamespaceHandler()
    {
    }

    @XmlSimpleName("message")
    public class MessageProcessor implements ElementProcessor
    {
        public Object process(ProcessingContext processingContext,
            XmlElement xmlElement) throws ConfigurationException
        {
            System.out.println("Greeting is: " + xmlElement.getString());
            return null;
        }
    }
}
```

Using Injection to Process Element Content

Element and attribute processors are used to hand-code the processing of XML content. However, the task can be repetitive for complex namespaces. To automate the task, the `ProcessingContext.inject` method is capable of injecting strongly typed values into a provided object, based on identifiable setter methods and values available for a specified XML element.

For example, given the following XML:

```
<ex:message>
  <ex:english>hello</ex:english>
</ex:message>
```

An element processor can be used to hand-code the processing of the `<english>` element:

```
import com.tangosol.config.ConfigurationException;
```

```

import com.tangosol.config.xml.AbstractNamespaceHandler;
import com.tangosol.config.xml.ElementProcessor;
import com.tangosol.config.xml.ProcessingContext;
import com.tangosol.config.xml.XmlSimpleName;
import com.tangosol.run.xml.XmlElement;

public class GreetingNamespaceHandler extends AbstractNamespaceHandler
{
    public GreetingNamespaceHandler()
    {
    }

    @XmlSimpleName("message")
    public class MessageProcessor implements ElementProcessor
    {
        public Object process(ProcessingContext processingContext,
            XmlElement xmlElement) throws ConfigurationException
        {
            String engMsg = processingContext.getMandatoryProperty("english",
                String.class, xmlElement);
            Message message = new Message();
            message.setEnglish(engMsg);
            System.out.println("Greeting is: "+ message.getEnglish());

            return message;
        }
    }
}

```

As an alternative, the `inject` method can perform the processing:

```

@XmlSimpleName("message")
public class MessageProcessor implements ElementProcessor
{
    public Object process(ProcessingContext processingContext,
        XmlElement xmlElement) throws ConfigurationException
    {
        return processingContext.inject(new Message(), xmlElement);
    }
}

```

The `inject` method uses Java reflection, under the assumption that the object to be configured follows the Java bean naming conventions. First the `inject` method identifies the appropriate setter methods that may be called on the Java bean. Typically, this is achieved by locating setter methods that are annotated with the `@Injectable` annotation. Next, it determines the appropriate types of values required by the setter methods. Lastly, it uses the provided `XmlElement` to locate, parse, convert, coerce, and then set appropriately typed values into the object using the available setter methods. The `inject` method supports primitives, enumerations, formatted values, complex user-defined types, and collection types (sets, lists, and maps). A `ConfigurationException` exception is thrown if the `inject` method fails. For example, it fails to format a value into the expected type.

The following example demonstrates a `Message` class for the above example that supports injection with the `inject` method:

```

import com.tangosol.config.annotation.Injectable;

public class Message
{

```

```
private String m_sEnglish = "a greeting";
public Message()
{
}

@Inject("english")
public void setEnglish (String sEnglish)
{
    m_sEnglish = sEnglish;
}

public String getEnglish()
{
    return m_sEnglish;
}
}
```

Note: If the `@Injectable` annotation property is omitted, then the inject method tries to use the setter method Java bean name. For the above example, `@injectable("")` results in the use of `english`.

Typically, element and attribute processors follow the same pattern when using the inject method. For example:

```
@XmlSimpleName("element")
public class XProcessor implements ElementProcessor
{
    public Object process(ProcessingContext processingContext,
        XmlElement xmlElement) throws ConfigurationException
    {
        return processingContext.inject(new X(), xmlElement);
    }
}
```

Declarations and registrations for such implementations can be automated using the `registerElementType` and `registerAttributeType` methods for elements and attributes, respectively. These methods are available in the `AbstractNamespaceHandler` class and are often used in constructors of `AbstractNamespaceHandler` sub-classes. The following example demonstrates using the `registerElementType` method and does not require a processor implementation.

Note: To support type-based registration of classes, the specified class must provide a no-argument constructor.

```
import com.tangosol.config.xml.AbstractNamespaceHandler;

public class GreetingNamespaceHandler extends AbstractNamespaceHandler
{
    public GreetingNamespaceHandler()
    {
        registerElementType("message", Message.class);
    }
}
```

Example: the JNDI Resource Namespace Handler

The JNDI resource namespace handler is reproduced here from the Coherence Incubator project that is hosted on java.net (<http://java.net/projects/cohinc>). The Incubator contains several namespace handler implementations, which can be found within the Common Package module.

The JNDI resource namespace handler provides the ability to lookup and reference resources defined by a JNDI context. The use of the namespace handler is often used to replace the need to statically create resources using the <class-scheme> or <instance> elements in the cache configuration file.

This section includes the following topics:

- [Create the JNDI Resource Namespace Handler](#)
- [Declare the JNDI Namespace Handler](#)
- [Use the JNDI Resource Namespace Handler](#)

Create the JNDI Resource Namespace Handler

The JNDI resource namespace handler is used at runtime to process <resource> elements that are found in a cache configuration file. The handler extends the `AbstractNamespaceHandler` class and registers the `JndiBasedParameterizedBuilder` class for the <resource> element. The following example shows the namespace handler definition.

```
import com.tangosol.coherence.config.builder.ParameterizedBuilder;
import com.tangosol.config.xml.AbstractNamespaceHandler;

public class JndiNamespaceHandler extends AbstractNamespaceHandler
{
    public JndiNamespaceHandler()
    {
        registerElementType("resource", JndiBasedParameterizedBuilder.class);
    }
}
```

The `JndiBasedParameterizedBuilder` class performs a JNDI context lookup to locate and create an object using the name and initialization parameters that are provided in the <resource-name> and <init-parms> elements, respectively. The setter methods for these elements (`setResourceNameExpression` and `setParameterList`) use the `@Injectable` annotation to pass the values configured in the cache configuration files.

```
import com.tangosol.coherence.config.ParameterList;
import com.tangosol.coherence.config.SimpleParameterList;
import com.tangosol.coherence.config.builder.ParameterizedBuilder;
import com.tangosol.coherence.config.builder.ParameterizedBuilder.
    ReflectionSupport;
import com.tangosol.config.annotation.Injectable;
import com.tangosol.config.expression.Expression;
import com.tangosol.config.expression.LiteralExpression;
import com.tangosol.config.expression.Parameter;
import com.tangosol.config.expression.ParameterResolver;
import com.tangosol.util.Base;
import java.util.Hashtable;
import java.util.logging.Level;
import java.util.logging.Logger;
import javax.naming.InitialContext;
import javax.naming.NamingException;
```

```
public class JndiBasedParameterizedBuilder implements
    ParameterizedBuilder<Object>, ReflectionSupport
{
    private static final Logger logger =
        Logger.getLogger(JndiBasedParameterizedBuilder.class.getName());

    private Expression<String> m_exprResourceName;

    private ParameterList m_parameterList;

    public JndiBasedParameterizedBuilder()
    {
        m_exprResourceName = new LiteralExpression<String>("");
        m_parameterList = new SimpleParameterList();
    }

    public Expression<String> getResourceNameExpression()
    {
        return m_exprResourceName;
    }

    @Injectable("resource-name")
    public void setResourceNameExpression(Expression<String> exprResourceName)
    {
        m_exprResourceName = exprResourceName;
    }

    public ParameterList getParameterList()
    {
        return m_parameterList;
    }

    @Injectable("init-params")
    public void setParameterList(ParameterList parameterList)
    {
        m_parameterList = parameterList;
    }

    public boolean realizes(Class<?> clazz,
        ParameterResolver parameterResolver,
        ClassLoader classLoader)
    {
        return clazz.isAssignableFrom(realize(parameterResolver, classLoader,
            null).getClass());
    }

    public Object realize(ParameterResolver parameterResolver,
        ClassLoader classLoader,
        ParameterList parameterList)
    {
        InitialContext initialContext;

        try
        {
            String sResourceName = m_exprResourceName.evaluate(parameterResolver);
            Hashtable<String, Object> env = new Hashtable<String, Object>();

            for (Parameter parameter : m_parameterList)
            {
```

```

        env.put(parameter.getName(), parameter.evaluate(parameterResolver));
    }

    initialContext = new InitialContext(env);

    if (logger.isLoggable(Level.FINE))
    {
        logger.log(Level.FINE,
            "Looking up {0} using JNDI with the environment {1}",
            new Object[] {sResourceName, env});
    }

    Object resource = initialContext.lookup(sResourceName);

    if (logger.isLoggable(Level.FINE))
    {
        logger.log(Level.FINE, "Found {0} using JNDI", resource);
    }

    return resource;
}
catch (NamingException e)
{
    throw Base.ensureRuntimeException(e, "Unable to resolve the JNDI
        resource: " + m_exprResourceName.toString());
}
}

public String toString()
{
    return String.format("%s{resourceName=%s, parameters=%s}",
        this.getClass().getName(), m_exprResourceName,
        m_parameterList);
}
}

```

Declare the JNDI Namespace Handler

The JNDI resource namespace handler must be declared within the cache configuration file. Declare the namespace by providing the URI to the handler class and assigning a namespace prefix. Any prefix can be used. The following example uses `jndi` as the prefix:

```

<?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"
    xmlns:jndi="class://com.examples.JndiNamespaceHandler">
...

```

Use the JNDI Resource Namespace Handler

The JNDI resource namespace handler can be used whenever an application requires a resource to be located and created. In addition, the namespace can be used when defining custom implementations using the `<class-scheme>` or `<instance>` elements.

Based on the handler implementation, the `<resource>` and `<resource-name>` element are required and the `<init-params>` element is optional.

The following example uses a JNDI resource for a cache store when defining a distributed scheme:

```
<?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"
  xmlns:jndi="class://com.examples.JndiNamespaceHandler">
...

  <キャッシング-schemes>
    <distributed-scheme>
      <scheme-name>distributed-rwbm</scheme-name>
      <backing-map-scheme>
        <read-write-backing-map-scheme>
          <internal-cache-scheme>
            <local-scheme/>
          </internal-cache-scheme>
          <cachestore-scheme>
            <class-scheme>
              <jndi:resource>
                <jndi:resource-name>MyCacheStore</jndi:resource-name>
                <init-params>
                  <init-param>
                    <param-type>java.lang.String</param-type>
                    <param-value>{cache-name}</param-value>
                  </init-param>
                </init-params>
              </jndi:resource>
            </class-scheme>
          </cachestore-scheme>
        </read-write-backing-map-scheme>
      </backing-map-scheme>
    </distributed-scheme>
  </キャッシング-schemes>
</cache-config>
```

The following example uses a JNDI resource to resolve a DNS record:

```
<?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"
  xmlns:jndi="class://com.examples.JndiNamespaceHandler">
...
  <jndi:resource>
    <jndi:resource-name>dns:///www.oracle.com</jndi:resource-name>
  </jndi:resource>
```

The following example uses a JNDI resource to resolve a JMS connection factory:

```
<?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"
  xmlns:jndi="class://com.examples.JndiNamespaceHandler">
```

```
...  
  
<jndi:resource>  
  <jndi:resource-name>ConnectionFactory</jndi:resource-name>  
  <init-params>  
    <init-param>  
      <param-name>java.naming.factory.initial</param-name>  
      <param-value>org.apache.activemq.jndi.ActiveMQInitialContextFactory  
    </param-value>  
    </init-param>  
    <init-param>  
      <param-name>java.naming.provider.url</param-name>  
      <param-value system-property="java.naming.provider.url"></param-value>  
    </init-param>  
  </init-params>  
</jndi:resource>
```


Part IV

Performing Data Grid Operations

Part IV contains the following chapters:

- Chapter 20, "Using Portable Object Format"
- Chapter 21, "Pre-Loading a Cache"
- Chapter 22, "Querying Data In a Cache"
- Chapter 23, "Using Continuous Query Caching"
- Chapter 24, "Processing Data In a Cache"
- Chapter 25, "Using Map Events"
- Chapter 26, "Controlling Map Operations with Triggers"
- Chapter 27, "Using Live Events"
- Chapter 28, "Using Coherence Query Language"
- Chapter 29, "Performing Transactions"
- Chapter 30, "Working with Partitions"
- Chapter 31, "Managing Thread Execution"
- Chapter 32, "Constraints on Re-entrant Calls"

Using Portable Object Format

This chapter provides instructions for using the Portable Object Format (POF) to serialize objects in Coherence. The instructions are specific to using POF for Java clients. For information on how to work with POF when building .NET extend clients, see "Building Integration Objects for .NET Clients" in *Developing Remote Clients for Oracle Coherence*. For information on how to work with POF when building C++ extend clients, see "Building Integration Objects for C++ Clients" in *Developing Remote Clients for Oracle Coherence*.

This chapter includes the following sections:

- [Understanding Serialization in Coherence](#)
- [Overview of POF Serialization](#)
- [Using the POF API to Serialize Objects](#)
- [Using POF Annotations to Serialize Objects](#)
- [Using POF Extractors and POF Updaters](#)
- [Serializing Keys Using POF](#)

Understanding Serialization in Coherence

Coherence caches value objects. These objects may represent data from any source, either internal (such as session data, transient data, and so on) or external (such as a database, mainframe, and so on).

Objects placed in the cache must be serializable. Because serialization is often the most expensive part of clustered data management, Coherence provides different options for serializing/deserializing data:

- `com.tangosol.io.pof.PofSerializer` – The Portable Object Format (also referred to as POF) is a language agnostic binary format. POF was designed to be incredibly efficient in both space and time and is the recommended serialization option in Coherence. See "[Using the POF API to Serialize Objects](#)" on page 20-2.
- `java.io.Serializable` – The simplest, but slowest option.
- `java.io.Externalizable` – This requires developers to implement serialization manually, but can provide significant performance benefits. Compared to `java.io.Serializable`, this can cut serialized data size by a factor of two or more (especially helpful with Distributed caches, as they generally cache data in serialized form). Most importantly, CPU usage is dramatically reduced.

- `com.tangosol.io.ExternalizableLite` – This is very similar to `java.io.Externalizable`, but offers better performance and less memory usage by using a more efficient I/O stream implementation.
- `com.tangosol.run.xml.XmlBean` – A default implementation of `ExternalizableLite` (For more details, see the API Javadoc for `XmlBean`).

Note: When serializing an object, Java serialization automatically crawls every visible object (by using object references, including collections like `Map` and `List`). As a result, cached objects **should not** refer to their parent objects directly (holding onto an identifying value like an integer is allowed). Objects that implement their own serialization routines are not affected.

Overview of POF Serialization

Serialization is the process of encoding an object into a binary format. It is a critical component to working with Coherence as data must be moved around the network. POF is a language agnostic binary format. POF was designed to be incredibly efficient in both space and time and has become a cornerstone element in working with Coherence. For more information on the POF binary stream, see [Appendix E, "The PIF-POF Binary Format."](#)

There are several options available for serialization including standard Java serialization, POF, and your own custom serialization routines. Each has their own trade-offs. Standard Java serialization is easy to implement, supports cyclic object graphs and preserves object identity. Unfortunately, it's also comparatively slow, has a verbose binary format, and restricted to only Java objects.

POF has the following advantages:

- It's language independent with current support for Java, .NET, and C++.
- It's very efficient, in a simple test class with a `String`, a `long`, and three `ints`, (de)serialization was seven times faster, and the binary produced was one sixth the size compared with standard Java serialization.
- It's versionable, objects can evolve and have forward and backward compatibility.
- It supports the ability to externalize your serialization logic.
- It's indexed which allows for extracting values without deserializing the whole object. See "[Using POF Extractors and POF Updaters](#)" on page 20-14.

Using the POF API to Serialize Objects

POF requires serialization routines that know how to serialize and deserialize an object. There are two interfaces available for serializing objects: the `com.tangosol.io.pof.PortableObject` interface and the `com.tangosol.io.pof.PofSerializer` interface. POF also supports annotations that automatically implement serialization without having to implement the `PortableObject` or `PofSerializer` interfaces. See "[Using POF Annotations to Serialize Objects](#)" on page 20-10 for details.

This section includes the following topics:

- [Implementing the PortableObject Interface](#)
- [Implementing the PofSerializer Interface](#)

- [Guidelines for Assigning POF Indexes](#)
- [Using POF Object References](#)
- [Registering POF Objects](#)
- [Configuring Coherence to Use the ConfigurablePofContext Class](#)

Implementing the PortableObject Interface

The `PortableObject` interface is an interface made up of two methods:

- `public void readExternal(PofReader reader)`
- `public void writeExternal(PofWriter writer)`

POF elements are indexed by providing a numeric value for each element that you write or read from the POF stream. It's important to keep in mind that the indexes must be unique to each element written and read from the POF stream, especially when you have derived types involved because the indexes must be unique between the super class and the derived class. The following example demonstrates implementing the `PortableObject` interface:

```
public void readExternal(PofReader in)
    throws IOException
{
    m_symbol    = (Symbol) in.readObject(0);
    m_ldtPlaced = in.readLong(1);
    m_fClosed   = in.readBoolean(2);
}

public void writeExternal(PofWriter out)
    throws IOException
{
    out.writeObject(0, m_symbol);
    out.writeLong(1, m_ldtPlaced);
    out.writeBoolean(2, m_fClosed);
}
```

Implementing the PofSerializer Interface

The `PofSerializer` interface provides a way to externalize the serialization logic from the classes you want to serialize. This is particularly useful when you do not want to change the structure of your classes to work with POF and Coherence. The `PofSerializer` interface is also made up of two methods:

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

As with the `PortableObject` interface, all elements written to or read from the POF stream must be uniquely indexed. Below is an example implementation of the `PofSerializer` interface:

Example 20–1 Implementation of the `PofSerializer` Interface

```
public Object deserialize(PofReader in)
    throws IOException
{
    Symbol symbol    = (Symbol)in.readObject(0);
    long   ldtPlaced = in.readLong(1);
    bool   fClosed   = in.readBoolean(2);
}
```

```
// mark that reading the object is done
in.readRemainder(null);

return new Trade(symbol, ldtPlaced, fClosed);
}

public void serialize(PofWriter out, Object o)
    throws IOException
{
    Trade trade = (Trade) o;
    out.writeObject(0, trade.getSymbol());
    out.writeLong(1, trade.getTimePlaced());
    out.writeBoolean(2, trade.isClosed());

    // mark that writing the object is done
    out.writeRemainder(null);
}
```

Guidelines for Assigning POF Indexes

Use the following guidelines when assigning POF indexes to an object's attributes:

- Order your reads and writes: start with the lowest index value in the serialization routine and finish with the highest. When deserializing a value, perform reads in the same order as writes.
- Non-contiguous indexes are acceptable but must be read/written sequentially.
- When Subclassing reserve index ranges: index's are cumulative across derived types. As such, each derived type must be aware of the POF index range reserved by its super class.
- Do not re-purpose indexes: to support Evolvable, it's imperative that indexes of attributes are not re-purposed across class revisions.
- Label indexes: indexes that are labeled with a `public static final int`, are much easier to work with, especially when using POF Extractors and POF Updaters. See ["Using POF Extractors and POF Updaters"](#) on page 20-14. Indexes that are labeled must still be read and written out in the same order as mentioned above.

Using POF Object References

POF supports the use of object identities and references for objects that occur more than once in a POF stream. Objects are labeled with an identity and subsequent instances of a labeled object within the same POF stream are referenced by its identity.

Using references avoids encoding the same object multiple times and helps reduce the data size. References are typically used when a large number of sizeable objects are created multiple times or when objects use nested or circular data structures. However, for applications that contain large amounts of data but only few repeats, the use of object references provides minimal benefits due to the overhead incurred in keeping track of object identities and references.

The use of object identity and references has the following limitations:

- Object references are only supported for user defined object types.
- Object references are not supported for `Evolvable` objects.
- Object references are not supported for keys.

- Objects that have been written out with a POF context that does not support references cannot be read by a POF context that supports references. The opposite is also true.
- POF objects that use object identity and references cannot be queried using POF extractors. Instead, use the `ValueExtractor` API to query object values or disable object references.
- The use of the `PofNavigator` and `PofValue` API has the following restrictions when using object references:
 - Only read operations are allowed. Write operations result in an `UnsupportedOperationException`.
 - User objects can be accessed in non-uniform collections but not in uniform collections.
 - For read operations, if an object appears in the data stream multiple times, then the object must be read where it first appears before it can be read in the subsequent part of the data. Otherwise, an `IOException: missing identity: <ID>` may be thrown. For example, if there are 3 lists that all contain the same person object, `p`. The `p` object must be read in the first list before it can be read in the second or third list.

This section includes the following topics:

- [Enabling POF Object References](#)
- [Registering POF Object Identities for Circular and Nested Objects](#)

Enabling POF Object References

Object references are not enabled by default and must be enabled either within a `pof-config.xml` configuration file or programmatically when using the `SimplePofContext` class.

To enable object references in the POF configuration file, include the `<enable-references>` element, within the `<pof-config>` element, and set the value to `true`. For example:

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

<pof-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-pof-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-pof-config
  coherence-pof-config.xsd">
  ...
  <enable-references>true</enable-references>
</pof-config>
```

To enable object references when using the `SimplePofContext` class, call the `setReferenceEnabled` method with a property set to `true`. For example:

```
SimplePofContext ctx = new SimplePofContext();
ctx.setReferenceEnabled(true);
```

Registering POF Object Identities for Circular and Nested Objects

Circular or nested objects must manually register an identity when creating the object. Otherwise, a child object that references the parent object will not find the identity of the parent in the reference map. Object identities can be registered from a serializer

during the deserialization routine using the `com.tangosol.io.pof.PofReader.registerIdentity` method.

The following examples demonstrate two objects (Customer and Product) that contain a circular reference and a serializer implementation that registers an identity on the Customer object.

The Customer object is defined as follows:

```
public class Customer
{
    private String m_sName;
    private Product m_product;

    public Customer(String sName)
    {
        m_sName = sName;
    }

    public Customer(String sName, Product product)
    {
        m_sName = sName;
        m_product = product;
    }

    public String getName()
    {
        return m_sName;
    }

    public Product getProduct()
    {
        return m_product;
    }

    public void setProduct(Product product)
    {
        m_product = product;
    }
}
```

The Product object is defined as follows:

```
public class Product
{
    private Customer m_customer;

    public Product(Customer customer)
    {
        m_customer = customer;
    }

    public Customer getCustomer()
    {
        return m_customer;
    }
}
```

The serializer implementation registers an identity during deserialization and is defined as follows:

```
public class CustomerSerializer implements PofSerializer
```

```

{
@Override
public void serialize(PofWriter pofWriter, Object o) throws IOException
{
    Customer customer = (Customer) o;
    pofWriter.writeString(0, customer.getName());
    pofWriter.writeObject(1, customer.getProduct());
    pofWriter.writeRemainder(null);
}

@Override
public Object deserialize(PofReader pofReader) throws IOException
{
    String sName = pofReader.readString(0);
    Customer customer = new Customer(sName);

    pofReader.registerIdentity(customer);
    customer.setProduct((Product) pofReader.readObject(1));
    pofReader.readRemainder();
    return customer;
}
}

```

Registering POF Objects

Coherence provides the `com.tangosol.io.pof.ConfigurablePofContext` serializer class which is responsible for mapping a POF serialized object to an appropriate serialization routine (either a `PofSerializer` implementation or by calling through the `PortableObject` interface).

Once your classes have serialization routines, the classes are registered with the `ConfigurablePofContext` class using a `pof-config.xml` configuration file. The POF configuration file has a `<user-type-list>` element that contains a list of classes that implement `PortableObject` or have a `PofSerializer` associated with them. The `<type-id>` for each class must be unique, and must match across all cluster instances (including extend clients). See [Appendix C, "POF User Type Configuration Elements,"](#) for detailed reference of the POF configuration elements.

The following is an example of a POF configuration file:

```

<?xml version='1.0'?>

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

    <!-- User types must be above 1000 -->
    <user-type>
      <type-id>1001</type-id>
      <class-name>com.examples.MyTrade</class-name>
      <serializer>
        <class-name>com.examples.MyTradeSerializer</class-name>
      </serializer>
    </user-type>

    <user-type>

```

```
<type-id>1002</type-id>
  <class-name>com.examples.MyPortableTrade</class-name>
</user-type>
</user-type-list>
</pof-config>
```

Note: Coherence reserves the first 1000 type-id's for internal use. As shown in the above example, the <user-type-list> includes the coherence-pof-config.xml file that is located in the root of the coherence.jar file. This is where Coherence specific user types are defined and should be included in all of your POF configuration files.

Configuring Coherence to Use the ConfigurablePofContext Class

Coherence can be configured to use the `ConfigurablePofContext` serializer class in three different ways based on the level of granularity that is required:

- Per Service – Each service provides a full `ConfigurablePofContext` serializer class configuration or references a predefined configuration that is included in the operational configuration file.
- All Services – All services use a global `ConfigurablePofContext` serializer class configuration. Services that provide their own configuration override the global configuration. The global configuration can also be a full configuration or reference a predefined configuration that is included in the operational configuration file.
- JVM – The `ConfigurablePofContext` serializer class is enabled for the whole JVM.

Configure the ConfigurablePofContext Class Per Service

To configure a service to use the `ConfigurablePofContext` class, add a <serializer> element to a cache scheme in a cache configuration file. See "serializer" on page B-117 for a complete reference of the <serializer> element.

The following example demonstrates a distributed cache that is configured to use the `ConfigurablePofContext` class and defines a custom POF configuration file:

```
<distributed-scheme>
  <scheme-name>example-distributed</scheme-name>
  <service-name>DistributedCache</service-name>
  <serializer>
    <instance>
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
      <init-params>
        <init-param>
          <param-type>String</param-type>
          <param-value>my-pof-config.xml</param-value>
        </init-param>
      </init-params>
    </instance>
  </serializer>
</distributed-scheme>
```

The following example references the default definition in the operational configuration file. Refer to "serializer" on page A-59 to see the default `ConfigurablePofContext` serializer definition.

```
<distributed-scheme>
  <scheme-name>example-distributed</scheme-name>
```

```

    <service-name>DistributedCache</service-name>
    <serializer>pof</serializer>
</distributed-scheme>

```

Configure the ConfigurablePofContext Class for All Services

To globally configure the `ConfigurablePofContext` class for all services, add a `<serializer>` element within the `<defaults>` element in a cache configuration file. Both of the below examples globally configure a serializer for all cache scheme definitions and do not require any additional configuration within individual cache scheme definitions. See ["defaults"](#) on page B-31 for a complete reference of the `<defaults>` element.

The following example demonstrates a global configuration for the `ConfigurablePofContext` class and defines a custom POF configuration file:

```

<?xml version='1.0'?>

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <defaults>
    <serializer>
      <instance>
        <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
        <init-params>
          <init-param>
            <param-type>String</param-type>
            <param-value>my-pof-config.xml</param-value>
          </init-param>
        </init-params>
      </instance>
    </serializer>
  </defaults>
  ...

```

The following example references the default definition in the operational configuration file. Refer to ["serializer"](#) on page A-59 to see the default `ConfigurablePofContext` serializer definition.

```

<?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>
  ...

```

Configure the ConfigurablePofContext Class For the JVM

An entire JVM instance can be configured to use POF using the following system properties:

- `tangosol.pof.enabled=true` - Enables POF for the entire JVM instance.

- `tangosol.pof.config=CONFIG_FILE_PATH` - The path to the POF configuration file you want to use. If the file is not in the classpath, then it must be presented as a file resource (for example, `file:///opt/home/coherence/mycustom-pof-config.xml`).

Using POF Annotations to Serialize Objects

POF annotations provide an automated way to implement the serialization and deserialization routines for an object. POF annotations are serialized and deserialized using the `PofAnnotationSerializer` class which is an implementation of the `PofSerializer` interface. Annotations offer an alternative to using the `PortableObject` and `PofSerializer` interfaces and reduce the amount of time and code that is required to make objects serializable.

This section includes the following topics:

- [Annotating Objects for POF Serialization](#)
- [Registering POF Annotated Objects](#)
- [Generating a POF Configuration File](#)
- [Enabling Automatic Indexing](#)
- [Providing a Custom Codec](#)

Annotating Objects for POF Serialization

Two annotations are available to indicate that a class and its properties are POF serializable:

- `@Portable` – Marks the class as POF serializable. The annotation is only permitted at the class level and has no members.
- `@PortableProperty` – Marks a member variable or method accessor as a POF serialized attribute. Annotated methods must conform to accessor notation (`get`, `set`, `is`). Members can be used to specify POF indexes as well as custom codecs that are executed before or after serialization or deserialization. Index values may be omitted and automatically assigned. If a custom codec is not entered, the default codec is used.

The following example demonstrates annotating a class, method, and properties and assigning explicit property index values. See "[Guidelines for Assigning POF Indexes](#)" on page 20-4 for additional details on POF indexing.

```
@Portable
public class Person
{
    @PortableProperty(0)
    public String getFirstName()
    {
        return m_firstName;
    }

    private String m_firstName;

    @PortableProperty(1)
    private String m_lastName;

    @PortableProperty(2)
    private int m_age;
```

}

Registering POF Annotated Objects

POF annotated objects, like all POF objects, must be registered in a `pof-config.xml` file within a `<user-type>` element. See [Appendix C, "POF User Type Configuration Elements,"](#) for a detailed reference of the POF configuration elements. As an alternative to manually creating a POF configuration file, the POF Configuration Generator tool can be used to automatically create a POF configuration file based on objects that use the `@Portable` annotation. For details on the POF Configuration Generator tool, see ["Generating a POF Configuration File"](#) on page 20-11.

POF annotated objects use the `PofAnnotationSerializer` serializer if an object does not implement `PortableObject` and is annotated as `Portable`; however, the serializer is automatically assumed if an object is annotated and does not need to be included in the user type definition. The following example registers a user type for an annotated `Person` object:

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

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

    <!-- User types must be above 1000 -->
    <user-type>
      <type-id>1001</type-id>
      <class-name>com.examples.Person</class-name>
    </user-type>
  </user-type-list>
</pof-config>
```

Generating a POF Configuration File

The POF Configuration Generator command line tool automatically creates a POF configuration file that includes user type entries for the classes that contain the `@Portable` annotation. The tool is an alternative to manually creating a POF configuration file and is ideal as part of a build process.

Start the POF Configuration Generator command line tool by using the `COHERENCE_HOME/bin/pof-config-gen` script (`.cmd` or `.sh`) or by directly running the `com.tangosol.io.pof.generator.Executor` class. Use the `-help` argument for detailed usage instructions. The usage is as follows:

```
pof-config-gen [OPTIONS] -root
```

The `-root` argument is required and lists the locations (separated directories, JAR files, or GAR file) to scan for POF annotated classes. A user type entry and ID is generated for each annotated class that is found and the resulting `pof-config.xml` file is written to the current working directory. For example:

```
pof-config-gen.cmd -root c:\src\myPofClasses.jar
```

Note: If you specify a GAR file as the root, the output is a new GAR file with a count suffix (*filename-n.gar*) that includes the generated POF configuration file.

The following optional arguments may be provided:

- `-out`: Use the `-out` argument to specify either the path to an output directory or a path and filename. The default output directory is the working directory. The default filename if only a directory is specified is `pof-config.xml`. If a directory is specified and a `pof-config.xml` file already exists, then a new file is created with a count suffix (`pof-config-n.xml`). If a path and filename are specified and the file currently exists, then the file is overwritten.
- `-config`: Use the `-config` argument to specify the path and filename of an existing POF configuration file from which existing user types must be added to the generated POF configuration file. Existing user type IDs are retained in the generated file. This argument can be used to support backwards compatibility when generating a POF configuration file multiple times.
- `-include`: Use the `-include` argument to specify whether an existing POF configuration file (as specified by the `-config` argument) should only be referenced in the generated POF configuration file. The argument results in an `<include>` element that references the existing file. Existing user types and IDs are not recreated in the generated file. At runtime, the referenced file must be located in the classpath.

Note: A reference to the Coherence-specific POF configuration file (`coherence-pof-config.xml`) is automatically added to the generated POF configuration file if it is not found in an existing POF configuration file and does not need to be added using the `-include` argument.

- `-packages`: Use the `-packages` argument to constrain the class scan to specific packages. The packages are entered as a comma separated list.
- `-startTypeId`: Use the `-startTypeId` argument to specify the user type ID number from which to start allocating IDs. IDs up to 1000 are reserved for Coherence-specific types and cannot be used.

The following example scans the `c:\classes\pof` directory and creates a new POF configuration file called `my-pof-config.xml` in the `c:\tmp` directory that includes (by reference) the existing `c:\tmp\pof-config.xml` file.

```
pof-config-gen.cmd -out c:\tmp\my-pof-config.xml -config c:\tmp\pof-config.xml  
-include -root c:\classes\pof
```

Enabling Automatic Indexing

POF annotations support automatic indexing which alleviates the need to explicitly assign and manage index values. Omit the index value when defining the `@PortableProperty` annotation. Index allocation is determined by the property name. Any property that does assign an explicit index value is not assigned an automatic index value. The following table demonstrates the ordering semantics of the automatic index algorithm. Notice that automatic indexing maintains explicitly defined indexes (as shown for property `c`) and assigns an index value if an index is omitted.

Property Name	Explicit Index	Determined Index
c	1	1
a	omitted	0
b	omitted	2

Note: Automatic indexing does not currently support evolvable classes.

To enable automatic indexing, the `PofAnnotationSerializer` serializer class must be explicitly defined when registering the object as a user type in the POF configuration file. The `fAutoIndex` boolean parameter in the constructor enables automatic indexing and must be set to `true`. For example:

```
<user-type>
  <type-id>1001</type-id>
  <class-name>com.examples.Person</class-name>
  <serializer>
    <class-name>com.tangosol.io.pof.PofAnnotationSerializer</class-name>
    <init-params>
      <init-param>
        <param-type>int</param-type>
        <param-value>{type-id}</param-value>
      </init-param>
      <init-param>
        <param-type>class</param-type>
        <param-value>{class}</param-value>
      </init-param>
      <init-param>
        <param-type>boolean</param-type>
        <param-value>true</param-value>
      </init-param>
    </init-params>
  </serializer>
</user-type>
```

Providing a Custom Codec

Codecs allow code to be executed before or after serialization or deserialization. The codec defines how to encode and decode a portable property using the `PofWriter` and `PofReader` interfaces. Codecs are typically used for concrete implementations that could get lost when being deserialized or to explicitly call a specific method on the `PofWriter` interface before serializing an object.

To create a codec, create a class that implements the `com.tangosol.io.pof.reflect.Codec` interface. The following example demonstrates a codec that defines the concrete implementation of a linked list type:

```
public static class LinkedListCodec implements Codec
{
  public Object decode(PofReader in, int index) throws IOException
  {
    return (List<String>) in.readCollection(index, new LinkedList<String>());
  }
  public void encode(PofWriter out, int index, Object value) throws IOException
```

```

    {
        out.writeCollection(index, (Collection) value);
    }
}

```

To assign a codec to a property, enter the codec as a member of the `@PortableProperty` annotation. If a codec is not specified, a default codec (`DefaultCodec`) is used. The following example demonstrates assigning the above `LinkedListCodec` codec:

```

@PortableProperty(codec = LinkedListCodec.class)
private List<String> m_aliases;

```

Using POF Extractors and POF Updaters

In Coherence, the `ValueExtractor` and `ValueUpdater` interfaces are used to extract and update values of objects that are stored in the cache. The `PofExtractor` and `PofUpdater` interfaces take advantage of the POF indexed state to extract or update an object without the requirement to go through the full serialization/deserialization routines.

`PofExtractor` and `PofUpdater` adds flexibility in working with non-primitive types in Coherence. For many extend client cases, a corresponding Java classes in the grid is no longer required. Because POF extractors and POF updaters can navigate the binary, the entire key and value does not have to be deserialized into object form. This implies that indexing can be achieved by simply using POF extractors to pull a value to index on. However, a corresponding Java class is still required when using a cache store. In this case, the deserialized version of the key and value is passed to the cache store to write to the back end.

Navigating a POF object

Due to the fact that POF is indexed, it's possible to quickly traverse the binary to a specific element for extraction or updating. It's the responsibility of the `PofNavigator` interface to traverse a POF value object and return the desired POF value object. Out of the box, Coherence provides a `SimplePofPath` class that can navigate a POF value based on integer indexes. In the simplest form, provide the index of the attribute to be extracted/updated.

Consider the following example:

```

public class Contact
    implements PortableObject
{
    ...
    // ----- PortableObject interface -----

    public void readExternal(PofReader reader)
        throws IOException
    {
        m_sFirstName    = reader.readString(FIRSTNAME);
        m_sLastName     = reader.readString(LASTNAME);
        m_addrHome      = (Address) reader.readObject(HOME_ADDRESS);
        m_addrWork      = (Address) reader.readObject(WORK_ADDRESS);
        m_mapPhoneNumber = reader.readMap(PHONE_NUMBERS, null);
    }

    public void writeExternal(PofWriter writer)
        throws IOException
    {

```

```

        writer.writeString(FIRSTNAME, m_sFirstName);
        writer.writeString(LASTNAME, m_sLastName);
        writer.writeObject(HOME_ADDRESS, m_addrHome);
        writer.writeObject(WORK_ADDRESS, m_addrWork);
        writer.writeMap(PHONE_NUMBERS, m_mapPhoneNumber);
    }

    ....

    // ----- constants -----

    public static final int FIRSTNAME = 0;
    public static final int LASTNAME = 1;
    public static final int HOME_ADDRESS = 2;
    public static final int WORK_ADDRESS = 3;
    public static final int PHONE_NUMBERS = 4;

    ...
}

```

Notice that there's a constant for each data member that is being written to and from the POF stream. This is an excellent practice to follow as it simplifies both writing your serialization routines and makes it easier to work with POF extractors and POF updaters. By labeling each index, it becomes much easier to think about the index. As mentioned above, in the simplest case, the work address can be pulled out of the contact by using the `WORK_ADDRESS` index. The `SimplePofPath` also allows using an Array of ints to traverse the `PofValues`. For example, to get the zip code of the work address use `[WORK_ADDRESS, ZIP]`. The example are discussed in more detail below.

Using POF Extractors

POF extractors are typically used when querying a cache and improves query performance. For example, using the class demonstrated above, to query the cache for all contacts with the last names Jones, the query is as follows:

```

ValueExtractor veName = new PofExtractor(String.class, Contact.LASTNAME);
Filter          filter = new EqualsFilter(veName, "Jones");

// find all entries that have a last name of Jones
Set setEntries = cache.entrySet(filter);

```

In the above case, `PofExtractor` has a convenience constructor that uses a `SimplePofPath` to retrieve a singular index, in our case the `Contact.LASTNAME` index. To find all contacts with the area code 01803, the query is as follows:

```

ValueExtractor veZip = new PofExtractor(
    String.class, new SimplePofPath(new int[] {Contact.WORK_ADDRESS,
Address.ZIP}));

Filter filter = new EqualsFilter(veZip, "01803");

// find all entries that have a work address in the 01803 zip code
Set setEntries = cache.entrySet(filter);

```

Notice that in the previous examples, the `PofExtractor` constructor has a first argument with the class of the extracted value or null. The reason for passing type information is that POF uses a compact form in the serialized value when possible. For example, some numeric values are represented as special POF intrinsic types in which the type implies the value. As a result, POF requires the receiver of a value to have implicit knowledge of the type. `PofExtractor` uses the class supplied in the

constructor as the source of the type information. If the class is null, PofExtractor infers the type from the serialized state, but the extracted type may differ from the expected type. String types, in fact, can be correctly inferred from the POF stream, so null is sufficient in the previous examples. In general, however, null should not be used.

Using POF Updaters

POF updaters work in the same way as POF extractors except that they update the value of an object rather than extract it. To change all entries with the last name of Jones to Smith, use the UpdaterProcessor class as follows:

```
ValueExtractor veName = new PofExtractor(String.class, Contact.LASTNAME);
Filter          filter  = new EqualsFilter(veName, "Jones");
ValueUpdater    updater = new PofUpdater(Contact.LASTNAME);

// find all Contacts with the last name Jones and change them to have the last
// name "Smith"

cache.invokeAll(filter, new UpdaterProcessor(updater, "Smith"));
```

Note: while these examples operate on String based values, this functionality works on any POF encoded value.

Serializing Keys Using POF

Key objects, like value objects, can be serialized using POF. However, the following issues must be considered:

- POF defines a cross-platform object format, it cannot always provide a symmetrical conversion. That is, when a serialized object is deserialized, the object type is different than the original type. This occurs because some data types in Java do not have equivalents in the .NET and C++ platforms. As a result, avoid using classes that potentially have an asymmetrical POF conversion as keys, or parts of keys, for caches and other Java collections.
- Avoided using the `java.util.Date` type. POF is designed to serialize to `java.sql.Timestamp` (which extends `java.util.Date`). The wire formats for those two classes are identical, and a deserialization of that wire representation always results in a `java.sql.Timestamp` instance. Unfortunately, the `equals` method of those two base classes breaks the symmetry requirement for keys in Java collections. That is, if you have two objects: D (of `java.util.Date`) and T (of `java.sql.Timestamp`) that are equivalent from the POF wire format perspective, then `D.equals(T)` yields true, while `T.equals(D)` yields false. Therefore, the use of `java.util.Date` must be avoided. Use a `Long` representation of the date or the `java.sql.Timestamp` type to avoid breaking the key symmetry requirement.
- Keys that are using POF object references cannot be serialized. In addition, POF object references support circular references. Therefore, you must ensure that your key class does not have circular references.

Pre-Loading a Cache

This chapter describes how to pre-load data into a cache using the bulk loading and distributed loading patterns.

This chapter includes the following sections:

- [Bulk Loading Data Into a Cache](#)
- [Performing Distributed Bulk Loading](#)

Bulk Loading Data Into a Cache

A common scenario when using Coherence is to pre-populate a cache before an application uses the data. [Example 21-1](#) demonstrates loading data using the `put` method. This technique works, but each call to `put` may result in network traffic, especially for partitioned and replicated caches. Additionally, each call to `put` returns the object it just replaced in the cache (as defined in the `java.util.Map` interface) which adds more unnecessary overhead.

Example 21-1 Pre-Loading a Cache

```
public static void bulkLoad(NamedCache cache, Connection conn)
{
    Statement s;
    ResultSet rs;

    try
    {
        s = conn.createStatement();
        rs = s.executeQuery("select key, value from table");
        while (rs.next())
        {
            Integer key = new Integer(rs.getInt(1));
            String value = rs.getString(2);
            cache.put(key, value);
        }
        ...
    }
    catch (SQLException e)
    { ... }
}
```

Loading the cache can be made much more efficient by using the `ConcurrentMap.putAll` method instead. This is illustrated in [Example 21-2](#):

Example 21–2 Pre-Loading a Cache Using ConcurrentMap.putAll

```

public static void bulkLoad(NamedCache cache, Connection conn)
{
    Statement s;
    ResultSet rs;
    Map        buffer = new HashMap();

    try
    {
        int count = 0;
        s = conn.createStatement();
        rs = s.executeQuery("select key, value from table");
        while (rs.next())
        {
            Integer key    = new Integer(rs.getInt(1));
            String  value = rs.getString(2);
            buffer.put(key, value);

            // this loads 1000 items at a time into the cache
            if ((count++ % 1000) == 0)
            {
                cache.putAll(buffer);
                buffer.clear();
            }
        }
        if (!buffer.isEmpty())
        {
            cache.putAll(buffer);
        }
        ...
    }
    catch (SQLException e)
    {
        ...
    }
}

```

Performing Distributed Bulk Loading

When pre-populating a Coherence partitioned cache with a large data set, it may be more efficient to distribute the work to Coherence cluster members. Distributed loading allows for higher data throughput rates to the cache by leveraging the aggregate network bandwidth and CPU power of the cluster. When performing a distributed load, the application must decide on the following:

- which cluster members performs the load
- how to divide the data set among the members

The application should consider the load that is placed on the underlying data source (such as a database or file system) when selecting members and dividing work. For example, a single database can easily be overwhelmed if too many members execute queries concurrently.

A Distributed Bulk Loading Example

This section outlines the general steps to perform a simple distributed load. The example assumes that the data is stored in files and is distributed to all storage-enabled members of a cluster.

1. Retrieve the set of storage-enabled members. For example, the following method uses the `getStorageEnabledMembers` method to retrieve the storage-enabled members of a distributed cache.

Example 21–3 Retrieving Storage-Enabled Members of the Cache

```
protected Set getStorageMembers(NamedCache cache)
{
    return ((PartitionedService) cache.getCacheService())
        .getOwnershipEnabledMembers();
}
```

2. Divide the work among the storage enabled cluster members. For example, the following routine returns a map, keyed by member, containing a list of files assigned to that member.

Example 21–4 Routine to Get a List of Files Assigned to a Cache Member

```
protected Map<Member, List<String>> divideWork(Set members, List<String>
fileNames)
{
    Iterator i = members.iterator();
    Map<Member, List<String>> mapWork = new HashMap(members.size());
    for (String sFileName : fileNames)
    {
        Member member = (Member) i.next();
        List<String> memberFileNames = mapWork.get(member);
        if (memberFileNames == null)
        {
            memberFileNames = new ArrayList();
            mapWork.put(member, memberFileNames);
        }
        memberFileNames.add(sFileName);

        // recycle through the members
        if (!i.hasNext())
        {
            i = members.iterator();
        }
    }
    return mapWork;
}
```

3. Launch a task that performs the load on each member. For example, use Coherence's `InvocationService` to launch the task. In this case, the implementation of `LoaderInvocable` must iterate through `memberFileNames` and process each file, loading its contents into the cache. The cache operations normally performed on the client must execute through the `LoaderInvocable`.

Example 21–5 Class to Load Each Member of the Cache

```
public void load()
{
    NamedCache cache = getCache();

    Set members = getStorageMembers(cache);

    List<String> fileNames = getFileNames();

    Map<Member, List<String>> mapWork = divideWork(members, fileNames);
}
```

```
InvocationService service = (InvocationService)
    CacheFactory.getService("InvocationService");

for (Map.Entry<Member, List<String>> entry : mapWork.entrySet())
{
    Member member = entry.getKey();
    List<String> memberFileNames = entry.getValue();

    LoaderInvocable task = new LoaderInvocable(memberFileNames,
cache.getCacheName());
    service.execute(task, Collections.singleton(member), this);
}
}
```

Querying Data In a Cache

This chapter provides instructions for performing queries and using indexes to retrieve data in a cache that matches a certain criteria. Queries and indexes can be simple, employing filters packaged with Coherence, or they can be run against multi-value attributes such as collections and arrays.

This chapter includes the following sections:

- [Query Overview](#)
- [Performing Queries](#)
- [Using Query Indexes](#)
- [Performing Batch Queries](#)
- [Performing Queries on Multi-Value Attributes](#)
- [Using Chained Extractors](#)
- [Evaluating Query Cost and Effectiveness](#)

Query Overview

Coherence provides the ability to search for cache entries that meet a given set of criteria. The result set may be sorted if desired. Queries are evaluated with Read Committed isolation.

Queries apply only to currently cached data (and do not use the `CacheLoader` interface to retrieve additional data that may satisfy the query). Thus, the data set should be loaded entirely into cache before queries are performed. In cases where the data set is too large to fit into available memory, it may be possible to restrict the cache contents along a specific dimension (for example, "date") and manually switch between cache queries and database queries based on the structure of the query. For maintainability, this is usually best implemented inside a cache-aware data access object (DAO).

Indexing requires the ability to extract attributes on each Partitioned cache node; for dedicated cache server instances, this implies (usually) that application classes must be installed in the cache server's classpath.

For Local and Replicated caches, queries can be evaluated locally against unindexed or indexed data. For Partitioned caches, queries are typically performed in parallel across the cluster and use indexes. Access to unindexed attributes requires object deserialization (though indexing on other attributes can reduce the number of objects that must be evaluated). Lastly, Coherence includes a Cost-Based Optimizer (CBO) and also provides support for trace and explain reports that help ensure the efficiency of a query.

Query Concepts

The concept of querying is based on the `ValueExtractor` interface. A value extractor is used to extract an attribute from a given object for querying (and similarly, indexing). Most developers need only the `ReflectionExtractor` implementation of this interface. The implementation uses reflection to extract an attribute from a value object by referring to a method name which is typically a getter method. For example:

```
ValueExtractor extractor = new ReflectionExtractor("getName");
```

Any void argument method can be used, including `Object` methods like `toString()` (useful for prototype/debugging). Indexes may be either traditional field indexes (indexing fields of objects) or functional-based indexes (indexing virtual object attributes). For example, if a class has field accessors `getFirstName` and `getLastName`, the class may define a function `getFullName` which concatenates those names, and this function may be indexed. See ["Using Query Indexes"](#) on page 22-4 for more information on indexes.

To query a cache that contains objects with `getName` attributes, a `Filter` must be used. A filter has a single method which determines whether a given object meets a criterion.

```
Filter filter = new EqualsFilter(extractor, "Bob Smith");
```

Note that the filters also have convenience constructors that accept a method name and internally construct a `ReflectionExtractor`:

```
Filter filter = new EqualsFilter("getName", "Bob Smith");
```

The following example shows a routine to select the entries of a cache that satisfy a particular filter:

```
for (Iterator iter = cache.entrySet(filter).iterator(); iter.hasNext(); )
{
    Map.Entry entry = (Map.Entry)iter.next();
    Integer key = (Integer)entry.getKey();
    Person person = (Person)entry.getValue();
    System.out.println("key=" + key + " person=" + person);
}
```

The following example uses a filter to select and sort cache entries:

```
// entrySet(Filter filter, Comparator comparator)
Iterator iter = cache.entrySet(filter, null).iterator();
```

The additional `null` argument specifies that the result set should be sorted using the "natural ordering" of `Comparable` objects within the cache. The client may explicitly specify the ordering of the result set by providing an implementation of `Comparator`. Note that sorting places significant restrictions on the optimizations that Coherence can apply, as sorting requires that the entire result set be available before sorting.

Performing Queries

[Example 22-1](#) demonstrates how to create a query and uses the `GreaterEqualsFilter` filter. Coherence includes many pre-built filters located in the `com.tangosol.util.filter` package. See the *Java API Reference for Oracle Coherence* for a complete list of all the pre-built filters.

Example 22–1 Querying the Cache with a Filter

```
Filter filter = new GreaterEqualsFilter("getAge", 18);

for (Iterator iter = cache.entrySet(filter).iterator(); iter.hasNext(); )
{
    Map.Entry entry = (Map.Entry) iter.next();
    Integer key = (Integer) entry.getKey();
    Person person = (Person) entry.getValue();
    System.out.println("key=" + key + " person=" + person);
}
```

Coherence provides a wide range of filters in the `com.tangosol.util.filter` package.

Note: Although queries can be executed through a near cache, the query does not use the front portion of a near cache. If using a near cache with queries, the best approach is to use the following sequence:

```
Set setKeys = cache.keySet(filter);
Map mapResult = cache.getAll(setKeys);
```

Efficient Processing of Filter Results

[Example 22–1](#) works for small data sets, but it may encounter problems, such as running out of heap space, if the data set is too large. [Example 22–2](#) illustrates a pattern to process query results when using large data sets. In this example, all keys for entries that match the filter are returned, but only `BUFFER_SIZE` (in this case, 100) entries are retrieved from the cache at a time.

Note: The `LimitFilter` API can process results in parts, similar to the example below. However `LimitFilter` is meant for scenarios where the results are paged, such as in a user interface. It is not an efficient means to process all data in a query result.

Example 22–2 Processing Query Results in Batches

```
public static void performQuery()
{
    NamedCache c = CacheFactory.getCache("test");

    // Search for entries that start with 'c'
    Filter query = new LikeFilter(IdentityExtractor.INSTANCE, "c%", '\\', true);

    // Perform query, return keys of entries that match
    Set keys = c.keySet(query);

    // The amount of objects to process at a time
    final int BUFFER_SIZE = 100;

    // Object buffer
    Set buffer = new HashSet(BUFFER_SIZE);

    for (Iterator i = keys.iterator(); i.hasNext(); )
    {
        buffer.add(i.next());

        if (buffer.size() >= BUFFER_SIZE)
```

```
        {
            // Bulk load BUFFER_SIZE number of objects from cache
            Map entries = c.getAll(buffer);

            // Process each entry
            process(entries);

            // Done processing these keys, clear buffer
            buffer.clear();
        }
    }
    // Handle the last partial chunk (if any)
    if (!buffer.isEmpty())
    {
        process(c.getAll(buffer));
    }
}

public static void process(Map map)
{
    for (Iterator ie = map.entrySet().iterator(); ie.hasNext();)
    {
        Map.Entry e = (Map.Entry) ie.next();
        out("key: "+e.getKey() + ", value: "+e.getValue());
    }
}
```

Using Query Indexes

Query indexes allow values (or attributes of those values) and corresponding keys to be correlated within a `QueryMap` to increase query performance.

This section includes the following topics:

- [Creating an Index](#)
- [Creating User-Defined Indexes](#)

Creating an Index

The `addIndex` method of the `QueryMap` class is used to create indexes. Any attribute able to be queried may be indexed using this method. The method includes three parameters:

```
addIndex(ValueExtractor extractor, boolean fOrdered, Comparator comparator)
```

[Example 22-3](#) demonstrates how to create an index:

Example 22-3 Sample Code to Create an Index

```
NamedCache cache = CacheFactory.getCache("MyCache");
ValueExtractor extractor = new ReflectionExtractor("getAttribute");
cache.addIndex(extractor, true, null);
```

The `fOrdered` argument specifies whether the index structure is sorted. Sorted indexes are useful for range queries, such as "select all entries that fall between two dates" or "select all employees whose family name begins with 'S'". For "equality" queries, an

unordered index may be used, which may have better efficiency in terms of space and time.

The comparator argument can provide a custom `java.util.Comparator` for ordering the index.

The `addIndex` method is only intended as a hint to the cache implementation and, as such, it may be ignored by the cache if indexes are not supported or if the desired index (or a similar index) exists. It is expected that an application calls this method to suggest an index even if the index may exist, just so that the application is certain that index has been suggested. For example in a distributed environment, each server likely suggests the same set of indexes when it starts, and there is no downside to the application blindly requesting those indexes regardless of whether another server has requested the same indexes.

Note that queries can be combined by Coherence if necessary, and also that Coherence includes a cost-based optimizer (CBO) to prioritize the usage of indexes. To take advantage of an index, queries must use extractors that are equal (`Object.equals()`) to the one used in the query.

A list of applied indexes can be retrieved from the `StorageManagerMBean` by using JMX. See *Managing Oracle Coherence* for more information on using JMX with Coherence.

Creating User-Defined Indexes

Applications can choose to create user-defined indexes to control which entries are added to the index. User-defined indexes are typically used to reduce the memory and processing overhead required to maintain an index. To create a user-defined index, an application must implement the `MapIndex` interface and the `IndexAwareExtractor` interfaces. This section also describes the `ConditionalIndex` and `ConditionalExtractor` classes which provide an implementation of the interfaces to create a conditional index that uses an associated filter to evaluate whether an entry should be indexed.

Implementing the MapIndex Interface

The `MapIndex` interface is used to correlate values stored in an indexed `Map` (or attributes of those values) to the corresponding keys in the indexed `Map`. Applications implement this interface to supply a custom index.

The following example implementation defines an index that only adds entries with non-null values. This would be useful in the case where there is a cache with a large number of entries and only a small subset have meaningful, non-null, values.

```
public class CustomMapIndex implements MapIndex
{
    public void insert(Map.Entry entry)
    {
        if (entry.getValue() != null)
        {
            ...
        }
    }
    ...
}
```

In the above example, the value of the entry is checked for `null` before extraction, but it could be done after. If the value of the entry is `null` then nothing is inserted into the index. A similar check for `null` would also be required for the `MapIndex.update`

method. The rest of the `MapIndex` methods must be implemented appropriately as well.

Implementing the `IndexAwareExtractor` Interface

The `IndexAwareExtractor` interface is an extension to the `ValueExtractor` interface that supports the creation and destruction of a `MapIndex` index. Instances of this interface are intended to be used with the `QueryMap` API to support the creation of custom indexes. The following example demonstrates how to implement this interface and is for the example `CustomMapIndex` class that was created above:

```
public class CustomIndexAwareExtractor
    implements IndexAwareExtractor, ExternalizableLite, PortableObject
{
    public CustomIndexAwareExtractor(ValueExtractor extractor)
    {
        m_extractor = extractor;
    }

    public MapIndex createIndex(boolean fOrdered, Comparator comparator,
        Map mapIndex)
    {
        ValueExtractor extractor = m_extractor;
        MapIndex index = (MapIndex) mapIndex.get(extractor);

        if (index != null)
        {
            throw new IllegalArgumentException(
                "Repetitive addIndex call for " + this);
        }

        index = new CustomMapIndex(extractor, fOrdered, comparator);
        mapIndex.put(extractor, index);
        return index;
    }

    public MapIndex destroyIndex(Map mapIndex)
    {
        return (MapIndex) mapIndex.remove(m_extractor);
    }
    ...
}
```

In the above example, an underlying extractor is actually used to create the index and ultimately extracts the values from the cache entries. The `IndexAwareExtractor` implementation is used to manage the creation and destruction of a custom `MapIndex` implementation while preserving the existing `QueryMap` interfaces.

The `IndexAwareExtractor` is passed into the `QueryMap.addIndex` and `QueryMap.removeIndex` calls. `Coherence`, in turn, calls `createIndex` and `destroyIndex` on the `IndexAwareExtractor`. Also note that it is the responsibility of the `IndexAwareExtractor` to maintain the `Map` of extractor-to-index associations that is passed into `createIndex` and `destroyIndex`.

Using a Conditional Index

A conditional index is a custom index that implements both the `MapIndex` and `IndexAwareExtractor` interfaces as described above and uses an associated filter to evaluate whether an entry should be indexed. An entry's extracted value is only added

to the index if the filter evaluates to true. The implemented classes are `ConditionalIndex` and `ConditionalExtractor`, respectively.

The `ConditionalIndex` is created by a `ConditionalExtractor`. The filter and extractor used by the `ConditionalIndex` are set on the `ConditionalExtractor` and passed to the `ConditionalIndex` constructor during the `QueryMap.addIndex` call.

The `ConditionalExtractor` is an `IndexAwareExtractor` implementation that is only used to create a `ConditionalIndex`. The underlying `ValueExtractor` is used for value extraction during index creation and is the extractor that is associated with the created `ConditionalIndex` in the given index map. Using the `ConditionalExtractor` to extract values is not supported. For example:

```
ValueExtractor extractor = new ReflectionExtractor("getLastName");
Filter filter = new NotEqualsFilter("getId", null);
ValueExtractor condExtractor = new ConditionalExtractor(filter, extractor, true);

// add the conditional index which should only contain the last name values for
// the
// entries with non-null Ids
cache.addIndex(condExtractor, true, null);
```

Performing Batch Queries

In order to preserve memory on the client issuing a query, there are various techniques that can retrieve query results in batches.

Using the key set form of the queries – combined with `getAll()` – reduces memory consumption since the entire entry set is not deserialized on the client simultaneously. It also takes advantage of near caching. For example:

Example 22–4 Using a key set Query Format

```
// key set(Filter filter)
Set setKeys = cache.keySet(filter);
Set setPageKeys = new HashSet();
int PAGE_SIZE = 100;
for (Iterator iter = setKeys.iterator(); iter.hasNext();)
{
    setPageKeys.add(iter.next());
    if (setPageKeys.size() == PAGE_SIZE || !iter.hasNext())
    {
        // get a block of values
        Map mapResult = cache.getAll(setPageKeys);

        // process the block
        // ...

        setPageKeys.clear();
    }
}
```

A `LimitFilter` may be used to limit the amount of data sent to the client, and also to provide paging. [Example 22–5](#) demonstrates using a `LimitFilter`:

Example 22–5 Using a Limit Filter

```
int pageSize = 25;
Filter filter = new GreaterEqualsFilter("getAge", 18);
// get entries 1-25
```

```

Filter limitFilter = new LimitFilter(filter, pageSize);
Set entries = cache.entrySet(limitFilter);

// get entries 26-50
limitFilter.nextPage();
entries = cache.entrySet(limitFilter);

```

When using a distributed/partitioned cache, queries can be targeted to partitions and cache servers using a `PartitionedFilter`. This is the most efficient way of batching query results as each query request is targeted to a single cache server, thus reducing the number of servers that must respond to a request and making the most efficient use of the network.

Note: Use of `PartitionedFilter` is limited to cluster members; it cannot be used by Coherence*Extend clients. Coherence*Extend clients may use the two techniques described above, or these queries can be implemented as an `Invocable` and executed remotely by a Coherence*Extend client.

To execute a query partition by partition:

```

DistributedCacheService service =
    (DistributedCacheService) cache.getCacheService();
int cPartitions = service.getPartitionCount();

PartitionSet parts = new PartitionSet(cPartitions);
for (int iPartition = 0; iPartition < cPartitions; iPartition++)
{
    parts.add(iPartition);
    Filter filterPart = new PartitionedFilter(filter, parts);
    Set setEntriesPart = cache.entrySet(filterPart);

    // process the entries ...
    parts.remove(iPartition);
}

```

Queries can also be executed on a server by server basis:

```

DistributedCacheService service =
    (DistributedCacheService) cache.getCacheService();
int cPartitions = service.getPartitionCount();

PartitionSet partsProcessed = new PartitionSet(cPartitions);
for (Iterator iter = service.getStorageEnabledMembers().iterator();
     iter.hasNext();)
{
    Member member = (Member) iter.next();
    PartitionSet partsMember = service.getOwnedPartitions(member);

    // due to a redistribution some partitions may have been processed
    partsMember.remove(partsProcessed);
    Filter filterPart = new PartitionedFilter(filter, partsMember);
    Set setEntriesPart = cache.entrySet(filterPart);

    // process the entries ...
    partsProcessed.add(partsMember);
}

// due to a possible redistribution, some partitions may have been skipped

```

```

if (!partsProcessed.isFull())
{
    partsProcessed.invert();
    Filter filter = new PartitionedFilter(filter, partsProcessed);

    // process the remaining entries ...
}

```

Performing Queries on Multi-Value Attributes

Coherence supports indexing and querying of multi-value attributes including collections and arrays. When an object is indexed, Coherence verifies if it is a multi-value type, and then indexes it as a collection rather than a singleton. The `ContainsAllFilter`, `ContainsAnyFilter` and `ContainsFilter` are used to query against these collections.

Example 22–6 Querying on Multi-Value Attributes

```

Set searchTerms = new HashSet();
searchTerms.add("java");
searchTerms.add("clustering");
searchTerms.add("books");

// The cache contains instances of a class "Document" which has a method
// "getWords" which returns a Collection<String> containing the set of
// words that appear in the document.
Filter filter = new ContainsAllFilter("getWords", searchTerms);

Set entrySet = cache.entrySet(filter);

// iterate through the search results
// ...

```

Using Chained Extractors

The `ChainedExtractor` implementation allows chained invocation of zero-argument (accessor) methods. In [Example 22–7](#), the extractor first uses reflection to call `getName()` on each cached `Person` object, and then uses reflection to call the `length` method on the returned `String`.

Example 22–7 Chaining Invocation Methods

```
ValueExtractor extractor = new ChainedExtractor("getName.length");
```

This extractor could be passed into a query, allowing queries (for example) to select all people with names not exceeding 10 letters. Method invocations may be chained indefinitely, for example `getName.trim.length`.

POF extractors and POF updaters offer the same functionality as `ChainedExtractors` through the use of the `SimplePofPath` class. For details about POF extractors and POF updaters, see ["Using POF Extractors and POF Updaters"](#) on page 20-14.

Evaluating Query Cost and Effectiveness

This section provides instructions for creating query explain plan records and query trace records in order to view the estimated cost and actual effectiveness of each filter

in a query, respectively. The records are used to evaluate how Coherence is running the query and to determine why a query is performing poorly or how it can be modified in order to perform better. See also the `StorageManagerMBean` reference in *Managing Oracle Coherence* for details on viewing query-based statistics.

This section includes the following topics:

- [Creating Query Records](#)
- [Interpreting Query Records](#)
- [Running The Query Record Example](#)

Creating Query Records

The `com.tangosol.util.aggregator.QueryRecorder` class produces an explain or trace record for a given filter. The class is an implementation of a parallel aggregator that is capable querying all nodes in a cluster and aggregating the results. The class supports two record types: an `EXPLAIN` record for showing the estimated cost for the filters in a query, and a `TRACE` record for showing the actual effectiveness of each filter in a query.

To create a query record, create a new `QueryRecorder` instance that specifies a `RecordType` parameter. Include the instance and the filter to be tested as parameters of the `aggregate` method. The following example creates an explain record:

```
NamedCache cache = CacheFactory.getCache("mycache");
cache.addIndex(new ReflectionExtractor("getAge"), true, null);

AllFilter filter = new AllFilter(new Filter[]
{
    new OrFilter(
        new EqualsFilter(new ReflectionExtractor("getAge"), 16),
        new EqualsFilter(new ReflectionExtractor("getAge"), 19)),
    new EqualsFilter(new ReflectionExtractor("getLastName"), "Smith"),
    new EqualsFilter(new ReflectionExtractor("getFirstName"), "Bob"),
});

QueryRecorder agent = new QueryRecorder(RecordType.EXPLAIN);
Object resultsExplain = cache.aggregate(filter, agent);

System.out.println("\n" + resultsExplain + "\n");
```

To create a trace record, change the `RecordType` parameter to `TRACE`:

```
QueryRecorder agent = new QueryRecorder(RecordType.TRACE);
```

Interpreting Query Records

Query records are used to evaluate the filters and indexes that make up a query. Explain plan records are used to evaluate the estimated cost associated with applying a filter. Trace records are used to evaluate how effective a filter is at reducing a key set.

This section provides a sample explain plan record and a sample trace record and discuss how to read and interpret the record. The records are based on an example query of 1500 entries that were located on a cluster of 4 storage-enabled nodes. The query consists of a filter that finds any people that are either age 16 or 19 with the first name Bob and the last name Smith. Lastly, an index is added for `getAge`. To run the complete example, see "[Running The Query Record Example](#)" on page 22-13.

```

NamedCache cache = CacheFactory.getCache("mycache");
cache.addIndex(new ReflectionExtractor("getAge"), true, null);

AllFilter filter = new AllFilter(new Filter[]
{
    new OrFilter(
        new EqualsFilter(new ReflectionExtractor("getAge"), 16),
        new EqualsFilter(new ReflectionExtractor("getAge"), 19)),
    new EqualsFilter(new ReflectionExtractor("getLastName"), "Smith"),
    new EqualsFilter(new ReflectionExtractor("getFirstName"), "Bob"),
});

```

Query Explain Plan Record

A query explain record provides the estimated cost of evaluating a filter as part of a query operation. The cost takes into account whether or not an index can be used by a filter. The cost evaluation is used to determine the order in which filters are applied when a query is performed. Filters that use an index have the lowest cost and get applied first.

[Example 22–8](#) shows a typical query explain plan record. The record includes an Explain Plain table for evaluating each filter in the query and a Index Lookups table that lists each index that can be used by the filter. The columns are described as follows:

- **Name** – This column shows the name of each filter in the query. Composite filters show information for each of the filters within the composite filter.
- **Index** – This column shows whether or not an index can be used with the given filter. If an index is found, the number shown corresponds to the index number on the Index Lookups table. In the example, an ordered simple map index (0) was found for `getAge()`.
- **Cost** – This column shows an estimated cost of applying the filter. If an index can be used, the cost is given as 1. The value of 1 is used since the operation of applying the index requires just a single access to the index content. In the example, there are 4 storage-enabled cluster members and thus the cost reflects accessing the index on all four members. If no index exists, the cost is calculated as *EVAL_COST * number of keys*. The *EVAL_COST* value is a constant value and is 1000. This is intended to show the relative cost of doing a full scan to reduce the key set using the filter. In the example, there are 1500 cache entries which need to be evaluated. Querying indexed entries is always relatively inexpensive as compared to non-indexed entries but does not necessarily guarantee effectiveness.

The record in [Example 22–8](#) shows that the equal filter for `getAge()` has a low cost because it has an associated index and would be applied before `getLastName()` and `getFirstName()`. However, the `getAge()` filter, while inexpensive, may not be very effective if all entries were either 16 and 19 and only few entries matched Bob and Smith. In this case, it is more effective to add an index for `getLastName()` and `getFirstName()`. Moreover, the cost (mainly memory consumption) associated with creating an index is wasted if the index does a poor job of reducing the key set.

Example 22–8 Sample Query Explain Plan Record

```

Explain Plan
Name                                     Index      Cost
=====
com.tangosol.util.filter.AllFilter      | ----    | 0
  com.tangosol.util.filter.OrFilter     | ----    | 0
    EqualsFilter(.getAge(), 16)         | 0        | 4

```

EqualsFilter(.getAge(), 19)	0	4
EqualsFilter(.getLastName(), Smit	1	1500000
EqualsFilter(.getFirstName(), Bob	2	1500000

Index Lookups

Index	Description	Extractor	Ordered
0	SimpleMapIndex: Extractor=.getAge(), Ord	.getAge()	true
1	No index found	.getLastName()	false
2	No index found	.getFirstName()	false

Query Trace Record

A query trace record provides the actual cost of evaluating a filter as part of a query operation. The cost takes into account whether or not an index can be used by a filter. The query is actually performed and the effectiveness of each filter at reducing the key set is shown.

[Example 22-9](#) shows a typical query trace record. The record includes a Trace table that shows the effectiveness of each filter in the query and an Index Lookups table that lists each index that can be used by the filter. The columns are described as follows:

- **Name** – This column shows the name of each filter in the query. Composite filters show information for each of the filters within the composite filter.
- **Index** – This column shows whether or not an index can be used with the given filter. If an index is found, the number shown corresponds to the index number on the Index Lookups table. In the example, an ordered simple map index (0) was found for `getAge()`.
- **Effectiveness** – This column shows the amount a key set was actually reduced as a result of each filter. The value is given as `prefilter_key_set_size | postfilter_key_set_size` and is also presented as a percentage. The `prefilter_key_set_size` value represents the key set size prior to evaluating the filter or applying an index. The `postfilter_key_set_size` value represents the size of the key set remaining after evaluating the filter or applying an index. For a composite filter entry, the value is the overall results for its contained filters. Once a key set size can no longer be reduced based on an index, the resulting key set is deserialized and any non index filters are applied.
- **Duration** – This column shows the number of milliseconds spent evaluating the filter or applying an index. A value of 0 indicates that the time registered was below the reporting threshold. In the example, the 63 milliseconds is the result of having to deserialize the key set which is incurred on the first filter `getLastName()` only.

The record in [Example 22-9](#) shows that it took approximately 63 milliseconds to reduce 1500 entries to find 100 entries with the first name Bob, last name Smith, and with an age of 16 or 19. The key set of 1500 entries was initially reduced to 300 using the index for `getAge()`. The resulting 300 entries (because they could not be further reduced using an index) were then deserialized and reduced to 150 entries based on `getLastName()` and then reduced to 100 using `getFirstName()`. The example shows that an index on `getAge()` is well worth the resources because it was able to effectively reduce the key set by 1200 entries. An index on `getLastName` and `getFirstName` would increase the performance of the overall query but may not be worth the additional resource required to create the index.

Example 22–9 Sample Query Trace Record

Trace Name	Index	Effectiveness	Duration
com.tangosol.util.filter.AllFilter	----	1500 300(80%)	0
com.tangosol.util.filter.OrFilter	----	1500 300(80%)	0
EqualsFilter(.getAge(), 16)	0	1500 150(90%)	0
EqualsFilter(.getAge(), 19)	0	1350 150(88%)	0
EqualsFilter(.getLastName(), Smit	1	300 300(0%)	0
EqualsFilter(.getFirstName(), Bob	2	300 300(0%)	0
com.tangosol.util.filter.AllFilter	----	300 100(66%)	63
EqualsFilter(.getLastName(), Smit	----	300 150(50%)	63
EqualsFilter(.getFirstName(), Bob	----	150 100(33%)	0

Index Lookups

Index	Description	Extractor	Ordered
0	SimpleMapIndex: Extractor=.getAge(), Ord	.getAge()	true
1	No index found	.getLastName()	false
2	No index found	.getFirstName()	false

Running The Query Record Example

The following example is a simple class that demonstrates creating query records. The class loads a distributed cache (mycache) with 1500 Person objects, creates an index on an attribute, performs a query, and creates both a query explain plan record and a query trace record that is emitted to the console before the class exits.

Example 22–10 A Query Record Example

```
import com.tangosol.net.CacheFactory;
import com.tangosol.net.NamedCache;
import com.tangosol.util.Filter;
import com.tangosol.util.aggregator.QueryRecorder;
import static com.tangosol.util.aggregator.QueryRecorder.RecordType;
import com.tangosol.util.extractor.ReflectionExtractor;
import com.tangosol.util.filter.AllFilter;
import com.tangosol.util.filter.EqualsFilter;
import com.tangosol.util.filter.OrFilter;
import java.io.Serializable;
import java.util.Properties;

public class QueryRecordExample
{
    public static void main(String[] args) {

        testExplain();
        testTrace();
    }

    public static void testExplain()
    {
        NamedCache cache = CacheFactory.getCache("mycache");
        cache.addIndex(new ReflectionExtractor("getAge"), true, null);
        PopulateCache(cache);

        AllFilter filter = new AllFilter(new Filter[]
```

```
{
    new OrFilter(
        new EqualsFilter(new ReflectionExtractor("getAge"), 16),
        new EqualsFilter(new ReflectionExtractor("getAge"), 19)),
    new EqualsFilter(new ReflectionExtractor("getLastName"), "Smith"),
    new EqualsFilter(new ReflectionExtractor("getFirstName"), "Bob"),
    });

    QueryRecorder agent = new QueryRecorder(RecordType.EXPLAIN);
    Object resultsExplain = cache.aggregate(filter, agent);
    System.out.println("\nExplain Plan=\n" + resultsExplain + "\n");
}

public static void testTrace()
{
    NamedCache cache = CacheFactory.getCache("hello-example");
    cache.addIndex(new ReflectionExtractor("getAge"), true, null);
    PopulateCache(cache);

    AllFilter filter = new AllFilter(new Filter[]
    {
        new OrFilter(
            new EqualsFilter(new ReflectionExtractor("getAge"), 16),
            new EqualsFilter(new ReflectionExtractor("getAge"), 19)),
        new EqualsFilter(new ReflectionExtractor("getLastName"), "Smith"),
        new EqualsFilter(new ReflectionExtractor("getFirstName"), "Bob"),
    });

    QueryRecorder agent = new QueryRecorder(RecordType.TRACE);
    Object resultsExplain = cache.aggregate(filter, agent);
    System.out.println("\nTrace =\n" + resultsExplain + "\n");
}

private static void PopulateCache(NamedCache cache)
{
    for (int i = 0; i < 1500; ++i)
    {
        Person person = new Person(i % 3 == 0 ? "Joe" : "Bob",
            i % 2 == 0 ? "Smith" : "Jones", 15 + i % 10);
        cache.put("key" + i, person);
    }
}

public static class Person implements Serializable
{
    public Person(String sFirstName, String sLastName, int nAge)
    {
        m_sFirstName = sFirstName;
        m_sLastName = sLastName;
        m_nAge = nAge;
    }

    public String getFirstName()
    {
        return m_sFirstName;
    }

    public String getLastName()
    {
        return m_sLastName;
    }
}
```

```
    }

    public int getAge()
    {
        return m_nAge;
    }

    public String toString()
    {
        return "Person( " +m_sFirstName + " " + m_sLastName + " : " +

            m_nAge + ")";
    }
    private String m_sFirstName;
    private String m_sLastName;
    private int m_nAge;
}
}
```

Using Continuous Query Caching

This chapter provides instructions for using continuous query caching to ensure that a query always retrieves the latest results from a cache in real-time.

This chapter includes the following sections:

- [Overview of Using Continuous Query Caching](#)
- [Understanding the Continuous Query Cache Implementation](#)
- [Constructing a Continuous Query Cache](#)
- [Caching only keys, or caching both keys and values](#)
- [Listening to the ContinuousQueryCache](#)
- [Making the ContinuousQueryCache Read-Only](#)

Overview of Using Continuous Query Caching

Queries provide the ability to obtain a point in time query result from a Coherence cache and it is possible to receive events that would change the result of that query. However, the continuous query feature combines a query result with a continuous stream of related events to maintain an up-to-date query result in a real-time fashion. This capability is called *Continuous Query*, because it has the same effect as if the desired query had zero latency *and* the query were being executed several times every millisecond. For more information on point in time query results and events, see [Chapter 22, "Querying Data In a Cache."](#)

Continuous query is implemented by materializing the results of the query into a continuous query cache and then keeping that cache up-to-date in real-time using event listeners on the query. In other words, a continuous query is a cached query result that never gets out-of-date.

Understanding Use Cases for Continuous Query Caching

There are several different general use categories for continuous query caching:

- It is an ideal building block for Complex Event Processing (CEP) systems and event correlation engines.
- It is ideal for situations in which an application repeats a particular query, and would benefit from always having instant access to the up-to-date result of that query.
- A continuous query cache is analogous to a *materialized view*, and is useful for accessing and manipulating the results of a query using the standard `NamedCache` API, and receiving an ongoing stream of events related to that query.

- A continuous query cache can be used in a manner similar to a Near Cache, because it maintains an up-to-date set of data locally *where it is being used*, for example on a particular server node or on a client desktop; note that a Near Cache is invalidation-based, but the continuous query cache actually maintains its data in an up-to-date manner.

An example use case is a trading system desktop, in which a trader's open orders and all related information must always be maintained in an up-to-date manner. By combining the Coherence*Extend functionality with Continuous Query Caching, an application can support literally tens of thousands of concurrent users.

Note: continuous query caches are useful in almost every type of application, including both client-based and server-based applications, because they provide the ability to very easily and efficiently maintain an up-to-date local copy of a specified sub-set of a much larger and potentially distributed cached data set.

Understanding the Continuous Query Cache Implementation

The Coherence implementation of continuous query is found in the `com.tangosol.net.cache.ContinuousQueryCache` class. This class, like all Coherence caches, implements the standard `NamedCache` interface, which includes the following capabilities:

- Cache access and manipulation using the `Map` interface: `NamedCache` extends the standard `Map` interface from the Java Collections Framework, which is the same interface implemented by the Java `HashMap` and `Hashtable` classes.
- Events for all objects modifications that occur within the cache: `NamedCache` extends the `ObservableMap` interface.
- Identity-based clusterwide locking of objects in the cache: `NamedCache` extends the `ConcurrentMap` interface.
- Querying the objects in the cache: `NamedCache` extends the `QueryMap` interface.
- Distributed Parallel Processing and Aggregation of objects in the cache: `NamedCache` extends the `InvocableMap` interface.

Since the `ContinuousQueryCache` implements the `NamedCache` interface, which is the same API provided by all Coherence caches, it is extremely simple to use, and it can be easily substituted for another cache when its functionality is called for.

Constructing a Continuous Query Cache

There are two items that define a continuous query cache:

1. The underlying cache that it is based on;
2. A query of that underlying cache that produces the sub-set that the continuous query cache caches.

The underlying cache is any Coherence cache, including another continuous query cache. A cache is usually obtained from a `CacheFactory`, which allows the developer to simply specify the name of the cache and have it automatically configured based on the application's cache configuration information; for example:

```
NamedCache cache = CacheFactory.getCache("orders");
```

See [Appendix B, "Cache Configuration Elements"](#) for more information on specifying cache configuration information.

The query is the same type of query that would be used to filter data. For example:

Example 23–1 A Query for a Continuous Query Cache

```
Filter filter = new AndFilter(new EqualsFilter("getTrader", traderid),
                             new EqualsFilter("getStatus", Status.OPEN));
```

See [Chapter 22, "Querying Data In a Cache"](#) for more information on queries.

Normally, to query a cache, a method from `QueryMap` is used. For example, to obtain a snap-shot of all open trades for a trader object:

Example 23–2 Getting Data for the Continuous Query Cache

```
Set setOpenTrades = cache.entrySet(filter);
```

Similarly, the continuous query cache is constructed from those same two pieces:

Example 23–3 Constructing the Continuous Query Cache

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter);
```

Cleaning up the resources associated with a ContinuousQueryCache

A continuous query cache places one or more event listeners on its underlying cache. If the continuous query cache is used for the duration of the application, then the resources are cleaned up when the node is shut down or otherwise stops. However, if the continuous query cache is only used for a period, then when the application is done using it, the application must call the `release()` method on the `ContinuousQueryCache`.

Caching only keys, or caching both keys and values

When constructing a continuous query cache, it is possible to specify that the cache should only keep track of the keys that result from the query, and obtain the values from the underlying cache only when they are asked for. This feature may be useful for creating a continuous query cache that represents a very large query result set, or if the values are never or rarely requested. To specify that only the keys should be cached, use the constructor that allows the `CacheValues` property to be configured; for example:

Example 23–4 A Constructor that Allows the CacheValues Property

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter,
false);
```

If necessary, the `CacheValues` property can also be modified after the cache has been instantiated; for example:

Example 23–5 Setting the CacheValues Property

```
cacheOpenTrades.setCacheValues(true);
```

CacheValues Property and Event Listeners

If the continuous query cache has any standard (non-lite) event listeners, or if any of the event listeners are filtered, then the `CacheValues` property is automatically set to true, because the continuous query cache uses the locally cached values to filter events and to supply the old and new values for the events that it raises.

Listening to the ContinuousQueryCache

Since the continuous query cache is itself observable, it is possible for the client to place one or more event listeners onto it. For example:

Example 23–6 Adding a Listener to a Continuous Query Cache

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter);
cacheOpenTrades.addMapListener(listener);
```

Assuming some processing has to occur against every item that is in the cache and every item added to the cache, there are two approaches. First, the processing could occur then a listener could be added to handle any later additions:

Example 23–7 Processing Continuous Query Cache Entries and Adding a Listener

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter);
for (Iterator iter = cacheOpenTrades.entrySet().iterator(); iter.hasNext(); )
{
    Map.Entry entry = (Map.Entry) iter.next();
    // .. process the cache entry
}
cacheOpenTrades.addMapListener(listener);
```

However, **that code is incorrect** because it allows events that occur in the split second after the iteration and before the listener is added to be missed! The alternative is to add a listener first, so no events are missed, and then do the processing:

Example 23–8 Adding a Listener Before Processing Continuous Query Cache Entries

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter);
cacheOpenTrades.addMapListener(listener);
for (Iterator iter = cacheOpenTrades.entrySet().iterator(); iter.hasNext(); )
{
    Map.Entry entry = (Map.Entry) iter.next();
    // .. process the cache entry
}
```

However, the same entry can appear in both an event and in the `Iterator`, and the events can be asynchronous, so the sequence of operations cannot be guaranteed.

The solution is to provide the listener during construction, and it receives one event for each item that is in the continuous query cache, whether it was there to begin with (because it was in the query) or if it got added during or after the construction of the cache:

Example 23–9 Providing a Listener When Constructing the Continuous Query Cache

```
ContinuousQueryCache cacheOpenTrades = new ContinuousQueryCache(cache, filter,
listener);
```

Achieving a Stable Materialized View

The ContinuousQueryCache implementation faced the same challenge: How to assemble an exact point-in-time snapshot of an underlying cache *while receiving a stream of modification events from that same cache*. The solution has several parts. First, Coherence supports an option for synchronous events, which provides a set of ordering guarantees. See [Chapter 25, "Using Map Events,"](#) for more information on this option.

Secondly, the ContinuousQueryCache has a two-phase implementation of its initial population that allows it to first query the underlying cache and then subsequently resolve all of the events that came in during the first phase. Since achieving these guarantees of data visibility without any missing or repeated events is fairly complex, the ContinuousQueryCache allows a developer to pass a listener during construction, thus avoiding exposing these same complexities to the application developer.

Support for Synchronous and Asynchronous Listeners

By default, listeners to the ContinuousQueryCache have their events delivered asynchronously. However, the ContinuousQueryCache does respect the option for synchronous events as provided by the SynchronousListener interface. See [Chapter 23, "Using Continuous Query Caching,"](#) for more information on this option.

Making the ContinuousQueryCache Read-Only

The ContinuousQueryCache can be made into a read-only cache; for example:

Example 23–10 Making the Continuous Query Cache Read-Only

```
cacheOpenTrades.setReadOnly(true);
```

A read-only ContinuousQueryCache does not allow objects to be added to, changed in, removed from or locked in the cache.

When a ContinuousQueryCache has been set to read-only, it cannot be changed back to read/write.

Processing Data In a Cache

This chapter provides instructions for using entry processors and aggregators to perform data grid processing across a cluster. These data grid features perform in a similar manner to other map-reduce patterns and allow the processing of large amounts of data at very low latencies.

This chapter includes the following sections:

- [Overview of Processing Data In a Cache](#)
- [Using Agents for Targeted, Parallel and Query-Based Processing](#)
- [Performing Data Grid Aggregation](#)
- [Performing Node-Based Processing](#)
- [Using a Work Manager](#)

Overview of Processing Data In a Cache

Coherence provides the ideal infrastructure for building data grid services and the client and server-based applications that use a data grid. At a basic level, Coherence can manage large amounts of data across a large number of servers in a grid; it can provide close to zero latency access for that data; it supports parallel queries across that data in a map-reduce manner; and it supports integration with database and EIS systems that act as the system of record for that data.

Performing Targeted Processing

Coherence provides for the ability to execute an agent against an entry in any map of data managed by a data grid:

```
map.invoke(key, agent);
```

In the case of partitioned data, the agent executes on the grid node that owns the data. The queuing, concurrency management, agent execution, data access by the agent, and data modification by the agent all occur on that grid node. (Only the synchronous backup of the resultant data modification, if any, requires additional network traffic.) For many processing purposes, it is much more efficient to move the serialized form of the agent (at most a few hundred bytes) than to handle distributed concurrency control, coherency and data updates.

For request and response processing, the agent returns a result:

```
Object oResult = map.invoke(key, agent);
```

Coherence, as a data grid, determines the location to execute the agent based on the configuration for the data topology. It moves the agent to the determined location, executes the agent (automatically handling concurrency control for the item while executing the agent), backs up the modifications (if any), and returns a result.

Performing Parallel Processing

Coherence provides map-reduce functionality which allows agents to be executed in parallel against a collection of entries across all nodes in the grid. Parallel execution allows large amounts of data to be processed by balancing the work across the grid. The `invokeAll` method is used as follows:

```
map.invokeAll(collectionKeys, agent);
```

For request and response processing, the agent returns one result for each key processed:

```
Map mapResults = map.invokeAll(collectionKeys, agent);
```

Coherence determines the optimal location(s) to execute the agent based on the configuration for the data topology. It then moves the agent to the determined locations, executes the agent (automatically handling concurrency control for the item(s) while executing the agent), backs up the modifications (if any), and returns the coalesced results. See "[Performing Data Grid Aggregation](#)" on page 24-7 for instructions on performing aggregation against a result set.

Performing Query-Based Processing

Coherence supports the ability to query across the entire data grid. For details on creating queries, see [Chapter 22, "Querying Data In a Cache."](#) For example, in a trading system it is possible to query for all open `Order` objects for a particular trader:

Example 24–1 Querying Across a Data Grid

```
NamedCache map    = CacheFactory.getCache("trades");
Filter    filter = new AndFilter(new EqualsFilter("getTrader", traderid),
                                new EqualsFilter("getStatus", Status.OPEN));
Set setOpenTradeIds = mapTrades.keySet(filter);
```

By combining this feature with the use of parallel executions in the data grid, Coherence provides the ability to execute an agent against a query. As in the previous section, the execution occurs in parallel, and instead of returning the identities or entries that match the query, Coherence executes the agent against the entries:

```
map.invokeAll(filter, agent);
```

For request and response processing, the agent returns one result for each key processed:

```
Map mapResults = map.invokeAll(filter, agent);
```

Coherence combines parallel query and parallel execution to achieve query-based agent invocation against a data grid.

Performing Data-Grid-Wide Processing

Passing an instance of `AlwaysFilter` (or `null`) to the `invokeAll` method causes the passed agent to be executed against all entries in the `InvocableMap`:

```
map.invokeAll((Filter) null, agent);
```

As with the other types of agent invocation, request and response processing is supported:

```
Map mapResults = map.invokeAll((Filter) null, agent);
```

An application can process all the data spread across a particular map in the data grid with a single line of code.

Using Agents for Targeted, Parallel and Query-Based Processing

An agent implements the `EntryProcessor` interface, typically by extending the `AbstractProcessor` class.

Several agents are included with Coherence, including:

- `AbstractProcessor` - an abstract base class for building an `EntryProcessor`
- `ExtractorProcessor` - extracts and returns a value (such as a property value) from an object stored in an `InvocableMap`
- `CompositeProcessor` - bundles a collection of `EntryProcessor` objects that are invoked sequentially against the same entry
- `ConditionalProcessor` - conditionally invokes an `EntryProcessor` if a `Filter` against the entry-to-process evaluates to true
- `PropertyProcessor` - an abstract base class for `EntryProcessor` implementations that depend on a `PropertyManipulator`
- `NumberIncrementor` - pre- or post-increments any property of a primitive integral type, and `Byte`, `Short`, `Integer`, `Long`, `Float`, `Double`, `BigInteger`, `BigDecimal`
- `NumberMultiplier` - multiplies any property of a primitive integral type, and `Byte`, `Short`, `Integer`, `Long`, `Float`, `Double`, `BigInteger`, `BigDecimal`, and returns either the previous or new value

The `EntryProcessor` interface (contained within the `InvocableMap` interface) contains only two methods: `process` and `processAll`. The `AbstractProcessor` provides the default implementation of the `processAll` method. When processing multiple keys, a single `EntryProcessor` object is re-used for all the keys and its state should not be mutated.

Note: If the `processAll` call throws an exception, changes are only made to the underlying `Map` for entries that were removed from the `setEntries`. Changes that are made to the remaining entries are not processed.

The `InvocableMap.Entry` that is passed to an `EntryProcessor` is an extension of the `Map.Entry` interface that allows an `EntryProcessor` implementation to obtain the necessary information about the entry and to make the necessary modifications in the most efficient manner possible.

Processing Entries in Multiple Caches

Entry processors can update cache entries in multiple caches within a single `process` or `processAll` operation. The caches must be managed by the same service and the

entries must be located in the same partition. For details about ensuring that entries are in the same partition, see ["Specifying Data Affinity"](#) on page 30-1.

The `process` and `processAll` operations are performed in a transaction-like manner that uses implicit locks when accessing, inserting, updating, modifying, or removing cache entries. If an exception is thrown during the processing of the entries, the entries are rolled back leaving all underlying values unchanged. The `processAll` operation is atomic with respect to all entries within a single partition (or member if no service threads are configured) rather than the individual entry or entire request.

Note: The implicit lock may create a deadlock if entries are locked in conflicting orders on different threads. The application is responsible for ensuring that cache entries are accessed (locked) in a deadlock-free manner. In the case where a deadlock is detected, an exception is thrown but the underlying service is not stopped.

The `com.tangosol.net.BackingMapContext` API is used to process entries in multiple caches and provides a way to directly access entries in a cache's backing map. The backing map is the actual `Map` implementation where entries are stored (as opposed to the logical representation of a cache typically used by an application). Entries in a backing map are stored in binary format and therefore require an application to handle the serialized form of an entry. For details on backing maps, see [Chapter 14, "Implementing Storage and Backing Maps."](#)

The `com.tangosol.util.BinaryEntry` API provides easy access to a backing map context and is typically used by an application. The following sample code demonstrates how to update entries in two different caches within the `process` method of an entry processor using the `BinaryEntry` API.

```
public Object process(Entry entry) {
    BinaryEntry binEntry = (BinaryEntry) entry;
    Binary binKey = binEntry.getBinaryKey();
    Trade trade = (Trade) binEntry.getValue();

    // Update a Trade object in cache1

    trade.setPrice(trade.getPrice() + factor);
    binEntry.setValue(trade);

    // update a Trade object in cache2

    BackingMapManagerContext ctx = binEntry.getContext();
    BinaryEntry binEntry2 =
        (BinaryEntry) ctx.getBackingMapContext("cache2").getBackingMapEntry(binKey);
    Trade trade2 = (Trade) binEntry2.getValue();
    trade2.setPrice(trade2.getPrice() + factor);
    binEntry2.setValue(trade2);

    return null;
}
```

Note: The `getBackingMapEntry` method may only be called within the context of an entry processor invocation. Any changes made to the entry are persisted with the same lifecycle as those made by the enclosing invocation. The returned entry is only valid for the duration of the enclosing invocation and multiple calls to this method within the same invocation context returns the same entry object.

Ignoring the Results of an Entry Processor

The `processAll` method of the `AbstractProcessor` class returns a map of results to a client application. The map contains the keys and values for every entry that was processed. Most often, the entry processor returns results that the client uses. However, there may be situations where some results are not usable by the client. More importantly, there may be situations where the processor must evaluate all the entries in a cache; in which case, the return map contains every key in the cache. In both situations, the agent should be designed to ignore results that are not wanted.

Designing an agent that only returns wanted results is a good pattern and best practice, because it:

- Makes the client's memory footprint independent of the size of the cache.
- Avoids transferring all affected keys to the client which could result in an `OutOfMemoryError` exception on the client if the cache is too large.
- Avoids deserialization costs in the client for all keys.
- Avoids transferring the map and all keys through a proxy node (for Extend clients).

To ignore entry processor results, override the processor's `processAll` method to return an empty `Map` or `null`. The following example demonstrates a simple entry processor agent that always returns `null` after processing an entry. The example is not very realistic but does show how to override the `processAll` method.

```
public static class Agent
    implements InvocableMap.EntryProcessor
    {
        private static final long serialVersionUID = 1L;

        @Override
        public Object process(Entry entry)
        {
            return null;
        }

        @Override
        public Map processAll(Set set)
        {
            for (Entry entry : (Set<Entry>) set)
            {
                process(entry);
            }
            return null;
        }
    }
```

Processing Entries Asynchronously

Entry processors can be invoked asynchronously using the `AsynchronousProcessor` class. The class implements the standard Java `Future` interface and also includes a Coherence-specific flow control mechanism to guard against excessive backlogs.

The `AsynchronousProcessor` class is used to wrap an entry processor implementation. For example:

```
UpdaterProcessor up = new UpdaterProcessor(null, value);
AsynchronousProcessor ap = new AsynchronousProcessor(up);

cache.invokeAll(filter, ap);
ap.getResult();
```

The above example invokes the underlying entry processor and uses automatic flow control (as defined by the underlying service's flow control logic) and a default unit-of-order ID (assigned to the calling thread's `hashCode` – as a thread's requests are naturally expected to execute in order). Ordering is guaranteed for each partition even during failover. Additional constructors are available to manually control request flow and assign the unit-of-order ID as required.

For advanced use cases, the `AsynchronousProcessor` class can be extended to define custom asynchronous functionality. The following example extends the `AsynchronousProcessor` class and overrides the `onResult`, `onComplete` and `onException` methods. Refer to the *Java API Reference for Oracle Coherence* for details on the `AsynchronousProcessor` class and its methods.

Note: Overriding implementations of the `onComplete`, `onResult`, and `onException` methods must be non-blocking and short-lived, because this call is made on the service thread of the client and blocks processing for responses on other threads.

```
AsynchronousProcessor processor = new AsynchronousProcessor(null)
{
    public synchronized void onResult(Entry entry)
    {
        super.onResult(entry);

        // process the result
    }

    public void onComplete()
    {
        super.onComplete();

        if (m_eReason == null)
        {
            // process the result
        }
        else
        {
            // process the (potentially partial) failure
        }
    }
}
```

```

public void onException(Throwable eReason)
{
    super.onException(eReason);

    // process the observed exception
}
};

```

Performing Data Grid Aggregation

In addition to *scalar* agents, the `InvocableMap` interface also supports entry aggregators that perform operations against a subset of entries to obtain a single result. Entry aggregation occurs in parallel across the grid to provide map-reduce support when working with large amounts of data.

Example 24–2 Aggregation in the `InvocableMap` API

```

/**
 * Perform an aggregating operation against the entries specified by the
 * passed keys.
 *
 * @param collKeys the Collection of keys that specify the entries within
 *                this Map to aggregate across
 * @param agent    the EntryAggregator that is used to aggregate across
 *                the specified entries of this Map
 *
 * @return the result of the aggregation
 */
public Object aggregate(Collection collKeys, EntryAggregator agent);

/**
 * Perform an aggregating operation against the set of entries that are
 * selected by the given Filter.
 *
 * <p/>
 * <b>Note:</b> calling this method on partitioned caches requires a
 * Coherence Enterprise Edition (or higher) license.
 *
 * @param filter the Filter that is used to select entries within this
 *                Map to aggregate across
 * @param agent  the EntryAggregator that is used to aggregate across
 *                the selected entries of this Map
 *
 * @return the result of the aggregation
 */
public Object aggregate(Filter filter, EntryAggregator agent);

```

A simple `EntryAggregator` processes a set of `InvocableMap.Entry` objects to achieve a result:

Example 24–3 `EntryAggregator` API

```

/**
 * An EntryAggregator represents processing that can be directed to occur
 * against some subset of the entries in an InvocableMap, resulting in a
 * aggregated result. Common examples of aggregation include functions
 * such as min(), max() and avg(). However, the concept of aggregation
 * applies to any process that must evaluate a group of entries to
 * come up with a single answer.

```

```
*/
public interface EntryAggregator
    extends Serializable
    {
    /**
    * Process a set of InvocableMap Entry objects to produce an
    * aggregated result.
    *
    * @param setEntries a Set of read-only InvocableMap Entry objects to
    *                   aggregate
    *
    * @return the aggregated result from processing the entries
    */
    public Object aggregate(Set setEntries);
    }
```

For efficient execution in a Data Grid, an aggregation process must be designed to operate in a parallel manner.

Example 24–4 ParallelAwareAggregator API for running Aggregation in Parallel

```
/**
* A ParallelAwareAggregator is an advanced extension to EntryAggregator
* that is explicitly capable of being run in parallel, for example in a
* distributed environment.
*/
public interface ParallelAwareAggregator
    extends EntryAggregator
    {
    /**
    * Get an aggregator that can take the place of this aggregator in
    * situations in which the InvocableMap can aggregate in parallel.
    *
    * @return the aggregator that is run in parallel
    */
    public EntryAggregator getParallelAggregator();

    /**
    * Aggregate the results of the parallel aggregations.
    *
    * @return the aggregation of the parallel aggregation results
    */
    public Object aggregateResults(Collection collResults);
    }
```

Coherence comes with all of the natural aggregation functions, including:

- Count
- DistinctValues
- DoubleAverage
- DoubleMax
- DoubleMin
- DoubleSum
- LongMax
- LongMin

- LongSum

Note: All aggregators that come with Coherence are parallel-aware.

See the `com.tangosol.util.aggregator` package for a list of Coherence aggregators. To implement your own aggregator, see the `AbstractAggregator` abstract base class.

Performing Node-Based Processing

Coherence provides an Invocation Service which allows execution of single-pass agents (called Invocable objects) anywhere within the grid. The agents can be executed on a particular node in the grid, in parallel on a particular set of nodes in the grid, or in parallel on all nodes of the grid.

An invocation service is configured using the `<invocation-scheme>` element in the cache configuration file. Using the name of the service, the application can easily obtain a reference to the service:

```
InvocationService service = (InvocationService)CacheFactory.getService
("MyService");
```

Agents are simply runnable classes that are part of the application. An example of a simple agent is one designed to request a GC from the JVM:

Example 24–5 Simple Agent to Request Garbage Collection

```
/**
 * Agent that issues a garbage collection.
 */
public class GCAGENT
    extends AbstractInvocable
{
    public void run()
    {
        System.gc();
    }
}
```

To execute that agent across the entire cluster, it takes one line of code:

```
service.execute(new GCAGENT(), null, null);
```

Here is an example of an agent that supports a grid-wide request/response model:

Example 24–6 Agent to Support a Grid-Wide Request and Response Model

```
/**
 * Agent that determines how much free memory a grid node has.
 */
public class FreeMemAgent
    extends AbstractInvocable
{
    public void run()
    {
        Runtime runtime = Runtime.getRuntime();
        int cbFree = runtime.freeMemory();
        int cbTotal = runtime.totalMemory();
    }
}
```

```

        setResult(new int[] {cbFree, cbTotal});
    }
}

```

To execute that agent across the entire grid and retrieve all the results from it, **it still takes only one line of code:**

```
Map map = service.query(new FreeMemAgent(), null);
```

While it is easy to do a grid-wide request/response, it takes a bit more code to print the results:

Example 24–7 Printing the Results from a Grid-Wide Request or Response

```

Iterator iter = map.entrySet().iterator();
while (iter.hasNext())
{
    Map.Entry entry = (Map.Entry) iter.next();
    Member member = (Member) entry.getKey();
    int[] anInfo = (int[]) entry.getValue();
    if (anInfo != null) // nullif member died
        System.out.println("Member " + member + " has "
            + anInfo[0] + " bytes free out of "
            + anInfo[1] + " bytes total");
}

```

The agent operations can be stateful, which means that their invocation state is serialized and transmitted to the grid nodes on which the agent is to be run.

Example 24–8 Stateful Agent Operations

```

/**
 * Agent that carries some state with it.
 */
public class StatefulAgent
    extends AbstractInvocable
    {
    public StatefulAgent(String sKey)
    {
        m_sKey = sKey;
    }

    public void run()
    {
        // the agent has the key that it was constructed with
        String sKey = m_sKey;
        // ...
    }

    private String m_sKey;
    }

```

Using a Work Manager

Coherence provides a grid-enabled implementation of the *CommonJ Work Manager*. Using a Work Manager, an application can submit a collection of work that must be executed. The Work Manager distributes that work in such a way that it is executed in parallel, typically across the grid. In other words, if there are ten work items submitted and ten servers in the grid, then each server likely processes one work item. Further,

the distribution of work items across the grid can be tailored, so that certain servers (for example, one that acts as a gateway to a particular mainframe service) is the first choice to run certain work items, for sake of efficiency and locality of data.

The application can then wait for the work to be completed, and can provide a timeout for how long it can wait. The API for this purpose is quite powerful, allowing an application to wait for the first work item to complete, or for a specified set of the work items to complete. By combining methods from this API, it is possible to do things like "Here are 10 items to execute; for these 7 unimportant items, wait no more than 5 seconds, and for these 3 important items, wait no more than 30 seconds".

Example 24–9 Using a Work Manager

```
Work[] aWork = ...
Collection collBigItems = new ArrayList();
Collection collAllItems = new ArrayList();
for (int i = 0, c = aWork.length; i < c; ++i)
{
    WorkItem item = manager.schedule(aWork[i]);

    if (i < 3)
    {
        // the first three work items are the important ones
        collBigItems.add(item);
    }

    collAllItems.add(item);
}

Collection collDone = manager.waitForAll(collAllItems, 5000L);
if (!collDone.containsAll(collBigItems))
{
    // wait the remainder of 30 seconds for the important work to finish
    manager.waitForAll(collBigItems, 25000L);
}
```

Using Map Events

This chapter provides instructions for using map event listeners to receive cache events and events from any class in Coherence that implements the `ObservableMap` interface.

This chapter includes the following sections:

- [Overview of Map Events](#)
- [Signing Up for All Events](#)
- [Using an Inner Class as a MapListener](#)
- [Configuring a MapListener For a Cache](#)
- [Signing Up For Events On Specific Identities](#)
- [Filtering Events](#)
- [Using Lite Events](#)
- [Listening to Queries](#)
- [Using Synthetic Events](#)
- [Using Backing Map Events](#)
- [Using Synchronous Event Listeners](#)

Overview of Map Events

Coherence provides cache events using the JavaBean Event model. The implementation allows applications to receive the events when and where they are needed, regardless of where the changes are actually occurring in the cluster. Developers that are familiar with the JavaBean model should have no difficulties working with events, even in a complex cluster.

Note: Coherence also includes the live event programming model. Live events provide support for common event types and can be used instead of map events. For details about using live events, see "[Using Live Events](#)" on page 27-1.

Listener Interface and Event Object

In the JavaBeans Event model, there is an `EventListener` interface that all listeners must extend. Coherence provides a `MapListener` interface, which allows application logic to receive events when data in a Coherence cache is added, modified or removed.

An application object that implements the `MapListener` interface can sign up for events from any Coherence cache or class that implements the `ObservableMap` interface, simply by passing an instance of the application's `MapListener` implementation to a `addMapListener()` method.

The `MapEvent` object that is passed to the `MapListener` carries all of the necessary information about the event that has occurred, including the *source* (`ObservableMap`) that raised the event, the *identity* (key) that the event is related to, what the *action* was against that identity (insert, update or delete), what the old value was and what the new value is.

For details about the `MapListener` interface and the `MapEvent` class, see the *Java API Reference for Oracle Coherence*.

Understanding Event Guarantees

The partitioned cache service guarantees that under normal circumstances an event is delivered only once. However, there are two scenarios that could break this guarantee:

- A catastrophic cluster failure that caused the data loss (for example, simultaneous crash of two machines holding data). In this case, the `PARTITION_LOST` event is emitted to all registered `PartitionListener` instances on the server side.
- Client disconnect. In this case, the `MEMBER_LEFT` event is emitted to all registered `MemberListener` instances on the client side.

Caches and Classes that Support Events

All Coherence caches implement `ObservableMap`; in fact, the `NamedCache` interface that is implemented by all Coherence caches extends the `ObservableMap` interface. That means that an application can sign up to receive events from any cache, regardless of whether that cache is local, partitioned, near, replicated, using read-through, write-through, write-behind, overflow, disk storage, and so on.

Note: Regardless of the cache topology and the number of servers, and even if the modifications are being made by other servers, the events are delivered to the application's listeners.

In addition to the Coherence caches (those objects obtained through a Coherence cache factory), several other supporting classes in Coherence also implement the `ObservableMap` interface:

- `ObservableHashMap`
- `LocalCache`
- `OverflowMap`
- `NearCache`
- `ReadWriteBackingMap`
- `AbstractSerializationCache`, `SerializationCache`, and `SerializationPagedCache`
- `WrapperObservableMap`, `WrapperConcurrentMap`, and `WrapperNamedCache`

Signing Up for All Events

To sign up for events, simply pass an object that implements the `MapListener` interface to a `addMapListener` method on `ObservableMap`. The `addMapListener` methods are illustrated in [Example 25-1](#).

Example 25-1 *Methods on the ObservableMap API*

```
public void addMapListener(MapListener listener);
public void addMapListener(MapListener listener, Object oKey, boolean fLite);
public void addMapListener(MapListener listener, Filter filter, boolean fLite);
```

Let's create an example `MapListener` implementation. [Example 25-2](#) illustrates a sample `MapListener` implementation that prints each event as it receive.

Example 25-2 *Sample MapListener Implementation*

```
/**
 * A MapListener implementation that prints each event as it receives
 * them.
 */
public static class EventPrinter
    extends Base
    implements MapListener
{
    public void entryInserted(MapEvent evt)
    {
        out(evt);
    }

    public void entryUpdated(MapEvent evt)
    {
        out(evt);
    }

    public void entryDeleted(MapEvent evt)
    {
        out(evt);
    }
}
```

Using this implementation, it is extremely simple to print all events from any given cache (since all caches implement the `ObservableMap` interface):

```
cache.addMapListener(new EventPrinter());
```

Of course, to be able to later remove the listener, it is necessary to hold on to a reference to the listener:

Example 25-3 *Holding a Reference to a Listener*

```
Listener listener = new EventPrinter();
cache.addMapListener(listener);
m_listener = listener; // store the listener in a field
```

Later, to remove the listener:

Example 25-4 *Removing a Listener*

```
Listener listener = m_listener;
if (listener != null)
```

```
{
    cache.removeMapListener(listener);
    m_listener = null; // clean up the listener field
}
```

Each `addMapListener` method on the `ObservableMap` interface has a corresponding `removeMapListener` method. To remove a listener, use the `removeMapListener` method that corresponds to the `addMapListener` method that was used to add the listener.

Using an Inner Class as a MapListener

When creating an inner class to use as a `MapListener`, or when implementing a `MapListener` that only listens to one or two types of events (inserts, updates or deletes), you can use the `AbstractMapListener` base class. For example, the anonymous inner class in [Example 25–5](#) prints out only the insert events for the cache.

Example 25–5 Inner Class that Prints Only Cache Insert Events

```
cache.addMapListener(new AbstractMapListener()
{
    public void entryInserted(MapEvent evt)
    {
        out(evt);
    }
});
```

Another helpful base class for creating a `MapListener` is the `MultiplexingMapListener`, which routes all events to a single method for handling. This class would allow you to simplify the `EventPrinter` example to the code illustrated in [Example 25–6](#). Since only one method must be implemented to capture all events, the `MultiplexingMapListener` can also be very useful when creating an inner class to use as a `MapListener`.

Example 25–6 Routing All Events to a Single Method for Handling

```
public static class EventPrinter
    extends MultiplexingMapListener
{
    public void onMapEvent(MapEvent evt)
    {
        out(evt);
    }
}
```

Configuring a MapListener For a Cache

If the listener should always be on a particular cache, then place it into the cache configuration using the `<listener>` element and Coherence automatically adds the listener when it configures the cache.

Signing Up For Events On Specific Identities

Signing up for events that occur against specific identities (keys) is just as simple. For example, to print all events that occur against the Integer key 5:

```
cache.addMapListener(new EventPrinter(), new Integer(5), false);
```

Thus, the code in [Example 25-7](#) would only trigger an event when the Integer key 5 is inserted or updated:

Example 25-7 Triggering an Event when a Specific Integer Key is Inserted or Updated

```
for (int i = 0; i < 10; ++i)
{
    Integer key = new Integer(i);
    String value = "test value for key " + i;
    cache.put(key, value);
}
```

Filtering Events

Similar to listening to a particular key, it is possible to listen to particular events. In [Example 25-8](#) a listener is added to the cache with a filter that allows the listener to only receive delete events.

Example 25-8 Adding a Listener with Filter for Deleted Events

```
// Filters used with partitioned caches must be
// Serializable, Externalizable or ExternalizableLite
public class DeletedFilter
    implements Filter, Serializable
{
    public boolean evaluate(Object o)
    {
        MapEvent evt = (MapEvent) o;
        return evt.getId() == MapEvent.ENTRY_DELETED;
    }
}

cache.addMapListener(new EventPrinter(), new DeletedFilter(), false);
```

Note: Filtering events versus filtering cached data:

When building a filter for querying, the object that is passed to the evaluate method of the `Filter` is a value from the cache, or - if the filter implements the `EntryFilter` interface - the entire `Map.Entry` from the cache. When building a filter for filtering events for a `MapListener`, the object that is passed to the evaluate method of the filter is of type `MapEvent`.

See ["Listening to Queries"](#) on page 25-7, for more information on how to use a query filter to listen to cache events, .

If you then make the following sequence of calls:

```
cache.put("hello", "world");
cache.put("hello", "again");
cache.remove("hello");
```

The result would be:

```
CacheEvent{LocalCache deleted: key=hello, value=again}
```

For more information, see the ["Listening to Queries"](#) on page 25-7.

Using Lite Events

By default, Coherence provides both the old and the new value as part of an event. Consider the following example:

Example 25–9 Inserting, Updating, and Removing a Value from the Cache

```
MapListener listener = new MultiplexingMapListener()
{
    public void onMapEvent(MapEvent evt)
    {
        out("event has occurred: " + evt);
        out("(the wire-size of the event would have been "
            + ExternalizableHelper.toBinary(evt).length()
            + " bytes.)");
    }
};
cache.addMapListener(listener);

// insert a 1KB value
cache.put("test", new byte[1024]);

// update with a 2KB value
cache.put("test", new byte[2048]);

// remove the 2KB value
cache.remove("test");
```

The output from running the test, illustrated in [Example 25–10](#), shows that the first event carries the 1KB inserted value, the second event carries both the replaced 1KB value and the new 2KB value, and the third event carries the removed 2KB value.

Example 25–10 Sample Output

```
event has occurred: CacheEvent{LocalCache added: key=test, value=[B@a470b8}
(the wire-size of the event would have been 1283 bytes.)
event has occurred: CacheEvent{LocalCache updated: key=test, old value=[B@a470b8,
new value=[B@1c6f579}
(the wire-size of the event would have been 3340 bytes.)
event has occurred: CacheEvent{LocalCache deleted: key=test, value=[B@1c6f579}
(the wire-size of the event would have been 2307 bytes.)
```

When an application does not require the old and the new value to be included in the event, it can indicate that by requesting only "lite" events. When adding a listener, you can request lite events by using a `addMapListener` method that takes an additional boolean `fLite` parameter. In [Example 25–9](#), the only change would be:

```
cache.addMapListener(listener, (Filter) null, true);
```

Note: Obviously, a lite event's old value and new value may be null. However, even if you request lite events, the old and the new value *may* be included if there is no additional cost to generate and deliver the event. In other words, requesting that a `MapListener` receive lite events is simply a hint to the system that the `MapListener` does not have to know the old and new values for the event.

Listening to Queries

All Coherence caches support querying by any criteria. When an application queries for data from a cache, the result is a point-in-time snapshot, either as a set of identities (`keySet`) or a set of identity/value pairs (`entrySet`). The mechanism for determining the contents of the resulting set is referred to as *filtering*, and it allows an application developer to construct queries of arbitrary complexity using a rich set of out-of-the-box filters (for example, `equals`, `less-than`, `like`, `between`, and so on), or to provide their own custom filters (for example, `XPath`).

The same filters that are used to query a cache can listen to events from a cache. For example, in a trading system it is possible to query for all open `Order` objects for a particular trader:

Example 25–11 *Listening for Events from a Cache*

```
NamedCache mapTrades = ...
Filter filter = new AndFilter(new EqualsFilter("getTrader", traderid),
                             new EqualsFilter("getStatus", Status.OPEN));
Set setOpenTrades = mapTrades.entrySet(filter);
```

To receive notifications of new trades being opened for that trader, closed by that trader or reassigned to or from another trader, the application can use the same filter:

Example 25–12 *Listening for Events on an Object*

```
// receive events for all trade IDs that this trader is interested in
mapTrades.addMapListener(listener, new MapEventFilter(filter), true);
```

The `MapEventFilter` converts a query filter into an event filter.

The `MapEventFilter` has several very powerful options, allowing an application listener to receive only the events that it is specifically interested in. More importantly for scalability and performance, only the desired events have to be communicated over the network, and they are communicated only to the servers and clients that have expressed interest in those specific events. [Example 25–13](#) illustrates these scenarios.

Example 25–13 *Using MapEventFilter to Filter on Various Events*

```
// receive all events for all trades that this trader is interested in
nMask = MapEventFilter.E_ALL;
mapTrades.addMapListener(listener, new MapEventFilter(nMask, filter), true);

// receive events for all this trader's trades that are closed or
// re-assigned to a different trader
nMask = MapEventFilter.E_UPDATED_LEFT | MapEventFilter.E_DELETED;
mapTrades.addMapListener(listener, new MapEventFilter(nMask, filter), true);

// receive events for all trades as they are assigned to this trader
nMask = MapEventFilter.E_INSERTED | MapEventFilter.E_UPDATED_ENTERED;
mapTrades.addMapListener(listener, new MapEventFilter(nMask, filter), true);

// receive events only for new trades assigned to this trader
nMask = MapEventFilter.E_INSERTED;
mapTrades.addMapListener(listener, new MapEventFilter(nMask, filter), true);
```

For more information on the various options supported, see the API documentation for `MapEventFilter`.

Filtering Events Versus Filtering Cached Data

When building a `Filter` for querying, the object that is passed to the `evaluate` method of the `Filter` is a value from the cache, or if the `Filter` implements the `EntryFilter` interface, the entire `Map.Entry` from the cache. When building a `Filter` for filtering events for a `MapListener`, the object that is passed to the `evaluate` method of the `Filter` is of type `MapEvent`.

The `MapEventFilter` converts a `Filter` that is used to do a query into a `Filter` that is used to filter events for a `MapListener`. In other words, the `MapEventFilter` is constructed from a `Filter` that queries a cache, and the resulting `MapEventFilter` is a filter that evaluates `MapEvent` objects by converting them into the objects that a query `Filter` would expect.

Using Synthetic Events

Events usually reflect the changes being made to a cache. For example, one server is modifying one entry in a cache while another server is adding several items to a cache while a third server is removing an item from the same cache, all while fifty threads on each and every server in the cluster is accessing data from the same cache! All the modifying actions produces events that any server within the cluster can choose to receive. We refer to these actions as *client actions*, and the events as being *dispatched to clients*, even though the "clients" in this case are actually servers. This is a natural concept in a true peer-to-peer architecture, such as a Coherence cluster: Each and every peer is both a client and a server, both consuming services from its peers and providing services to its peers. In a typical Java Enterprise application, a "peer" is an application server instance that is acting as a container for the application, and the "client" is that part of the application that is directly accessing and modifying the caches and listening to events from the caches.

Some events originate from within a cache itself. There are many examples, but the most common cases are:

- When entries automatically expire from a cache;
- When entries are evicted from a cache because the maximum size of the cache has been reached;
- When entries are transparently added to a cache as the result of a Read-Through operation;
- When entries in a cache are transparently updated as the result of a Read-Ahead or Refresh-Ahead operation.

Each of these represents a modification, but the modifications represent natural (and typically automatic) operations from within a cache. These events are referred to as *synthetic* events.

When necessary, an application can differentiate between client-induced and synthetic events simply by asking the event if it is synthetic. This information is carried on a sub-class of the `MapEvent`, called `CacheEvent`. Using the previous `EventPrinter` example, it is possible to print only the synthetic events:

Example 25–14 Determining Synthetic Events

```
public static class EventPrinter
    extends MultiplexingMapListener
{
    public void onMapEvent(MapEvent evt)
    {
```

```

        if (evt instanceof CacheEvent && ((CacheEvent) evt).isSynthetic())
        {
            out(evt);
        }
    }
}

```

For more information on this feature, see the API documentation for `CacheEvent`.

Using Backing Map Events

While it is possible to listen to events from Coherence caches, each of which presents a local view of distributed, partitioned, replicated, near-cached, continuously-queried, read-through/write-through and write-behind data, it is also possible to peek behind the curtains, so to speak.

For some advanced use cases, it may be necessary to "listen to" the "map" behind the "service". Replication, partitioning and other approaches to managing data in a distributed environment are all distribution *services*. The service still has to have something in which to actually *manage* the data, and that *something* is called a "backing map".

Backing maps can be configured. If all the data for a particular cache should be kept in object form on the heap, then use an unlimited and non-expiring `LocalCache` (or a `SafeHashMap` if statistics are not required). If only a small number of items should be kept in memory, use a `LocalCache`. If data are to be read on demand from a database, then use a `ReadWriteBackingMap` (which knows how to read and write through an application's DAO implementation), and in turn give the `ReadWriteBackingMap` a backing map such as a `SafeHashMap` or a `LocalCache` to store its data in.

Some backing maps are observable. The events coming from these backing maps are not usually of direct interest to the application. Instead, Coherence translates them into actions that must be taken (by Coherence) to keep data synchronous and properly backed up, and it also translates them when appropriate into clustered events that are delivered throughout the cluster as requested by application listeners. For example, if a partitioned cache has a `LocalCache` as its backing map, and the local cache expires an entry, that event causes Coherence to expire all of the backup copies of that entry. Furthermore, if any listeners have been registered on the partitioned cache, and if the event matches their event filter(s), then that event is delivered to those listeners on the servers where those listeners were registered.

In some advanced use cases, an application must process events on the server where the data are being maintained, and it must do so on the structure (backing map) that is actually managing the data. In these cases, if the backing map is an observable map, a listener can be configured on the backing map or one can be programmatically added to the backing map. (If the backing map is not observable, it can be made observable by wrapping it in an `WrapperObservableMap`.)

Each backing map event is dispatched once and only once. However, multiple backing map events could be generated from a single `put`. For example, if the entry from `put` has to be redistributed, then distributed events (deleted from original node, and inserted in a new node) are created. In this case, the backing map listener is called multiple times for the single `put`.

Lastly, backing map listeners are always synchronous; they are fired on a thread that is doing the modification operation while holding the synchronization monitor for the backing map itself. Often times for internal backing map listeners, events are not processed immediately, but are queued and processed later asynchronously.

For more information on this feature, see the API documentation for `BackingMapManager`.

Producing Readable Backing MapListener Events from Distributed Caches

Backing `MapListener` events are returned from replicated caches in readable Java format. However, backing `MapListener` events returned from distributed caches are in internal Coherence format. The Coherence Incubator Common project provides an `AbstractMultiplexingBackingMapListener` class that enables you to obtain readable backing `MapListener` events from distributed caches. See <http://coherence.oracle.com/display/INCUBATOR/Coherence+Common> to download Coherence Common libraries.

To produce readable backing `MapListener` events from distributed caches:

1. Implement the `AbstractMultiplexingBackingMapListener` class.
2. Register the implementation in the `<listener>` section of the `backing-map-scheme` in the `cache-config` file.
3. Start the cache server application file and the client file with the `cacheconfig` Java property:

```
-Dtangosol.coherence.cacheconfig="cache-config.xml"
```

The `AbstractMultiplexingBackingMapListener` class provides an `onBackingMapEvent` method which you can override to specify how you would like the event returned.

The following listing of the `VerboseBackingMapListener` class is a sample implementation of `AbstractMultiplexingBackingMapListener`. The `onBackingMapEvent` method has been over-ridden to send the results to standard output.

Example 25–15 An AbstractMultiplexingBackingMapListener Implementation

```
import com.tangosol.net.BackingMapManagerContext;
import com.tangosol.util.MapEvent;

public class VerboseBackingMapListener extends
AbstractMultiplexingBackingMapListener {

    public VerboseBackingMapListener(BackingMapManagerContext context) {
        super(context);
    }

    @Override
    protected void onBackingMapEvent(MapEvent mapEvent, Cause cause) {

        System.out.printf("Thread: %s Cause: %s Event: %s\n",
            Thread.currentThread().getName(), cause, mapEvent);
    }
}
```

Example 25–16 is an example distributed scheme definition. In the `<listener>` section of the file, the `VerboseBackingMapListener` is identified as being of type `com.tangosol.net.BackingMapManagerContext`.

Example 25–16 Distributed Scheme Specifying a Verbose Backing Map Listener

```
<distributed-scheme>
```

```

<scheme-name>my-dist-scheme</scheme-name>
<service-name>DistributedCache</service-name>
  <backing-map-scheme>
    <read-write-backing-map-scheme>
      <internal-cache-scheme>
        <local-scheme>
          <high-units>0</high-units>
          <expiry-delay>0</expiry-delay>
        </local-scheme>
      </internal-cache-scheme>
    <cachestore-scheme>
      <class-scheme>
        <class-name>CustomCacheStore</class-name>
        <init-params>
          <init-param>
            <param-type>java.lang.String</param-type>
            <param-value>{cache-name}</param-value>
          </init-param>
        </init-params>
      </class-scheme>
    </cachestore-scheme>
  <listener>
    <class-scheme>
      <class-name>VerboseBackingMapListener</class-name>
      <init-params>
        <init-param>
          <param-type>com.tangosol.net.BackingMapManagerContext
          </param-type>
          <param-value>{manager-context}</param-value>
        </init-param>
      </init-params>
    </class-scheme>
  </listener>
</read-write-backing-map-scheme>
</backing-map-scheme>
<autostart>true</autostart>
</distributed-scheme>

```

Using Synchronous Event Listeners

Some events are delivered asynchronously, so that application listeners do not disrupt the cache services that are generating the events. In some rare scenarios, asynchronous delivery can cause ambiguity of the ordering of events compared to the results of ongoing operations. To guarantee that the cache API operations and the events are ordered as if the local view of the clustered system were single-threaded, a `MapListener` must implement the `SynchronousListener` marker interface.

One example in Coherence itself that uses synchronous listeners is the Near Cache, which can use events to invalidate locally cached data ("Seppuku").

For more information on this feature, see the API documentation for `MapListenerSupport.SynchronousListener`.

Controlling Map Operations with Triggers

This chapter provides instructions for using map triggers to validate, reject, or modify map operations before a change is committed to a map entry.

This chapter contains the following sections:

- [Overview of Map Triggers](#)
- [A Map Trigger Example](#)

Overview of Map Triggers

Map triggers supplement the standard capabilities of Coherence to provide a highly customized cache management system. Map triggers can be used to prevent invalid transactions, enforce complex security authorizations or complex business rules, provide transparent event logging and auditing, and gather statistics on data modifications. Other possible use for triggers include restricting operations against a cache to those issued during application re-deployment time.

For example, assume that you have code that is working with a `NamedCache`, and you want to change an entry's behavior or contents before the entry is inserted into the map. The addition of a map trigger enables you to make this change without having to modify all the existing code.

Map triggers could also be used as part of an upgrade process. The addition of a map trigger could prompt inserts to be diverted from one cache into another.

A map trigger in the Coherence cache is somewhat similar to a trigger that might be applied to a database. It is a functional agent represented by the `MapTrigger` interface that is run in response to a pending change (or removal) of the corresponding map entry. The pending change is represented by the `MapTrigger.Entry` interface. This interface inherits from the `InvocableMap.Entry` interface, so it provides methods to retrieve, update, and remove values in the underlying map.

The `MapTrigger` interface contains the `process` method that is used to validate, reject, or modify the pending change in the map. This method is called before an operation that intends to change the underlying map content is committed. An implementation of this method can evaluate the pending change by analyzing the original and the new value and produce any of the following results:

- override the requested change with a different value
- undo the pending change by resetting the original value
- remove the entry from the underlying map
- reject the pending change by throwing a runtime exception

- do nothing, and allow the pending change to be committed

MapTrigger functionality is typically added as part of an application start-up process. It can be added programmatically as described in the MapTrigger API, or it can be configured using the class-factory mechanism in the coherence-cache-config.xml configuration file. In this case, a MapTrigger is registered during the very first CacheFactory.getCache(...) call for the corresponding cache. [Example 26-1](#) assumes that the createMapTrigger method would return a new MapTriggerListener(new MyCustomTrigger());:

Example 26-1 Example MapTriggerListener Configuration

```
<distributed-scheme>
  ...
  <listener>
    <class-scheme>
      <class-factory-name>package.MyFactory</class-factory-name>
      <method-name>createTriggerListener</method-name>
      <init-params>
        <init-param>
          <param-type>string</param-type>
          <param-value>{cache-name}</param-value>
        </init-param>
      </init-params>
    </class-scheme>
  </listener>
</distributed-scheme>
```

In addition to the MapTrigger.Entry and MapTrigger interfaces, Coherence provides the FilterTrigger and MapTriggerListener classes. The FilterTrigger is a generic MapTrigger implementation that performs a predefined action if a pending change is rejected by the associated Filter. The FilterTrigger can either reject the pending operation, ignore the change and restore the entry's original value, or remove the entry itself from the underlying map.

The MapTriggerListener is a special purpose MapListener implementation that is used to register a MapTrigger with a corresponding NamedCache. In [Example 26-2](#), MapTriggerListener is used to register the PersonMapTrigger with the People named cache.

Example 26-2 A MapTriggerListener Registering a MapTrigger with a Named Cache

```
NamedCache person = CacheFactory.getCache("People");
MapTrigger trigger = new PersonMapTrigger();
person.addMapListener(new MapTriggerListener(trigger));
```

These API reside in the com.tangosol.util package. For more information on these API, see *Java API Reference for Oracle Coherence*.

A Map Trigger Example

The code in [Example 26-3](#) illustrates a map trigger and how it can be called. In the PersonMapTrigger class, the process method is implemented to modify an entry before it is placed in the map. In this case, the last name attribute of a Person object is converted to upper case characters. The object is then returned to the entry.

Example 26-3 A MapTrigger Class

```
...
```

```

public class PersonMapTrigger implements MapTrigger
{
    public PersonMapTrigger()
    {
    }

    public void process(MapTrigger.Entry entry)
    {
        Person person = (Person) entry.getValue();
        String sName = person.getLastName();
        String sNameUC = sName.toUpperCase();

        if (!sNameUC.equals(sName))
        {
            person.setLastName(sNameUC);

            System.out.println("Changed last name of [" + sName + "] to [" +
                person.getLastName() + "]);

            entry.setValue(person);
        }
    }

    // ---- hashCode() and equals() must be implemented

    public boolean equals(Object o)
    {
        return o != null && o.getClass() == this.getClass();
    }

    public int hashCode()
    {
        return getClass().getName().hashCode();
    }
}

```

The `MapTrigger` in [Example 26-4](#), calls the `PersonMapTrigger`. The new `MapTriggerListener` passes the `PersonMapTrigger` to the `People NamedCache`.

Example 26-4 *Calling a MapTrigger and Passing it to a Named Cache*

...

```

public class MyFactory
{
    /**
     * Instantiate a MapTriggerListener for a given NamedCache
     */
    public static MapTriggerListener createTriggerListener(String sCacheName)
    {
        MapTrigger trigger;
        if ("People".equals(sCacheName))
        {
            trigger = new PersonMapTrigger();
        }
        else
        {
            throw IllegalArgumentException("Unknown cache name " + sCacheName);
        }
    }
}

```

```
        System.out.println("Creating MapTrigger for cache " + sCacheName);

        return new MapTriggerListener(trigger);
    }

    public static void main(String[] args)
    {
        NamedCache cache = CacheFactory.getCache("People");
        cache.addMapListener(createTriggerListener("People"));

        System.out.println("Installed MapTrigger into cache People");
    }
}
```

Using Live Events

This chapter describes live events and provides instructions for being notified of events using event interceptors. Applications use live events to react to cluster operations with application logic.

This chapter includes the following sections:

- [Overview of Live Events](#)
- [Understanding Live Event Types](#)
- [Handling Live Events](#)

Overview of Live Events

Coherence provides an event programming model that allows extensibility within a cluster when performing operations against a data grid. The model uses events to represent observable occurrences of cluster operations. The events that are currently supported include:

- **Partitioned Cache Events** – A set of events that represent the operations being performed against a set of entries in a cache. Partitioned cache events include both entry events and entry processor events. Entry events are related to inserting, removing, and updating entries in a cache. Entry processor events are related to the execution of entry processors.
- **Partitioned Service Events** – A set of events that represent the operations being performed by a partitioned service. Partitioned service events include both partition transfer events and partition transaction events. Partition transfer events are related to the movement of partitions among cluster members. Partition transaction events are related to changes that may span multiple caches and are performed within the context of a single request.
- **Lifecycle Events** – A set of events that represent the activation and disposal of a `ConfigurableCacheFactory` instance.

Applications create and register event interceptors to consume events. Event interceptors handle the events and implement any custom logic as required. Events have different rules which govern whether or not mutable actions may be performed upon receiving the event.

Understanding Live Event Types

Event types represent observable occurrences of cluster operations. Applications handle the events using event interceptors and decide what action to take based on the

event type. This section describes each of the supported event types and is organized according to the functional areas in which the events are raised.

The following topics are included in this section:

- [Understanding Partitioned Cache Events](#)
- [Understanding Partitioned Service Events](#)
- [Understanding Lifecycle Events](#)

Understanding Partitioned Cache Events

Partitioned cache events represent operations that are performed against a set of entries in a cache. Partitioned cache events include entry events (`EntryEvent`) and entry processor events (`EntryProcessorEvent`). These events are defined within the `com.tangosol.net.events.partition.cache` package.

Entry Events

Entry events represent operations for inserting, removing, and updating entries in a cache. Precommit entry events (`INSERTING`, `REMOVING`, and `UPDATING`) are raised before the operation is performed to allow modification to an entry. The following holds true when modifying entries:

- Event interceptors that are registered for precommit entry events are synchronously called.
- A lock is held for each entry during the processing of the event to prevent concurrent updates.
- Throwing an exception prevents the operation from being committed.

Postcommit entry events (`INSERTED`, `REMOVED`, and `UPDATED`) are raised after an operation is performed and in the same order as the events occurred. Postcommit events indicate that an entry is no longer able to be modified. Event interceptors for postcommit entry events are asynchronously processed.

[Table 27–1](#) lists the entry event types.

Table 27–1 *Entry Events*

Event Types	Description
<code>INSERTING</code>	Indicates that an entry (or multiple entries) is going to be inserted in the cache.
<code>INSERTED</code>	Indicates that an entry (or multiple entries) has been inserted in the cache.
<code>REMOVING</code>	Indicates that an entry (or multiple entries) is going to be removed from the cache.
<code>REMOVED</code>	Indicates that an entry (or multiple entries) has been removed from the cache.
<code>UPDATING</code>	Indicates that an entry (or multiple entries) is going to be updated in the cache.
<code>UPDATED</code>	Indicates that an entry (or multiple entries) has been updated in the cache.

Entry Processor Events

Entry processor events represent the execution of an entry processor on a set of binary entries. Precommit entry processor events (`EXECUTING`) are raised before an entry

processor is executed to allow modification to the entry processor instance. The following holds true when modifying an entry processor:

- Event interceptors that are registered for precommit entry processor events are synchronously called.
- Entry processors can be shared across threads; therefore, ensure thread safety when modifying an entry processor.
- A lock is held for each entry during the processing of the event to prevent concurrent updates.
- Throwing an exception prevents the entry processor from being executed.

Postcommit entry processor events (`EXECUTED`) are raised after an entry processor is executed and in the same order that the events occurred. Postcommit events indicate that an entry is no longer able to be modified. Event interceptors for postcommit entry processor events are asynchronously processed.

[Table 27–2](#) lists the entry processor event types.

Table 27–2 *Entry Processor Events*

Event Types	Description
<code>EXECUTING</code>	Indicates that an entry processor is going to be executed on a set of entries.
<code>EXECUTED</code>	Indicates that an entry processor has been executed on a set of entries.

Understanding Partitioned Service Events

Partitioned service events represent operations being performed by a partitioned service. Partitioned service events include transfer events (`TransferEvent`) and transaction events (`TransactionEvent`). These events are defined within the `com.tangosol.net.events.partition` package.

Transfer Events

Partitioned service transfer events represent partition transfers between storage enabled members. The event includes the service name for which the transfer is taking place, the partition ID, the cluster members involved in the transfer and a map of cache names to entries. The entries cannot be modified.

Note: Transfer events are raised while holding a lock on the partition being transferred that blocks any operations for the partition.

[Table 27–3](#) lists the transition event types.

Table 27–3 *Transition Events*

Event Types	Description
<code>DEPARTING</code>	Indicates that a set of entries are being transferred from the current member.
<code>ARRIVED</code>	Indicates that a set of entries has been transferred to or restored by the current member.

Transaction Events

Partitioned service transaction events represent changes to binary entries (possibly from multiple caches) that are made in the context of a single service request.

Precommit transaction events (`COMMITTING`) are raised before any operations are performed to allow modification to the entries. The following holds true when modifying entries:

- A lock is held for each entry during the processing of the event to prevent concurrent updates.
- Throwing an exception prevents the operation from being committed.

Postcommit transaction events (`COMMITTED`) are raised after an operation is performed. Postcommit events indicate that the entries are no longer able to be modified.

Table 27–4 lists the transaction event types.

Table 27–4 Transaction Events

Event Types	Description
<code>COMMITTING</code>	Indicates that entries are going to be inserted in their respective cache.
<code>COMMITTED</code>	Indicates that entries have been inserted in their respective cache.

Understanding Lifecycle Events

Lifecycle events (`LifecycleEvent`) represent actions that occur on a `ConfigurableCacheFactory` instance. These events are defined within the `com.tangosol.net.events.application` package.

An `ACTIVATED` event is raised after all services that are associated with a cache factory are started. The services are defined in the cache configuration file and must be configured to autostart. A `DISPOSING` event is raised before all services are shut down and any resources are reclaimed. Event interceptors that handle a `DISPOSING` event are notified before the services are shutdown. A `ConfigurableCacheFactory` instance can only be activated and disposed of once.

Note: Lifecycle events are dispatched to event interceptors by the same thread calling the lifecycle methods on the `ConfigurableCacheFactory` implementation. This thread may be synchronized. Event interceptors must ensure that any spawned threads do not synchronize on the same `ConfigurableCacheFactory` object.

Table 27–5 lists the lifecycle event types.

Table 27–5 Lifecycle Events

Event Types	Description
<code>ACTIVATED</code>	Indicates that a <code>ConfigurableCacheFactory</code> instance is active.
<code>DISPOSING</code>	Indicates that a <code>ConfigurableCacheFactory</code> instance is going to be disposed.

Handling Live Events

Applications handle live events using event interceptors. 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.

This section includes the following topics:

- [Creating Event Interceptors](#)
- [Understanding Event Threading](#)
- [Registering Event Interceptors](#)
- [Chaining Event Interceptors](#)

Creating Event Interceptors

Event interceptors are created by implementing the `EventInterceptor` interface. The interface is defined using generics and allows you to subscribe to events 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 *Java API Reference for Oracle Coherence*. The following example demonstrates subscribing to all transfer events and is taken from [Example 27-1](#):

```
public class RedistributionInterceptor
    implements EventInterceptor<TransferEvent>

    public void onEvent(TransferEvent event)
    {
        ...
    }
```

The `@Interceptor` annotation can be used to further restrict the events to specific event types and also provides further configuration of the interceptor. The following example defines an interceptor identifier and restricts the events to only transfer DEPARTING events:

```
@Interceptor(identifier = "redist", transferEvents = TransferEvent.Type.DEPARTING)
public class RedistributionInterceptor
    implements EventInterceptor<TransferEvent>

    public void onEvent(TransferEvent event)
    {
        ...
    }
```

The `@Interceptor` annotation includes the following attributes:

- `identifier` – Specifies a unique identifier for the interceptor. The identifier can be overridden when registering an interceptor class in the cache configuration file. This attribute is optional. A unique name is automatically generated by the event infrastructure if the attribute is omitted.
- `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. See ["Chaining Event Interceptors"](#) on page 27-10. The legal values are `LOW` and `HIGH`. A value of `HIGH` indicates that the interceptor is placed at the front of the chain of interceptors. A value of `LOW` indicates no order preference. The default value is `LOW`. The order can be overridden when registering an interceptor class in the cache configuration file.

The following example demonstrates a basic event interceptor implementation that subscribes to all transfer event types (both `DEPARTING` and `ARRIVED`). The `onEvent` method simply logs the events to show partition activity. The example is part of the Coherence examples.

Note: Event instances are immutable and their lifecycle is controlled by the underlying system. References to event classes must not be held across multiple invocations of the `onEvent()` method.

Example 27-1 Example Event Interceptor Implementation

```
package com.tangosol.examples.events;
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;

@Interceptor(identifier = "redist")
public class RedistributionInterceptor
    implements EventInterceptor<TransferEvent>
{

    public void onEvent(TransferEvent event)
    {
        CacheFactory.log(String.format("Discovered event %s for partition-id %d
            from remote member %s\n", event.getType(), event.getPartitionId(),
            event.getRemoteMember()), CacheFactory.LOG_INFO);
    }
}
```

Understanding Event Threading

Event interceptors can have a significant impact on cache operations and must be careful not to block or otherwise affect any underlying threads. The impact for both precommit event types and postcommit event types should be carefully considered when creating event interceptors.

Note: `EventInterceptor` instances can be reused; however, they should be immutable or thread-safe so that they can be dispatched by multiple threads concurrently.

Precommit Events

Precommit event types allow event interceptors to modify entries before the entries are committed to a cache. The interceptors are processed synchronously and must not perform long running operations (such as database access) that could potentially block or slow cache operations. Calls to external resource must always return as quickly as possible to avoid blocking cache operations.

Configure a thread pool for a partitioned service if event interceptors are to handle precommit events. The thread pool is disabled by default and requires setting the `<thread-count>` element within a distributed cache definition. For details on the `<thread-count>` element, see "[distributed-scheme Subelements](#)" on page B-33. The thread pool creates additional threads to process cache operations and helps alleviate the overall impact of event interceptors that handle precommit events, but the potential for blocking still exists.

Postcommit Events

Postcommit events do not allow an event interceptor to modify entries. The events are raised in the same order as the events occurred and the interceptors are processed asynchronously. Event interceptors that perform long running operations can cause a backlog of requests that could ultimately affect performance. It is a best practice to use the Java Executor service to perform such operations on a separate thread.

Registering Event Interceptors

Event interceptors are registered within a cache configuration file. Event interceptors are registered either for a specific cache or for a partitioned service. Event interceptors that are registered for a specific cache only receive events that pertain to that cache. Event interceptors that are registered for a partitioned service receive events for all caches that are managed by the service.

Note: Event interceptors for service-level events (such as transfer events and transaction events) must be registered for a partitioned service and cannot be restricted to a specific cache.

This section contains the following topics:

- [Registering Event Interceptors For a Specific Cache](#)
- [Registering Event Interceptors For a Partitioned Service](#)
- [Registering Event Interceptors For a Cache Configuration Factory](#)
- [Using Custom Registration](#)
- [Guidelines for Registering Event Interceptors](#)

Registering Event Interceptors For a Specific Cache

To register interceptors on a specific cache, include an `<interceptors>` element, within a `<cache-mapping>` element, that includes any number of `<interceptor>` subelements. Each `<interceptor>` element must include an `<instance>` subelement and provide a fully qualified class name that implements the `EventInterceptor` interface. See "["interceptor"](#)" on page B-55 for a detailed reference of the `<interceptor>` element. The following example registers an event interceptor class called `MyInterceptor`.

```
<caching-scheme-mapping>
  <cache-mapping>
    <cache-name>example</cache-name>
    <scheme-name>distributed</scheme-name>
    <interceptors>
      <interceptor>
        <name>MyInterceptor</name>
        <instance>
          <class-name>
            com.tangosol.examples.events.MyInterceptor
          </class-name>
        </instance>
      </interceptor>
    </interceptors>
  </cache-mapping>
</caching-scheme-mapping>
```

```

        </class-name>
    </instance>
</interceptor>
</interceptors>
</cache-mapping>
</caching-scheme-mapping>

```

Registering Event Interceptors For a Partitioned Service

To register interceptors on a partitioned service, include an `<interceptors>` element, within a `<distributed-scheme>` element, that includes any number of `<interceptor>` subelements. Each `<interceptor>` element must include an `<instance>` subelement and provide a fully qualified class name that implements the `EventInterceptor` interface. See ["interceptor"](#) on page B-55 for a detailed reference of the `<interceptor>` element. The following example registers the `RedistributionInterceptor` class defined in [Example 27-1](#).

```

<distributed-scheme>
  <scheme-name>distributed</scheme-name>
  <service-name>PartitionedService1</service-name>
  <backing-map-scheme>
    <local-scheme/>
  </backing-map-scheme>
  <autostart>true</autostart>
  <interceptors>
    <interceptor>
      <name>MyInterceptor</name>
      <instance>
        <class-name>
          com.tangosol.examples.events.RedistributionInterceptor
        </class-name>
      </instance>
    </interceptor>
  </interceptors>
</distributed-scheme>

```

Registering Event Interceptors For a Cache Configuration Factory

To register interceptors on a `ConfigurableCacheFactory` instance, include an `<interceptors>` element, within a `<cache-config>` element, that includes any number of `<interceptor>` subelements. Each `<interceptor>` element must include an `<instance>` subelement and provide a fully qualified class name that implements the `EventInterceptor` interface. See ["interceptor"](#) on page B-55 for a detailed reference of the `<interceptor>` element. The following example registers an event interceptor class called `MyInterceptor`.

```

<cache-config>
  <interceptors>
    <interceptor>
      <name>MyInterceptor</name>
      <instance>
        <class-name>com.tangosol.examples.events.MyInterceptor</class-name>
      </instance>
    </interceptor>
  </interceptors>
  ...
</cache-config>

```

Using Custom Registration

The `@Interceptor` annotation and generic types are used by the event infrastructure to register event interceptors with the appropriate event dispatcher. This mechanism is acceptable for most use cases. However, for advanced use cases, an event interceptor can choose to implement the `EventDispatcherAwareInterceptor` interface and manually register an event interceptor with the required event dispatcher.

The `introduceEventDispatcher` method includes the event dispatcher to which the interceptor will be registered. The methods on the dispatcher are then used to add and remove interceptors, restrict specific event types, and configure the interceptor as required. The following example shows a custom implementation that explicitly registers an interceptor, subscribes to entry `INSERTING` events, and configures ordering to ensure that the interceptor is called and notified first:

```
public void introduceEventDispatcher(String sIdentifier, EventDispatcher
    dispatcher)
{
    dispatcher.addEventInterceptor(sIdentifier, this,
        new HashSet(Arrays.asList(EntryEvent.Type.INSERTING)), true);
}
```

Note: If an interceptor is configured without using the annotations, then the configuration cannot be overridden using the cache configuration file.

Interceptors can also be programmatically registered using the `InterceptorRegistry` API. Registering an interceptor causes it to be introduced to all currently registered and future event dispatchers. An interceptor can determine whether or not to bind to a dispatcher by using the `introduceEventDispatcher` method as shown in the previous example.

The `InterceptorRegistry` API is available from the `ConfigurableCacheFactory` interface and is called using the `getInterceptorRegistry` method. The API can be used together with the cache configuration file when declaratively registering interceptors. The API is often used with custom `DefaultCacheServer` implementations to add interceptors programmatically, or the API is used to selectively register interceptors when using the `InvocationService` interface. The following example demonstrates registering an interceptor.

```
CacheFactory.getConfigurableCacheFactory().getInterceptorRegistry()
    .registerEventInterceptor(new MyEventIntercepor());
```

Guidelines for Registering Event Interceptors

Interceptors can be registered in multiple distributed schemes for the same service. In addition, interceptor classes can be inherited if a distributed scheme uses scheme references. In both cases, the interceptor classes are registered with the service.

For most cases, registering multiple interceptor classes is not an issue. However, there are increased chances for duplicating the same interceptor classes and identifier names for a given service. The following guidelines should be followed to ensure registration errors do not occur because of duplication:

- An interceptor class can be duplicated multiple time in a distributed scheme or in multiple schemes of the same service as long as the identifier names are unique or no identifier name is defined. For the later, a unique name is automatically generated by the event infrastructure.

- An interceptor class (duplicated or not) with the same identifier name cannot be registered multiple times in a distributed scheme and results in a registration error.
- An interceptor class that is inherited by scheme reference is registered once for each distinct service name in the reference chain.

Chaining Event Interceptors

Event interceptors that are registered for the same event type are serially called by the thread responsible for dispatching an event. The ability to chain interceptors in this manner allows complex processing scenarios where custom logic is executed based on the outcome of other interceptors in the chain. Each event interceptor in a chain can:

- Modify data associated with the event if allowed. For example, precommit operations such as `INSERTING`, `UPDATING`, and `REMOVING` entry events allow data modifications.
- Deny a precommit operations by throwing an exception.
- Enlist a new entry into a partition-level transaction.
- Observe the results of any side effects caused by event interceptors further down the chain. If the interceptor chain is associated with a precommitted storage event, the ability to observe the results provides a second opportunity to deny the processing.

Observing the side effects of downstream event interceptors is accomplished using the `Event.nextInterceptor` method. When this method returns, it signifies that all downstream event interceptors executed and any changes to the state associated with the event can be inspected. The `Event` object holds state on the processing of the event. The event calls each event interceptor's `onEvent` method as long as there are still event interceptors in the chain. If the event interceptor itself calls the `Event.nextInterceptor` method, it triggers the next event interceptor in the chain to execute. If the event interceptor returns, the event itself triggers the next event interceptor in the chain's `onEvent` method. Either way, all event interceptors are executed, but those that choose to call the `nextInterceptor` method have the option of taking action based on the side effects that are observed.

Specifying an Event Interceptor Chain Order

Event interceptors in a chain are executed based on the order in which they are registered. Use the `order` attribute on the `@Interceptor` annotation to specify whether an interceptor is placed in the front of the chain. A value of `HIGH` places the interceptor at the front of the chain. A value of `LOW` indicates no order preference and is the default value. For example:

```
@Interceptor(identifier = "MyInterceptor",
             entryEvents = {Type.INSERTING, Type.INSERTED}
             order = Order.HIGH)
public class MyInterceptor
    implements EventInterceptor<EntryEvent>
...

```

The order can also be specified declaratively when registering an event interceptor in the cache configuration file and overrides the `order` attribute that is specified in an event interceptor class.

To specify the ordering of interceptors in the cache configuration file, include an `<order>` element, within an `<interceptor>` element, that is set to HIGH or LOW. For example:

```
<interceptors>
  <interceptor>
    <name>MyInterceptor</name>
    <order>HIGH</order>
    <instance>
      <class-name>package.MyInterceptor</class-name>
    </instance>
  </interceptor>
  <interceptor>
    <name>MySecondInterceptor</name>
    <instance>
      <class-name>package.MySecondInterceptor</class-name>
    </instance>
  </interceptor>
</interceptors>
```

Using Coherence Query Language

This chapter describes how to use Coherence Query Language (CohQL) to interact with Coherence caches. CohQL is a light-weight syntax (in the tradition of SQL) that is used to perform cache operations on a Coherence cluster. The language can be used either programmatically or from a command-line tool.

This chapter includes the following sections:

- [Understanding Coherence Query Language Syntax](#)
- [Using the CohQL Command-Line Tool](#)
- [Building Filters in Java Programs](#)
- [Additional Coherence Query Language Examples](#)

Note:

- Although the CohQL syntax may appear similar to SQL, it is important to remember that the syntax is *not* SQL and is actually more contextually related to the Java Persistence Query Language (JPQL) standard.
 - CQL (Continuous Query Language) is a query language related to Complex Event Processing (CEP) and should not be confused with CohQL.
-
-

Understanding Coherence Query Language Syntax

The following sections describe the functionality provided by CohQL. Each section describes a particular statement, its syntax, and an example. You can find more query examples in "[Additional Coherence Query Language Examples](#)" on page 28-15.

Note: CohQL does not support subqueries.

This section includes the following topics:

- [Query Syntax Basics](#)
- [Retrieving Data](#)
- [Managing the Cache Lifecycle](#)
- [Working with Cache Data](#)
- [Working with Indexes](#)

- [Issuing Multiple Query Statements](#)
- [Viewing Query Cost and Effectiveness](#)

For reference, [Table 28–1](#) lists the Coherence query statements, clauses, and expressions in alphabetical order.

Table 28–1 Coherence Query Language Statements

For this statement, clause, or expression...	See this section
BACKUP CACHE	Writing a Serialized Representation of a Cache to a File
bind variables	Using Bind Variables
CREATE CACHE	Creating a Cache
CREATE INDEX	Creating an Index on the Cache
DELETE	Deleting Entries in the Cache
DROP CACHE	Removing a Cache from the Cluster
DROP INDEX	Removing an Index from the Cache
ENSURE CACHE	Creating a Cache
ENSURE INDEX	Creating an Index on the Cache
GROUP BY	Aggregating Query Results
INSERT	Inserting Entries in the Cache
key() pseudo-function	Using Key and Value Pseudo-Functions
path-expressions	Using Path-Expressions
RESTORE CACHE	Loading Cache Contents from a File
SELECT	Retrieving Data from the Cache
SOURCE	Processing Query Statements in Batch Mode
UPDATE	Changing Existing Values
value() pseudo-function	Using Key and Value Pseudo-Functions
WHERE	Filtering Entries in a Result Set

Query Syntax Basics

This section describes some building blocks of the syntax, such as path expressions, bind variables, and pseudo-functions.

Using Path-Expressions

One of the main building blocks of CohQL are path-expressions. Path expressions are used to navigate through a graph of object instances. An identifier in a path expression is used to represent a property in the Java Bean sense. It is backed by a `ReflectionExtractor` that is created by prepending a `get` and capitalizing the first letter. Elements are separated by the "dot" (.) character, that represents object traversal. For example the following path expression is used to navigate an object structure:

```
a.b.c
```

It reflectively invokes these methods:

```
getA().getB().getC()
```

Using Bind Variables

For programmatic uses, the API passes strings to a simple set of query functions. Use bind variables to pass the value of variables without engaging in string concatenation. There are two different formats for bind variables.

- the question mark (?)—Enter a question mark, immediately followed by a number to signify a positional place holder that indexes a collection of objects that are "supplied" before the query is run. The syntax for this form is: `?n` where *n* can be any number. Positional bind variables can be used by the `QueryHelper` class in the construction of filters. For example:

```
QueryHelper.createFilter("number = ?1" , new Object[]{new Integer(42)};
```

- the colon (:)—Enter a colon, immediately followed by the identifier to be used as a named place holder for the object to be supplied as a key value pair. The syntax for this is `:identifier` where *identifier* is an alpha-numeric combination, starting with an alphabetic character. Named bind variables can be used by the `QueryHelper` class in the construction of filters. For example:

```
HashMap env = new HashMap();
env.put("iNum",new Integer(42));
QueryHelper.createFilter("number = :iNum" , env);
```

See "[Building Filters in Java Programs](#)" on page 28-14 for more information on the `QueryHelper` class and constructing filters programmatically.

Using Key and Value Pseudo-Functions

CohQL provides a `key()` pseudo-function because many users store objects with a `key` property. The `key()` represents the cache's key. The query syntax also provides a `value()` pseudo-function. The `value()` is implicit in chains that do not start with `key()`. The `key()` and `value()` pseudo-functions are typically used in `WHERE` clauses, where they test against the key or value of the cache entry. For examples of using `key()` and `value()`, see "[Key and Value Pseudo-Function Examples](#)" on page 28-17 and "[A Command-Line Example](#)" on page 28-12.

Using Aliases

Although not needed semantically, CohQL supports aliases to make code artifacts as portable as possible to JPQL. CohQL supports aliases attached to the cache name and at the head of dotted path expressions in the `SELECT`, `UPDATE`, and `DELETE` commands. CohQL also allows the cache alias as a substitute for the `value()` pseudo function and as an argument to the `key()` pseudo function.

Using Quotes with Literal Arguments

Generally, you do not have to enclose literal arguments (such as *cache-name* or *service-name*) in quotes. Quotes (either single or double) would be required only if the argument contains an operator (such as `-`, `+`, `..`, `<`, `>`, `=`, and so on) or whitespace.

Filenames should also be quoted. Filenames often contain path separators (`/` or `\`) and dots to separate the name from the extension.

The compiler throws an error if it encounters an *unquoted* literal argument or filename that contains an offending character.

Retrieving Data

The following sections describe the `SELECT` statement and the `WHERE` clause. These entities are the basic building blocks of most cache queries.

Retrieving Data from the Cache

The `SELECT` statement is the basic building block of a query: it retrieves data from the cache. The clause can take several forms, including simple and complex path expressions, key expressions, transformation functions, multiple expressions, and aggregate functions. The `SELECT` statement also supports the use of aliases.

The form of the `SELECT` statement is as follows:

```
SELECT (properties* aggregators* | * | alias)
FROM "cache-name" [[AS] alias]
[WHERE conditional-expression] [GROUP [BY] properties+]
```

The asterisk (*) character represents the full object instead of subparts. It is not required to prefix a path with the `cache-name`. The `FROM` part of the `SELECT` statement targets the cache that forms the domain over which the query should draw its results. The `cache-name` is the name of an existing cache.

See "[Simple SELECT * FROM Statements that Highlight Filters](#)" on page 28-15 for additional examples.

Example:

- Select all of the items from the cache dept.

```
select * from "dept"
```

Filtering Entries in a Result Set

Use the `WHERE` clause to filter the entries returned in a result set. One of the key features of CohQL is that they can use path expressions to navigate object structure during expression evaluation. Conditional expressions can use a combination of logical operators, comparison expressions, primitive and function operators on fields, and so on.

In the literal syntax of the `WHERE` clause, use single quotes to enclose string literals; they can be escaped within a string by prefixing the quote with another single quote. Numeric expressions are defined according to the conventions of the Java programming language. Boolean values are represented by the literals `TRUE` and `FALSE`. Date literals are not supported.

Note: CohQL does not have access to type information. If a getter returns a numeric type different than the type of the literal, you may get a `false` where you would have expected a `true` on the comparison operators. The work around is to specify the type of the literal with `l`, for long, `d` for double, or `s` for short. The defaults are `Integer` for literals *without* a period (.) and `Float` for literals with a period (.).

Operator precedence within the `WHERE` clause is as follows:

1. Path operator (.)
2. Unary + and -
3. Multiplication (*) and division (/)

4. Addition (+) and subtraction (-)
5. Comparison operators: =, >, >=, <, <=, <>, [NOT] BETWEEN, [NOT] LIKE, [NOT] IN, IS [NOT] NULL, CONTAINS [ALL|ANY]
6. Logical operators (AND, OR, NOT)

The WHERE clause supports only arithmetic at the language level.

The BETWEEN operator can be used in conditional expressions to determine whether the result of an expression falls within an inclusive range of values. Numeric, or string expressions can be evaluated in this way. The form is: BETWEEN *lower* AND *upper*.

The LIKE operator can use the _ and % wildcards. The _ wildcard is used to match exactly one character, while the % wildcard is used to match zero or more occurrences of any characters. To escape the wildcards, precede them with an escape character that is defined using the escape keyword. The following example escapes the % wildcard using the \ escape character in order to select a key literally named k%1.

```
SELECT key(),value() FROM mycache WHERE key() LIKE "k\%1" escape "\"
```

In addition, any character may be defined as the escape character. For example:

```
SELECT key(),value() FROM mycache WHERE key() LIKE "k#%1" escape "#"
```

The IN operator can check whether a single-valued path-expression is a member of a collection. The collection is defined as an inline-list or expressed as a bind variable. The syntax of an inline-list is:

```
"(" literal* ")"
```

CONTAINS [ALL|ANY] are very useful operators because Coherence data models typically use de-normalized data. The CONTAINS operator can determine if a many-valued path-expression contains a given value. For example:

```
e.citys CONTAINS "Boston"
```

The ALL and ANY forms of CONTAINS take an inline-list or bind-variable with the same syntax as the IN operator.

Note: Coherence provides a programmatic API that enables you to create standalone Coherence filters based on the WHERE clause conditional-expression syntax. See "[Building Filters in Java Programs](#)" on page 28-14.

See "[Simple SELECT * FROM Statements that Highlight Filters](#)" on page 28-15 for additional examples.

Example:

- Select all of the items in the cache dept where the value of the deptno key equals 10.

```
select * from "dept" where deptno = 10
```

Managing the Cache Lifecycle

The following sections describe how to create and remove caches. They also describe how to backup and restore cache contents.

Creating a Cache

Before sending queries, connect to an existing cache or create a new cache using the `CREATE CACHE` or `ENSURE CACHE` statements, respectively. This statement first attempts to connect to a cache with the specified *cache-name*. If the cache is not found in the cluster, Coherence attempts to create a cache with the specified name based on the current cache configuration file. This statement is especially useful on the command line. If you are using this statement in a program, you have the option of specifying service and classloader information instead of a name (classloaders cannot be accessed from the command line).

Note: Cache names and service names must be enclosed in quotes (either double-quotes (" ") or single-quotes (' ')) in a statement.

The syntax is:

```
[ CREATE | ENSURE ] CACHE "cache-name"  
[ SERVICE "service-name" ]
```

Example:

- Create a cache named dept.

```
create cache "dept"
```

Writing a Serialized Representation of a Cache to a File

Use the `BACKUP CACHE` statement to write a serialized representation of the given cache to a file represented by the given *filename*. The *filename* is an operating system-dependent path and must be enclosed in single or double quotes. The `BACKUP CACHE` statement is available only in the command-line tool. The syntax is:

```
BACKUP CACHE "cache-name" [ TO ] [ FILE ] "filename"
```

Note: The backup (and subsequent restore) functionality is designed for use in a development and testing environment and should not be used on a production data set as it makes no provisions to ensure data consistency. It is not supported as a production backup, snapshot, or checkpointing utility.

In particular:

- The backup is slow since it only operates on a single node in the cluster.
 - The backup is not atomic. That is, it misses changes to elements which occur during the backup and results in a dirty read of the data.
 - The backup stops if an error occurs and results in an incomplete backup. In such scenarios, an `IOException` is thrown that describes the error.
 - The backup is not forward or backward compatible between 3.x and 12.1.x.
-
-

Example:

- Write a serialized representation of the cache dept to the file `textfile`.

```
backup cache "dept" to file "textfile"
```

Loading Cache Contents from a File

Use the `RESTORE CACHE` statement to read a serialized representation of the given cache from a file represented by the given *filename*. The *filename* is an operating system-dependent path and must be enclosed in single or double quotes. The `RESTORE CACHE` statement is available only in the command-line tool. The syntax is:

```
RESTORE CACHE "cache-name" [ FROM ] [ FILE ] "filename"
```

Note: Backups cannot be restored between 3.x and 12.1.x versions of Coherence.

Example:

- Restore the cache `dept` from the file `textfile`.

```
restore cache "dept" from file "textfile"
```

Removing a Cache from the Cluster

Use the `DROP CACHE` statement to remove the specified cache completely from the cluster. The cache is removed by a call to the Java `destroy()` method. If any cluster member holds a reference to the dropped cache and tries to perform any operations on it, then the member receives an `IllegalStateException`. The syntax for the Coherence query `DROP CACHE` statement is:

```
DROP CACHE "cache-name"
```

Example:

- Remove the cache `orders` from the cluster.

```
drop cache "orders"
```

Working with Cache Data

The following sections describe how to work with data in the cache, such as inserting and deleting cache data and filtering result sets.

Aggregating Query Results

An aggregate query is a variation on the `SELECT` query. Use an aggregate query when you want to group results and apply aggregate functions to obtain summary information about the results. A query is considered an aggregate query if it uses an aggregate function or has a `GROUP BY` clause. The most typical form of an aggregate query involves the use of one or more grouping expressions followed by aggregate functions in the `SELECT` clause paired with the same lead grouping expressions in a `GROUP BY` clause.

CohQL supports these aggregate functions: `COUNT`, `AVG`, `MIN`, `MAX`, and `SUM`. The functions can operate on the `Double`, `Long`, and `BigDecimal` types. To specify a type, include the type followed by an underscore (`_`) as a prefix to the function. For example:

```
long_sum, bd_sum
```

The `Double` type is assumed if a type is not explicitly specified.

See ["Complex Queries that Feature Projection, Aggregation, and Grouping"](#) on page 28-16 for additional examples.

Example:

- Select the total amount and average price for items from the orders cache, grouped by supplier.

```
select supplier,sum(amount),avg(price) from "orders" group by supplier
```
- Select the total amount and average price (using a BigDecimal type) for items from the orders cache, grouped by supplier.

```
select supplier,bd_sum(amount),bd_avg(price) from "orders" group by supplier
```

Changing Existing Values

Use the UPDATE statement to change an existing value in the cache. The syntax is:

```
UPDATE "cache-name" [[AS] alias]
SET update-statement {, update-statement}*
[ WHERE conditional-expression ]
```

Each *update-statement* consists of a path expression, assignment operator (=), and an expression. The expression choices for the assignment statement are restricted. The right side of the assignment must resolve to a literal, a bind-variable, a static method, or a new Java-constructor with only literals or bind-variables. The UPDATE statement also supports the use of aliases.

See "[UPDATE Examples](#)" on page 28-17 for additional examples.

Example:

- For employees in the employees cache whose ranking is above grade 7, update their salaries to 1000 and vacation hours to 200.

```
update "employees" set salary = 1000, vacation = 200 where grade > 7
```

Inserting Entries in the Cache

Use the INSERT statement to store the given VALUE under the given KEY. If the KEY clause is not provided, then the newly created object is sent the message `getKey()`, if possible. Otherwise, the value object is used as the key.

Note that the INSERT statement operates on Maps of Objects. The syntax is:

```
INSERT INTO "cache-name"
[ KEY (literal | new java-constructor | static method) ]
VALUE (literal | new java-constructor | static method)
```

Example:

- Insert the key writer with the value David into the employee cache.

```
insert into "employee" key "writer" value "David"
```

Deleting Entries in the Cache

Use the DELETE statement to delete specified entries in the cache. The syntax is:

```
DELETE FROM "cache-name" [[AS] alias]
[WHERE conditional-expression]
```

The WHERE clause for the DELETE statement functions the same as it would for a SELECT statement. All *conditional-expressions* are available to filter the set of entities to be removed. The DELETE statement also supports the use of aliases.

Be Careful: If the `WHERE` clause is not present, then all entities in the given cache are removed.

Example:

- Delete the entry from the cache `employee` where `bar.writer` key is not David.

```
delete from "employee" where bar.writer IS NOT "David"
```

Working with Indexes

The following sections describe how to create and remove indexes on cache data. Indexes are a powerful tool that allows Coherence's built-in optimizer to more quickly and efficiently analyze queries and return results.

Creating an Index on the Cache

Use the `CREATE INDEX` or the `ENSURE INDEX` statement to create indexes on an identified cache. The syntax is:

```
[ CREATE | ENSURE ] INDEX [ON] "cache-name" (value-extractor-list)
```

The *value-extractor-list* is a comma-delimited list that uses path expressions to create `ValueExtractors`. If multiple elements exist, then a `MultiExtractor` is used. To create a `KeyExtractor`, then start the path expression with a `key()` pseudo-function.

Natural ordering for the index is assumed.

Example:

- Create an index on the attribute `lastname` in the `orders` cache.

```
create index "orders" lastname
```

Removing an Index from the Cache

The `DROP INDEX` statement removes the index based on the given `ValueExtractor`. This statement is available only for the command-line tool. The syntax is:

```
DROP INDEX [ON] "cache-name" (value-extractor-list)
```

Example:

- Remove the index on the `lastname` attribute in the `orders` cache.

```
drop index "orders" lastname
```

Issuing Multiple Query Statements

The following section describes how to more efficiently issue multiple query statements to the cache.

Processing Query Statements in Batch Mode

The `SOURCE` statement allows for the "batch" processing of statements. The `SOURCE` statement opens and reads one or more query statements from a file represented by the given *filename*. The *filename* is an operating system-dependent path and must be enclosed in single or double quotes. Each query statement in the file must be separated by a semicolon (;) character. Sourcing is available only in the command-line tool, where you naturally want to load files consisting of sequences of commands. Source files may source other files. The syntax is:

```
SOURCE FROM [ FILE ] "filename"
```

SOURCE can be abbreviated with an "at" symbol (@) as in @"filename". On the command line only, a "period" symbol '.' can be used as an abbreviation for '@' but must not contain quotes around the filename.

Example:

- Process the statements in the file `command_file`.

```
source from file "command_file"
```

or,

```
@ "command_file"
```

or,

```
. command_file
```

Viewing Query Cost and Effectiveness

The `EXPLAIN PLAN FOR` and `TRACE` commands are used to create and output query records that are used to determine the cost and effectiveness of a query. A query explain record provides the estimated cost of evaluating a filter as part of a query operation. A query trace record provides the actual cost of evaluating a filter as part of a query operation. Both query records take into account whether or not an index can be used by a filter. See ["Interpreting Query Records"](#) on page 22-10 for additional details on understanding the data provided in an explain plan record and trace record. The syntax for the commands are:

Query Explain Plan:

```
EXPLAIN PLAN FOR select statement | update statement | delete statement
```

Trace:

```
TRACE select statement | update statement | delete statement
```

Example:

```
EXPLAIN PLAN FOR select * from "mycache" where age=19 and firstName=Bob
```

or,

```
TRACE SELECT * from "MyCache" WHERE age=19
```

Using the CohQL Command-Line Tool

The CohQL command-line tool provides a non-programmatic way to interact with caches by allowing statements to be issued from the command line. The tool can be run using the `com.tangosol.coherence.dslquery.QueryPlus` class or, for convenience, a startup script is available to run the tool and is located in the `COHERENCE_HOME/bin/` directory. The script is available for both Windows (`query.cmd`) and UNIX (`query.sh`).

The script starts a cluster node in console mode; that is, storage is not enabled on the node. This is the suggested setting for production environments and assumes that the node joins a cluster that contains storage-enabled cache servers. However, a

storage-enabled node can be created for testing by changing the `storage_enabled` setting in the script to `true`.

Note: As configured, the startup script uses the default operational configuration file (`tangosol-coherence.xml`) and the default cache configuration file (`coherence-cache-config.xml`) that are located in the `coherence.jar` when creating/joining a cluster and configuring caches. For more information on configuring Coherence, see [Chapter 3, "Understanding Configuration."](#)

The script provides the option for setting the `COHERENCE_HOME` environment variable. If `COHERENCE_HOME` is not set on the computer, set it in the script to the location where Coherence was installed.

CohQL uses JLine for enhanced command-line editing capabilities, such as having the up and down arrows move through the command history. However, JLine is not required to use CohQL. The script automatically uses the `jline.jar` library that is located in the `COHERENCE_HOME/lib/` directory. A different location can be specified by modifying the `JLINE_HOME` variable and classpath in the script. If the JLine library is not found, a message displays and CohQL starts without JLine capabilities.

Starting the Command-line Tool

The following procedure demonstrates how to start the CohQL command-line tool using the startup script and assumes that the `storage_enabled` setting in the script is set to `false` (the default):

1. Start a cache server cluster node or ensure that an existing cache server cluster node is started.

To start a cache server cluster node, open a command prompt or shell and execute the cache server startup script that is located in the `/bin` directory: `cache-server.cmd` on the Windows platform or `cache-server.sh` for UNIX platforms. The cache server starts and output is emitted that provides information about this cluster member.

2. Open a command prompt or shell and execute the CohQL command-line startup script that is located in the `/bin` directory: `query.cmd` on the Windows platform or `query.sh` for UNIX platforms. Information about the Java environment displays. The command-line tool prompt (`CohQL>`) is returned.

Note: When joining an existing cache server node, modify the startup script to use the same cluster settings as the existing cache server node, including the same cache configuration.

3. Enter `help` at the prompt to view the complete command-line help. Enter commands to list the help without detailed descriptions.

See ["A Command-Line Example"](#) on page 28-12 for a series of query statements that exercise the command-line tool.

Using Command-Line Tool Arguments

The CohQL command-line tool includes a set of arguments that are read and executed before the `CohQL>` prompt returns. This is useful when using the script as part of a

larger script— for example, as part of a build process or to pipe I/O. Enter `help` at the `CohQL>` prompt to view help for the arguments within the command-line tool.

Table 28–2 Coherence Query Language Command-Line Tool Arguments

Argument	Description
<code>-t</code>	enable trace mode to print debug information.
<code>-c</code>	Exit the command-line tool after processing the command-line arguments. This argument should not be used when redirecting from standard input; in which case, the tool exits as soon as the command line arguments are finished being processed and the redirected input is never read.
<code>-s</code>	Run the command-line tool in silent mode to remove extraneous verbiage. This allows the command line tool to be used in pipes or filters by redirecting standard input (<code><myInput</code>) and standard output (<code>>myOutput</code>).
<code>-e</code>	Run the command-line tool in extended language mode. This mode allows object literals in update and insert commands. See the command-line help for complete usage information.
<code>-l statement</code>	Execute the given statement. Statements must be enclosed in single or double quotes. Any number of <code>-l</code> arguments can be used.
<code>-f filename</code>	Process the statements in the given file. The statements in the file must be separated by a semicolon (;). The file is an operating system-dependent path and must be enclosed in single or double quotes. Any number of <code>-f</code> arguments can be used.

Examples

Return all entries in the `contact` cache and print the entries to the standard out then exit the command-line tool.

```
query.sh -c -l "select * from contact"
```

Return all entries in the `dist-example` cache and print the entries (suppressing extra verbiage) to the file named `myOutput` then exit the command-line tool.

```
query.cmd -s -c -l "select * from 'dist-example'" >myOutput
```

Process all the segments in the file named `myStatements` then exit the command-line tool.

```
query.sh -c -f myStatements
```

Read the commands from the `myInput` file and print the output (suppressing extra verbiage) to the file named `myOutput`.

```
query.sh -s <myInput >myOutput
```

A Command-Line Example

The following examples illustrate using the command-line tool on Windows. This example is intended for a single cluster member, so the `storage_enabled` setting in the startup script is set to `true`. The example illustrates creating and dropping a cache, storing and retrieving entries, and restoring the cache from a backup file. It also highlights the use of the `key()` and `value()` pseudo-functions.

When starting the `query.cmd` script at the command prompt, information about the Java environment, the Coherence version and edition, and Coherence cache server is displayed. Enter query statements at the prompt (`CohQL>`).

Start the CohQL command-line tool:

```
C:/coherence/bin/query.cmd
```

Create a cache named `employees`:

```
CohQL> create cache "employees"
```

Insert an entry (key-value pair) into the cache:

```
CohQL> insert into "employees" key "David" value "ID-5070"
```

Insert an object into the cache:

```
CohQL> insert into "employees" value new com.my.Employee("John", "Doe",  
"address", 34)
```

Change the value of the key:

```
CohQL> update employees set value() = "ID-5080" where key() like "David"
```

Retrieve the values in the cache:

```
CohQL> select * from "employees"
```

Retrieve the value of a key that does not exist. An empty result set is returned:

```
CohQL> select key(), value() from "employees" where key() is "Richard"
```

Delete an existing key in the cache. An empty result set is returned:

```
CohQL> delete from employees where key() = "David"
```

Delete the contents of the `employees` cache. An empty result set is returned:

```
CohQL> delete from "employees"
```

Destroy the `employees` cache:

```
CohQL> drop cache "employees"
```

Re-create the `employees` cache:

```
CohQL> create cache "employees"
```

Insert more entries into the cache:

```
CohQL> insert into "employees" key "David" value "ID-5080"
```

```
CohQL> insert into "employees" key "Julie" value "ID-5081"
```

```
CohQL> insert into "employees" key "Julie" value "ID-5082"
```

```
CohQL> insert into "employees" key "Mike" value "ID-5083"
```

Retrieve the keys and value in the `employees` cache:

```
CohQL> select key(), value() from "employees"
```

Save a serialized representation of the cache in a file:

```
CohQL> backup cache "employees" to "emp.bkup"
```

Delete a key from the cache:

```
CohQL> delete from "employees" where key() = "David"
```

Retrieve the cache contents again. Notice that the deleted key and value are not present.

```
CohQL> select key(), value() from "employees"
```

Delete the contents of the cache:

```
CohQL> delete from "employees"
```

Retrieve the contents of the cache. An empty result set is returned:

```
CohQL> select * from "employees"
```

Restore the cache contents from the backup file:

```
CohQL> restore cache "employees" from file "emp.bkup"
```

Retrieve the cache contents. Notice that all of the entries have been restored and returned:

```
CohQL> select key(), value() from "employees"
```

Destroy the employees cache:

```
CohQL> drop cache "employees"
```

Exit the command-line tool:

```
CohQL> bye
```

Building Filters in Java Programs

The `FilterBuilder` API is a string-oriented way to filter a result set from within a Java program, without having to remember details of the Coherence API. The API provides a set of four overloaded `createFilter` factory methods in the `com.tangosol.util.QueryHelper` class.

The following list describes the different forms of the `createFilter` method. The passed string uses the Coherence query `WHERE` clause syntax (as described in ["Filtering Entries in a Result Set"](#) on page 28-4), but without the literal `WHERE`. The forms that take an `Object` array or `Map` are for passing objects that are referenced by bind variables. Each form constructs a filter from the provided Coherence query string.

- `public static Filter createFilter(String s)`—where `s` is a `String` in the Coherence query representing a `Filter`.
- `public static Filter createFilter(String s, Object[] aBindings)`—where `s` is a `String` in the Coherence query representing a `Filter` and `aBindings` is an array of `Objects` to use for bind variables.
- `public static Filter createFilter(String s, Map bindings)`—where `s` is a `String` in the Coherence query representing a `Filter` and `bindings` is a `Map` of `Objects` to use for bind variables.
- `public static Filter createFilter(String s, Object[] aBindings, Map bindings)`—where `s` is a `String` in the Coherence query representing a `Filter`, `aBindings` is an array of `Objects` to use for bind variables, and `bindings` is a `Map` of `Objects` to use for bind variables.

These factory methods throw a `FilterBuildingException` if there are any malformed, syntactically incorrect expressions, or semantic errors. Since this exception is a subclass

of `RuntimeException`, catching the error is not required, but the process could terminate if you do not.

Example

The following statement uses the `createFilter(String s)` form of the method. It constructs a filter for employees who live in Massachusetts but work in another state.

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

This statement is equivalent to the following filter/extractor using the Coherence API:

```
AndFilter(EqualsFilter(ChainedExtractor(#getHomeAddress[], #getState[]), MA),
NotEqualsFilter(ChainedExtractor(#getWorkAddress[], #getState[]), MA))
```

The `QueryHelper` class also provides a `createExtractor` method that enables you to create value extractors when building filters. The extractor is used to both extract values (for example, for sorting or filtering) from an object, and to provide an identity for that extraction. The following example demonstrates using `createExtractor` when creating an index:

```
cache.addIndex(QueryHelper.createExtractor("key().lastName"), /*fOrdered*/ true,
/*comparator*/ null);
```

Additional Coherence Query Language Examples

This section provides additional examples and shows their equivalent Coherence API calls with instantiated Objects (Filters, ValueExtractors, Aggregators, and so on). The simple `select *` examples that highlight Filters can understand the translation for `FilterBuilder` API if you focus only on the `Filter` part. Use the full set of examples to understand the translation for the `QueryBuilder` API and the command-line tool.

The examples use an abbreviated form of the path syntax where the cache name to qualify an identifier is dropped.

The Java language form of the examples also use `ReducerAggregator` instead of `EntryProcessors` for projection. Note also that the use of `KeyExtractor` should no longer be needed given changes to `ReflectionExtractor` in Coherence 3.5.

Simple SELECT * FROM Statements that Highlight Filters

- Select the items from the cache `orders` where 40 is greater than the value of the price key.

```
select * from "orders" where 40 > price
```

- Select the items from the cache `orders` where the value of the price key exactly equals 100, and the value of insurance key is less than 10 or the value of the shipping key is greater than or equal to 20.

```
select * from "orders" where price is 100 and insurance < 10 or shipping >= 20
```

- Select the items from the cache `orders` where the value of the price key exactly equals 100, and *either* the value of insurance key is less than 10 or the value of the shipping key is greater than or equal to 20.

```
select * from "orders" where price is 100 and (insurance < 10 or shipping >= 20)
```

- Select the items from the cache orders where either the value of the price key equals 100, or the bar key equals 20.

```
select * from "orders" where price = 100 or shipping = 20
```

- Select the items from the cache orders where the value of the insurance key is not null.

```
select * from "orders" where insurance is not null
```

- Select the items from the cache employees where the emp_id key has a value between 1 and 1000 or the bar.emp key is not "Smith".

```
select * from "employees" where emp_id between 1 and 1000 or bar.emp is not "Smith"
```

- Select items from the cache orders where the value of item key is similar to the value "coat".

```
select * from "orders" where item like "coat%"
```

- Select items from the cache employees where the value of emp_id is in the set 5, 10, 15, or 20.

```
select * from "employees" where emp_id in (5,10,15,20)
```

- Select items from the cache employees where emp_id contains the list 5, 10, 15, and 20.

```
select * from "employees" where emp_id contains (5,10,15,20)
```

- Select items from the cache employees where emp_id contains all of the items 5, 10, 15, and 20.

```
select * from "employees" where emp_id contains all (5,10,15,20)
```

- Select items from the cache employees where emp_id contains any of the items 5, 10, 15, or 20.

```
select * from "employees" where emp_id contains any (5,10,15,20)
```

- Select items from cache employees where the value of foo key is less than 10 and occurs in the set 10, 20.

```
select * from "employees" where emp_id < 10 in (10,20)
```

Complex Queries that Feature Projection, Aggregation, and Grouping

- Select the home state and age of employees in the cache ContactInfoCache, and group by state and age.

```
select homeAddress.state, age, count() from "ContactInfoCache" group by homeAddress.state, age
```

- Select the spurious frobit key from the orders cache. Note, an empty result set is returned.

```
select frobit, supplier, sum(amount), avg(price) from "orders" group by supplier
```

- For the items in the orders cache that are greater than \$1000, select the items, their prices and colors.

```
select item_name,price,color from "orders" where price > 1000
```

- Select the total amount for items from the orders cache. The Double type is assumed.

```
select sum(amount) from "orders"
```

- Select the total amount for items from the orders cache as a Long type.

```
select long_sum(amount) from "orders"
```

- Select the total amount for items from the orders cache as a BigDecimal type.

```
select bd_sum(amount) from "orders"
```

- Select the total amount for items from the orders cache where the color attribute is red or green.

```
select sum(amount) from "orders" where color is "red" or color is "green"
```

- Select the total amount and average price for items from the orders cache

```
select sum(amount),avg(price) from "orders"
```

- Select one copy of the lastname and city from possible duplicate rows from the employees cache, where the state is California.

```
select distinct lastName,city from "employees" where state = "CA"
```

UPDATE Examples

- For employees in the employees cache whose ranking is above grade 7, increase their salaries by 10% and add 50 hours of vacation time.

```
update "employees" set salary = salary*1.10, vacation = vacation + 50 where grade > 7
```

Key and Value Pseudo-Function Examples

This section provides examples of how to use the `key()` and `value()` pseudo-functions. For additional examples, see ["A Command-Line Example"](#) on page 28-12.

- Select the employees from the ContactInfoCache whose home address is in Massachusetts, but work out of state.

```
select key().firstName, key().lastName from "ContactInfoCache" where homeAddress.state is 'MA' and workAddress.state != "MA"
```

- Select the employees from the ContactInfoCache cache whose age is greater than 42.

```
select key().firstName, key().lastName, age from "ContactInfoCache" where age > 42
```

Performing Transactions

This chapter provides instructions for using Coherence's transaction and data concurrency features. Users should be familiar with transaction principles before reading this chapter. In addition, the Coherence Resource Adapter requires knowledge of J2EE Connector Architecture (J2CA), Java Transaction API (JTA) and Java EE deployment.

This chapter includes the following sections:

- [Overview of Transactions](#)
- [Using Explicit Locking for Data Concurrency](#)
- [Using Entry Processors for Data Concurrency](#)
- [Using the Transaction Framework API](#)
- [Using the Coherence Resource Adapter](#)

Overview of Transactions

Transactions ensure correct outcomes in systems that undergo state changes by allowing a programmer to scope multiple state changes into a unit of work. The state changes are committed only if each change can complete without failure; otherwise, all changes must be rolled back to their previous state.

Transactions attempt to maintain a set of criteria that are commonly referred to as ACID properties (Atomicity, Consistency, Isolation, Durability):

- **Atomic** - The changes that are performed within the transaction are either all committed or all rolled back to their previous state.
- **Consistent** - The results of a transaction must leave any shared resources in a valid state.
- **Isolated** - The results of a transaction are not visible outside of the transaction until the transaction has been committed.
- **Durable** - The changes that are performed within the transaction are made permanent.

Sometimes ACID properties cannot be maintained solely by the transaction infrastructure and may require customized business logic. For instance, the consistency property requires program logic to check whether changes to a system are valid. In addition, strict adherence to the ACID properties can directly affect infrastructure and application performance and must be carefully considered.

Coherence offers various transaction options that provide different transaction guarantees. The options should be selected based on an application's or solution's transaction requirements.

[Table 29–1](#) summarizes the various transactions option that Coherence offers.

Table 29–1 Coherence Transaction Options

Option Name	Description
Explicit locking	The <code>ConcurrentMap</code> interface (which is extended by the <code>NamedCache</code> interface) supports explicit locking operations. The locking API guarantees data concurrency but does not offer atomic guarantees. For detailed information on this option, see "Using Explicit Locking for Data Concurrency" on page 29-2.
Entry Processors	Coherence also supports a lock-free programming model through the <code>EntryProcessor</code> API. For many transaction types, this minimizes contention and latency and improves system throughput, without compromising the fault-tolerance of data operations. This option offers high-level concurrency control but does not offer atomic guarantees. For detailed information on this option, see "Using Entry Processors for Data Concurrency" on page 29-3.
Implicit locking	Coherence supports partition-level transactions using implicit locking through the <code>EntryProcessor</code> API. Partition-level transactions provide atomic guarantees when updating multiple caches in a single operation. For details, see "Processing Entries in Multiple Caches" on page 24-3.
Transaction Framework API	Coherence Transaction Framework API is a connection-based API that provides atomic transaction guarantees across partitions and caches even with a client failure. The framework supports the use of <code>NamedCache</code> operations, queries, aggregation, and entry processors within the context of a transaction. For detailed information on this option, see "Using the Transaction Framework API" on page 29-5.
Coherence Resource Adapter	The Coherence resource adapter leverages the Coherence Transaction Framework API and allows Coherence to participate as a resource in XA transactions that are managed by a JavaEE container's transaction manager. This transaction option offers atomic guarantees. For detailed information on this option, see "Using the Coherence Resource Adapter" on page 29-21.

Using Explicit Locking for Data Concurrency

The standard `NamedCache` interface extends the `ConcurrentMap` interface which includes basic locking methods. Locking operations are applied at the entry level by requesting a lock against a specific key in a `NamedCache`:

Example 29–1 Applying Locking Operations on a Cache

```
...
NamedCache cache = CacheFactory.getCache("dist-cache");
Object key = "example_key";
cache.lock(key, -1);
try
{
    Object value = cache.get(key);
    // application logic
    cache.put(key, value);
}
finally
```

```

{
// Always unlock in a "finally" block
// to ensure that uncaught exceptions
// do not leave data locked
cache.unlock(key);
}
...

```

Coherence lock functionality is similar to the Java `synchronized` keyword and the C# `lock` keyword: locks only block locks. Threads must cooperatively coordinate access to data through appropriate use of locking. If a thread has locked the key to an item, another thread can read the item without locking.

Locks are unaffected by server failure and failover to a backup server. Locks are immediately released when the lock owner (client) fails.

Locking behavior varies depending on the timeout requested and the type of cache. A timeout of -1 blocks indefinitely until a lock can be obtained, 0 returns immediately, and a value greater than 0 waits the specified number of milliseconds before timing out. The boolean return value should be examined to ensure the caller has actually obtained the lock. See `ConcurrentMap.lock()` for more details. Note that if a timeout value is not passed to `lock()` the default value is zero. With replicated caches, the entire cache can be locked by using `ConcurrentMap.LOCK_ALL` as the key, although this is usually not recommended. This operation is not supported with partitioned caches.

In both replicated and partitioned caches, gets are permitted on keys that are locked. In a replicated cache, puts are blocked, but they are not blocked in a partitioned cache. When a lock is in place, it is the responsibility of the caller (either in the same thread or the same cluster node, depending on the `lease-granularity` configuration) to release the lock. This is why locks should always be released with a `finally` clause (or equivalent). If this is not done, unhandled exceptions may leave locks in place indefinitely. For more information on `lease-granularity` configuration, see ["DistributedCache Service Parameters"](#).

Using Entry Processors for Data Concurrency

The `InvocableMap` superinterface of `NamedCache` allows for concurrent lock-free execution of processing code within a cache. This processing is performed by an entry processor. In exchange for reduced flexibility compared to the more general `ConcurrentMap` explicit locking API, The `EntryProcessor` API provides the highest levels of efficiency without compromising data reliability. For details on entry processors, see [Chapter 24, "Processing Data In a Cache."](#)

Since entry processors perform an implicit low-level lock on the entries they are processing, the end user can place processing code in an `EntryProcessor` implementation without having to worry about concurrency control. Note that this is different than the explicit `lock(key)` functionality provided by `ConcurrentMap` API.

`InvocableMap` provides three methods of starting entry processors:

- Invoke an entry processor on a specific key. Note that the key need not exist in the cache to invoke an entry processor on it.
- Invoke an entry processor on a collection of keys.
- Invoke an entry processor on a `Filter`. In this case, the `Filter` is executed against the cache entries. Each entry that matches the `Filter` criteria has the entry processor executed against it. For more information on `Filters`, see [Chapter 22, "Querying Data In a Cache"](#).

Entry processors are executed in parallel across the cluster (on the nodes that own the individual entries.) This provides a significant advantage over having a client lock all affected keys, pull all required data from the cache, process the data, place the data back in the cache, and unlock the keys. The processing occurs in parallel across multiple computers (as opposed to serially on one computer) and the network overhead of obtaining and releasing locks is eliminated.

Note: EntryProcessor implementations must be available in the classpath for each cluster node.

Here is a sample of high-level concurrency control. Code that requires network access is commented:

Example 29–2 Concurrency Control without Using EntryProcessors

```
final NamedCache cache = CacheFactory.getCache("dist-test");
final String key = "key";

cache.put(key, new Integer(1));

// begin processing

// *requires network access*
if (cache.lock(key, 0))
{
    try
    {
        // *requires network access*
        Integer i = (Integer) cache.get(key);
        // *requires network access*
        cache.put(key, new Integer(i.intValue() + 1));
    }
    finally
    {
        // *requires network access*
        cache.unlock(key);
    }
}

// end processing
```

The following is an equivalent technique using an entry processor. Again, network access is commented:

Example 29–3 Concurrency Control Using EntryProcessors

```
final NamedCache cache = CacheFactory.getCache("dist-test");
final String key = "key";

cache.put(key, new Integer(1));

// begin processing

// *requires network access*
cache.invoke(key, new MyCounterProcessor());
```

```

// end processing

...

public static class MyCounterProcessor
    extends AbstractProcessor
    {
    // this is executed on the node that owns the data,
    // no network access required
    public Object process(InvocableMap.Entry entry)
    {
        Integer i = (Integer) entry.getValue();
        entry.setValue(new Integer(i.intValue() + 1));
        return null;
    }
    }

```

entry processors are individually executed atomically; however, multiple entry processor invocations, through the use of `InvocableMap.invokeAll()`, do not execute as one atomic unit. As soon as an individual entry processor has completed, any updates made to the cache is immediately visible while the other entry processors are executing. Furthermore, an uncaught exception in an entry processor does not prevent the others from executing. Should the primary node for an entry fail while executing an entry processor, the backup node performs the execution instead. However if the node fails after the completion of an entry processor, the entry processor is not invoked on the backup.

Generally, entry processors should be short lived. Applications with longer running entry processor should increase the size of the distributed service thread pool so that other operations performed by the distributed service are not blocked by a long running entry processor. For more information on the distributed service thread pool, see "[DistributedCache Service Parameters](#)".

Using the Transaction Framework API

The Transaction Framework API allows TCMP clients to perform operations and use queries, aggregators, and entry processors within the context of a transaction. The transactions provide read consistency and atomic guarantees across partitions and caches even with client failure. The framework uses its own concurrency strategy and storage implementation and its own recovery manager for failed transactions.

Note: The `TransactionMap` API has been deprecated and is superseded by the Transaction Framework API. The two APIs are mutually exclusive.

Known Limitations

The Transaction Framework API has the following limitations:

- Database Integration – For existing Coherence users, the most noticeable limitation is the lack of support for database integration as compared to the existing `Partitioned NamedCache` implementation.
- Server-Side Functionality – Transactional caches do not support eviction or expiry, though they support garbage collection of older object versions. Backing map listeners, triggers, and `CacheStore` modules are not supported.

- Explicit Locking and Pessimistic Transactions – Pessimistic/explicit locking (`ConcurrentMap` interface) are not supported.
- Filters – Filters, such as `PartitionedFilter`, `LimitFilter` and `KeyAssociationFilter`, are not supported.
- Synchronous Listener – The `SynchronousListener` interface is not supported.
- Near Cache – Wrapping a near cache around a transactional cache is not supported.
- Key Partitioning Strategy – You cannot specify a custom `KeyPartitioningStrategy` for a transactional cache; although, `KeyAssociation` or a custom `KeyAssociator` works.

This section includes the following topics:

- [Defining Transactional Caches](#)
- [Performing Cache Operations within a Transaction](#)
- [Creating Transactional Connections](#)
- [Using Transactional Connections](#)
- [Using the `OptimisticNamedCache` Interface](#)
- [Configuring POF When Performing Transactions](#)
- [Configuring Transactional Storage Capacity](#)
- [Performing Transactions from Java Extend Clients](#)
- [Performing Cache Operations within a Transaction](#)

The Transaction Framework API is also the underlying transaction framework for the Coherence JCA resource adapter. For details on using the resource adapter, see "[Using the Coherence Resource Adapter](#)" on page 29-21.

Defining Transactional Caches

Transactional caches are specialized distributed caches that provide transactional guarantees. Transactional caches are required whenever performing a transaction using the Transaction Framework API. Transactional caches are not interoperable with non-transactional caches.

At run-time, transactional caches are automatically used with a set of internal transactional caches that provide transactional storage and recovery. Transactional caches also allow default transaction behavior (including the default behavior of the internal transactional caches) to be overridden at run-time.

Transactional caches are defined within a cache configuration file using a `<transactional-scheme>` element. A transaction scheme includes many of the same elements and attributes that are available to a distributed cache scheme. For detailed information about the `<transactional-scheme>` element and all its subelements, see "[transactional-scheme](#)" on page B-127.

Note: The use of transaction schemes within near cache schemes is currently not supported.

The following example demonstrates defining a transactional cache scheme in a cache configuration file. The cache is named `MyTxCache` and maps to a

Performing Cache Operations within a Transaction

Applications perform cache operations within a transaction in one of three ways:

- [Using the NamedCache API](#) – Applications use the `NamedCache` API to implicitly perform cache operations within a transaction.
- [Using the Connection API](#) – Applications use the `Connection` API to explicitly perform cache operations within a transaction.
- [Using the Coherence Resource Adapter](#) – Java EE applications use the Coherence Resource Adapter to connect to a Coherence data cluster and perform cache operations as part of a distributed (global) transaction.

Using the NamedCache API

The `NamedCache` API can perform cache operations implicitly within the context of a transaction. However, this approach does not allow an application to change default transaction behavior. For example, transactions are in auto-commit mode when using the `NamedCache` API approach. Each operation is immediately committed when it successfully completes; multiple operations cannot be scoped into a single transaction. Applications that require more control over transactional behavior must use the `Connection` API. See ["Using Transactional Connections"](#) on page 29-11 for a detailed description of a transaction's default behaviors.

The `NamedCache` API approach is ideally suited for ensuring atomicity guarantees when performing single operations such as `putAll`. The following example demonstrates a simple client that creates a `NamedCache` instance and uses the `CacheFactory.getCache()` method to get a transactional cache. The example uses the transactional cache that was defined in [Example 29-4](#). The client performs a `putAll` operation that is only committed if all the `put` operations succeed. The transaction is automatically rolled back if any `put` operation fails.

```
...
String key = "k";
String key2 = "k2";
String key3 = "k3";
String key4 = "k4";

CacheFactory.ensureCluster();
NamedCache cache = CacheFactory.getCache("MyTxCache");

Map map = new HashMap();
map.put(key, "value");
map.put(key2, "value2");
map.put(key3, "value3");
map.put(key4, "value4");

//operations performed on the cache are atomic
cache.putAll(map);

CacheFactory.shutdown();
...
```

Using the Connection API

The `Connection` API is used to perform cache operations within a transaction and provides the ability to explicitly control transaction behavior. For example, applications can enable or disable auto-commit mode or change transaction isolation levels.

The examples in this section demonstrate how to use the `Connection` interface, `DefaultConnectionFactory` class, and the `OptimisticNamedCache` interface which are located in the `com.tangosol.coherence.transaction` package. The examples use the transactional cache that was defined in [Example 29-4](#). The `Connection` API is discussed in detail following the examples.

[Example 29-5](#) demonstrates an auto-commit transaction; where, two insert operations are each executed as separate transactions.

Example 29-5 Performing an Auto-Commit Transaction

```
...
Connection con = new DefaultConnectionFactory().
    createConnection("TransactionalCache");

OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

cache.insert(key, value);
cache.insert(key2, value2);

con.close();
...
```

[Example 29-6](#) demonstrates a non auto-commit transaction; where, two insert operations are performed within a single transaction. Applications that use non auto-commit transactions must manually demarcate transaction boundaries.

Example 29-6 Performing a Non Auto-Commit Transaction

```
...
Connection con = new DefaultConnectionFactory().
    createConnection("TransactionalCache");

con.setAutoCommit(false);

try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

    cache.insert(key, value);
    cache.insert(key2, value2);
    con.commit();

catch (Exception e)
{
    con.rollback();
    throw e;
}

finally
{
    con.close();
}
...
```

[Example 29-7](#) demonstrates performing a transaction that spans multiple caches. Each transactional cache must be defined in a cache configuration file.

Example 29–7 Transaction Across Multiple Caches

```

...
Connection con = new DefaultConnectionFactory().
    createConnection("TransactionalCache");

con.setAutoCommit(false);
OptimisticNamedCache cache = con.getNamedCache("MyTxCache");
OptimisticNamedCache cache1 = con.getNamedCache("MyTxCache1");

cache.insert(key, value);
cache1.insert(key2, value2);

con.commit();

con.close();
...

```

Note: Transactions can span multiple partitions and caches within the same service but cannot span multiple services.

Creating Transactional Connections

The `com.tangosol.coherence.transaction.DefaultConnectionFactory` class is used to create `com.tangosol.coherence.transaction.Connection` instances. The following code from [Example 29–5](#) demonstrates creating a `Connection` instance using the factory's no argument constructor:

```

Connection con = new DefaultConnectionFactory().
    createConnection("TransactionalCache");

```

In this example, the first cache configuration file found on the classpath (or specified using the `-Dtangosol.coherence.cacheconfig` system property) is used by this `Connection` instance. Optionally, a URI can be passed as an argument to the factory class that specifies the location and name of a cache configuration file. For example, the following code demonstrates constructing a connection factory that uses a cache configuration file named `cache-config.xml` that is located in a `config` directory found on the classpath.

```

Connection con = new DefaultConnectionFactory("config/cache-config.xml").
    createConnection("TransactionalCache");

```

The `DefaultConnectionFactory` class provides methods for creating connections:

- `createConnection()` – The no-argument method creates a connection that is a member of the default transactional service, which is named `TransactionalCache`. Use the no-argument method when the `<transactional-scheme>` element being used does not include a specific `<service-name>` element. For details on defining transactional cache schemes and specifying the service name, see ["Defining Transactional Caches"](#) on page 29-6.
- `createConnection(ServiceName)` – This method creates a connection that is a member of a transactional service. The service name is a `String` that indicates the transactional service to which this connection belongs. The `ServiceName` maps to a `<service-name>` element that is defined within a `<transactional-scheme>` element in the cache configuration file. If no service name is used, the default name (`TransactionalCache`) is used as the service name. For details on defining

transactional cache schemes and specifying the service name, see ["Defining Transactional Caches"](#) on page 29-6.

- `createConnection(ServiceName, loader)` – This method also creates a connection that is a member of a transactional service. In addition, it specifies the class loader to use. In the above example, the connection is created by only specifying a service name; in which case, the default class loader is used.

Using Transactional Connections

The `com.tangosol.coherence.transaction.Connection` interface represents a logical connection to a Coherence service. An active connection is always associated with a transaction. A new transaction implicitly starts when a connection is created and also when a transaction is committed or rolled back.

Transactions that are derived from a connection have several default behaviors that are listed below. The default behaviors balance ease-of-use with performance.

- A transaction is automatically committed or rolled back for each cache operation. See ["Using Auto-Commit Mode"](#) on page 29-11.
- A transaction uses the read committed isolation level. See ["Setting Isolation Levels"](#) on page 29-12.
- A transaction immediately performs operations on the cache. See ["Using Eager Mode"](#) on page 29-13.
- A transaction has a default timeout of 300 seconds. See ["Setting Transaction Timeout"](#) on page 29-13.

A connection's default behaviors can be changed using the `Connection` instance's methods as required.

Using Auto-Commit Mode

Auto-commit mode allows an application to choose whether each cache operation should be associated with a separate transaction or whether multiple cache operations should be executed as a single transaction. Each cache operation is executed in a distinct transaction when auto-commit is enabled; the framework automatically commits or rolls back the transaction after an operation completes and then the connection is associated with a new transaction and the next operation is performed. By default, auto-commit is enabled when a `Connection` instance is created.

The following code from [Example 29-5](#) demonstrates `insert` operations that are each performed as a separate transaction:

```
OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

cache.insert(key, value);
cache.insert(key2, value2);
```

Multiple operations are performed as part of a single transaction by disabling auto-commit mode. If auto-commit mode is disabled, an application must manually demarcate transaction boundaries. The following code from [Example 29-6](#) demonstrates `insert` operations that are performed within a single transaction:

```
con.setAutoCommit(false);

OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

cache.insert(key, value);
cache.insert(key2, value2);
```

```
con.commit();
```

An application cannot use the `commit()` or `rollback()` method when auto-commit mode is enabled. Moreover, if auto-commit mode is enabled while in an active transaction, any work is automatically rolled back.

Setting Isolation Levels

Isolation levels help control data concurrency and consistency. The Transaction Framework uses implicit write-locks and does not implement read-locks. Any attempt to write to a locked entry results in an `UnableToAcquireLockException`; the request does not block. When a transaction is set to eager mode, the exception is thrown immediately. In non-eager mode, exceptions may not be thrown until the statement is flushed, which is typically at the next read or when the transaction commits. See ["Using Eager Mode"](#) on page 29-13.

The Coherence Transaction Framework API supports the following isolation levels:

- `READ_COMMITTED` – This is the default isolation level if no level is specified. This isolation level guarantees that only committed data is visible and does not provide any consistency guarantees. This is the weakest of the isolation levels and generally provides the best performance at the cost of read consistency.
- `STMT_CONSISTENT_READ` – This isolation level provides statement-scoped read consistency which guarantees that a single operation only reads data for the consistent read version that was available at the time the statement began. The version may or may not be the most current data in the cache. See the note below for additional details.
- `STMT_MONOTONIC_CONSISTENT_READ` – This isolation level provides the same guarantees as `STMT_CONSISTENT_READ`, but reads are also guaranteed to be monotonic. A read is guaranteed to return a version equal or greater than any version that was previously encountered while using the connection. Due to the monotonic read guarantee, reads with this isolation may block until the necessary versions are available.
- `TX_CONSISTENT_READ` – This isolation level provides transaction-scoped read consistency which guarantees that all operations performed in a given transaction read data for the same consistent read version that was available at the time the transaction began. The version may or may not be the most current data in the cache. See the note below for additional details.
- `TX_MONOTONIC_CONSISTENT_READ` – This isolation level provides the same guarantees as `TX_CONSISTENT_READ`, but reads are also guaranteed to be monotonic. A read is guaranteed to return a version equal or greater than any version that was previously encountered while using the connection. Due to the monotonic read guarantee, the initial read in a transaction with this isolation may block until the necessary versions are available.

Note: Consistent read isolation levels (statement or transaction) may lag slightly behind the most current data in the cache. If a transaction writes and commits a value, then immediately reads the same value in the next transaction with a consistent read isolation level, the updated value may not be immediately visible. If reading the most recent value is critical, then the `READ_COMMITTED` isolation level is required.

Isolation levels are set on a `Connection` instance and must be set before starting an active transaction. For example:

```
...
Connection con = new DefaultConnectionFactory().
createConnection("TransactionalCache");

con.setIsolationLevel(STMT_CONSISTENT_READ);
...
```

Using Eager Mode

Eager mode allows an application to control when cache operations are performed on the cluster. If eager mode is enabled, cache operations are immediately performed on the cluster. If eager mode is disabled, cache operations are deferred, if possible, and queued to be performed as a batch operation. Typically, an operation can only be queued if it does not return a value. An application may be able to increase performance by disabling eager mode.

By default, eager mode is enabled and cache operations are immediately performed on the cluster. The following example demonstrates disabling eager mode.

```
...
Connection con = new DefaultConnectionFactory().
createConnection("TransactionalCache");

con.setEager(false);
...
```

Setting Transaction Timeout

The transaction timeout allows an application to control how long a transaction can remain active before it is rolled back. The transaction timeout is associated with the current transaction and any new transactions that are associated with the connection.

The timeout value is specified in seconds. The default timeout value is 300 seconds. The following example demonstrates setting the transaction timeout value.

```
...
Connection con = new DefaultConnectionFactory().
createConnection("TransactionalCache");

con.setTransactionTimeout(420);
...
```

Using the OptimisticNamedCache Interface

The `com.tangosol.coherence.transaction.OptimisticNamedCache` interface extends the `NamedCache` interface and adds the operations: `update()`, `delete()`, and `insert()`.

All transactional caches are derived from this type. This cache type ensures that an application use the framework's concurrency and data locking implementations.

Note: `OptimisticNamedCache` does not extend any operations from the `ConcurrentMap` interface since it uses its own locking strategy.

The following code sample from [Example 29-5](#) demonstrates getting a transactional cache called `MyTxCache` and performs operations on the cache. For this example, a transactional cache that is named `MyTxCache` must be located in the cache configuration file at run-time. For details on defining a transactional cache, see ["Defining Transactional Caches"](#) on page 29-6.

```
OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

cache.insert(key, value);
cache.insert(key2, value2);
```

Configuring POF When Performing Transactions

Transactional caches support Portable Object Format (POF) serialization within transactions. POF is enabled within a transactional cache scheme using the `<serializer>` element. The following example demonstrates enabling POF serialization in a transactional cache scheme.

```
<transactional-scheme>
  <scheme-name>example-transactional</scheme-name>
  <service-name>TransactionalCache</service-name>
  <serializer>
    <instance>
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
    </instance>
  </serializer>
  <autostart>true</autostart>
</transactional-scheme>
```

The Transaction Framework API also includes its own POF types which are defined in the `txn-pof-config.xml` POF configuration file which is included in `coherence.jar`. The POF types are required and must be found at run-time.

To load the transaction POF types at run time, modify an application's POF configuration file and include the `txn-pof-config.xml` POF configuration file using the `<include>` element. For example:

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

See ["Combining Multiple POF Configuration Files"](#) on page 3-10 for more information on using the `<include>` element to combine POF configuration files.

Configuring Transactional Storage Capacity

The Transaction Framework API stores transactional data in internal distributed caches that use backing maps. The data includes versions of all keys and their values for a transactional cache. The framework uses the stored data in roll-back scenarios and also during recovery.

Due to the internal storage requirements, transactional caches have a constant overhead associated with every entry written to the cache. Moreover, transactional caches use multi-version concurrency control, which means that every write operation produces a new row into the cache even if it is an update. Therefore, the Transaction Framework API uses a custom eviction policy to help manage the growth of its internal storage caches. The eviction policy works by determining which versions of an entry can be kept and which versions are eligible for eviction. The latest version for a given key (the most recent) is never evicted. The eviction policy is enforced whenever a configured high-water mark is reached. After the threshold is reached, 25% of the eligible versions are removed.

Note:

- The eviction policy does not take the entire transactional storage into account when comparing the high-water mark. Therefore, transactional storage slightly exceeds the high-water mark before the storage eviction policy is notified.
 - It is possible that storage for a transactional cache exceeds the maximum heap size if the cache is sufficiently broad (large number of distinct keys) since the current entry for a key is never evicted.
-
-

Because the storage eviction policy is notified on every write where the measured storage size exceeds the high-water mark, the default high-water mark may have to be increased so that it is larger than the size of the current data set. Otherwise, the eviction policy is notified on every write after the size of the current data set exceeds the high water mark resulting in decreased performance. If consistent reads are not used, the value can be set so that it slightly exceeds the projected size of the current data set since no historical versions is ever read. When using consistent reads, the high-water mark should be high enough to provide for enough historical versions. Use the below formulas to approximate the transactional storage size.

The high-water mark is configured using the `<high-units>` element within a transactional scheme definition. The following example demonstrates configuring a high-water mark of 20 MB.

```
<transactional-scheme>
...
  <high-units>20M</high-units>
...
</transactional-scheme>
```

The following formulas provide a rough estimate of the memory usage for a row in a transactional cache.

For insert operations:

- Primary – $\text{key}(\text{serialized}) + \text{key}(\text{on-heap size}) + \text{value}(\text{serialized}) + 1095$ bytes constant overhead
- Backup – $\text{key}(\text{serialized}) + \text{value}(\text{serialized}) + 530$ bytes constant overhead

For updated operations:

- Primary – $\text{value}(\text{serialized}) + 685$ bytes constant overhead
- Backup – $\text{value}(\text{serialized}) + 420$ bytes constant overhead

Performing Transactions from Java Extend Clients

The Transaction Framework API provides Java extend clients with the ability to perform cache operations within a transaction. In this case, the transaction API is used within an entry processor that is located on the cluster. At run time, the entry processor is executed on behalf of the Java client.

The instructions in this section do not include detailed instructions on how to setup and use Coherence*Extend. For those new to Coherence*Extend, see "Setting Up Coherence*Extend" in *Developing Remote Clients for Oracle Coherence*. For details on performing transactions from C++ or .NET clients, see "Performing Transactions for C++ Clients" and "Performing Transactions for .NET Clients" in the *Developing Remote Clients for Oracle Coherence*.

The following topics are included in this section and are required to perform transactions from Java extend clients:

- [Create an Entry Processor for Transactions](#)
- [Configure the Cluster-Side Transaction Caches](#)
- [Configure the Client-Side Remote Cache](#)
- [Use the Transactional Entry Processor from a Java Client](#)

Create an Entry Processor for Transactions

Transactions are performed using the transaction API within an entry processor that resides on the cluster. The entry processor is executed on behalf of a Java extend client.

[Example 29–8](#) demonstrates an entry processor that performs a simple update operation within a transaction. At run time, the entry processor must be located on both the client and cluster.

Example 29–8 Entry Processor for Extend Client Transaction

```
public class MyTxProcessor extends AbstractProcessor
{
    public Object process(InvocableMap.Entry entry)
    {
        // obtain a connection and transaction cache
        ConnectionFactory connFactory = new DefaultConnectionFactory();
        Connection conn = connFactory.createConnection("TransactionalCache");
        OptimisticNamedCache cache = conn.getNamedCache("MyTxCache");

        conn.setAutoCommit(false);

        // get a value for an existing entry
        String sValue = (String) cache.get("existingEntry");

        // create predicate filter
        Filter predicate = new EqualsFilter(IdentityExtractor.INSTANCE, sValue);

        try
        {
            // update the previously obtained value
            cache.update("existingEntry", "newValue", predicate);
        }
        catch (PredicateFailedException e)
        {
            // value was updated after it was read
            conn.rollback();
        }
    }
}
```

```

        return false;
    }
    catch (UnableToAcquireLockException e)
    {
        // row is being updated by another transaction
        conn.rollback();
        return false;
    }
    try
    {
        conn.commit();
    }
    catch (RollbackException e)
    {
        // transaction was rolled back
        return false;
    }
    return true;
}
}

```

Configure the Cluster-Side Transaction Caches

Transactions require a transactional cache to be defined in the cluster-side cache configuration file. For details on defining a transactional cache, see ["Defining Transactional Caches"](#) on page 29-6.

The following example defines a transactional cache that is named `MyTxCache`, which is the cache name that was used by the entry processor in [Example 29-8](#). The example also includes a proxy scheme and a distributed cache scheme that are required to execute the entry processor from a remote client. The proxy is configured to accept client TCP/IP connections on localhost at port 9099.

```

<?xml version='1.0'?>

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>MyTxCache</cache-name>
      <scheme-name>example-transactional</scheme-name>
    </cache-mapping>
    <cache-mapping>
      <cache-name>dist-example</cache-name>
      <scheme-name>example-distributed</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <transactional-scheme>
      <scheme-name>example-transactional</scheme-name>
      <thread-count>7</thread-count>
      <high-units>15M</high-units>
      <task-timeout>0</task-timeout>
      <autostart>true</autostart>
    </transactional-scheme>
    <distributed-scheme>
      <scheme-name>example-distributed</scheme-name>

```

```

        <service-name>DistributedCache</service-name>
        <backing-map-scheme>
            <local-scheme/>
        </backing-map-scheme>
        <autostart>true</autostart>
    </distributed-scheme>
    <proxy-scheme>
        <service-name>ExtendTcpProxyService</service-name>
        <acceptor-config>
            <tcp-acceptor>
                <local-address>
                    <address>localhost</address>
                    <port>9099</port>
                </local-address>
            </tcp-acceptor>
        </acceptor-config>
        <autostart>true</autostart>
    </proxy-scheme>
</caching-schemes>
</cache-config>

```

Configure the Client-Side Remote Cache

Remote clients require a remote cache to connect to the cluster's proxy and run a transactional entry processor. The remote cache is defined in the client-side cache configuration file.

The following example configures a remote cache to connect to a proxy that is located on localhost at port 9099. In addition, the name of the remote cache (`dist-example`) must match the name of a cluster-side cache that is used when initiating the transactional entry processor.

```

<?xml version='1.0'?>
<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  <caching-scheme-mapping>
    <cache-mapping>
      <cache-name>dist-example</cache-name>
      <scheme-name>extend</scheme-name>
    </cache-mapping>
  </caching-scheme-mapping>

  <caching-schemes>
    <remote-cache-scheme>
      <scheme-name>extend</scheme-name>
      <service-name>ExtendTcpCacheService</service-name>
      <initiator-config>
        <tcp-initiator>
          <remote-addresses>
            <socket-address>
              <address>localhost</address>
              <port>9099</port>
            </socket-address>
          </remote-addresses>
          <connect-timeout>30s</connect-timeout>
        </tcp-initiator>
        <outgoing-message-handler>
          <request-timeout>30s</request-timeout>
        </outgoing-message-handler>
      </initiator-config>
    </remote-cache-scheme>
  </caching-schemes>
</cache-config>

```

```

        </outgoing-message-handler>
    </initiator-config>
</remote-cache-scheme>
</caching-schemes>
</cache-config>

```

Use the Transactional Entry Processor from a Java Client

A Java extend client invokes an entry processor as normal. However, at run time, the cluster-side entry processor is invoked. The client is unaware that the invocation has been delegated. The following example demonstrates how a Java client calls the entry processor shown in [Example 29–8](#).

```

NamedCache cache = CacheFactory.getCache("dist-example");
Object oReturn = cache.invoke("AnyKey", new MyTxProcessor());

System.out.println("Result of extend tx execution: " + oReturn);

```

Viewing Transaction Management Information

The transaction framework leverages the existing Coherence JMX management framework. See *Managing Oracle Coherence* for detailed information on enabling and using JMX in Coherence.

This section describes two MBeans that provide transaction information: CacheMBean and TransactionManagerMBean.

CacheMBeans for Transactional Caches

The CacheMBean managed resource provides attributes and operations for all caches, including transactional caches. Many of the MBeans attributes are not applicable to transactional cache; invoking such attributes simply returns a -1 value. A cluster node may have zero or more instances of cache managed beans for transactional caches. The object name uses the form:

```

type=Cache, service=service name, name=cache name, nodeId=cluster node's
id

```

[Table 29–2](#) describes the CacheMBean attributes that are supported for transactional caches.

Table 29–2 Transactional Cache Supported Attributes

Attribute	Type	Description
AverageGetMillis	Double	The average number of milliseconds per <code>get()</code> invocation
AveragePutMillis	Double	The average number of milliseconds per <code>put()</code> invocation since the cache statistics were last reset.
Description	String	The cache description.
HighUnits	Integer	The limit of the cache size measured in units. The cache prunes itself automatically after it reaches its maximum unit level. This is often referred to as the high water mark of the cache.
Size	Integer	The number of entries in the current data set
TotalGets	Long	The total number of <code>get()</code> operations since the cache statistics were last reset.

Table 29–2 (Cont.) Transactional Cache Supported Attributes

Attribute	Type	Description
TotalGetsMillis	Long	The total number of milliseconds spent on <code>get()</code> operations since the cache statistics were last reset.
TotalPuts	Long	The total number of <code>put()</code> operations since the cache statistics were last reset.
TotalPutsMillis	Long	The total number of milliseconds spent on <code>put()</code> operations since the cache statistics were last reset.

For transactional caches, the `resetStatistics` operation is supported and resets all transaction manager statistics.

TransactionManagerBean

The `TransactionManagerMBean` managed resource is specific to the transactional framework. It provides global transaction manager statistics by aggregating service-level statistics from all transaction service instances. Each cluster node has an instance of the transaction manager managed bean per service. The object name uses the form:

```
type=TransactionManager, service=service name, nodeId=cluster node's id
```

Note: For certain transaction manager attributes, the count is maintained at the coordinator node for the transaction, even though multiple nodes may have participated in the transaction. For example, a transaction may include modifications to entries stored on multiple nodes but the `TotalCommitted` attribute is only incremented on the MBean on the node that coordinated the commit of that transaction.

Table 29–3 describes `TransactionManager` attributes.

Table 29–3 TransactionManagerMBean Attributes

Attribute	Type	Description
TotalActive	Long	The total number of currently active transactions. An active transaction is counted as any transaction that contains at least one modified entry and has yet to be committed or rolled back. Note that the count is maintained at the coordinator node for the transaction, even though multiple nodes may have participated in the transaction.
TotalCommitted	Long	The total number of transactions that have been committed by the Transaction Manager since the last time the statistics were reset. Note that the count is maintained at the coordinator node for the transaction being committed, even though multiple nodes may have participated in the transaction.
TotalRecovered	Long	The total number of transactions that have been recovered by the Transaction Manager since the last time the statistics were reset. Note that the count is maintained at the coordinator node for the transaction being recovered, even though multiple nodes may have participated in the transaction.

Table 29–3 (Cont.) TransactionManagerMBean Attributes

Attribute	Type	Description
TotalRolledback	Long	The total number of transactions that have been rolled back by the Transaction Manager since the last time the statistics were reset. Note that the count is maintained at the coordinator node for the transaction being rolled back, even though multiple nodes may have participated in the transaction.
TotalTransactionMillis	Long	The cumulative time (in milliseconds) spent on active transactions.
TimeoutMillis	Long	The transaction timeout value in milliseconds. Note that this value only applies to transactional connections obtained after the value is set. This attribute is currently not supported.

The `TransactionManagerMBean` includes a single operation called `resetStatistics`, which resets all transaction manager statistics.

Using the Coherence Resource Adapter

Coherence includes a J2EE Connector Architecture (J2CA) 1.5 compliant resource adaptor that is used to get connections to a Coherence cache. The resource adapter leverages the connection API of the Coherence Transaction Framework and therefore provides default transaction guarantees. In addition, the resource adapter provides full XA support which allows Coherence to participate in global transactions. A global transaction is unit of work that is managed by one or more resource managers and is controlled and coordinated by an external transaction manager, such as the transaction manager that is included with WebLogic server or OC4J.

The resource adapter is packaged as a standard Resource Adaptor Archive (RAR) and is named `coherence-transaction.rar`. The resource adapter is located in `COHERENCE_HOME/lib` and can be deployed to any Java EE container compatible with J2CA 1.5. The resource adapter includes proprietary resource adapter deployment descriptors for WebLogic (`weblogic-ra.xml`) and OC4J (`oc4j-ra.xml`) and can be deployed to these platforms without modification. Check your application server vendor's documentation for details on defining a proprietary resource adapter descriptor that can be included within the RAR.

Note: Coherence continues to include the `coherence-tx.rar` resource adapter for backward compatibility. However, it is strongly recommended that applications use the `coherence-transaction.rar` resource adapter which provides full XA support. Those accustomed to using the Coherence `CacheAdapter` class can continue to do so with either resource adapter. See "[Using the Coherence Cache Adapter for Transactions](#)" on page 29-26.

This section includes the following topics:

- [Performing Cache Operations within a Transaction](#)
- [Packaging the Application](#)
- [Using the Coherence Cache Adapter for Transactions](#)

Performing Cache Operations within a Transaction

Java EE application components (Servlets, JSPs, and EJBs) use the Coherence resource adapter to perform cache operations within a transaction. The resource adapter supports both local transactions and global transactions. Local transactions are used to perform cache operations within a transaction that is only scoped to a Coherence cache and cannot participate in a global transaction. Global transactions are used to perform cache operations that automatically commit or roll back based on the outcome of multiple resources that are enlisted in the transaction.

Like all JavaEE application components, the Java Naming and Directory Interface (JNDI) API is used to lookup the resource adapter's connection factory. The connection factory is then used to get logical connections to a Coherence cache.

The following examples demonstrate how to use the Coherence resource adapter to perform cache operations within a global transaction. [Example 29–9](#) is an example of using Container Managed Transactions (CMT); where, the container ensures that all methods execute within the scope of a global transaction. [Example 29–10](#) is an example of user-controlled transactions; where, the application component uses the Java Transaction API (JTA) to manually demarcate transaction boundaries.

Transactions require a transactional cache scheme to be defined within a cache configuration file. These examples use the transactional cache that was defined in [Example 29–4](#).

Example 29–9 Performing a Transaction When Using CMT

```
Context initCtx = new InitialContext();
ConnectionFactory cf = (ConnectionFactory)
    initCtx.lookup("java:comp/env/eis/CoherenceTxCF");

Connection con = cf.createConnection("TransactionalCache");

try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

    cache.delete("key1", null);
    cache.insert("key1", "value1");
}
finally
{
    con.close();
}
```

Example 29–10 Performing a User-Controlled Transaction

```
Context initCtx = new InitialContext();
ConnectionFactory cf = (ConnectionFactory)
    initCtx.lookup("java:comp/env/eis/CoherenceTxCF");

UserTransaction ut = (UserTransaction) new
    InitialContext().lookup("java:comp/UserTransaction");
ut.begin();

Connection con = cf.createConnection("TransactionalCache");

try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");
```

```

        cache.delete("key1", null);
        cache.insert("key1", "value1");
        ut.commit();
    }

    catch (Exception e)
    {
        ut.rollback();
        throw e;
    }

    finally
    {
        con.close();
    }

```

Creating a Coherence Connection

Applications use the `com.tangosol.coherence.ConnectionFactory` interface to create connections to a Coherence cluster. An instance of this interface is obtained using a JNDI lookup. The following code sample from [Example 29–10](#) performs a JNDI lookup for a connection factory that is bound to the `java:comp/env/eis/CoherenceTxCF` namespace:

```

Context initCtx = new InitialContext();
ConnectionFactory cf = (ConnectionFactory)
    initCtx.lookup("java:comp/env/eis/CoherenceTxCF");

```

The `ConnectionFactory` is then used to create a `com.tangosol.coherence.transaction.Connection` instance. The `Connection` instance represents a logical connection to a Coherence service:

```

Connection con = cf.createConnection("TransactionalCache");

```

The `createConnection(ServiceName)` method creates a connection that is a member of a transactional service. The service name is a `String` that indicates which transactional service this connection belongs to and must map to a service name that is defined in a `<transactional-scheme>` within a cache configuration file. For details on defining transactional cache schemes and specifying the service name, see ["Defining Transactional Caches"](#) on page 29-6.

A `Connection` instance always has an associated transaction which is scoped within the connection. A new transaction is started when a transaction is completed. The following default behaviors are associated with a connection. For more information on the `Connection` interface and changing the default settings, see ["Using Transactional Connections"](#) on page 29-11.

- Connections are in auto-commit mode by default which means that each statement is executed in a distinct transaction and when the statement completes the transaction is committed and the connection is associated with a new transaction.

Note: When the connection is used for a global transaction, auto-commit mode is disabled and cannot be enabled. Cache operations are performed in a single transaction and either commit or roll back as a unit. In addition, the `Connection` interface's commit and rollback methods cannot be used if the connection is enlisted in a global transaction.

- The connection's isolation level is set to `READ_COMMITTED`. The transaction can only view committed data from other transactions.
- Eager mode is enabled by default which means every operation is immediately flushed to the cluster and are not queued to be flushed in batches.
- The default transaction timeout is 300 seconds.

Note: When the connection is used for a global transaction, the transaction timeout that is associated with a connection is overridden by the transaction timeout value that is set by a container's JTA configuration. If an application attempts to set the transaction timeout value directly on the connection while it is enlisted in a global transaction, the attempt is ignored and a warning message is emitted indicating that the transaction timeout cannot be set. The original timeout value that is set on the connection is restored after the global transaction completes.

Getting a Named Cache

The `com.tangosol.coherence.transaction.OptimisticNamedCache` interface extends the `NamedCache` interface. It supports all the customary named cache operations and adds its own operations for updating, deleting, and inserting objects into a cache. When performing transactions, all cache instances must be derived from this type. The following code sample from [Example 29–10](#) demonstrates getting a named cache called `MyTxCache` and performing operations on the cache. The cache must be defined in the cache configuration file.

```
try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

    cache.delete("key1", null);
    cache.insert("key1", "value1");
}
```

Note: `OptimisticNamedCache` does not extend any operations from the `ConcurrentMap` interface since it uses its own locking strategy.

Demarcating Transaction Boundaries

Application components that perform user-controlled transactions use a JNDI lookup to get a JTA `UserTransaction` interface instance. The interface provides methods for demarcating the transaction. The following code sample from [Example 29–10](#) demonstrates getting a `UserTransaction` instance and demarcating the transaction boundaries:

```
UserTransaction ut = (UserTransaction) new
```

```

InitialContext().lookup("java:comp/UserTransaction");

ut.begin();
Connection con = cf.createConnection("TransactionalCache");

try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

    cache.delete("key1", null);
    cache.insert("key1", "value1");
    ut.commit();
}

```

The above code demonstrates a typical scenario where the connection and the named cache exist within the transaction boundaries. However, the resource adapter also supports scenarios where connections are used across transaction boundaries and are obtained before the start of a global transaction. For example:

```

Connection con = cf.createConnection("TransactionalCache");

try
{
    OptimisticNamedCache cache = con.getNamedCache("MyTxCache");

    cache.delete("key1", null);

    UserTransaction ut = (UserTransaction) new
        InitialContext().lookup("java:comp/UserTransaction");

    ut.begin();
    cache.insert("key1", "value1");
    ut.commit();
}

```

Packaging the Application

This section provides instructions for packaging JavaEE applications that use the Coherence resource adapter so that they can be deployed to an application server. This section includes the following topics:

- [Configure the Connection Factory Resource Reference](#)
- [Configure the Resource Adapter Module Reference](#)
- [Include the Required Libraries](#)

Configure the Connection Factory Resource Reference

Application components must provide a resource reference for the resource adapter's connection factory. For EJBs, the resource references are defined in the `ejb-jar.xml` deployment descriptor. For Servlets and JSPs, the resource references are defined in the `web.xml` deployment descriptor. The following sample demonstrates defining a resource reference for the resource adapter's connection factory and is applicable to the code in [Example 29–10](#):

```

<resource-ref>
  <res-ref-name>eis/CoherenceTxCF</res-ref-name>
  <res-type>
    com.tangosol.coherence.transaction.ConnectionFactory
  </res-type>
  <res-auth>Container</res-auth>
</resource-ref>

```

```
</resource-ref>
```

In addition to the standard Java EE application component deployment descriptors, many application servers require a proprietary deployment descriptor as well. For example, WebLogic server resource references are defined in the `weblogic.xml` or `weblogic-ejb-jar.xml` files respectively:

```
<reference-descriptor>
  <resource-description>
    <res-ref-name>eis/CoherenceTxCF</res-ref-name>
    <jndi-name>tangosol.coherenceTx</jndi-name>
  </resource-description>
</reference-descriptor>
```

Consult your application server vendor's documentation for detailed information on using their proprietary application component deployment descriptors and information on alternate methods for defining resource reference using dependency injection or annotations.

Configure the Resource Adapter Module Reference

JavaEE applications must provide a module reference for the Coherence resource adapter. The module reference is defined in the EAR's `application.xml` file. The module reference points to the location of the Coherence RAR file (`coherence-transaction.rar`) within the EAR file. For example, the following definition points to the Coherence resource adapter RAR file that is located in the root of the EAR file:

```
<application>
...
<module>
  <connector>coherence-transaction.rar</connector>
</module>
...
</application>
```

In addition to the standard Java EE application deployment descriptors, many application servers require a proprietary application deployment descriptor as well. For example, the Coherence resource adapter is defined in the WebLogic server `weblogic-application.xml` file as follows:

```
<weblogic-application>
  <classloader-structure>
    ...
    <module-ref>
      <module-uri>coherence-transaction.rar</module-uri>
    </module-ref>
    ...
  </classloader-structure>
</weblogic-application>
```

Consult your application server vendor's documentation for detailed information on using their proprietary application deployment descriptors

Include the Required Libraries

JavaEE applications that use the Coherence resource adapter must include the `coherence-transaction.rar` file and the `coherence.jar` file within the EAR file. The following example places the libraries at the root of the EAR file:

```

/
/coherence-transaction.rar
/coherence.jar

```

When deploying to WebLogic server, the `coherence.jar` file must be placed in the `/APP-INF/lib` directory of the EAR file. For example:

```

/
/coherence-transaction.rar
/APP-INF/lib/coherence.jar

```

This deployment scenario results in a single Coherence cluster node that is shared by all application components in the EAR. See *Administering Oracle Coherence* for different Coherence deployment options.

Using the Coherence Cache Adapter for Transactions

The Coherence `CacheAdapter` class provides an alternate client approach for creating transactions and is required when using the `coherence-tx.rar` resource adapter. The new `coherence-transaction.rar` resource adapter also supports the `CacheAdapter` class (with some modifications) and allows those accustomed to using the class to leverage the benefits of the new resource adapter. However, it is recommended that applications use the Coherence resource adapter natively which offers stronger transactional support. Examples for both resource adapters is provided in this section.

[Example 29–11](#) demonstrates performing cache operations within a transaction when using the `CacheAdapter` class with the new `coherence-transaction.rar` resource adapter. For this example a transactional cache named `MyTxCache` must be configured in the cache configuration file. The cache must map to a transactional cache scheme with the service name `TransactionalCache`. See ["Defining Transactional Caches"](#) on page 29-6 for more information on defining a transactional cache scheme.

Example 29–11 Using the CacheAdapter Class When Using coherence-transaction.rar

```

Context initCtx = new InitialContext();

CacheAdapter adapter = new CacheAdapter(initCtx,
    "java:comp/env/eis/CoherenceTxCCICF", 0, 0, 0);

adapter.connect("TransactionalCache", "scott", "tiger");

try
{
    UserTransaction ut = (UserTransaction) new
        InitialContext().lookup("java:comp/UserTransaction");

    ut.begin();
    OptimisticNamedCache cache =
        (OptimisticNamedCache) adapter.getNamedCache("MyTxCache",
            getClass().getClassLoader());
    cache.delete("key", null);
    cache.insert("key", "value");
    ut.commit();

}
finally
{
    adapter.close();
}

```

[Example 29–12](#) demonstrates performing cache operations within a transaction when using the `CacheAdapter` class with the `coherence-tx.rar` resource adapter.

Example 29–12 Using the `CacheAdapter` Class When Using `coherence-tx.rar`

```
String          key = "key";
Context         ctx = new InitialContext();
UserTransaction tx = null;
try
{
    // the transaction manager from container
    tx = (UserTransaction) ctx.lookup("java:comp/UserTransaction");
    tx.begin();

    // the try-catch-finally block below is the block of code
    // that could be on an EJB and therefore automatically within
    // a transactional context
    CacheAdapter adapter = null;
    try
    {
        adapter = new CacheAdapter(ctx, "tangosol.coherenceTx",
            CacheAdapter.CONCUR_OPTIMISTIC,
            CacheAdapter.TRANSACTION_GET_COMMITTED, 0);

        NamedCache cache = adapter.getNamedCache("dist-test",
            getClass().getClassLoader());

        int n = ((Integer)cache.get(key)).intValue();
        cache.put(key, new Integer(++n));
    }
    catch (Throwable t)
    {
        String sMsg = "Failed to connect: " + t;
        System.err.println(sMsg);
        t.printStackTrace(System.err);
    }
    finally
    {
        try
        {
            adapter.close();
        }
        catch (Throwable ex)
        {
            System.err.println("SHOULD NOT HAPPEN: " + ex);
        }
    }
}
finally
{
    try
    {
        tx.commit();
    }
    catch (Throwable t)
    {
        String sMsg = "Failed to commit: " + t;
        System.err.println(sMsg);
    }
}
```

}

Working with Partitions

This chapter provides instructions for using data affinity and includes instructions for changing the default partition setup. The instructions are specific to distributed caches.

This chapter includes the following sections:

- [Specifying Data Affinity](#)
- [Changing the Number of Partitions](#)
- [Changing the Partition Distribution Strategy](#)

Specifying Data Affinity

This section includes the following topics:

- [Overview of Data Affinity](#)
- [Specifying Data Affinity with a KeyAssociation](#)
- [Specifying Data Affinity with a KeyAssociator](#)
- [Deferring the Key Association Check](#)
- [Example of Using Affinity](#)

Overview of Data Affinity

Data affinity describes the concept of ensuring that a group of related cache entries is contained within a single cache partition. This ensures that all relevant data is managed on a single primary cache node (without compromising fault-tolerance).

Affinity may span multiple caches (if they are managed by the same cache service, which generally is the case). For example, in a master-detail pattern such as an `Order-LineItem`, the `Order` object may be co-located with the entire collection of `LineItem` objects that are associated with it.

There are two benefits for using data affinity. First, only a single cache node is required to manage queries and transactions against a set of related items. Second, all concurrency operations are managed locally and avoids the need for clustered synchronization.

Several standard Coherence operations can benefit from affinity, including cache queries, `InvocableMap` operations and the `getAll`, `putAll`, and `removeAll` methods.

Note: Data affinity is specified in terms of entry keys (not values). As a result, the association information must be present in the key class. Similarly, the association logic applies to the key class, not the value class.

Affinity is specified in terms of a relationship to a partitioned key. In the `Order-LineItem` example above, the `Order` objects would be partitioned normally, and the `LineItem` objects would be associated with the appropriate `Order` object.

The association does not have to be directly tied to the actual parent key - it only must be a functional mapping of the parent key. It could be a single field of the parent key (even if it is non-unique), or an integer hash of the parent key. All that matters is that all child keys return the same associated key; it does not matter whether the associated key is an actual key (it is simply a "group id"). This fact may help minimize the size impact on the child key classes that do not contain the parent key information (as it is derived data, the size of the data may be decided explicitly, and it also does not affect the behavior of the key). Note that making the association too general (having too many keys associated with the same "group id") can cause a "lumpy" distribution (if all child keys return the same association key regardless of what the parent key is, the child keys are all assigned to a single partition, and are not spread across the cluster).

There are two ways to ensure that a set of cache entries are co-located. Note that association is based on the cache key, not the value (otherwise updating a cache entry could cause it to change partitions). Also, note that while the `Order` is co-located with the child `LineItems`, Coherence does not currently support composite operations that span multiple caches (for example, updating the `Order` and the collection of `LineItems` within a single invocation request `com.tangosol.util.InvocableMap.EntryProcessor`).

Specifying Data Affinity with a KeyAssociation

For application-defined keys, the class (of the cache key) may implement `com.tangosol.net.cache.KeyAssociation` as follows:

Example 30–1 *Creating a Key Association*

```
import com.tangosol.net.cache.KeyAssociation;

public class LineItemId implements KeyAssociation
{
    // {...}

    public Object getAssociatedKey()
    {
        return getOrderId();
    }

    // {...}
}
```

Specifying Data Affinity with a KeyAssociator

Applications may also provide a custom `KeyAssociator`:

Example 30–2 A Custom KeyAssociator

```
import com.tangosol.net.partition.KeyAssociator;

public class LineItemAssociator implements KeyAssociator
{
    public Object getAssociatedKey(Object oKey)
    {
        if (oKey instanceof LineItemId)
        {
            return ((LineItemId) oKey).getOrderId();
        }
        else if (oKey instanceof OrderId)
        {
            return oKey;
        }
        else
        {
            return null;
        }
    }

    public void init(PartitionedService service)
    {
    }
}

```

The key associator is configured for a NamedCache in the <distributed-scheme> element that defined the cache:

Example 30–3 Configuring a Key Associator

```
<distributed-scheme>
...
<key-associator>
    <class-name>LineItemAssociator</class-name>
</key-associator>
</distributed-scheme>

```

Deferring the Key Association Check

Key association can be implemented either on the cluster or on the extend client. When using extend clients, the best practice is to implement key association on the client, which provides the best performance by processing the keys before they are sent to the cluster. Key association is processed on the client by default. Existing client implementations that rely on key association on the cluster must set the `defer-key-association-check` parameter in order to force the processing of key classes on the cluster.

To force key association processing to be done on the cluster side instead of by the extend client, set the `<defer-key-association-check>` element, within a `<remote-cache-scheme>` element, in the client-side cache configuration to `true`. For example:

```
<remote-cache-scheme>
...
<defer-key-association-check>true</defer-key-association-check>
</remote-cache-scheme>

```

Note: If the parameter is set to true, a key class implementation must be found on the cluster even if key association is no being used.

See *Developing Remote Clients for Oracle Coherence* (.NET and C++) for more information on deferring key association with .NET and C++ clients, respectively.

Example of Using Affinity

Example 30–4 illustrates how to use affinity to create a more efficient query (`NamedCache.entrySet(Filter)`) and cache access (`NamedCache.getAll(Collection)`).

Example 30–4 Using Affinity for a More Efficient Query

```
OrderId orderId = new OrderId(1234);

// this Filter is applied to all LineItem objects to fetch those
// for which getOrderId() returns the specified order identifier
// "select * from LineItem where OrderId = :orderId"Filter filterEq = new
EqualsFilter("getOrderId", orderId);

// this Filter directs the query to the cluster node that currently owns
// the Order object with the given identifier
Filter filterAsc = new KeyAssociatedFilter(filterEq, orderId);

// run the optimized query to get the ChildKey objects
Set setLineItemKeys = cacheLineItems.keySet(filterAsc);

// get all the Child objects immediately
Set setLineItems = cacheLineItems.getAll(setLineItemKeys);

// Or remove all immediately
cacheLineItems.keySet().removeAll(setLineItemKeys);
```

Changing the Number of Partitions

The default partition count for a distributed cache service is 257 partitions. Each cache server in the cluster that hosts a distributed cache service manages a balanced number of the partitions. For example, each cache server in a cluster of four cache servers manages 64 partitions. The default partition count is typically acceptable for clusters containing up to 16 cache servers. However, larger clusters require more partitions to ensure optimal performance.

To change the number of partitions for a distribute cache service, edit the cache configuration file and add a `<partition-count>` element, within the `<distributed-scheme>` element, that includes the number of partitions to use for the service. For example:

```
<distributed-scheme>
  <scheme-name>distributed</scheme-name>
  <service-name>DistributedCache</service-name>
  <partition-count>1181</partition-count>
  ...
</distributed-scheme>
```

Deciding the number of Partitions

There is no exact formula for selecting a partition count. An ideal partition count balances the number of partitions on each cluster member with the amount of data each partition holds. Use the following guidelines when selecting a partition count and always perform tests to verify that the partition count is not adversely affecting performance.

- The partition count should always be a prime number. A list of primes can be found at <http://primes.utm.edu/lists/>.
- The number of partitions must be large enough to support a balanced distribution without each member managing too few partitions. For example, a partition count that results in only two partitions on each member is too constraining.
- The number of partitions must not be too large that network bandwidth is wasted with transfer overhead and bookkeeping for many partition transfers (a unit of transfer is a partition). For example, transferring thousands of partitions to a new cache server member requires a greater amount of network resources and can degrade cluster performance especially during startup.
- The amount of data a partition manages must not be too large (the more data a partition manages: the higher the partition promotion and transfer costs). The amount of data a partition manages is only limited by the amount of available memory on the cache server. A partition limit of 50MB typically ensures good performance. A partition limit between 50MB-100MB (even higher with 10GbE or faster) can be used for larger clusters. Larger limits can be used with the understanding that there will be a slight increase in transfer latency and that larger heaps with more overhead space are required.

As an example, consider a cache server that is configured with a 4G heap and stores approximately 1.3G of primary data not including indexes (leaving 2/3 of the heap for backup and scratch space). If the decided partition limit is a conservative 25MB, then a single cache server can safely use 53 partitions (1365M/25M rounded down to the previous prime). Therefore, a cluster that contains 20 cache servers can safely use 1051 partitions (53*20 rounded down to the previous prime) and stores approximately 25G of primary data. A cluster of 100 cache servers can safely use 5297 partitions and can store approximately 129G of primary data.

Changing the Partition Distribution Strategy

Partition distribution defines how partitions are assigned to storage-enabled cluster members. There are two styles of distribution available:

- Autonomous distribution – This method of distribution requires each storage-enabled service member to calculate its own balanced share of the available partitions and to request distribution in order to balance the service.
- Centralized distribution – This method of distribution uses a centralized partition assignment strategy to make a global distribution decision to be carried out by each storage-enabled member. The centralized distribution allows for more expressive distribution algorithms to be utilized and uses a more complete and global view of the service.

Custom centralized distribution strategy can be created by implementing the `com.tangosol.net.partition.PartitionAssignmentStrategy` interface.

Specifying a Partition Assignment Strategy

The following predefined partition assignment strategies are available:

- `legacy` – (deprecated) The legacy assignment strategy indicates that partition distribution is managed individually on each cluster member. The legacy partition assignment strategy is an autonomous distribution strategy.
- `simple` – (default) The simple assignment strategy is a centralized distribution strategy that attempts to balance partition distribution while ensuring machine-safety and is more deterministic and efficient than the legacy strategy.
- `mirror:<service-name>` – The mirror assignment strategy is a centralized distribution strategy that attempts to co-locate the service's partitions with the partitions of the specified service. This strategy is used to increase the likelihood that key-associated, cross-service cache access remains local to a member.
- `custom` – a class that implements the `com.tangosol.net.partition.PartitionAssignmentStrategy` interface.

To configure a partition assignment strategy for a specific partitioned cache service, add a `<partition-assignment-strategy>` element within a distributed cache definition:

```
<distributed-scheme>
  ...
  <partition-assignment-strategy>mirror:<MyService>
</partition-assignment-strategy>
  ...
</distributed-scheme>
```

To configure the partition assignment strategy for all instances of the distributed cache service type, override the partitioned cache service's `partition-assignment-strategy` initialization parameter in an operational override file. For example:

```
<?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>
    <services>
      <service id="3">
        <init-params>
          <init-param id="21">
            <param-name>partition-assignment-strategy</param-name>
            <param-value>mirror:<MyService></param-value>
          </init-param>
        </init-params>
      </service>
    </services>
  </cluster-config>
</coherence>
```

Enabling a Custom Partition Assignment Strategy

To specify a custom partition assignment strategy, include an `<instance>` subelement within the `<partition-assignment-strategy>` element and provide a fully qualified class name that implements the `com.tangosol.net.partition.PartitionAssignmentStrategy` interface. A custom class can also extend the `com.tangosol.net.partition.SimpleAssignmentStrategy` class. See ["instance"](#) on page B-54 for detailed instructions on using the `<instance>`

element. The following example enables a partition assignment strategy that is implemented in the `MyPAStrategy` class.

```
<distributed-scheme>
  ...
  <partition-assignment-strategy>
    <instance>
      <class-name>package.MyPAStrategy</class-name>
    </instance>
  </partition-assignment-strategy>
  ...
</distributed-scheme>
```

As an alternative, the `<instance>` element supports the use of a `<class-factory-name>` element to use a factory class that is responsible for creating `PartitionAssignmentStrategy` instances, and a `<method-name>` element to specify the static factory method on the factory class that performs object instantiation. The following example gets a strategy instance using the `getStrategy` method on the `MyPAStrategyFactory` class.

```
<distributed-scheme>
  ...
  <partition-assignment-strategy>
    <instance>
      <class-factory-name>package.MyPAStrategyFactory</class-factory-name>
      <method-name>getStrategy</method-name>
    </instance>
  </partition-assignment-strategy>
  ...
</distributed-scheme>
```

Any initialization parameters that are required for an implementation can be specified using the `<init-params>` element. The following example sets the `iMaxTime` parameter to 2000.

```
<distributed-scheme>
  ...
  <partition-assignment-strategy>
    <instance>
      <class-name>package.MyPAStrategy</class-name>
      <init-params>
        <init-param>
          <param-name>iMaxTime</param-name>
          <param-value>2000</param-value>
        </init-param>
      </init-params>
    </instance>
  </partition-assignment-strategy>
  ...
</distributed-scheme>
```

Managing Thread Execution

This chapter provides instructions for controlling the execution behavior of Coherence service threads using task timeouts and the `PriorityTask` API for custom execution processing.

This chapter includes the following sections:

- [Overview of Priority Tasks](#)
- [Setting Priority Task Timeouts](#)
- [Creating Priority Task Execution Objects](#)

Overview of Priority Tasks

Coherence priority tasks provide applications that have critical response time requirements better control of the execution of processes within Coherence. Execution and request timeouts can be configured to limit wait time for long running threads. In addition, a custom task API allows applications to control queue processing. Use these features with extreme caution because they can dramatically affect performance and throughput of the data grid.

Setting Priority Task Timeouts

Care should be taken when configuring Coherence task execution timeouts especially for Coherence applications that pre-date this feature and thus do not handle timeout exceptions. For example, if a write-through in a `CacheStore` is blocked and exceeds the configured timeout value, the Coherence task manager attempts to interrupt the execution of the thread and an exception is thrown. In a similar fashion, queries or aggregations that exceed configured timeouts are interrupted and an exception is thrown. Applications that use this feature should ensure that they handle these exceptions correctly to ensure system integrity. Since this configuration is performed on a service by service basis, changing these settings on existing caches/services not designed with this feature in mind should be done with great care.

Configuring Execution Timeouts

The `<request-timeout>`, `<task-timeout>`, and the `<task-hung-threshold>` elements are used to configure execution timeouts for a service's worker threads. These timeout settings are configured for a service in a cache configuration file and can also be set using command line parameters. See [Chapter 11, "Using the Service Guardian,"](#) for information on setting timeouts for service threads.

[Table 31-1](#) describes the execution timeout elements.

Table 31–1 Execution Timeout Elements

Element Name	Description
<code><request-timeout></code>	<p>Specifies the default timeout value for requests that can time out (for example, implement the <code>PriorityTask</code> interface), but do not explicitly specify the request timeout value. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ol style="list-style-type: none"> 1. The time it takes to deliver the request to an executing node (server). 2. The interval between the time the task is received and placed into a service queue until the execution starts. 3. The task execution time. 4. The time it takes to deliver a result back to the client. <p>If the value does not contain a unit, a unit of milliseconds is assumed. Legal values are positive integers or zero (indicating no default timeout). Default value is an infinite timeout (0s) for clustered client requests and 30 seconds (30s) for non-clustered client requests.</p>
<code><task-timeout></code>	<p>Specifies the default timeout value for tasks that can be timed-out (for example, entry processors that implement the <code>PriorityTask</code> interface), but do not explicitly specify the task execution timeout value. The task execution time is measured on the server side and does not include the time spent waiting in a service backlog queue before being started. This attribute is applied only if the thread pool is used (the <code>thread-count</code> value is positive). If zero is specified, the default <code>service-guardian <timeout-milliseconds></code> value is used.</p>
<code><task-hung-threshold></code>	<p>Specifies the amount of time in milliseconds that a task can execute before it is considered "hung". Note: A posted task that has not yet started is never considered as hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive).</p>

The following example sets a distributed cache's thread count to 7 with a task time out of 5000 milliseconds and a task hung threshold of 10000 milliseconds:

Example 31–1 Sample Task Time and Task Hung Configuration

```
< caching-schemes >
  < distributed-scheme >
    < scheme-name > example-distributed < /scheme-name >
    < service-name > DistributedCache < /service-name >
    < thread-count > 7 < /thread-count >
    < task-hung-threshold > 10000 < /task-hung-threshold >
    < task-timeout > 5000 < /task-timeout >
  < /distributed-scheme >
< /caching-schemes >
```

Setting the client request timeout to 15 milliseconds

Example 31–2 Sample Client Request Timeout Configuration

```
< distributed-scheme >
  < scheme-name > example-distributed < /scheme-name >
  < service-name > DistributedCache < /service-name >
  < request-timeout > 15000ms < /request-timeout >
```

```
</distributed-scheme>
```

Note: The request-timeout should always be longer than the thread-hung-threshold or the task-timeout.

Command Line Options

Use the command line options to set the service type default (such as distributed cache, invocation, proxy, and so on) for the node. [Table 31-2](#) describes the options.

Table 31-2 *Command Line Options for Setting Service Type*

Option	Description
tangosol.coherence.replicated.request.timeout	The default client request timeout for the Replicated cache service
tangosol.coherence.optimistic.request.timeout	The default client request timeout for the Optimistic cache service
tangosol.coherence.distributed.request.timeout	The default client request timeout for distributed cache services
tangosol.coherence.distributed.task.timeout	The default server execution timeout for distributed cache services
tangosol.coherence.distributed.task.hung	The default time before a thread is reported as hung by distributed cache services
tangosol.coherence.invocation.request.timeout	The default client request timeout for invocation services
tangosol.coherence.invocation.task.hung	The default time before a thread is reported as hung by invocation services
tangosol.coherence.invocation.task.timeout	The default server execution timeout invocation services
tangosol.coherence.proxy.request.timeout	The default client request timeout for proxy services
tangosol.coherence.proxy.task.timeout	The default server execution timeout proxy services
tangosol.coherence.proxy.task.hung	The default time before a thread is reported as hung by proxy services

Creating Priority Task Execution Objects

The `PriorityTask` interface enables you to control the ordering in which a service schedules tasks for execution using a thread pool and hold the task execution time to a specified limit. Instances of `PriorityTask` typically also implement either the `Invocable` or `Runnable` interface. Priority Task Execution is only relevant when a task back log exists.

The API defines the following ways to schedule tasks for execution

- `SCHEDULE_STANDARD`—a task is scheduled for execution in a natural (based on the request arrival time) order
- `SCHEDULE_FIRST`—a task is scheduled in front of any equal or lower scheduling priority tasks and executed as soon as any of worker threads become available

- `SCHEDULE_IMMEDIATE`—a task is immediately executed by any idle worker thread; if all of them are active, a new thread is created to execute this task

APIs for Creating Priority Task Objects

Coherence provides the following classes to help create priority task objects:

- `PriorityProcessor` can be extended to create a custom entry processor.
- `PriorityFilter` can be extended to create a custom priority filter.
- `PriorityAggregator` can be extended to create a custom aggregation.
- `PriorityTask` can be extended to create an priority invocation class.

After extending each of these classes the developer must implement several methods. The return values for `getRequestTimeoutMillis`, `getExecutionTimeoutMillis`, and `getSchedulingPriority` should be stored on a class-by-class basis in your application configuration parameters. These methods are described in [Table 31–3](#).

Table 31–3 *Methods to Support Task Timeout*

Method	Description
<pre>public long getRequestTimeoutMillis()</pre>	Obtains the maximum amount of time a calling thread is can wait for a result of the request execution. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes: the time it takes to deliver the request to the executing node(s); the interval between the time the task is received and placed into a service queue until the execution starts; the task execution time; the time it takes to deliver a result back to the client. The value of <code>TIMEOUT_DEFAULT</code> indicates a default timeout value configured for the corresponding service; the value of <code>TIMEOUT_NONE</code> indicates that the client thread is can wait indefinitely until the task execution completes or is canceled by the service due to a task execution timeout specified by the <code>getExecutionTimeoutMillis()</code> value.
<pre>public long getExecutionTimeoutMillis()</pre>	Obtains the maximum amount of time this task is allowed to run before the corresponding service attempts to stop it. The value of <code>TIMEOUT_DEFAULT</code> indicates a default timeout value configured for the corresponding service; the value of <code>TIMEOUT_NONE</code> indicates that this task can execute indefinitely. If, by the time the specified amount of time passed, the task has not finished, the service attempts to stop the execution by using the <code>Thread.interrupt()</code> method. In the case that interrupting the thread does not result in the task's termination, the <code>runCanceled</code> method is called.
<pre>public int getSchedulingPriority()</pre>	Obtains this task's scheduling priority. Valid values are <code>SCHEDULE_STANDARD</code> , <code>SCHEDULE_FIRST</code> , <code>SCHEDULE_IMMEDIATE</code>
<pre>public void runCanceled(boolean fAbandoned)</pre>	This method is called if and only if all attempts to interrupt this task were unsuccessful in stopping the execution or if the execution was canceled before it had a chance to run at all. Since this method is usually called on a service thread, implementors must exercise extreme caution since any delay introduced by the implementation causes a delay of the corresponding service.

Errors Thrown by Task Timeouts

When a task timeout occurs the node gets a `RequestTimeoutException`. [Example 31-3](#) illustrates an exception that may be thrown.

Example 31-3 *Exception Thrown by a TaskTimeout*

```
com.tangosol.net.RequestTimeoutException: Request timed out after 4015 millis
    at
com.tangosol.coherence.component.util.daemon.queueProcessor.Service.checkRequestTi
meout(Service.CDB:8)
    at
com.tangosol.coherence.component.util.daemon.queueProcessor.Service.poll(Service.C
DB:52)
    at
com.tangosol.coherence.component.util.daemon.queueProcessor.Service.poll(Service.C
DB:18)
    at
com.tangosol.coherence.component.util.daemon.queueProcessor.service.InvocationServ
ice.query(InvocationService.CDB:17)
    at
com.tangosol.coherence.component.util.safeService.SafeInvocationService.query(Safe
InvocationService.CDB:1)
```

Constraints on Re-entrant Calls

This chapter describes the constraints on service re-entrant calls and provides general guidelines for making calls between service threads.

This chapter includes the following sections:

- [Overview of Constraints on Re-Entrant Calls](#)
- [Re-entrancy, Services, and Service Threads](#)
- [Re-entrancy and Listeners](#)

Overview of Constraints on Re-Entrant Calls

Coherence does not support re-entrant calls. A "re-entrant service call" occurs when a service thread, in the act of processing a request, makes a request to that same service. As all requests to a service are delivered by using the inbound queue, and Coherence uses a thread-per-request model, each reentrant request would consume an additional thread (the calling thread would block while awaiting a response). Note that this is distinct from the similar-sounding concept of recursion.

The Coherence architecture is based on a collection of services. Each Coherence service consists of the Coherence code that implements the service, along with an associated configuration. The service runs on an allocated pool of threads with associated queues that receive requests and return responses.

Re-entrancy, Services, and Service Threads

A service is defined as a unique combination of a service name and a service type (such as Invocation, Replicated, or Distributed). For example, you can call from a distributed service `Dist-Customers` into a distributed service named `Dist-Inventory`, or from a distributed service named `Dist-Customers` into a replicated service named `Repl-Catalog`. Service names are configured in the cache configuration file using the `<service-name>` element.

Parent-Child Object Relationships

In the current implementation of Coherence, it is irrelevant whether the "call" is local or remote. This complicates the use of key association to support the efficient assembly of parent-child relationships. If you use key association to co-locate a Parent object with all of its Child objects, then you cannot send an `EntryProcessor` to the parent object and have that `EntryProcessor` "grab" the (local) Child objects. This is true even though the Child objects are in-process.

To access both a parent object and its child objects, you can do any of the following:

- Embed the child objects within the parent object (using an "aggregate" pattern) or,
- Use direct access to the server-side backing map (which requires advanced knowledge to do safely), or
- Run the logic on another service (for example, Invocation targeted by using `PartitionedService.getKeyOwner`), and have that service access the data by using `NamedCache` interfaces, or
- Place the child objects on another service which would allow reentrant calls (but incur network access since there is no affinity between partitions in different cache services).

Using the aggregate pattern is probably the best solution for most use cases. However, if this is impractical (due to size restrictions, for example), and there is a requirement to access both the parent and child objects without using a client/server model, the Invocation service approach is probably the best compromise for most use cases.

Avoiding Deadlock

Even when re-entrancy is allowed, one should be very careful to avoid saturating the thread pool and causing catastrophic deadlock. For example, if service A calls service B, and service B calls service A, there is a possibility that enough concurrent calls could fill a thread pool, which would cause a form of deadlock. As with traditional locking, using ordered access (for example, service A can call service B, but not vice versa) can help.

So:

- Service A calling into service A is never allowed
- Service A calling into service B, and service B calling back into service A is technically allowed but is deadlock-prone and should be avoided if at all possible.
 - Service A calling into service B, and service B calling into service C, and service C calling back into service A is similarly restricted
- Service A calling into service B is allowed
 - Service A calling into service B, and service B calling into service C, and service A calling into service C is similarly allowed

A service thread is defined as any thread involved in *fulfilling* a Coherence API request. Service threads may invoke any of the following entities:

- Map Listeners
- Membership Listeners
- Custom Serialization/Deserialization such as `ExternalizableLite` implementations
- Backing Map Listeners
- `CacheLoader/CacheStore` Modules
- Query logic such as `Aggregators`, `Filters`, `ValueExtractors` and `Comparators`
- Entry Processors
- Triggers
- `InvocationService` Invocables

These entities should never make re-entrant calls back into their own services.

Re-entrancy and Listeners

Membership listeners can observe the active set of members participating in the cluster or a specific service. Membership listener threading can be complex; thus, re-entrant calls from a member listener to any Coherence service should be avoided.

Part V

Using the Coherence JCache Implementation

Part V contains the following chapters:

- [Chapter 33, "Introduction to Coherence JCache"](#)
- [Chapter 34, "Building Your First Coherence JCache Application"](#)
- [Chapter 35, "Performing Basic Coherence JCache Tasks"](#)
- [Chapter 36, "Using JCache Events"](#)
- [Chapter 37, "Processing JCache Entries"](#)

Introduction to Coherence JCache

This chapter provides an overview of the Coherence implementation of the JSR-107 JCache - Java Caching API specification. The specification and API is commonly referred to as JCache in this documentation. A JCache overview section is also provided and includes a basic introduction to the API. For complete details about the API, download the JCache specification, Java sources, and JavaDoc from the Java Community Process (JCP) website:

<https://www.jcp.org/en/jsr/detail?id=107>

This chapter includes the following sections:

- [Overview of the Coherence JCache Implementation](#)
- [Comparison of JCache and NamedCache Features](#)
- [Dependencies for Coherence JCache](#)
- [Overview of Configuration for the Coherence JCache Provider](#)
- [JCache Primer](#)

Overview of the Coherence JCache Implementation

Coherence includes a JCache provider implementation (`COHERENCE_HOME\lib\coherence-jcache.jar`). JCache is a common API for using caching in Java. Application developers use the JCache API (`javax.cache.*`) 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 caching systems. For additional information about JCache, see "[JCache Primer](#)" on page 33-4.

The Coherence JCache provider uses existing Coherence technology 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 through JCache interfaces.

Supported Cache Types

The Coherence JCache provider offers three cache types:

- **Local Cache** – A cache that is local to an application process. Entries that are stored in local caches do not persist after an application process ends. A local cache is similar to a `NamedCache` cache that is configured using a local-scheme cache definition. The local cache implementation is defined in the `com.tangosol.coherence.jcache.localcache` package. For details about creating local caches, see "[Creating Local Caches](#)" on page 35-2.

- **Partitioned Cache** – A cache that is partitioned (distributed) among multiple processes in a Coherence cluster. Entries that are stored in partitioned caches are backed up and persist on the cluster after an application process ends. A partitioned cache is similar to a `NamedCache` cache that is configured using a distributed-scheme cache definition. The partitioned cache implementation is defined in the `com.tangosol.coherence.jcache.partitionedcache` package. For details about creating partitioned caches, see ["Creating Partitioned Caches"](#) on page 35-3. To learn more about partitioned caches, see ["Understanding Distributed Caches"](#) on page 12-1.
- **Pass-Through Cache** – A cache that delegates to an existing `NamedCache` cache. Pass-through caches offer applications the ability to use all Coherence native features from a JCache interface. Pass-through caches are ideal for applications that want to migrate to JCache but also want to reuse their existing Coherence application components. The pass-through cache implementation is defined in the `com.tangosol.coherence.jcache.passthroughcache` package. For details about creating pass-through caches, see ["Creating Pass-Through Caches"](#) on page 35-4.

Coherence JCache Events

The Coherence JCache provider uses the native Coherence event APIs to implement JCache events. The local and partitioned cache implementations leverage the Coherence `MapListener` API. The pass-through cache implementation only supports the Coherence `MapEvents` that map directly to the JCache events and there is no support for JCache expired events. Each cache type is responsible for registering map listeners and for dispatching map events. Event classes are located in the `com.tangosol.coherence.jcache.common` package as well as in each cache type package. For details about creating and using JCache events, see ["Using JCache Events"](#) on page 36-1.

Notes:

- There is no equivalent of the `javax.cache.event.CacheEntryExpiredListener` API in the Coherence `MapListener` API.
 - The `NamedCache.clear` method results in a Coherence `MapListener.entryDeleted` event; however, the JCache `Cache.clear` method does not result in any events.
-
-

Coherence JCache Entry Processors

The Coherence JCache provider uses the native Coherence `InvocableMap.EntryProcessor` API to implement JCache entry processors. Each cache type includes an `InvokeProcessor` class in their respective processors package that is responsible for executing JCache entry processors when the `invoke` or `invokeAll` methods are called from a cache. For details about creating and using JCache entry processors, see ["Processing JCache Entries"](#) on page 37-1.

The `processors` package for each cache type also includes many native Coherence entry processors that are used to perform cache operations. For example, when using a partitioned cache, the use of the `put` method results in the use of the `PutProcessor` class.

Coherence Serialization for JCache

The Coherence JCache provider makes use of Coherence Portable Object Format (POF) serialization. POF is a proven binary format within Coherence and is efficient in both

space and time. For partitioned and pass-through caches, many cache operations utilize POF. Cache configuration, entry processors, event listeners and filters, and JCache statistics also make use of POF.

POF is also used to provide serialization as required by parts of the JCache specification. The `com.tangosol.coherence.jcache.serialization` package includes POF serializer implementations to support JCache factory builders, expiry policies, and cache entry listener configuration.

Lastly, applications can choose to use POF for serialization as required; however, it is not a requirement when using the Coherence JCache provider. In use cases where portability between cache providers is a requirement, applications should use Java serialization.

Coherence JCache Management

The Coherence JCache provider implements the JCache `CacheMXBean` and `CacheStatisticsMXBean` MXBean interfaces. The implementation are located in the `com.tangosol.coherence.jcache.common` package. Management information for local and partitioned caches are registered to the default MBean server and are found under the `javax.cache` namespace. Management information for pass-through caches are reported using the native Coherence JMX management implementation. For details about enabling JCache management, see "[Viewing JCache Management Information](#)" on page 35-13.

Comparison of JCache and NamedCache Features

The Coherence JCache provider offers support for many features that are also available with the Coherence native `NamedCache` API. However, not all features are available through JCache. [Table 33-1](#) shows a comparison of the two APIs.

Table 33-1 Comparison of JCache and NamedCache Features

Feature	JCache	NamedCache
Local Cache	X	X
Partitioned (Distributed) Cache	X	X
Replicated Cache		X
Optimistic Cache		X
Near Cache		X
Read Through	X	X
Write Through	X	X
Events	X	X
Query Filters		X
Indexes		X
Entry Processors	X	X
Aggregation		X

Dependencies for Coherence JCache

Applications that use JCache and the Coherence JCache provider must include the following libraries on the application classpath:

- COHERENCE_HOME\lib\cache-api.jar – The standard JCache API.
- COHERENCE_HOME\lib\coherence-jcache.jar – The Coherence JCache provider implementation.
- COHERENCE_HOME\lib\coherence.jar – The core Coherence library.

The Coherence JCache provider includes a service definition in the META-INF/services directory of the coherence-jcache.jar library. The definition allows Coherence to be automatically loaded and used as the default caching provider by applications that use the javax.cache.Caching bootstrap class. For details about using Coherence as the default JCache provider, see "[Specifying Coherence as the JCache Provider](#)" on page 35-1.

Overview of Configuration for the Coherence JCache Provider

The JCache provider utilizes the same configuration files as the native Coherence NamedCache API. However, the need to customize the configuration files has been simplified and in some cases not required at all. The following lists the configuration file used by the JCache implementation:

- tangosol-coherence-override.xml – A Coherence operational override file is used when configuring a Coherence cluster for partitioned caches and when using pass-through caches. The override file is not required for local caches. For details about operational override files, see "[Specifying an Operational Configuration File](#)" on page 3-2.
- coherence-jcache-cache-config.xml – A Coherence JCache provider-specific cache configuration file that is called coherence-jcache-cache-cofig.xml is included in the provider JAR file and used to create local and partitioned caches; however, applications are not expected to edit the configuration. The included cache configuration file defines a JCacheNamespace handler class that is used to programmatically define local and partitioned caches for use by JCache applications.
- coherence-jcache-pof-config.xml – A Coherence JCache provider-specific POF configuration file that is called coherence-jcache-pof-cofig.xml is included in the provider JAR file and is used to define JCache POF types. For details about including JCache POF types with an existing Coherence application, see "[Configuring a JCache POF Configuration file](#)" on page 35-13.

JCache Primer

This section provides an overview of the JCache specification and API and is intended for those that are new to JCache. It includes basic concepts that are used when completing the instructions in this book. If you are familiar with JCache, you can skip this section.

This section is not intended to replace the specification or the API documentation. For complete details, download the JCache specification, Java sources, and JavaDoc from the Java Community Process (JCP) website:

<https://www.jcp.org/en/jsr/detail?id=107>

What is JCache

The JCache specification defines an API for creating and using caches in Java programs. Applications often use caches to store and reuse resources that require a significant cost to create. Applications can then quickly access the resources in

memory without having to incur the cost associated with recreating the resources. Applications commonly use caching to increase application performance, availability, and scalability.

The JCache API defines a provider-based model for caching. The provider model separates the cache client API from the cache implementation. Applications use a well-defined client API and cache providers are responsible for the actual cache implementation. The provider-based model frees application developers from having to create and manage complex caching sub-systems and ensures portability between cache providers that implement the specification.

JCache Caching Providers and Cache Managers

The JCache API defines the `CachingProvider` and `CacheManager` interfaces. Applications use the `CachingProvider` interface to get and use a cache manager. Applications use the `CacheManager` interface to create and use caches. Applications are free to use multiple cache providers. However, a cache manager can only be associated with a single cache provider.

JCache offers several ways to get cache providers and access cache managers. A common access pattern that is used throughout this documentation is to use the `Caching` bootstrap class. The class provides a convenient way to get a `CachingProvider` implementation and automatically discovers providers that include a standard Java service definition.

The following example gets a default `CachingProvider` implementation and then creates a cache manager:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();
```

JCache Caches

The JCache API defines a `Cache` interface. The `Cache` interface creates a data structure that stores key and value pairs. Each key and value pair is referred to an entry and is defined by the `Cache.Entry` interface. A cache is similar to a Java `Map` data structure; However, there are some key differences:

- Keys or values cannot be null.
- `Cache.put` operations do not return an entry's previous value. The `Cache.getAndPut` operation is functionally equivalent to the `Map.put` operation.
- Cache Entries expire and can be evicted.
- Values can be automatically loaded from, and written to, an external source to support read-through and write-through caching.
- Cache entry changes can be observed.
- Cache statistics can be collected.

The `Cache` interface includes methods for putting, getting, replacing, and removing cache entries. Methods are also provided for loading a cache, registering cache listeners, and invoking entry processors.

The following example demonstrates using a cache manager to create a `Cache` instance called `MyCache`:

```
Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

JCache makes use of generics to support both compile and runtime type checking. The example creates a cache that requires keys to be of type `String` and values to be of type `Integer`. Type checking is not required but is often a best practice.

Operations are performed on the cache instance:

```
String key = "k";
Integer value = 1;

cache.put(key, value);
```

JCache Cache Configuration

The JCache API defines the `CompleteConfiguration` interface that is used to configure a cache. The `MutableConfiguration` class is a default implementation of the interface. The configuration options include:

- setting store-by semantics (by value or by reference)
- setting cache entry types
- setting cache expiry
- enabling read-through and write-through caching
- enabling management and statistics

Caches are configured when the cache is created. In the previous cache example, the `createCache` method required both a name and configuration for the cache. The following example demonstrates creating a configuration object to be used by the `createCache` method:

```
MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setStoreByValue(true).setTypes(String.class, Integer.class)
    .setReadThrough(true)
    .setWriteThrough(true)
    .setManagementEnabled(true)
    .setStatisticsEnabled(true)
    .setExpiryPolicyFactory(CreatedExpiryPolicy.factoryOf(Duration.FIVE_MINUTES));

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

JCache Custom Programming

The JCache API provides multiple interfaces that give applications the ability to customize caching. To use an implementation, you must use the `Factory` interface to create the instance. This ensures that the instance is serializable. The following interfaces can be implemented by an application:

- `ExpiryPolicy` – This interface is used to define when (`Duration`) cache entries expire based on entry creation, access, and modification operations.
- `CacheLoader` – This interface is used to load data into a cache from an external resource as is required when using read-through caching.
- `CacheWriter` – This interface is used to write data to an external resource as is required when using read-through caching.
- `CacheEntryListener` – A set of subinterfaces (`CacheEntryCreatedListener`, `CacheEntryUpdatedListener`, `CacheEntryRemovedListener`, and `CacheEntryExpiredListener`) that are used to receive and react to Cache events.

- `EntryProcessor` – This interface is used to perform compound operations on cache entries in an atomic, lock-free manner. Unlike the other interfaces, the `EntryProcessor` interface does not require the use of the `Factory` interface to create an instance; however, the implementation will need to be serialized if the intention is to use distributed caching.

JCache Management

The JCache API defines two dynamic MBeans that are used to manage caches. The `CacheMXBean` MBean reports cache configuration information. The `CacheStatisticsMXBean` MBean reports cache performance statistics that are used to troubleshoot potential issues. The dynamic MBeans are registered with an implementation-specific MBean server and are obtained using standard JMX; including, the use of any JMX MBean-compliant browser.

Building Your First Coherence JCache Application

This chapter provides step-by-step instructions for building and running a basic Coherence JCache example and demonstrates fundamental concepts of both JCache and the Coherence JCache provider. The sample application is a simple application that stores a domain object (the `Person` object) into a cache. The example demonstrates using a local cache, a partitioned cache, and a pass-through cache.

If you are new to Coherence, you may consider also running the native Coherence `NamedCache` example, see ["Building Your First Coherence Application"](#) on page 4-1.

This chapter includes the following sections:

- [Task 1: Create a Simple Object](#)
- [Task 2: Store the Object in a Local Cache](#)
- [Task 3: Configure an Example Cluster](#)
- [Task 4: Store the Object in a Partitioned Cache](#)
- [Task 5: Store the Object in a Pass-Through Cache](#)

Task 1: Create a Simple Object

The examples in this chapter uses a simple `Person` object. The `Person` object contains a constructor and three fields for a first name, last name, and age. The `Person` object implements the `Serializable` interface. Serialization is required when the object is stored in a partitioned cache.

Example 34–1 A Simple Person Object

```
package com.examples;

import java.io.Serializable;

public class Person implements Serializable {
    private String m_sFirstName;
    private String m_sLastName;
    private int m_nAge;
    private static final long serialVersionUID = 99L;

    public Person(String sFirstName, String sLastName, int nAge)
    {
        m_sFirstName = sFirstName;
        m_sLastName = sLastName;
        m_nAge = nAge;
    }
}
```

```
    }

    public String getFirstName()
    {
        return m_sFirstName;
    }

    public String getLastName()
    {
        return m_sLastName;
    }

    public int getAge()
    {
        return m_nAge;
    }

    public String toString()
    {
        return "Person( " + m_sFirstName + " " + m_sLastName + " : " + m_nAge + ")";
    }
}
```

Task 2: Store the Object in a Local Cache

Applications use the JCache API to access and interact with a cache. The API provides methods for creating and using a cache. The default cache type that Coherence uses if no cache type is defined is a local cache (local to the application process).

Create the Sample JCache Application

The following application stores a single `Person` object to a local cache. The application demonstrates getting a cache provider, creating a cache manager, configuring and creating a cache, and using the cache.

Example 34-2 An Example JCache Application

```
package com.examples;

import javax.cache.Cache;
import javax.cache.CacheManager;
import javax.cache.Caching;
import javax.cache.configuration.MutableConfiguration;
import javax.cache.spi.CachingProvider;

public class JCacheExample {
    public static void main(String[] args)
    {
        CachingProvider cachingProvider = Caching.getCachingProvider();
        CacheManager cacheManager = cachingProvider.getCacheManager();

        MutableConfiguration<String, Object> config =
            new MutableConfiguration<String, Object>();
        config.setStoreByValue(true).setTypes(String.class, Object.class);

        Cache<String, Object> cache = cacheManager.createCache("MyCache", config);

        Person p = new Person("John", "Doe", 24);
```

```

String key = "k";
Person value = p;

cache.put(key, value);
System.out.println("\n Cache: " + cache.getName() + " contains: " +
    cache.get(key) + "\n");

cacheManager.close();
}
}

```

Run the Sample JCache Application

To run the standalone application example:

1. From a command prompt, compile the `Person.java` and `JCacheExample.java` files. The following example assumes that the files are in a single directory that is referred to as `APPLICATION_HOME` for the remainder of the tasks in this chapter:

```

cd APPLICATION_HOME
javac -cp COHERENCE_HOME\lib\cache-api.jar com\examples\*

```

2. Run the `JCacheExample` class and include the location of the `coherence.jar`, `coherence-jcache.jar`, and `cache-api.jar` libraries on the classpath using the Java `-cp` option. For example:

```

java -cp .;COHERENCE_HOME\lib\cache-api.jar;
COHERENCE_HOME\lib\coherence-jcache.jar;COHERENCE_HOME\lib\coherence.jar
com.examples.JCacheExample

```

Coherence log messages are emitted that indicate the Coherence configuration resources that are being used and the Coherence cache factory being created. The application emits the entry that is in the cache and then the application exits.

Task 3: 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. Create a file named `tangosol-coherence-override.xml`.
2. Add the following override configuration and replace `cluster_name` and `port` with values that are unique for this cluster. For example, use your name for the cluster name and the last four digits of your phone number for the port.

```

<?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 the file to the `APPLICATION_HOME\config` directory.

Task 4: Store the Object in a Partitioned Cache

A partitioned cache is a cache that distributes cache entries among any number of cache servers in a Coherence cluster. Entries that are stored in partitioned caches are backed up and persist on the cluster after the application process ends. For details about using partitioned caches with the JCache provider, see ["Creating Partitioned Caches"](#) on page 35-3.

In this task, two separate Java processes form the cluster: a cache server process and the `JCacheExample` application process. For simplicity, the two processes are collocated on a single computer. The cache server, by default, is configured to store cache data. Lastly, a Coherence `CacheFactory` is used to verify that the `JCacheExample` application successfully created and loaded the cache on the cluster.

Start the Example Cache Server

From a command prompt, start a cache server instance using the `DefaultCacheServer` class and use the `Java -cp` option to include the `APPLICATION_HOME\config` directory. The classpath must also include the `cache-api.jar`, `coherence-jcache.jar`, and `coherence.jar` libraries. Make sure that the operational override file and the `coherence-jcache.jar` are loaded on the classpath before the `coherence.jar` library. Lastly, use the `tangosol.coherence.cacheconfig` system property to explicitly use the JCache `coherence-jcache-cache-config.xml` cache configuration file that is located in the `coherence-jcache.jar`. For example:

```
java -Dtangosol.coherence.cacheconfig=coherence-jcache-cache-config.xml
-cp APPLICATION_HOME\config;COHERENCE_HOME\lib\cache-api.jar;
COHERENCE_HOME\lib\coherence-jcache.jar;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer
```

From the cache server output, notice that a distributed cache service that is called `jcache-partitioned-service` is created and is the senior member of the cluster:

```
(thread=DistributedCache:jcache-partitioned-service, member=1): Service
jcache-partitioned-service joined the cluster with senior service member 1
```

Run The Application

The `tangosol.coherence.jcache.configuration.classname` system property configures the Coherence JCache provider to use a partitioned cache instead of a local cache. The application code does not need to be modified in any way, which allows portability between JCache providers. In addition, Coherence manages the application scope and cache configuration.

To store the `Person` object in a partitioned cache:

1. From a command prompt, run the application that was created in [Example 34–2](#) and set the `tangosol.coherence.jcache.configuration.classname` system property to `partitioned` and the `tangosol.coherence.distributed.localstorage` system property to `false`. Use the Java `-cp` option to include the `APPLICATION_HOME\config` directory. The classpath must also include the `cache-api.jar`, `coherence-jcache.jar`, and `coherence.jar` libraries. Make sure that the operational override file and the `coherence-jcache.jar` library are loaded on the classpath before the `coherence.jar` library. For example:

```
java -Dtangosol.coherence.jcache.configuration.classname=partitioned
-Dtangosol.coherence.distributed.localstorage=false
-cp .;APPLICATION_HOME\config;COHERENCE_HOME\lib\cache-api.jar;
COHERENCE_HOME\lib\coherence-jcache.jar;COHERENCE_HOME\lib\coherence.jar
com.examples.JCacheExample
```

Coherence log messages are emitted that indicate the Coherence configuration resources that are being used. Notice that the `tangosol-coherence-override.xml` file was loaded. Lastly, notice that the application process joins the cluster and that the `jcache-partitioned-service` instance joins with the senior service on the cache server:

```
(thread=DistributedCache:jcache-partitioned-service, member=2): Service
jcache-partitioned-service joined the cluster with senior service member 1
```

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.

This step uses the cache factory command-line tool to connect to the cache and list all items in the cache.

To verify the cache:

1. From a command prompt, start a standalone cache factory instance using the `CacheFactory` class. Use the Java `-cp` option to include the `APPLICATION_HOME\config` directory. The classpath must also include the `Person` object, `cache-api.jar`, `coherence-jcache.jar`, and `coherence.jar` libraries. Make sure that the operational override file and the `coherence-jcache.jar` are loaded on the classpath before the `coherence.jar` library. Lastly, set the `tangosol.coherence.cacheconfig` system property to `coherence-jcache-cache-config.xml` and the `tangosol.coherence.distributed.localstorage` system property to `false`. For example:

```
java -Dtangosol.coherence.cacheconfig=coherence-jcache-cache-config.xml
-Dtangosol.coherence.distributed.localstorage=false
-cp APPLICATION_HOME\config;APPLICATION_HOME\person.jar;
COHERENCE_HOME\lib\cache-api.jar;COHERENCE_HOME\lib\coherence-jcache.jar;
COHERENCE_HOME\lib\coherence.jar com.tangosol.net.CacheFactory
```

The cache factory instance starts and becomes a member of the cluster and returns a command prompt for the command-line tool.

2. At the command-line tool command prompt, get the `MyCache` cache using the `cache` command:

```
cache jcache-partitioned-coherence-jcache-cache-config.xml$MyCache
```

Note: For the purpose of this example, the cache name includes the application scope. Applications do not need to explicitly include the application scope when using a cache.

3. At the command-line tool command prompt, retrieve the contents of the cache using the `list` command.

```
list
```

The command returns and displays:

```
k = Person( John Doe : 24)
```

4. Shutdown all processes.

Task 5: 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.

In this task, two separate Java processes form the cluster: a cache server process and the `JCacheExample` application process. For simplicity, the two processes are collocated on a single computer. The cache server, by default, is configured to store cache data. Lastly, a Coherence `CacheFactory` is used to verify that the `JCacheExample` application successfully created and loaded the cache on the cluster.

Define the Example Cache

For this example, a cache configuration is created that defines a distributed cache that is explicitly mapped to the `MyCache` name.

To define the example cache:

1. Create an XML file named `example-config.xml`.
2. Copy the following distributed cache definition to the file:

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

<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  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>

```

3. Save the file to the `APPLICATION_HOME\config` directory.

Start the Example Cache Server

From a command prompt, start a cache server instance using the `DefaultCacheServer` class and use the Java `-cp` option to include the `APPLICATION_HOME\config` directory and the `coherence.jar` library. Make sure that the operational override file is loaded on the classpath before the `coherence.jar` library. Lastly, use the `tangosol.coherence.cacheconfig` system property to explicitly define the `example-config.xml` cache configuration file. For example:

```

java -Dtangosol.coherence.cacheconfig=example-config.xml
-cp APPLICATION_HOME\config;COHERENCE_HOME\lib\coherence.jar
com.tangosol.net.DefaultCacheServer

```

Run the Application

The `tangosol.coherence.jcache.configuration.classname` system property configures the Coherence JCache provider to use a pass-through cache. The application code does not need to be modified in any way.

From a command prompt, run the `JCacheExample` class and set the `tangosol.coherence.jcache.configuration.classname` system property to `passthrough`, the `tangosol.coherence.cacheconfig` system property to `example-config`, and the `tangosol.coherence.distributed.localstorage` system property to `false`. Use the Java `-cp` option to include the `APPLICATION_HOME\config` directory. The classpath must also include the `cache-api.jar`, `coherence-jcache.jar`, and `coherence.jar` libraries. Make sure that the operational override file is loaded on the classpath before the `coherence.jar` library. For example:

```

java -Dtangosol.coherence.jcache.configuration.classname=passthrough
-Dtangosol.coherence.cacheconfig=example-config.xml
-Dtangosol.coherence.distributed.localstorage=false
-cp .;APPLICATION_HOME\config;COHERENCE_HOME\lib\cache-api.jar;
COHERENCE_HOME\lib\coherence-jcache.jar;COHERENCE_HOME\lib\coherence.jar
com.examples.JCacheExample

```

Coherence log messages are emitted that indicate the Coherence configuration resources that are being used. Notice that the `tangosol-coherence-override.xml` file and `example-config.xml` file were loaded. The application process connects to the cluster that contains the cache server process and both processes are running the `DistributedCache` service. As before, the application emits the entry that is in the cache and then the application exits.

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.

This step uses the cache factory command-line tool to connect to the MyCache cache and list all items in the cache.

To verify the cache:

1. From a command prompt, start a standalone cache factory instance using the CacheFactory class. Use the Java -cp option to include the APPLICATION_HOME\config directory. The classpath must also include the Person object and the coherence.jar library. Make sure that the operational override file is loaded on the classpath before the coherence.jar library. Lastly, set the tangosol.coherence.cacheconfig system property to example-config.xml and the tangosol.coherence.distributed.localstorage system property to false. For example:

```
java -Dtangosol.coherence.cacheconfig=example-config.xml
-Dtangosol.coherence.distributed.localstorage=false
-cp APPLICATION_HOME\config;APPLICATION_HOME\person.jar;
COHERENCE_HOME\lib\coherence.jar com.tangosol.net.CacheFactory
```

The cache factory instance starts and becomes a member of the cluster and returns a command prompt for the command-line tool.

2. At the command-line tool command prompt, get the MyCache cache using the cache command:

```
cache MyCache
```

3. At the command-line tool command prompt, retrieve the contents of the cache using the list command.

```
list
```

The command returns and displays:

```
k = Person( John Doe : 24)
```

Performing Basic Coherence JCache Tasks

This chapter includes basic tasks that are typical of application development when using the Coherence JCache provider. Many of the instructions demonstrate the JCache API and include details that are specific to the Coherence JCache provider implementation.

This chapter includes the following sections:

- [Specifying Coherence as the JCache Provider](#)
- [Creating Coherence JCache Caches](#)
- [Configuring Coherence JCache Caches](#)
- [Performing Cache Operations](#)
- [Using Read-Through and Write-Through Caching](#)
- [Configuring a JCache POF Configuration file](#)
- [Viewing JCache Management Information](#)

Specifying Coherence as the JCache Provider

The `META-INF/services/javax.cache.spi.CachingProvider` service definition that is located in the `coherence-jcache.jar` library assures that applications using the `javax.cache.Caching` bootstrap class use the Coherence JCache provider by default. The instructions and examples in this chapter assume that the Coherence JCache provider is the default JCache provider. However, applications are able to register and use multiple cache providers. In such cases, applications have several options to select the Coherence JCache provider.

Note: If multiple JCache providers are registered, then the use of the `getCachingProvider()` or `getCachingProvider(ClassLoader)` methods result in a cache exception.

The first option is to override the default cache provider using the `javax.cache.spi.cachingprovider` system property and specifying the fully qualified name of the Coherence JCache provider implementation class. For example:

```
System.setProperty("javax.cache.spi.cachingprovider",  
    "com.tangosol.coherence.jcache.CoherenceBasedCachingProvider");
```

The system property can also be specified on the command line at runtime. For example,

```
-Djavax.cache.spi.cachingprovider=com.tangosol.coherence.jcache.  
CoherenceBasedCachingProvider
```

The second option is to use the `Caching.getCachingProvider(String)` or `Caching.getCachingProvider(String, ClassLoader)` methods to explicitly request the Coherence JCache provider implementation. For example:

```
CachingProvider cachingProvider = Caching.getCachingProvider(  
    "com.tangosol.coherence.jcache.CoherenceBasedCachingProvider");  
CacheManager cacheManager = cachingProvider.getCacheManager();  
...
```

Use the `getCachingProviders` methods to iterate the list of registered providers if multiple caching providers are registered.

Lastly, applications can directly instantiate the Coherence JCache provider. However, this option is not portable across providers. The following example instantiates the Coherence JCache provider:

```
CachingProvider cachingProvider = new CoherenceBasedCachingProvider();  
CacheManager cacheManager = cachingProvider.getCacheManager();
```

Creating Coherence JCache Caches

The Coherence JCache provider supports three cache types: local, partitioned, and pass-through. A local cache is a cache that is local to the application process. A partitioned cache distributes cached data across Coherence storage-enabled cluster members. A pass-through cache delegates to any native Coherence cache that is configured within a Coherence cache configuration file. This section demonstrates how to create each of these cache types using the JCache API.

This section includes the following topics:

- [Creating Local Caches](#)
- [Creating Partitioned Caches](#)
- [Creating Pass-Through Caches](#)
- [Using Native Coherence Functionality from JCache](#)

Creating Local Caches

Applications can cache data using a local cache. Local caches are the default cache type when using the Coherence JCache provider and are similar to a Coherence local cache scheme. Local caches do not provide data backup and the data does not persist after the application process exits. The following example creates a local cache using the JCache API.

```
CachingProvider cachingProvider = Caching.getCachingProvider();  
CacheManager cacheManager = cachingProvider.getCacheManager();  
  
MutableConfiguration<String, String> config =  
    new MutableConfiguration<String, String>();  
config.setStoreByValue(true).setTypes(String.class, String.class);  
  
Cache<String, String> cache = cacheManager.createCache("MyCache", config);
```

A local cache results in the creation of a Coherence `NamedCache` instance that use `jcache-local-*` cache names that are mapped to a local cache scheme that is named `jcache-local-scheme`, which is managed by the `jcache-local-service` service.

Creating Partitioned Caches

Applications can cache data to a Coherence partitioned cache. The application process automatically joins a Coherence cluster and Coherence manages the distribution and backup of the data across the cluster. Partitioned caches do not require any application code changes; therefore, existing JCache applications can easily be migrated to use Coherence partitioned caches.

Note: Partitioned caches do not support store-by-reference semantics.

To create a partitioned cache, use the `tangosol.coherence.jcache.configuration.classname` property and set it to `partitioned`. For example:

```
-Dtangosol.coherence.jcache.configuration.classname=partitioned
```

The system property also supports a value of `local`, which is the default value if no value is specified and results in a local cache being created.

A partitioned cache results in the creation of a Coherence `NamedCache` instance that use `jcache-partitioned-*` cache names that are mapped to a partitioned cache scheme that is named `jcache-partitioned-scheme`, which is managed by the `jcache-partitioned-service` service.

Operational Configuration

JCache applications must use a `tangosol-coherence-override.xml` operational override file or Coherence system properties, or both, to configure Coherence operational settings. The operational settings, among other things, allow applications to join an existing cluster. For details about the operational override file, see ["Specifying an Operational Configuration File"](#) on page 3-2. For example, an application can specify the following system properties at runtime to join a cluster that is named `Cluster1` and has a multicast address of `231.1.1.1` and port `3060`.

```
-Dtangosol.coherence.cluster=Cluster1
-Dtangosol.coherence.clusteraddress=231.1.1.1
-Dtangosol.coherence.clusterport=3060
```

Cache Configuration

Partitioned caches for JCache automatically use a default Coherence cache configuration file that is included in the `coherence-jcache.jar` library. The configuration file is called `coherence-jcache-cache-config.xml`. Any cache servers in the cluster must also use the `coherence-jcache-cache-config.xml` file. For example, a cache server can explicitly set the cache configuration file using the `tangosol.coherence.cacheconfig` system property:

```
-Dtangosol.coherence.cacheconfig=coherence-jcache-cache-config.xml
```

Note: For details on using an existing Coherence cache configuration file, see ["Using Native Coherence Functionality from JCache"](#) on page 35-5.

Creating Pass-Through Caches

Applications can use a pass-through cache to delegate all cache operations to pre-existing Coherence caches. A pass-through cache results in the use of a native Coherence `NamedCache` instance from a `JCache` interface. A pass-through cache allows an application to take full advantage of all Coherence native features and configuration.

To create a pass-through cache, an application can use the Coherence `PassThroughCacheConfiguration` `JCache` configuration object and specify the name of an existing cache mapping that is defined in a Coherence cache configuration file. For example:

```
...
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

PassThroughCacheConfiguration<String, Object> config =
    new PassThroughCacheConfiguration<String, Object>();
config.setTypes(String.class, Object.class);

Cache<String, Object> cache = cacheManager.createCache("MyCache", config);
```

As an alternative, existing `JCache` applications can continue to use a `MutableConfiguration` object and create a pass-through cache by specifying the `tangosol.coherence.jcache.configuration.classname` property and setting the value to `passthrough`. For example:

```
-Dtangosol.coherence.jcache.configuration.classname=passthrough
```

The system property allows `JCache` applications to use Coherence native features without having to change any application code. However, most `MutableConfiguration` object properties are ignored. A warning message is emitted if the system property is used to create a pass-through cache.

```
WARNING: Lossy conversion of configuration
javax.cache.configuration.MutableConfiguration to a PassThroughConfiguration.
Most properties from class javax.cache.configuration.MutableConfiguration are
ignored. Configure PassThroughCache using native Coherence configuration
methodologies.
```

Operational Configuration

Pass-through caches for `JCache` use a `tangosol-coherence-override.xml` operational override file or Coherence system properties, or both, to configure Coherence operational settings. The operational settings, among other things, allow applications to join an existing cluster. For details about the operational override file, see ["Specifying an Operational Configuration File"](#) on page 3-2.

Cache Configuration

Pass-through caches for `JCache` use an existing Coherence cache configuration file. Applications can specify the location of the file at runtime using the `tangosol.coherence.cacheconfig` property. For example:

```
-Dtangosol.coherence.cacheconfig=my-cache-config.xml
```

The above technique changes the default URI a cache manager uses to get a specified cache configuration file. An alternative way to specify a cache configuration that uses the JCache API and does not rely on setting a system property is to specify the URI when creating a cache manager. For example:

```
Caching.getCacheManager(new URI(my-cache-config.xml), null, null);
```

Any cache created from the above returned cache manager uses the specified cache configuration file to the `getCacheManager` call.

For details about the cache configuration file, see ["Specifying a Cache Configuration File"](#) on page 3-6.

Using Native Coherence Functionality from JCache

The Coherence JCache provider allows applications to use native Coherence functionality. Applications that use native Coherence functionality are not portable among JCache providers. Applications typically use native functionality to reuse existing Coherence implementations and configuration.

This section includes the following topics:

- [Accessing NamedCache Instances from JCache](#)
- [Using Coherence Configuration with JCache](#)

Accessing NamedCache Instances from JCache

JCache applications can directly access the underlying Coherence `NamedCache` instance for a cache. A cache cannot be accessed directly using the `NamedCache` and JCache API interchangeably. In addition, using the `NamedCache` instance to access cache keys and values bypasses additional behavior provided by the Coherence JCache provider implementation.

The following example directly accesses the underlying `NamedCache` instance for a JCache cache and uses the instance to put and get an entry:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<String, String> config =
    new MutableConfiguration<String, String>();
config.setStoreByValue(true).setTypes(String.class, String.class);

Cache<String, String> cache = cacheManager.createCache("MyCache", config);

String key = "k";
String value = "Hello World";

NamedCache nc = cache.unwrap(NamedCache.class);

nc.put(key, value);

System.out.println("The value is " + nc.get(key) + "\n");

nc.destroy();
cacheManager.close();
```

Using Coherence Configuration with JCache

Any native Coherence concept that does not have an equivalent JCache concept (such as eviction) can be configured using a Coherence cache configuration file, operational override file, or Coherence system properties.

Note: Applications that are designed to be portable across JCache provider implementations should only rely on the configuration that is provided through the JCache `CompleteConfiguration` API.

When using an existing Coherence cache configuration file for JCache partitioned and local caches, then the file must include a `jcache` namespace handler definition. For example:

```
<cache-config xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://xmlns.oracle.com/coherence/coherence-cache-config"
  xmlns:jcache="class://com.tangosol.coherence.jcache.JCacheNamespace"
  xsi:schemaLocation="http://xmlns.oracle.com/coherence/coherence-cache-config
  coherence-cache-config.xsd">
  ...
```

The JCache namespace handler generates any missing elements that are required for the JCache-specific cache configuration file and allows an applications to extend the standard cache configuration file. The JCache namespace handler does not generate an element if it is already defined in the cache configuration file.

Configuring Coherence JCache Caches

Coherence JCache-based caches are configured programmatically using the `MutableConfiguration` class during cache creation. This is a standard JCache class and should be used to maintain portability among JCache providers. For example:

```
MutableConfiguration<String, String> config =
  new MutableConfiguration<String, String>();
config.setStoreByValue(true).setTypes(String.class, String.class);

Cache<String, String> cache = cacheManager.createCache("MyCache", config);
```

Applications that use local and partitioned caches can optionally use the Coherence JCache provider-specific implementations of the JCache `CompleteConfiguration` API. The implementations are `LocalCacheConfiguration` and `PartitionedCacheConfiguration`, respectively. However, the use of these classes is not portable among JCache providers. For example:

```
PartitionedCacheConfiguration<String, String> config =
  new PartitionedCacheConfiguration<String, String>();
config.setStoreByValue(true).setTypes(String.class, String.class);
```

Application that use pass-through caches, require the Coherence JCache provider `PassThroughCacheConfiguration` configuration class. Pass-through caches are configured using native Coherence configuration and therefore do not support using JCache-specific configuration options.

```
PassThroughCacheConfiguration<String, String> config =
  new PassThroughCacheConfiguration<String, String>();
```

This section includes the following topics:

- [Setting Store-By Semantics](#)
- [Setting Cache Entry Types](#)
- [Setting Cache Expiry](#)
- [Enabling Read-Through and Write-Through Caching](#)
- [Enabling Management](#)

Setting Store-By Semantics

JCache provides the option to specify whether a cache uses store-by-reference or store-by-value semantics. The `setStoreByValue` method configures store-by semantics for both keys and values. A value of `true` indicates store-by-value semantics and a value of `false` indicates store-by-reference semantics. The Coherence JCache provider uses store-by-value semantics by default for all cache types and only supports store-by-reference for local caches. Partitioned caches do not support store-by-reference. In addition, the provider relies on either Java Serialization or POF to implement store-by-value semantics for all Coherence JCache cache types. Applications that use local caches and configure store-by-reference do not require that keys and values be serializable or POF-enabled.

The following example configures a local cache to use store-by-reference semantics.

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setStoreByValue(false);

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

Note: If store-by-reference is enabled, the cache can be mutated by any threads holding a reference to the cache. Keys that are mutated may not be retrievable. In addition, values that are mutated may be observed by all threads in the JVM if Java permissions are not properly set. Beyond the local heap, entries need to be transformed into a representation and any mutations that occur after the transformation may not be reflected in the cache.

Setting Cache Entry Types

JCache allows you to set the expected key and value types of an entry. Any entry that is placed in the cache must then adhere to the declared types; otherwise, a runtime exception occurs. The `setTypes` method is used to configure the entry types, which cannot be set to null. The following example sets the key type to `String` and the value type to `Integer`:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setTypes(String.class, Integer.class);

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

Note: The Coherence JCache implementation does not perform runtime checks to ensure that objects passed into mutative cache operations match with what was configured through the `javax.cache.configuration.Configuration` API. Applications should use generics to operate on the cache and take advantage of static compile time checking.

The default key and value type, if no type is configured, is `Object.class`. Using the default type or explicitly configuring the `Object.class` type disables runtime type checking and allows an application to use any key or value type. However, it is then the responsibility of the application to ensure type safety. The following example disables type checking by explicitly setting the key and value types to `Object.class` and omitting the type parameters when getting the cache:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<Object, Object> config =
    new MutableConfiguration<Object, Object>();
config.setStoreByValue(true).setTypes(Object.class, Object.class);

Cache<Object, Object> cache = cacheManager.getCache("MyCache");
```

Although it is not required, the above examples also use compile-time type checking. When omitted, the compiler will not check for type safety. The following example disables both compile-time and runtime type checking.

```
MutableConfiguration config = new MutableConfiguration();
cacheManager.createCache("MyCache", config);
```

Setting Cache Expiry

JCache allows you to configure the amount of time an entry is available in a cache. Entries that expire are no longer valid and are not available to an application.

Note: The Coherence JCache provider may evict entries that are not due to expire if the maximum cache capacity is reached. Cache entries are evicted using a default eviction policy that is based on a combination of how often and recently entries are accessed. Entries that are accessed least frequently and are not accessed for the longest period are evicted first.

Expiry is configured using the `setExpiryPolicyFactory` method to select an expiry policy and to set a time value. The following example configures entries in the cache to expire 5 minutes after they are created:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setExpiryPolicyFactory(CreatedExpiryPolicy.factoryOf(
    Duration.FIVE_MINUTES));
```

```
Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

If the policy is set to null or if expiry is not configured, then the eternal policy is used by default and entries are never expired. Each policy can specify the duration of time that must pass before a cache entry is considered expired. For convenience, pre-defined durations are provided: ZERO, ONE_MINUTE, FIVE_MINUTES, TEN_MINUTES, TWENTY_MINUTES, THIRTY_MINUTES, ONE_HOUR, and ONE_DAY. Any non-negative duration value can be configured.

The following expiry policies are supported:

- Created – Cache entries are expired based on when they are created. An update does not reset the expiry time. This policy is implemented in the JCache CreatedExpiryPolicy class.
- Accessed – Cache entries are expired based on the last time they accessed. Accessed does not include a cache update. This policy is implemented in the JCache AccessedExpiryPolicy class.
- Modified – Cache entries are expired based on the last time it was updated. Updating includes created and changing (updating) an entry. This policy is implemented in the JCache ModifiedExpiryPolicy class.
- Touched – Cache Entry based on when it was last touched. A touch includes creation, update or access. This policy is implemented in the JCache TouchedExpiryPolicy class.
- Eternal (default) – Cache entries are never expired. This policy is implemented in the JCache EternalExpiryPolicy class.

Expiry policies and durations must be serialized to support distributed caching scenarios. The Coherence JCache provider uses Portable Object Format (POF) for serialization and includes POF serializers for expiry types. These types must be configured to be used by the Coherence JCache provider if partitioned caches are used together with pass-through caches. For details, see ["Configuring a JCache POF Configuration file"](#) on page 35-13.

Enabling Read-Through and Write-Through Caching

Read-through and write-through caching allow applications to load data into a cache from a data source and to write data from a cache into a data source. Databases are the most common data source integration, but any data source can be integrated with JCache caches. Read-through and write-through caching are not enabled by default and require application-specific implementations of the JCache CacheLoader and CacheWriter interfaces, respectively.

To enable read-through or write-through caching, set the `setReadThrough` and `setWriteThrough` methods, respectively, to `true`. For example:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();
```

```
MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setReadThrough(true).setWriteThrough(true);
```

```
Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

To register a `CacheLoader` and `CacheWriter` implementation, use the `setCacheLoaderFactory` and `setCacheWriterFactory` methods, respectively, and enter the fully qualified name of the implementation class. For example:

```
cacheWriter = new MyCacheWriter();
cacheLoader = new MyCacheLoader();

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setReadThrough(true).setWriteThrough(true)
    .setCacheWriterFactory(FactoryBuilder.factoryOf(cacheWriter));
    .setCacheLoaderFactory(FactoryBuilder.factoryOf(cacheLoader));

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);
```

The implementations are automatically used when performing certain cache operations. For details on using read-through and write-through caching, see ["Using Read-Through and Write-Through Caching"](#) on page 35-11.

Enabling Management

JCache provides two dynamic mbeans: the `CacheMXBean` and `CacheStatisticsMXBean` mbeans. The `CacheMXBean` mbean shows the configuration settings of a cache. The `CacheStatisticsMXBean` mbean shows performance statistics for a cache. For details about JCache management, see ["Viewing JCache Management Information"](#) on page 35-13.

Management is disabled by default. To enable management information, set the `setManagementEnabled` and `setStatisticsEnabled` methods to `true` when configuring a cache. For example:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration config = new MutableConfiguration();
config.setManagementEnabled(true).setStatisticsEnabled(true);

Cache cache = cacheManager.createCache("MyCache", config);
```

Management can also be enabled at runtime using the cache manager:

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration config = new MutableConfiguration();

Cache cache = cacheManager.createCache("MyCache", config);

cacheManager.enableManagement("MyCache", true);
cacheManager.enableStatistics("MyCache", true);
```

Performing Cache Operations

JCache includes many operations for interacting with a cache. The operations are defined in the `javax.cache.Cache` interface. Refer to the Cache API documentation for the semantics and details of all the available JCache operations.

A cache must first be created and configured before cache operations can be performed. The following example demonstrates performing simple put and get operations:

Note: Key and values cannot be null.

```
CachingProvider provider = Caching.getCachingProvider();
CacheManager cacheManager = provider.getCacheManager();

MutableConfiguration config = new MutableConfiguration();

Cache cache = cacheManager.createCache("MyCache", config);

cache.put("k1", "Hello World");
System.out.println("The value is " + cache.get("k1")+ "\n");
```

The above example does not perform compile or runtime entry type checking. For details on performing type checking, see ["Setting Cache Entry Types"](#) on page 35-7.

Understanding Coherence JCache Operations

Cache operations are implemented differently for each cache type: `LocalCache`, `PartitionedCache`, and `PassThroughCache`. For example, partitioned cache operations are implemented using Coherence entry processors that can take advantage of Coherence data serialization. Each of the cache types provides implementations of cache operations that take advantage of the cache topology being used.

Using Read-Through and Write-Through Caching

JCache supports the use of read-through and write-through caching to integrate caches with external resources. Read-through caching automatically loads entries from external resources and write-through caching automatically writes entries to external resources. Read-through and write-through caching require an application to implement the JCache `CacheLoader` and `CacheWriter` interfaces, respectively. Read-through and writer-through caching are not enabled by default. See ["Enabling Read-Through and Write-Through Caching"](#) on page 35-9.

Note: Applications that choose to use a Coherence pass-through cache, can use read-through and write-through caching natively in Coherence and are not required to include JCache specific loader and writer implementations.

Providing a Read-Through Implementation

Read-through caching requires an application to implement the `CacheLoader` interface. The implementation details are specific to the external resource that is being used. For details about implementing `CacheLoader` methods, refer to the JCache API documentation.

The `CacheLoader` interface provides the `load` and `loadAll` methods. An implementation uses these methods to include the necessary logic to connect and retrieve a value, or set of values, from an external resource. A cache loader implementation is automatically invoked whenever an entry for a given key is not found as a result of performing a `get`, `getAll`, `getAndRemove`, or `getAndReplace` operation. When using entry processors, the `invoke` and `invokeAll` operations

automatically use the cache loader if the entry processor uses the `getValue` method. For details about using entry processors, see ["Processing JCache Entries"](#) on page 37-1.

Pre-Loading a Cache

The Cache API includes the `Cache.loadAll` method that can be used to pre-load a cache. The use of this method results in a call to the `loadAll` method of a `CacheLoader` implementation. In this case, the `CacheLoader` implementation must still be configured on the cache, but read-through caching does not need to be enabled. For example:

```
cacheLoader = new MyCacheLoader();

MutableConfiguration<String, String> config =
    new MutableConfiguration<String, String>();
config.setTypes(String.class, String.class)
    .setReadThrough(false)
    .setCacheLoaderFactory(FactoryBuilder.factoryOf(cacheLoader));
```

In the above example, the `factoryOf` method takes an instance of the `MyCacheLoader` implementation. The method is used for implementations that have state and requires that the implementation class be serializable. If the implementation does not have state, then it is best to use the `factoryOf(Class)` or `factoryOf(String classname)` methods instead.

Loading a cache from an external resource may take a long time to complete. The `CompletionListener` interface allows an application to be notified when the cache has been loaded or if an exception has occurred while loading the cache. The `CompletionListenerFuture` class is a default implementation that can be used as required. For example:

```
cacheLoader = new MyCacheLoader();

MutableConfiguration<String, String> config =
    new MutableConfiguration<String, String>();
config.setTypes(String.class, String.class)
    .setReadThrough(false)
    .setCacheLoaderFactory(FactoryBuilder.factoryOf(cacheLoader));
Cache<String, String> cache = cacheManager.createCache("MyCache", config);

CompletionListenerFuture future = new CompletionListenerFuture();

cache.loadAll(keys, true, future);
```

Providing a Write-Through Implementation

Write-through caching requires an application to implement the `CacheWriter` interface. The implementation details are specific to the external resource that is being used. For details about implementing `CacheWriter` methods, refer to the JCache API documentation.

The `CacheWriter` interface provides methods for writing entries (`write` and `writeAll`) to an external resource and methods for deleting entries (`delete` and `deleteAll`) from an external resource. An implementation uses these methods to include the necessary logic to connect and update data on an external resource. A cache writer implementation is automatically invoked whenever the following cache operations are performed: `put`, `putAll`, `putIfAbsent`, `remove`, `removeAll`, `replace`, `getAndPut`, `getAndRemove`, `getAndReplace`, `invoke`, and `invokeAll`.

Configuring a JCache POF Configuration file

The Coherence JCache provider uses POF for serialization and requires the `coherence-pof-config.xml` file. JCache specific POF types are defined in the `coherence-jacache.jar\coherence-jcache-pof-config.xml` POF configuration file. If you are using partitioned caches together with pass-through caches, the JCache POF types must be included as part of your POF configuration file. For example:

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

For details on using POF configuration files, see ["Specifying a POF Configuration File"](#) on page 3-8.

Viewing JCache Management Information

The Coherence JCache provider implements both the `CacheMXBean` and `CacheStatisticsMXBean` Dynamic MBean interfaces. The interfaces provide the following management information:

- `CacheMXBean` – Reports configuration information for a cache. Each configuration option and its current settings are listed as attributes.
- `CacheStatisticsMXBean` – Reports performance information for a cache. The performance statistics are listed as attributes and are used to help troubleshoot possible issues with a cache.

Management information is not enabled by default. See ["Enabling Management"](#) on page 35-10 for details about enabling management.

Note: Management information for pass-through caches are reported using the native Coherence JMX management implementation. For details about enabling native Coherence management, see *Managing Oracle Coherence*.

Coherence JCache MBeans

Management information can be viewed using any JMX MBean-compliant browser such as the Java VisualVM console that is included with the JDK (`JDK_HOME/bin/jvisualvm`). Management MBeans for local and partitioned caches are registered to the default MBean server and are found in a JMX browser under `javax.cache`.

Coherence-Java VisualVM Plug-in

JCache management information can be viewed using the Coherence-Java VisualVM plug-in. The plug-in includes a JCache tab that aggregates the management information over time and is used to troubleshoot configuration and performance issues. For details on the Coherence reports for JCache, see *Managing Oracle Coherence*.

Coherence Reports

JCache management information can also be viewed using Coherence reports. The Coherence JCache reports aggregate management information over time and are used to troubleshoot configuration and performance issues. For details on the Coherence reports for JCache, see *Managing Oracle Coherence*.

Understanding the CacheConfiguration MBean

The `CoherenceCacheMXBean` class implements the `CacheMXBean` interface and provides configuration information for a cache. An MBean object is registered for each cache. The object name of the MBean is:

```
javax.cache:type=CacheConfiguration,CacheManager=coherence-jcache-cache-co
nfig.xml,Cache=cache_name
```

Attributes

Table 35–1 describes the attributes for the `CacheConfiguration` MBean.

Table 35–1 *CacheConfiguration MBean Attributes*

Attribute	Type	Access	Description
<code>KeyType</code>	String	read-only	The required key type for the cache. The default value, if no required key type is configured, is <code>java.lang.Object</code> and indicates that type checking is disabled.
<code>ManagementEnabled</code>	Boolean	read-only	Specifies whether management is enabled for the cache. The default value is <code>false</code> .
<code>ReadThrough</code>	Boolean	read-only	Specifies whether the cache operates in read-through mode. The default value is <code>false</code> .
<code>StatisticsEnabled</code>	Boolean	read-only	Specifies whether performance statistics are being collected for the cache. The default value is <code>false</code> .
<code>StoreByValue</code>	Boolean	read-only	Specifies whether the cache uses store-by-value or store-by-reference semantics. The default value is <code>true</code> and indicates that keys and values are stored by value. A value of <code>false</code> indicates that keys and values are stored by reference.
<code>ValueType</code>	String	read-only	The required value type for the cache. The default value, if no required value type is configured, is <code>java.lang.Object</code> and indicates that type checking is disabled.
<code>WriteThrough</code>	Boolean	read-only	Specifies whether the cache operates in write-through mode. The default value is <code>false</code> .

Operations

The `CacheConfiguration` MBean includes a `clear` operation that resets all configuration management information.

Understanding the CacheStatistics MBean

The Coherence JCache provider includes two implementations of the `JCacheCacheStatisticsMXBean` interface. The `ContextJCacheStatistics` implementation is used to collect performance statistics for local caches. The `PartitionedJCacheStatistics` is used to collect and aggregate performance statistics for all storage members in a Coherence cluster. An MBean object is registered for each cache. The object name of the MBean is:

```
javax.cache:type=CacheStatistics,CacheManager=coherence-jcache-cache-config.xml,Cache=cache_name
```

Attributes

Table 35–2 describes the attributes for the CacheStatistics MBean.

Table 35–2 Cache Statistics Attributes

Attribute	Type	Access	Description
AverageGetTime	Float	read-only	The average time to perform <code>get</code> operations. For read-through caches, the time does not include the time that is required to load entries because of a cache miss.
AveragePutTime	Float	read-only	The average time to perform <code>put</code> operations
AverageRemoveTime	Float	read-only	The average time to perform <code>remove</code> operations
CacheEvictions	Long	read-only	The total number of evictions from the cache. An eviction is initiated by the cache to free up space. An eviction is not considered a <code>remove</code> operation. Note: This attribute is not implemented by the Coherence JCache provider.
CacheGets	Long	read-only	The total number of <code>get</code> operations. The value is equal to the sum of hits and misses and does not include operations that check for the existence of a key.
CacheHitPercentage	Float	read-only	The percentage of cache requests that return an entry. The percentage is reported as a decimal value and is calculated using the value of cache hits divided by cache <code>get</code> operations.
CacheHits	Long	read-only	The number of successful <code>get</code> operations
CacheMissPercentage	Float	read-only	The percentage of cache requests that do not return an entry. The percentage is reported as a decimal value and is calculated using the value of cache misses divided by cache <code>get</code> operations.
CacheMisses	Long	read-only	The number of unsuccessful <code>get</code> operations
CachePuts	Long	read-only	The total number of <code>put</code> operations including operations that replace and existing entry.
CacheRemovals	Long	read-only	The total number of <code>remove</code> operations. The value does not include evictions initiated by the cache to free up space.

Operations

The CacheStatistics MBean includes a `clear` operation that resets all cache statistics.

Changing the Refresh Interval for Partitioned Cache Statistics

The Coherence JCache provider uses a refresh interval to determine when to refresh performance statistics for partitioned caches. The refresh is performed lazily; statistics are refreshed only after the refresh interval is reached and a call to get a statistic is made. Statistics are not refreshed if a call to get a statistic is never made even if the refresh interval is reached.

The default refresh interval is 3 seconds and can be changed to accommodate different cluster sizes and network performance. For example, a cluster with many storage members may require a longer refresh interval to allow statistic aggregation to be performed across all members and to guard against constant updating.

To change the refresh interval, use the `tangosol.coherence.jcache.statistics.refreshtime` system property and set it to a time entered in milliseconds. The following example configures the refresh interval to 5 seconds.

```
-Dtangosol.coherence.jcache.statistics.refreshtime=5000
```

Using JCache Events

This chapter provides instructions for creating and registering event listeners to handle JCache events. The JCache event model is defined in the `javax.cache.event` package and described in Chapter 8, "Cache EntryListeners," of the *Java Caching API* specification.

This chapter includes the following sections:

- [Overview of Using JCache Events](#)
- [Creating Event Listeners](#)
- [Creating Event Filters](#)
- [Registering Event Listeners and Filters](#)

Overview of Using JCache Events

The JCache event model allows applications to receive and process events that represent observable changes to the entries in a cache. The event model uses standard Java event and event listener conventions that are common in Java applications.

A JCache event is defined in the `CacheEntryEvent` class and is a standard Java event that is specific to cache entries. JCache defines four event types for cache entries:

- `CREATED` – Indicates that the cache entry was created
- `UPDATED` – Indicates that the cache entry was updated
- `REMOVED` – Indicates that the cache entry was removed
- `EXPIRED` – Indicates that the cache entry has expired

The JCache event model uses event listeners to handle events and perform any necessary event processing. Each event type has a corresponding event listener interface that can be implemented as required. In addition, event filters can be used to process events before the events are dispatched to a listener. Event listeners and filters can be statically registered on a cache during configuration or dynamically after the cache has been created.

The Coherence JCache provider supports the use of JCache events for local, partitioned, and pass-through caches. The provider makes use of the native Coherence `MapListener` and `MapEvent` APIs to implement JCache events. Applications can directly access the underlying `NamedCache` instance and use the `MapListener` API; however, doing so directly bypasses additional behavior provided by the JCache Coherence implementation.

Creating Event Listeners

Each event type has a corresponding event listener interface that extends the `CacheEntryListener` interface. The event type interfaces include the `CacheEntryCreatedListener`, `CacheEntryUpdatedListener`, `CacheEntryRemovedListener`, and `CacheEntryExpiredListener` interfaces. A single event listener can choose to implement multiple event type listener interfaces or multiple event listeners can implement the same event type listener interfaces. The following example creates an event listener for `CREATED` events that emits a log message that includes the event details every time an entry is created in a cache.

Example 36–1 An Example Event Listener Implementation

```
import java.io.Serializable;
import javax.cache.event.CacheEntryCreatedListener;
import javax.cache.event.CacheEntryEvent;
import javax.cache.event.CacheEntryListenerException;

public class MyCacheEntryListener<K, V>
    implements CacheEntryCreatedListener<K, V>, Serializable
    {
        private static final long serialVersionUID = 1L;

        public void onCreated(Iterable<CacheEntryEvent<? extends K, ? extends V>>
            events)
            throws CacheEntryListenerException
            {
                for (CacheEntryEvent<? extends K, ? extends V> event : events)
                {
                    System.out.println("Received a " + event);
                }
            }
    }
}
```

Event listeners that require serialization can use POF serialization. However, POF is not portable among cache provider implementations.

Creating Event Filters

Cache entry event filters provide the opportunity to evaluate cache events before the events are dispatched to an entry event listener. Event filters allow additional processing to be performed as required. Event filters must implement the `CacheEntryEventFilter` interface. The following example creates an event filter for `CREATED` events that stops the event from being dispatched and emits a system message.

Example 36–2 An Example Event Filter Implementation

```
import java.io.Serializable;
import javax.cache.event.CacheEntryEvent;
import javax.cache.event.CacheEntryEventFilter;
import javax.cache.event.CacheEntryListenerException;
import javax.cache.event.EventType;

public class MyCacheEntryEventFilter<K, V>
    implements CacheEntryEventFilter<K, V>, Serializable
    {
        private static final long serialVersionUID = 1L;
```

```

public boolean evaluate(CacheEntryEvent<? extends K, ? extends V> event)
    throws CacheEntryListenerException
{
    boolean result = false;

    if (event.getEventType() == EventType.CREATED)
    {
        System.out.println("filter event=" + event + " filter result=" +
            result);
    }

    return result;
}
}

```

Event filters that require serialization can use POF serialization. However, POF is not portable among cache provider implementations.

Registering Event Listeners and Filters

Cache entry listeners and event filters can be registered statically on a cache during configuration or dynamically after a cache instance has been created. Either method requires the use of a listener configuration. The configuration is defined in the `CacheEntryListenerConfiguration` interface. The `MutableCacheEntryListenerConfiguration` class provides a default implementation that can be used as required and is demonstrated in this section. The configuration is used to specify the listener implementation class to use, the filter implementation class to use, whether to send the old value as part of the event, and whether event notification should be synchronous or asynchronous. The order in which listeners are notified is not guaranteed.

Registering Event Listeners and Filters During Cache Configuration

To register `CacheEntryListener` and `CacheEntryEventFilter` implementations statically during configuration, use the `addCacheEntryListenerConfiguration` method and include the implementation classes and configure the listener as required. The following example registers the event listener and filter that was created in [Example 36-1](#) and [Example 36-2](#), respectively.

```

CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

m_listener = new MyCacheEntryListener();

MutableConfiguration<String, String> config =
    new MutableConfiguration<String, String>();
config.setTypes(String.class, String.class).addCacheEntryListenerConfiguration(
    new MutableCacheEntryListenerConfiguration<String, String>
        (FactoryBuilder.factoryOf(m_listener), FactoryBuilder.factoryOf(
            new MyCacheEntryEventFilter<String, String>()), true, true));

Cache<String, String> cache = cacheManager.createCache("MyCache", config);

```

The example configuration sets event notifications to include the old value of the entry and to use synchronous dispatching as indicated by the two `true` properties.

The `removeCacheEntryListenerConfiguration` method removes a cache entry listener that was previously registered.

Registering Event Listeners and Filters at Runtime

To register `CacheEntryListener` and `CacheEntryEventFilter` implementations dynamically on a cache instance at runtime, use the `RegisterCacheEntryListener` method and include the implementation classes and configure the listener as required. The following example registers the event listener and filter that was created in [Example 36-1](#) and [Example 36-2](#), respectively.

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

m_listener = new MyCacheEntryListener();

MutableConfiguration<String, String> config =
    new MutableConfiguration<String, String>();
config.setTypes(String.class, String.class);

Cache<String, String> cache = cacheManager.createCache("MyCache", config);

cache.registerCacheEntryListener(
    new MutableCacheEntryListenerConfiguration<String, String>
        (FactoryBuilder.factoryOf(m_listener), FactoryBuilder.factoryOf(
            new MyCacheEntryEventFilter<String, String>()), false, false));
```

The example configuration sets event notifications to not include the old value of the entry and to use asynchronous dispatching as indicated by the two `false` properties.

The `deregisterCacheEntryListener` method removes a cache entry listener that was previously registered.

Processing JCache Entries

This chapter provides instructions for creating and using JCache entry processors to modify cache entries. Entry processors are defined in the `javax.cache.processor` package and described in Chapter 9, "Entry Processors," of the *Java Caching API* specification.

This chapter includes the following sections:

- [Overview of Processing JCache Entries](#)
- [Creating Entry Processors](#)
- [Using Entry Processors](#)

Overview of Processing JCache Entries

JCache supports the use of entry processors to perform updates on cache entries in an atomic, lock-free manner. In distributed cache environments, entries are processed in parallel across each of the different servers that holds cached data.

Entry processors are often used to make multiple changes to a cache in a single operation. For example, the entry processor may evaluate the values for a set of keys and then return different values based on some logic. The application can only view the final result of the processing and does not have access to intermediary results while the entry processor is being invoked. If an error occurs during processing, then an exception is thrown and no changes are made to the cache.

Entry processors must implement the `EntryProcessor` interface. Entry processor implementations are invoked on cache entries at runtime using the `Cache.invoke` and `Cache.invokeAll` methods.

Lastly, the Coherence JCache provider supports the use of JCache entry processors for local, partitioned, and pass-through caches. The provider makes use of the native Coherence `InvocableMap.EntryProcessor` API to implement JCache entry processors.

Creating Entry Processors

Entry processors must implement the `EntryProcessor` interface. The interface contains a single `process` method that is used to provide any processing logic for cache entries. Entry processors operate on `MutableEntry` entries. The `MutableEntry` interface ensures that entry processors have exclusive access to entries during processing. The `process` method also allows any arguments to be defined. The arguments can be passed to the processor when the processor is invoked.

Operations that are performed as part of an entry processor are not visible to an application and only take affect after the `process` method has completed. If an error occurs during the `process` method, then no changes are made to the cache entries.

Entry processors are not guaranteed to be executed in-process and therefore should always be serializable. For example, when using a Coherence partitioned cache, an entry processor may be executed on the cache server that contains the data to be processed. For Coherence caches, entry processors have the option of using POF serialization. However, POF is not portable among cache provider implementations.

[Example 37–1](#) creates an entry processor that increments the value of a cache entry by one. The value of the entry is an integer. The key, value, and return types are explicitly defined to ensure type safety as required by the API.

Example 37–1 An Example EntryProcessor Implementation

```
import java.io.Serializable;
import javax.cache.processor.EntryProcessor;
import javax.cache.processor.EntryProcessorException;
import javax.cache.processor.MutableEntry;

public class MyEntryProcessor implements EntryProcessor <String, Integer,
    Integer>, Serializable
{
    public static final long serialVersionUID = 1L;

    public Integer process(MutableEntry<String, Integer> entry,
        Object... arguments) throws EntryProcessorException
    {

        if (entry.exists())
        {
            Integer current = entry.getValue();
            entry.setValue(current + 1);
            return current;
        }
        else
        {
            entry.setValue(0);
            return -1;
        }
    }
}
```

Using Entry Processors

The Cache API provides two methods that are used to invoke an entry processor. The `invoke` method operates on a single cache entry and the `invokeAll` method operates on a set of cache entries. Entries are specified using the key name.

Invoking Entry Processors for a Single Key

Entry processors are invoked on a single key using the `invoke` method from a `Cache` instance. The following example demonstrates processing a single key. The examples uses the `MyEntryProcessor` implementation that was created in [Example 37–1](#).

```
CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();
```

```

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setTypes(String.class, Integer.class);

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);

String key = "k";
Integer value = 1;

cache.put(key, value);

System.out.println("The value is " + cache.get(key) + "\n");

cache.invoke(key, new MyEntryProcessor());

System.out.println("The value is now " + cache.get(key) + "\n");

```

Invoking Entry Processors for Multiple Keys

Entry processors are invoked on multiple keys using the `invokeAll` method. The keys must be grouped together using a `Set` implementation. The processor is invoked for each key in the set and the order in which keys are processed is not guaranteed. The following example demonstrates processing multiple keys that are grouped using the `HashSet` class and also uses the `EntryProcessorResult.get` method to retrieve the value returned by the entry processor for a specific key. The example uses the `MyEntryProcessor` implementation that was created in [Example 37-1](#).

```

CachingProvider cachingProvider = Caching.getCachingProvider();
CacheManager cacheManager = cachingProvider.getCacheManager();

MutableConfiguration<String, Integer> config =
    new MutableConfiguration<String, Integer>();
config.setTypes(String.class, Integer.class);

Cache<String, Integer> cache = cacheManager.createCache("MyCache", config);

String key = "k";
Integer value = 1;
String key1 = "k1";
Integer value1 = 1;

cache.put(key, value);
cache.put(key1, value1);

HashSet hs = new HashSet();
hs.add(key);
hs.add(key1);

Map<String, EntryProcessorResult<Integer>> map = cache.invokeAll(hs,
    new MyEntryProcessor());

System.out.println("The value of k is now " + cache.get(key) +
    " the result of invokeAll for k is previous value of " + map.get(key).get() +
    "\n");

System.out.println("The value of k1 is now " + cache.get(key1) +
    " the result of invokeAll for k1 is previous value of " + map.get(key1).get() +
    "\n");

```


Part VI

Appendices

Part VI contains the following appendices:

- [Appendix A, "Operational Configuration Elements"](#)
- [Appendix B, "Cache Configuration Elements"](#)
- [Appendix C, "POF User Type Configuration Elements"](#)
- [Appendix D, "System Property Overrides"](#)
- [Appendix E, "The PIF-POF Binary Format"](#)

Operational Configuration Elements

This appendix provides a detailed reference of the operational deployment descriptor elements and briefly describes the deployment descriptor files in which these elements can appear.

This appendix includes the following sections:

- [Operational Deployment Descriptor](#)
- [Operational Override File](#)
- [Element Reference](#)
- [Attribute Reference](#)

Operational Deployment Descriptor

The `tangosol-coherence.xml` operational deployment descriptor specifies the operational and run-time settings that control clustering, communication, and data management services. The operational deployment descriptor is located in the root of the `coherence.jar` library. A custom `tangosol-coherence.xml` file can be created; however, the preferred approach to changing the operational settings is to use a `tangosol-coherence-override.xml` operational override file as described in "[Operational Override File](#)" below.

The operational deployment descriptor schema is defined in the `coherence-operational-config.xsd` file, which imports the `coherence-operational-config-base.xsd` file, which, in turn, implicitly imports the `coherence-config-base.xsd` file. The operational deployment descriptor schema file is located in the root of the `coherence.jar` library and at the following Web URL:

<http://xmlns.oracle.com/coherence/coherence-operational-config/1.2/coherence-operational-config.xsd>

The `<coherence>` element is the root element of the operational descriptor and includes an XSD and Coherence namespace reference and the location of the `coherence-operational-config.xsd` file. For example:

```
<?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">
```

Notes:

- The schema located in the `coherence.jar` library is always used at run time even if the `xsi:schemaLocation` attribute references the Web URL.
 - The `xsi:schemaLocation` attribute can be omitted to disable schema validation.
 - When deploying Coherence into environments where the default character set is EBCDIC rather than ASCII, ensure that the deployment descriptor file is in ASCII format and is deployed into its run-time environment in the binary format.
-
-

Operational Override File

The preferred approach for configuring operational settings is to use an operational override file. The schema for the override file and the operational deployment descriptor are the same except that all elements are optional. Any missing elements are loaded from the `tangosol-coherence.xml` operational deployment descriptor. The default name for the override file is `tangosol-coherence-override.xml`. At run time, this file must be found in the classpath before the `coherence.jar` library.

Additional override files can be configured using the `xml-override` attribute within the `<coherence>` element. This allows for additional fine tuning between similar deployment environments such as staging and production. For an example of this feature, see the `tangosol-coherence-override-eval.xml`, `tangosol-coherence-override-dev.xml`, and `tangosol-coherence-override-prod.xml` files within `coherence.jar`. See ["Attribute Reference"](#) on page A-100 for details on using the `xml-override` attribute.

Element Reference

Table A-1 lists all non-terminal operational configuration elements.

Table A-1 Non-Terminal Operational Configuration Elements

Element	Used in
access-controller	security-config
address-provider	well-known-addresses, address-providers
address-providers	cluster-config
authorized-hosts	cluster-config
cache-factory-builder-config	coherence
callback-handler	security-config
cluster-config	coherence
cluster-quorum-policy	cluster-config
coherence	<i>root element</i>
configurable-cache-factory-config	coherence
filter	filters
filter	cluster-config
flashjournal-manager	journaling-config
flow-control	packet-delivery
host-range	authorized-hosts
identity-asserter	security-config
identity-manager	ssl
identity-transformer	security-config
incoming-message-handler	cluster-config
init-param	init-params
init-params	access-controller, address-provider, callback-handler, configurable-cache-factory-config, filter, service
instance	socket-provider, service-failure-policy
journaling-config	cluster-config
key-store	identity-manager, trust-manager
license-config	coherence
logging-config	coherence
management-config	coherence
mbean	mbeans
mbeans	management-config
mbean-filter	management-config
member-identity	cluster-config
multicast-listener	cluster-config

Table A-1 (Cont.) Non-Terminal Operational Configuration Elements

Element	Used in
notification-queueing	packet-publisher
outgoing-message-handler	cluster-config
outstanding-packets	flow-control
packet-buffer	multicast-listener, packet-publisher, unicast-listener
packet-bundling	packet-delivery
packet-delivery	packet-publisher
packet-publisher	cluster-config
packet-size	packet-publisher
packet-speaker	cluster-config
pause-detection	flow-control
provider	ssl, identity-manager, trust-manager
ramjournal-manager	journaling-config
reporter	management-config
security-config	coherence
serializer	serializers
serializers	cluster-config
service-guardian	cluster-config
service	services
services	cluster-config
shutdown-listener	cluster-config
socket-address	well-known-addresses
socket-provider	socket-providers, unicast-listener
socket-providers	cluster-config
ssl	socket-provider
tcp-ring-listener	cluster-config
traffic-jam	packet-publisher
trust-manager	ssl
unicast-listener	cluster-config
volume-threshold	packet-speaker
well-known-addresses	unicast-listener

access-controller

Used in: [security-config](#).

Description

The `access-controller` element contains the configuration information for the class that implements the `com.tangosol.net.security.AccessController` interface, which is used by the Coherence Security Framework to check access right and encrypt/decrypt node-to-node communications.

Elements

[Table A-2](#) describes the subelements of the `access-controller` element.

Table A-2 *access-controller Subelements*

Element	Required/Optional	Description
<code><class-name></code>	Required	Specifies the name of a Java class that implements <code>com.tangosol.net.security.AccessController</code> interface, which is used by the security framework to check access rights for clustered resources and encrypt/decrypt node-to-node communications regarding those rights. See <i>Securing Oracle Coherence</i> for more information on using an access controller. The default value is <code>com.tangosol.net.security.DefaultController</code> .
<code><init-params></code>	Optional	<p>Contains one or more initialization parameter(s) for a class that implements the <code>AccessController</code> interface. For the default <code>AccessController</code> implementation the parameters are the paths to the key store file and permissions description file, specified as follows:</p> <pre> <init-params> <init-param id="1"> <param-type>java.io.File</param-type> <param-value system-property="tangosol.coherence.security.keystore"></param-value> </init-param> <init-param id="2"> <param-type>java.io.File</param-type> <param-value system-property="tangosol.coherence.security.permissions"></param-value> </init-param> </init-params> </pre> <p>The preconfigured system property overrides based on the default <code>AccessController</code> implementation and the default parameters as specified above are <code>tangosol.coherence.security.keystore</code> and <code>tangosol.coherence.security.permissions</code>. For more information on the subelements of the <code>init-param</code> element, see "init-param" on page A-28.</p>

address-provider

Used in: [well-known-addresses](#), [address-providers](#)

Description

The `address-provider` element specifies either socket address information (IP, or DNS name, and port) or an implementation of the `com.tangosol.net.AddressProvider` interface. The interface offers a programmatic way to define socket addresses.

Within the `well-known-addresses` element, use the `address-provider` element to specify an address factory that implements the `com.tangosol.net.AddressProvider` interface. The interface offers a programmatic way to define Well Known Addresses (WKA) members. For details on WKA, see ["Using Well Known Addresses"](#) on page 7-9. The following example demonstrates using the `address-provider` element within the `well-known-addresses` element:

```
<unicast-listener>
  <well-known-addresses>
    <address-provider>
      <class-name>package.MyAddressProvider</class-name>
    </address-provider>
  </well-known-addresses>
</unicast-listener>
```

Within the `address-providers` element, use the `address-provider` element to specify a socket address or an address factory that implements the `com.tangosol.net.AddressProvider` interface. The address provider definitions are referenced by TCP/IP acceptors and TCP/IP initiators which are used to setup Coherence*Extend. A TCP/IP acceptor is also available for memcached clients.

The `tcp-acceptor`, `memcached-acceptor`, `remote-addresses`, and `name-service-addresses` elements in the cache configuration file reference address provider definitions using the specified `id` attribute value. For details on the `tcp-acceptor` element, see ["tcp-acceptor"](#) on page B-121. For details on the `memcached-acceptor` element, see ["memcached-acceptor"](#) on page B-71. For details on the `remote-addresses` element, see ["remote-addresses"](#) on page B-109. For details on the `name-service-addresses` element, see ["name-service-addresses"](#) on page B-72. The following example demonstrates defining address provider definitions within the `<address-providers>` element.

```
<address-providers>
  <address-provider id="ap1">
    <class-name>package.MyAddressProvider</class-name>
  </address-provider>
  <address-provider id="ap2">
    <socket-address>
      <address>192.168.1.3</address>
      <port>9999</port>
    </socket-address>
  </address-provider>
  <address-provider id="ap3">
    <socket-address>
      <address>192.168.1.4</address>
      <port>9999</port>
    </socket-address>
  </address-provider>
</address-providers>
```

Elements

Table A-3 describes the subelements of the address-provider element.

Table A-3 address-provider Subelements

Element	Required/ Optional	Description
<class-name>	Optional	Specifies the fully qualified name of a class that implements the <code>com.tangosol.net.AddressProvider</code> interface. This element cannot be used with the <class-factory-name> element.
<class-factory-name>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <class-name> element and is used with the <method-name> element.
<method-name>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<init-params>	Optional	Specifies initialization parameters which are accessible by implementations that include a public constructor with a matching signature. Initialization parameters can be specified when using both the <class-name> element and the <class-factory-name> element.
<socket-address>	Optional	Specifies the address (IP, or DNS name, and port) to which a socket is bound. This element should only be used when defining socket addresses for a TCP/IP acceptor. This element cannot be used if an address provider implementation is defined using the <class-name> or <class-factory-name> element.

address-providers

Used in: [cluster-config](#)

Description

The `address-providers` element contains the declarative data for each address provider.

Elements

[Table A-4](#) describes the subelements of the `address-providers` element.

Table A-4 *address-providers* Subelements

Element	Required/ Optional	Description
<code><address-provider></code>	Optional	Specifies either socket address information or an implementation of the <code>com.tangosol.net.AddressProvider</code> interface. Multiple <code>address-provider</code> elements can be specified.

authorized-hosts

Used in: [cluster-config](#).

Description

If specified, restricts cluster membership to the cluster nodes specified in the collection of unicast addresses, or address range. The unicast address is the address value from the authorized cluster nodes' [unicast-listener](#) element. Any number of `host-address` and `host-range` elements may be specified.

Elements

[Table A-5](#) describes the subelements of the `authorized-hosts` element.

Table A-5 *authorized-hosts Subelements*

Element	Required/ Optional	Description
<code><host-address></code>	Optional	Specifies an IP address or host name. If any are specified, only hosts with specified host-addresses or within the specified host-ranges is allowed to join the cluster. The content override attributes <code>id</code> can be optionally used to fully or partially override the contents of this element with XML document that is external to the base document.
<code><host-range></code>	Optional	Specifies a range of IP addresses. If any are specified, only hosts with specified host-addresses or within the specified host-ranges is allowed to join the cluster. The content override attributes <code>id</code> can be optionally used to fully or partially override the contents of this element with XML document that is external to the base document.
<code><host-filter></code>	Optional	Specifies class configuration information for a <code>com.tangosol.util.Filter</code> implementation that is used by the cluster to determine whether to accept a new cluster member. The <code>evaluate()</code> method is passed the <code>java.net.InetAddress</code> of the client. Implementations should return <code>true</code> to allow the new member to join the cluster.

cache-factory-builder-config

Used in: [coherence](#)

Description

The `cache-factory-builder-config` element contains the configuration information for constructing an instance of the `com.tangosol.net.CacheFactoryBuilder` interface. The default implementation is the `com.tangosol.net.DefaultCacheFactoryBuilder` class, which can be extended in advanced use-cases to provide further domain-specific logic for creating and managing `ConfigurableCacheFactory` instances.

A custom `CacheFactoryBuilder` implementation is used to build and manage multiple cache factory configurations across multiple class loaders. This is an advanced use case that allows applications that are scoped by different class loaders to use separate cache configuration files (as is the case with JavaEE and OSGI). For example, the following code uses a custom `ConfigurableCacheFactory` implementation from two classloaders.

```
CacheFactoryBuilder cfb = CacheFactory.getCacheFactoryBuilder();

//load the first configuration
cfb.getConfigurableCacheFactory("example-config.xml", loader0);
CacheFactory.ensureCluster();
NamedCache cache = CacheFactory.getCache("dist-example");

//load the second configuration
cfb.getConfigurableCacheFactory("example-config1.xml", loader1);
CacheFactory.ensureCluster();
NamedCache cache1 = CacheFactory.getCache("dist-example1");
```

Elements

[Table A-6](#) describes the subelements of the `cache-factory-builder-config` element.

Table A-6 *cache-factory-builder-config* Subelements

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies the name of a Java class that implements the <code>com.tangosol.net.CacheFactoryBuilder</code> interface. The default value is <code>com.tangosol.net.DefaultCacheFactoryBuilder</code> .
<code><init-params></code>	Optional	Contains initialization parameters for the cache factory builder implementation.
<code><scope-resolver></code>	Optional	Specifies the configuration information for a class that implements the <code>com.tangosol.net.ScopeResolver</code> interface. A scope resolver implementation provides the ability to modify the scope name for a given <code>ConfigurableCacheFactory</code> at run time to enforce (or disable) isolation between applications running in the same cluster. The custom scope resolver implementation is specified within an <code><class-name></code> subelement. See <i>Java API Reference for Oracle Coherence</i> for details on the <code>ScopeResolver</code> interface. See the <code><scope-name></code> subelement of the <code><cache-config></code> element on page B-22 for details on specifying a scope name within a cache configuration file.

callback-handler

Used in: [security-config](#).

[Table A-7](#) describes the subelements of the callback-handler element.

Table A-7 *callback-handler Subelement*

Element	Required/ Optional	Description
<code><class-name></code>	Required	Specifies the name of a Java class that provides the implementation for the <code>javax.security.auth.callback.CallbackHandler</code> interface.
<code><init-params></code>	Optional	Contains one or more initialization parameter(s) for a <code>CallbackHandler</code> implementation.

cluster-config

Used in: <coherence>

Description

Contains the cluster configuration information, including communication and service parameters.

Elements

Table A-8 describes the subelements of the `cluster-config` element.

Table A-8 *cluster-config* Subelements

Element	Required/ Optional	Description
<member-identity>	Optional	Specifies detailed identity information that is useful for defining the location and role of the cluster member.
<unicast-listener>	Required	Specifies the configuration information for the unicast listener, used for receiving point-to-point network communications.
<multicast-listener>	Required	Specifies the configuration information for the multicast listener, used for receiving point-to-multipoint network communications.
<tcp-ring-listener>	Required	Specifies configuration information for the TCP ring listener, used to death detection.
<shutdown-listener>	Required	Specifies the action to take upon receiving an external shutdown request.
<service-guardian>	Required	Specifies the configuration information for the service guardians, used for detecting and resolving service deadlock.
<packet-speaker>	Required	Specifies configuration information for the packet speaker, used for network data transmission.
<packet-publisher>	Required	Specifies configuration information for the packet publisher, used for managing network data transmission.
<incoming-message-handler>	Required	Specifies configuration information for the incoming message handler, used for dispatching incoming cluster communications.
<outgoing-message-handler>	Required	Specifies configuration information for the outgoing message handler, used for dispatching outgoing cluster communications.
<authorized-hosts>	Optional	Specifies the hosts which are allowed to join the cluster.
<services>	Required	Specifies the declarative data for all available Coherence services.
<filters>	Optional	Specifies data transformation filters, which can perform custom transformations on data being transferred between cluster nodes.
<serializers>	Optional	Specifies any number of serializer class configurations that implement <code>com.tangosol.io.Serializer</code> .
<address-providers>	Optional	Specifies any number of address provider definitions that can be referenced by a proxy service's TCP/IP acceptor.

Table A-8 (Cont.) cluster-config Subelements

Element	Required/ Optional	Description
<code><socket-providers></code>	Required	Contains socket provider definitions.
<code><cluster-quorum-policy></code>	Optional	Contains the configuration information for the quorum-based action policy for the Cluster service.
<code><journaling-config></code>	Optional	Specifies configuration for the journaling subsystem.

cluster-quorum-policy

Used in: [<cluster-config>](#)

Description

The `cluster-quorum-policy` element contains quorum policy settings for the Cluster service.

Element

[Table A-9](#) describes the subelements of the `cluster-quorum-policy` element.

Table A-9 *cluster-quorum-policy-scheme Subelements*

Element	Required/ Optional	Description
<code><timeout-survivor-quorum></code>	Optional	<p>Specifies the minimum number of cluster members that must remain to terminate one or more cluster members due to a detected network timeout, irrespective of the root cause. The value must be a nonnegative integer.</p> <p>Use the <code>role</code> attribute to specify this value for cluster members of a given role (as defined in the <code><role-name></code> element). For example:</p> <pre><timeout-survivor-quorum role="Server">50 </timeout-survivor-quorum></pre>
<code><class-name></code>	Optional	<p>Specifies a class that provides custom quorum policies. This element cannot be used with the <code><timeout-survivor-quorum></code> or the <code><class-factory-name></code> element.</p> <p>The class must implement the <code>com.tangosol.net.ActionPolicy</code> interface. Initialization parameters can be specified using the <code><init-params></code> element.</p>
<code><class-factory-name></code>	Optional	<p>Specifies a factory class for creating custom action policy instances. This element cannot be used with the <code><timeout-survivor-quorum></code> or <code><class-name></code> elements.</p> <p>This element is used with the <code><method-name></code> element. The action policy instances must implement the <code>com.tangosol.net.ActionPolicy</code> interface. In addition, initialization parameters can be specified using the <code><init-params></code> element.</p>

coherence

root element

Description

The coherence element is the root element of the operational deployment descriptor `tangosol-coherence.xml`.

Elements

Table A–10 describes the subelements of the coherence element.

Table A–10 coherence Subelements

Element	Required/ Optional	Description
<code><cluster-config></code>	Required	Contains the cluster configuration information. This element is where most communication and service parameters are defined.
<code><logging-config></code>	Required	Contains the configuration information for the logging facility.
<code><configurable-cache-factory-configuration></code>	Required	Contains configuration information for the configurable cache factory, which controls from where and how the cache configuration settings are loaded.
<code><cache-factory-builder-config></code>	Required	Contains the configuration information for a cache factory builder, which allows building and managing multiple cache factory configurations across multiple class loaders.
<code><management-config></code>	Required	Contains the configuration information for the coherence Management Framework. See <i>Managing Oracle Coherence</i> for more information.
<code><security-config></code>	Optional	Contains the configuration information for the Coherence Security Framework.
<code><license-config></code>	Optional	Contains the edition and operational mode configuration.

configurable-cache-factory-config

Used in: [coherence](#)

Description

The `configurable-cache-factory-config` element contains the configuration information for constructing an instance of the `com.tangosol.net.ConfigurableCacheFactory` interface. The default implementation is the `com.tangosol.net.ExtensibleConfigurableCacheFactory` class.

Using a custom `ConfigurableCacheFactory` implementation is an advanced use case and is typically used to allow applications that are scoped by different class loaders to use separate cache configuration files (as is the case with JavaEE and OSGI).

The following example loads two configuration files which contain different cache definitions and use different `ClassLoaders`.

```
//load the first configuration and use a cache

ConfigurableCacheFactory eccf= new
    ExtensibleConfigurableCacheFactory("example-config.xml", loader0);
NamedCache cache = eccf.ensureCache("dist-example", loader0);
cache.put(key, value);

//load the second cache configuration and use a cache

ConfigurableCacheFactory eccf1= new
    ExtensibleConfigurableCacheFactory("example-config1.xml", loader1);
NamedCache cache1 = eccf1.ensureCache("dist-example1", loader1);
cache1.put(key, value);
```

Note: This example requires each cache definition to use a different service name; otherwise, an exception is thrown indicating that the service was started by a factory with a different configuration descriptor.

Elements

[Table A-11](#) describes the subelements of the `configurable-cache-factory-config` element.

Table A-11 *configurable-cache-factory-config Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	<p>Specifies the name of a Java class that implements the <code>com.tangosol.net.ConfigurableCacheFactory</code> interface. The default value is <code>com.tangosol.net.ExtensibleConfigurableCacheFactory</code>.</p> <p>The preconfigured system property override is <code>tangosol.coherence.cachefactory</code>.</p>
<code><init-params></code>	Optional	<p>Contains initialization parameters for the cache configuration factory implementation. For the default cache configuration factory class, a single parameter is used as follows:</p> <pre><init-param> <param-type>java.lang.String</param-type> <param-value>coherence-cache-config.xml</param-value> </init-param></pre> <p>Unless an absolute or relative path is specified, such as with <code>./path/to/config.xml</code>, the application's classpath is used to find the specified descriptor.</p> <p>The preconfigured system property override is <code>tangosol.coherence.cacheconfig</code>.</p>

filter

Used in: [filters](#).

Description

Data transformation filters can be used by a service to apply a custom transformation on data being transferred between cluster nodes. This can be used for instance to compress network traffic. See the `<filter-class>` element for more information.

Implementation

Data transformation filters are implementations of the `com.tangosol.util WrapperStreamFactory` interface.

Note: Data transformation filters are not related to `com.tangosol.util.Filter`, which is part of the Coherence API for querying caches.

Elements

[Table A-12](#) describes the subelements of each `filter` element.

Table A-12 *filter* Subelements

Element	Required/ Optional	Description
<code><filter-name></code>	Required	Specifies the canonical name of the filter. This name is unique within the cluster. For example: <code>gzip</code> .
<code><filter-class></code>	Required	Specifies the class name of the filter implementation. This class must have a zero-parameter public constructor and must implement the <code>com.tangosol.util WrapperStreamFactory</code> interface.
<code><init-params></code>	Optional	Specifies initialization parameters for configuring filters. For example when using a <code>com.tangosol.net.CompressionFilter</code> the parameters are specified as follows: <pre> <init-param> <param-name>strategy</param-name> <param-value>gzip</param-value> </init-param> <init-param> <param-name>level</param-name> <param-value>default</param-value> </init-param> </pre> For more information on the parameter values for the standard filters, refer to "Using Network Filters" on page 10-12.

filters

Used in [cluster-config](#).

Description

The filters element contains the declarative data for each filter.

Elements

[Table A-13](#) describes the subelements of the filters element.

Table A-13 filters Subelements

Element	Required/ Optional	Description
<code><filter></code>	Optional	The filter element contains the declarative data of a particular filter.

flashjournal-manager

Used in: [journaling-config](#)

Description

The <flashjournal-manager> element contains the configuration for a flash journal resources manager, which manages I/O for temporary journal-based files to a solid state device.

Elements

[Table A-14](#) describes the subelements of the flashjournal-manager element.

Table A-14 flashjournal-manager Subelements

Element	Required/Optional	Description
<minimum-load-factor>	Optional	Specifies the factor of live data below which a journal file is eligible for compaction (garbage collection).
<maximum-value-size>	Optional	Specifies the maximum size, in bytes, of binary values that are to be stored in the flash journal. The value cannot exceed 64MB. The default value is 64MB.
<maximum-file-size>	Optional	Specifies the maximum file size of the underlying journal files. The value must be a power of two and a multiple of the block size. The value must be between 1MB and 4GB and must be large enough so that a file is capable of storing at least 2 values. The default value is 2GB.
<collector-timeout>	Optional	Specifies the amount of time that the journal collector can remain unresponsive prior to considering it timed out. The minimum timeout is 30s. Legal values are strings representing time intervals. The Default value is 10m.
<block-size>	Optional	Specifies the size of the write buffers in which writes to an underlying disk file occur. The size should match or be a multiple of the physical device's optimal block size and must be a power of two. The value must be between 4KB and 1MB. The default value is 256KB.
<maximum-pool-size>	Optional	Specifies the size, in bytes, for the buffer pool. The size does not limit the number of buffers that can be allocated or that can exist at any point in time. The size only determines the amount of buffers that are recycled. The pools size cannot exceed 1GB. The default value is 16MB.
<directory>	Optional	Specifies the directory where the journal files should be placed. The directory must exist and is not created at run time. If the directory does not exist or is not specified, the JVM/operating system default temporary directory is used. The suggested location is a local flash (SSD) drive. Specifying a directory that is located on a drive which is shared by other applications or system operations increases the potential for unplanned space usage. Use a directory location on a non-shared disk partition to ensure a more predictable environment.

Table A-14 (Cont.) flashjournal-manager Subelements

Element	Required/ Optional	Description
<async-limit>	Optional	Specifies the maximum size, in bytes, of the backlog. The backlog is the amount of data that has yet to be persisted. Client threads are blocked if the configured limit is exceeded and remain blocked until the backlog recedes below the limit. This helps prevent out-of-memory conditions. Note: The maximum amount of memory used by the backlog is at least twice the configured amount, since the data is in binary form and rendered to the write-behind buffers. The value must be between 4KB and 1GB. The default value is 16MB.
<tmp-purge-delay>	Optional	Specifies the amount of time to wait before a temporary file that is used by the Journaling subsystem is eligible for removal. The delay begins after the file is last used. The default value is 2 hours.
<high-journal-size>	Optional	Specifies the soft limit, in bytes, on the journal size or a percentage of the flash journal capacity. The soft limit allows the compaction (garbage collection) thread to tune itself to remove stale values and keep the journal within the soft limit. This is not a hard limit and the journal can still grow up to the maximum file count (512). The default value is 11GB. The preconfigured system property override is <code>tangosol.coherence.flashjournal.highjournal.size</code> .
<writer-timeout>	Optional	Specifies the amount of time that the flash journal writer can remain unresponsive prior to considering it timed out. The minimum timeout is 30s. Legal values are strings representing time intervals. The Default value is 8h. If a write fails (after the <code>writer-timeout</code> value is reached), then the journal becomes read-only until the member is restarted. When the write backlog maximum is reached (as defined by the <code>async-limit</code> value), the journal responds to subsequent store requests with an exception either until the write is resolved or indefinitely as the <code>writer-timeout</code> is surpassed.

flow-control

Used in: [packet-delivery](#).

Description

The flow-control element contains configuration information related to packet throttling and remote GC detection.

Elements

[Table A-15](#) describes the subelements of the flow-control element.

Table A-15 *flow-control Subelements*

Element	Required/ Optional	Description
<enabled>	Optional	Specifies if flow control is enabled. Valid values are true or false. The default value is true
< pause-detection >	Optional	Defines the number of packets that are resent to an unresponsive cluster node after which the node is assumed to be paused.
< outstanding-packets >	Optional	Defines the number of unconfirmed packets that are sent to a cluster node before packets addressed to that node are deferred.

host-range

Used in: [authorized-hosts](#).

Description

Specifies a range of unicast addresses of nodes which are allowed to join the cluster.

Elements

[Table A-16](#) describes the subelements of each `host-range` element.

Table A-16 *host-range Subelements*

Element	Required/ Optional	Description
<from-address>	Required	Specifies the starting IP address for a range of host addresses. For example: 198.168.1.1.
<to-address>	Required	Specifies to-address element specifies the ending IP address (inclusive) for a range of hosts. For example: 198.168.2.255.

identity-asserter

Used in: [security-config](#)

Description

The <identity-asserter> element contains the configuration information for a class that implements the `com.tangosol.net.security.IdentityAsserter` interface. The class is called to validate an identity token to establish a user's identity and is used on a Coherence*Extend proxy server. The identity asserter is used with an identity transformer (used on a Coherence*Extend client) to ensure that only valid clients are allowed to connect to an extend proxy.

Elements

[Table A-17](#) describes the subelements of the <identity-asserter> element.

Table A-17 *identity-asserter Subelements*

Element	Required/ Optional	Description
<class-name>	Optional	Specifies a class that implements <code>com.tangosol.net.security.IdentityAsserter</code> . This element cannot be used with the <class-factory-name> element.
<class-factory-name>	Optional	Specifies a factory class for creating asserter instances. The instances must implement <code>com.tangosol.net.security.IdentityAsserter</code> . This element cannot be used with the <class-name> element. This element can be used with the <method-name> element.
<method-name>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<init-params>	Optional	Contains class initialization parameters for the asserter implementation.

identity-manager

Used in: [ssl](#).

Description

The <identity-manager> element contains the configuration information for initializing a `javax.net.ssl.KeyManager` instance.

The identity manager is responsible for managing the key material which is used to authenticate the local connection to its peer. If no key material is available, the connection cannot present authentication credentials.

Elements

[Table A-18](#) describes the subelements of the `identity-manager` element.

Table A-18 *identity-manager Subelements*

Element	Required/ Optional	Description
<algorithm>	Optional	Specifies the algorithm used by the identity manager. The default value is <code>SunX509</code> .
<provider>	Optional	Specifies the configuration for a security provider instance.
<key-store>	Optional	Specifies the configuration for a key store implementation.
<password>	Required	Specifies the private key password.

identity-transformer

Used in: [security-config](#)

Description

The `<identity-transformer>` element contains the configuration information for a class that implements the `com.tangosol.net.security.IdentityTransformer` interface. The class is called to transform a `Subject` (Principal in .NET) to a token that asserts identity and is used on a Coherence*Extend client. The identity transformer is used with an identity asserter (used on a Coherence*Extend proxy server) to ensure that only valid clients are allowed to connect to an extend proxy.

Elements

[Table A-19](#) describes the subelements of the `<identity-transformer>` element.

Table A-19 *identity-transformer Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies a class that implements <code>com.tangosol.net.security.IdentityTransformer</code> . This element cannot be used with the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies a factory class for creating asserter instances. The instances must implement <code>com.tangosol.net.security.IdentityTransformer</code> . This element cannot be used with the <code><class-name></code> element. This element can be used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the transformer implementation.

incoming-message-handler

Used in: [cluster-config](#).

Description

The `incoming-message-handler` assembles UDP packets into logical messages and dispatches them to the appropriate Coherence service for processing.

Elements

[Table A-20](#) describes the subelements of the `incoming-message-handler` element.

Table A-20 *incoming-message-handler Subelements*

Element	Required/ Optional	Description
<code><maximum-time-variance></code>	Required	Specifies the maximum time variance between sending and receiving broadcast Messages when trying to determine the difference between a new cluster Member's system time and the cluster time. The smaller the variance, the more certain one can be that the cluster time is closer between multiple systems running in the cluster; however, the process of joining the cluster is extended until an exchange of Messages can occur within the specified variance. Normally, a value as small as 20 milliseconds is sufficient, but with heavily loaded clusters and multiple network hops a larger value may be necessary. The default value is 16.
<code><use-nack-packets></code>	Required	Specifies whether the packet receiver uses negative acknowledgments (packet requests) to pro-actively respond to known missing packets. See " notification-queueing " on page A-45 for additional details and configuration. Legal values are <code>true</code> or <code>false</code> . The default value is <code>true</code> .
<code><priority></code>	Required	Specifies a priority of the incoming message handler execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 7.

init-param

Used in: [init-params](#).

Description

Defines an initialization parameter. Any number of `init-param` elements may be specified.

Elements

[Table A-21](#) describes the subelements of the `init-param` element.

Table A-21 *init-param* Subelement

Element	Required/ Optional	Description
<code><param-name></code>	Optional	<p>Specifies the name of the initialization parameter. For example:</p> <pre><init-param> <param-name>sTableName</param-name> <param-value>EmployeeTable</param-value> </init-param></pre> <p>The <code><param-name></code> element cannot be specified if the <code><param-type></code> element is specified. See "Initialization Parameter Settings" on page A-62 for information on the pre-defined parameters that are available for specific services.</p>
<code><param-type></code>	Optional	<p>Specifies the Java type of the initialization parameter. The following standard types are supported:</p> <ul style="list-style-type: none"> ▪ <code>java.lang.String</code> (string) ▪ <code>java.lang.Boolean</code> (boolean) ▪ <code>java.lang.Integer</code> (int) ▪ <code>java.lang.Long</code> (long) ▪ <code>java.lang.Double</code> (double) ▪ <code>java.math.BigDecimal</code> ▪ <code>java.io.File</code> ▪ <code>java.sql.Date</code> ▪ <code>java.sql.Time</code> ▪ <code>java.sql.Timestamp</code> <p>For example:</p> <pre><init-param> <param-type>java.lang.String</param-type> <param-value>EmployeeTable</param-value> </init-param></pre> <p>The <code><param-type></code> element cannot be specified if the <code><param-name></code> element is specified.</p>
<code><param-value></code>	Required	<p>Specifies the value of the initialization parameter. The value is in the format specific to the Java type of the parameter.</p>
<code><description></code>	Optional	<p>Specifies a description for the initialization parameter.</p>

init-params

Used in: [address-provider](#), [filter](#), [service](#), [configurable-cache-factory-config](#), [access-controller](#), and [callback-handler](#).

Description

Defines a series of initialization parameters.

Elements

[Table A-22](#) describes the subelements of the `init-params` element.

Table A-22 *init-params* Subelement

Element	Required/ Optional	Description
<code><init-param></code>	Optional	Defines an individual initialization parameter.

instance

Used in: service-failure-policy, scope-resolver, and partition-assignment-strategy

Description

The <instance> element contains the configuration of an implementation class or class factory that is used to plug in custom functionality.

Elements

[Table A-23](#) describes the subelements of the instance element.

Table A-23 *instance Subelements*

Element	Required/ Optional	Description
<class-name>	Optional	Specifies the fully qualified name of an implementation class. This element cannot be used with the <class-factory-name> element.
<class-factory-name>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <class-name> element and is used with the <method-name> element.
<method-name>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<init-params>	Optional	Specifies initialization parameters which are accessible by implementations that include a public constructor with a matching signature. Initialization parameters can be specified when using both the <class-name> element and the <class-factory-name> element.

journaling-config

Used in: [cluster-config](#)

Description

The <journaling-config> element contains the configuration for the resource managers that are responsible for storing data in a binary format to flash and RAM memory.

Elements

[Table A-23](#) describes the subelements of the journaling-config element.

Table A-24 *journaling-config Subelements*

Element	Required/ Optional	Description
<ramjournal-manager>	Required	Specifies the RAM Journal Resource Manager's configuration.
<flashjournal-manager>	Required	Specifies the Flash Journal Resource Manager's configuration.

key-store

Used in: [identity-manager](#), [trust-manager](#).

Description

The `key-store` element specifies the configuration for a key store implementation to use when implementing SSL. The key store implementation is an instance of the `java.security.KeyStore` class.

Elements

[Table A-25](#) describes the subelements of the `key-store` element.

Table A-25 *key-store Subelements*

Element	Required/ Optional	Description
<code><url></code>	Required	Specifies the Uniform Resource Locator (URL) to a key store.
<code><password></code>	Optional	Specifies the password for the key store.
<code><type></code>	Optional	Specifies the type of a <code>java.security.KeyStore</code> instance. The default value is JKS.

license-config

Used in: [coherence](#).

[Table A-26](#) describes the subelements of the `license-config` element.

Table A-26 *license-config* Subelements

Element	Required/ Optional	Description
<code><edition-name></code>	Optional	Specifies the product edition that the member uses. Valid values are: <code>GE</code> (Grid Edition), <code>EE</code> (Enterprise Edition), <code>SE</code> (Standard Edition), <code>RTC</code> (Real-Time Client), <code>DC</code> (Data Client). The default value is <code>GE</code> . Note: The edition switches no longer enforce license restrictions. Do not change the default setting (<code>GE</code>).
<code><license-mode></code>	Optional	Specifies whether the product is being used in a development or production mode. Valid values are <code>prod</code> (Production), and <code>dev</code> (Development). Note: This value cannot be overridden in <code>tangosol-coherence-override.xml</code> . It must be specified in <code>tangosol-coherence.xml</code> or (preferably) supplied as system property <code>tangosol.coherence.mode</code> on the Java command line. The default value is <code>dev</code> .

logging-config

Used in: [coherence](#).

Elements

The following table describes the subelements of the logging-config element.

Table A-27 logging-config Subelements

Element	Required/ Optional	Description
<destination>	Required	<p>Specifies the output device used by the logging system. Legal values are:</p> <ul style="list-style-type: none"> ▪ stdout ▪ stderr (default) ▪ jdk ▪ log4j ▪ slf4j ▪ <i>file name</i> <p>If log4j is specified, the Log4j libraries must be in the classpath. In both cases, the appropriate logging configuration mechanism (system properties, property files, and so on) are necessary to configure the JDK/Log4j logging libraries.</p> <p>The preconfigured system property override is <code>tangosol.coherence.log</code>.</p>
<logger-name>	Optional	<p>Specifies a logger name within chosen logging system that logs Coherence related messages. This value is only used by the JDK and log4j logging systems. The default value is <code>Coherence</code>.</p> <p>The preconfigured system property override is <code>tangosol.coherence.log.logger</code>.</p>
<severity-level>	Required	<p>Specifies which logged messages are emitted to the log destination. The legal values are -1 to 9. No messages are emitted if -1 is specified. More log messages are emitted as the log level is increased.</p> <p>The preconfigured system property override is <code>tangosol.coherence.log.level</code>.</p>
<message-format>	Required	<p>Specifies how messages that have a logging level specified are formatted before passing them to the log destination. The format can include static text and any of the following replaceable parameters: {date}, {uptime}, {product}, {version}, {level}, {thread}, {member}, {location}, {role}, {text}, and {ecid}. The default value is:</p> <pre>{date}/{uptime} {product} {version} &lt;{level}&gt; (thread={thread}, member={member}): {text}</pre>
<character-limit>	Required	<p>Specifies the maximum number of characters that the logger daemon processes from the message queue before discarding all remaining messages in the queue. All messages that are discarded are summarized by the logging system with a single log entry that details the number of messages that were discarded and their total size. Legal values are positive integers or 0. Zero implies no limit. The default value in production mode is 1048576 and 2147483647 in development mode.</p> <p>The preconfigured system property override is <code>tangosol.coherence.log.limit</code>.</p>

management-config

Used in: [coherence](#).

Elements

[Table A-28](#) describes the subelements of the management-config element.

Table A-28 *management-config Subelements*

Element	Optional/ Required	Description
<managed-nodes>	Required	<p>Specifies whether a cluster node's JVM has an [in-process] MBean server and if so, whether this node allows management of other nodes' managed objects. Legal values are:</p> <ul style="list-style-type: none"> ▪ none – (default) No MBean server is instantiated on this cluster node. ▪ local-only – Manage only MBeans which are local to this cluster node (that is, within the same JVM). ▪ remote-only – Manage MBeans on other remotely manageable cluster nodes. See <allowed-remote-management> subelement. ▪ all – Manage both local and remotely manageable cluster nodes. See <allowed-remote-management> subelement. <p>The preconfigured system property override is <code>tangosol.coherence.management</code>.</p>
<allow-remote-management>	Required	<p>Specifies whether this cluster node exposes its managed objects to remote MBean server(s). Legal values are: true or false. The default value is true.</p> <p>The preconfigured system property override is <code>tangosol.coherence.management.remote</code>.</p>
<refresh-policy>	Optional	<p>Specifies the method which is used to refresh remote management information. Legal values are: refresh-ahead, refresh-behind or refresh-expired. The default value is refresh-ahead.</p> <p>The preconfigured system property override is <code>tangosol.coherence.management.refresh.policy</code></p>
<refresh-expiry>	Optional	<p>Specifies the time interval (in milliseconds) after which a remote MBean information is invalidated on the management node. Legal values are strings representing time intervals. The default value is 1s.</p> <p>The preconfigured system property override is <code>tangosol.coherence.management.refresh.expiry</code></p>
<refresh-timeout>	Optional	<p>Specifies the duration which the management node waits for a response from a remote node when refreshing MBean information. This value must be less than the refresh-expiry interval. Legal values are strings representing time intervals. The default value is 250ms.</p> <p>The preconfigured system property override is <code>tangosol.coherence.management.refresh.timeout</code></p>

Table A–28 (Cont.) management-config Subelements

Element	Optional/ Required	Description
<read-only>	Optional	Specifies whether the managed objects exposed by this cluster node allow operations that modify run-time attributes. Legal values are: true or false. The default value is false. The preconfigured system property override is <code>tangosol.coherence.management.readonly</code> .
<default-domain-name>	Optional	Specifies the domain name of an existing MBean server that is used to register MBeans exposed by the Coherence management framework. This element is used only if a cluster member has management enabled and the MBean server is located in the same process as the cluster member. If a value is not specified, the first existing MBean server is used. The element should only be used to identify an existing MBean server. This element is also used when implementing the <code>MBeanServerFinder</code> interface. See the <server-factory> element below.
<service-name>	Optional	Specifies the name of the Invocation Service used for remote management. This element is used only if <code>allow-remote-management</code> is set to true.
<server-factory>	Optional	Contains the configuration information for an <code>MBeanServer</code> factory that implements the <code>com.tangosol.net.management.MBeanServerFinder</code> interface, which is used to find an MBean server that is used by the Coherence JMX framework to register new or locate existing MBeans. If a domain name is provided in the <default-domain-name> element, then it is used when instantiating the class. The class name is entered using the <class-name> subelement and supports initialization parameters using the <init-params> element.
<mbeans>	Optional	Contains a list of MBeans to be registered when a node joins the cluster.
<mbean-filter>	Optional	Contains the configuration information of a filter class that is used to filter MBeans before they are registered.
<reporter>	Optional	Contains the Reporter's configuration.
<extended-mbean-name>	Optional	Specifies whether global MBean names that are identified with a <code>nodeId</code> attribute are extended to identify the corresponding member name (if specified). Legal values are: true or false. The default value is false and indicates that the member name is not included in the Global MBean name. The preconfigured system property override is <code>tangosol.coherence.management.extendedmbeanname</code> .

mbean

Used in: [mbeans](#)

Description

The `mbean` element contains a list of elements to be instantiated and registered with the Coherence management framework.

Elements

[Table A-29](#) describes the subelements of the `mbean` element.

Table A-29 *Subelements of mbean*

Element	Required/ Optional	Description
<code><mbean-class></code>	Optional	<p>Specifies the full class name of the standard MBean to instantiate and register with the Coherence management framework. The MBean class must be in the classpath to correctly instantiate.</p> <p>This element cannot be used with the <code><mbean-factory></code> element or the <code><mbean-query></code> element.</p>
<code><mbean-factory></code>	Optional	<p>Specifies the name of a class factory used to obtain MBeans to register with the Coherence management framework. The factory class must be in the classpath to correctly instantiate. This element is used with the <code><mbean-accessor></code> element.</p> <p>This element cannot be used with the <code><mbean-class></code> element or the <code><mbean-query></code> element.</p>
<code><mbean-query></code>	Optional	<p>Specifies a JMX <code>ObjectName</code> query pattern. The query pattern is executed against a local MBean server and the resulting objects are registered with the Coherence management framework. This allows for a single point of consolidation of MBeans for the grid. For example, the following query includes all the MBeans under the <code>java.lang</code> domain in the Coherence management infrastructure.</p> <pre><mbean-query>java.lang:*/mbean-query</pre> <p>This element cannot be used with the <code><mbean-class></code> element or the <code><mbean-factory></code> element.</p>
<code><mbean-server-domain></code>	Optional	<p>Specifies the name of a default domain for the source MBean server. This is used to locate the MBean server where the <code>mbean-query</code> should be executed.</p>
<code><mbean-accessor></code>	Optional	<p>Specifies the method name on the factory class (specified by the <code><mbean-factory></code> element) that is used to instantiate the MBean.</p>

Table A–29 (Cont.) Subelements of mbean

Element	Required/ Optional	Description
<mbean-name>	Required	Specifies the JMX <code>ObjectName</code> prefix for the MBean that is registered with the Coherence management framework. The prefix should be a comma-delimited <code>Key=Value</code> pair. The Coherence MBean naming convention stipulates that the name should begin with a type/value pair (for example, <code>type=Platform</code>).
<local-only>	Optional	Specifies whether the MBean is visible across the cluster. Valid values are <code>true</code> or <code>false</code> . If set to <code>true</code> , the MBean is registered only with a local MBean server and is not accessible by other cluster nodes. If set to <code>false</code> , the <code>nodeId=...</code> key attribute is added to its name and the MBean is visible from any of the managing nodes (nodes that set the <managed-nodes> element to values of <code>all</code> or <code>remote-only</code>). The default value is <code>false</code> .
<enabled>	Optional	Specifies whether the MBean should be instantiated and registered on this instance. Valid values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<extend-lifecycle>	Optional	Specifies whether the MBean should extend beyond the node connection life cycle. Valid values are <code>true</code> or <code>false</code> . If <code>true</code> , the MBean maintains the statistics and values across connections (coincides with the JVM life cycle). If <code>false</code> , the MBean is destroyed and re-created when a node is disconnected from the grid. The default value is <code>false</code> .

mbeans

Used in: [management-config](#)

Description

The `mbeans` element is the root element for defining custom mbeans and is the root element of a custom mbean configuration file. It contains a list of mbean elements to be instantiated and registered with the Coherence management framework.

Elements

[Table A-30](#) describes the subelements of the `mbeans` element.

Table A-30 *Subelement of mbeans*

Element	Required/ Optional	Description
<code><mbean></code>	Required	Specifies the MBean type, implementation, and <code>ObjectName</code> that are instantiated and registered with the Coherence management framework.

mbean-filter

Used in [management-config](#).

Description

The `mbean-filter` element is used to specify a filter that evaluates MBean names before they are registered in the MBean server. The `com.tangosol.net.management.ObjectNameExcludeFilter` class is the default filter and is used to exclude MBeans from being registered based on their JMX object name using standard regex patterns. The list is entered as a list of names separated by any white space characters. The following MBeans are excluded by the out-of-box configuration:

```
<management-config>
  <mbean-filter>
    <class-name>com.tangosol.net.management.ObjectNameExcludeFilter</class-name>
    <init-params>
      <init-param>
        <param-type>string</param-type>
        <param-value system-property="tangosol.coherence.management.exclude">
          .*type=Service,name=Management,.*
          .*type=Platform,Domain=java.lang,subType=ClassLoading,.*
          .*type=Platform,Domain=java.lang,subType=Compilation,.*
          .*type=Platform,Domain=java.lang,subType=MemoryManager,.*
          .*type=Platform,Domain=java.lang,subType=Threading,.*
        </param-value>
      </init-param>
    </init-params>
  </mbean-filter>
</management-config>
```

Elements

[Table A-44](#) describes the subelements of the `mbean-filter` element.

Table A-31 *mbean-filter* Subelements

Element	Required/Optional	Description
<code><class-name></code>	Optional	Specifies the name of a filter class for filtering mbeans. This element cannot be used with the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies a factory class for creating filter instances. This element cannot be used with the <code><name></code> element or the <code><class-name></code> element. This element can be used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the filter implementation.

member-identity

Used in: [cluster-config](#).

The `member-identity` element contains detailed identity information that is useful for defining the location and role of the cluster member.

Elements

[Table A-32](#) describes the subelements of the `member-identity` element.

Table A-32 *member-identity Subelements*

Element	Required/ Optional	Description
<code><cluster-name></code>	Optional	<p>The <code>cluster-name</code> element contains the name of the cluster. To join the cluster, all members must specify the same cluster name. A cluster name should always be specified for production systems to prevent accidental cluster discovery among applications.</p> <p>The preconfigured system property override is <code>tangosol.coherence.cluster</code>.</p>
<code><site-name></code>	Optional	<p>The <code>site-name</code> element contains the name of the geographic site that the member is hosted at. For WAN clustering, this value identifies the datacenter within which the member is located. The site name can be used as the basis for intelligent routing, load balancing, and disaster recovery planning (that is, the explicit backing up of data on separate geographic sites). The site name also helps determine where to back up data when using distributed caching and the default partition assignment strategy. Lastly, the name is useful for displaying management information (for example, JMX) and interpreting log entries.</p> <p>The preconfigured system property override is <code>tangosol.coherence.site</code>.</p>
<code><rack-name></code>	Optional	<p>The <code>rack-name</code> element contains the name of the location within a geographic site that the member is hosted at and is often a cage, rack, or bladeframe identifier. The rack name can be used as the basis for intelligent routing, load balancing, and disaster recovery planning (that is, the explicit backing up of data on separate bladeframes). The rack name also helps determine where to back up data when using distributed caching and the default partition assignment strategy. Lastly, the name is useful for displaying management information (for example, JMX) and interpreting log entries.</p> <p>The preconfigured system property override is <code>tangosol.coherence.rack</code>.</p>
<code><machine-name></code>	Optional	<p>The <code>machine-name</code> element contains the name of the physical server that the member is hosted on. This is often the same name as the server identifies itself as (for example, its <code>HOSTNAME</code>, or its name as it appears in a DNS entry). If provided, the name is used as the basis for creating a ID, which in turn is used to guarantee that data are backed up on different computers to prevent single points of failure (SPOFs). The name is also useful for displaying management information (for example, JMX) and interpreting log entries. It is optional to provide a value for this element. However, it is strongly encouraged that a name always be provided.</p> <p>The preconfigured system property override is <code>tangosol.coherence.machine</code>.</p>

Table A–32 (Cont.) member-identity Subelements

Element	Required/ Optional	Description
<process-name>	Optional	<p>The <code>process-name</code> element contains the name of the process (JVM) that the member is hosted on. This name makes it possible to easily differentiate among multiple JVMs running on the same computer. The name is also useful for displaying management information (for example, JMX) and interpreting log entries. It is optional to provide a value for this element. Often, a single member exists per JVM, and in that situation this name would be redundant.</p> <p>The preconfigured system property override is <code>tangosol.coherence.process</code>.</p>
<member-name>	Optional	<p>The <code>member-name</code> element contains the name of the member itself. This name makes it possible to easily differentiate among members, such as when multiple members run on the same computer (or even within the same JVM). The name is also useful for displaying management information (for example, JMX) and interpreting log entries. It is optional to provide a value for this element. However, it is strongly encouraged that a name always be provided.</p> <p>The preconfigured system property override is <code>tangosol.coherence.member</code>.</p>
<role-name>	Optional	<p>The <code>role-name</code> element contains the name of the member role. This name allows an application to organize members into specialized roles, such as cache servers and cache clients. The name is also useful for displaying management information (for example, JMX) and interpreting log entries. It is optional to provide a value for this element. However, it is strongly encouraged that a name always be provided.</p> <p>The preconfigured system property override is <code>tangosol.coherence.role</code>.</p>
<priority>	Optional	<p>The <code>priority</code> element specifies a priority of the corresponding member. The priority is used as the basis for determining tie-breakers between members. If a condition occurs in which one of two members are ejected from the cluster, and in the rare case that it is not possible to objectively determine which of the two is at fault and should be ejected, then the member with the lower priority is ejected. Valid values are from 1 to 10 where 10 is the highest priority.</p> <p>The preconfigured system property override is <code>tangosol.coherence.priority</code>.</p>

multicast-listener

Used in: [cluster-config](#).

Description

Specifies the configuration information for the Multicast listener. This element is used to specify the address and port that a cluster uses for cluster wide and point-to-multipoint communications. All nodes in a cluster must use the same multicast address and port, whereas distinct clusters on the same network should use different multicast addresses. If you are having difficulties establishing a cluster when using multicast, see *Administering Oracle Coherence* for instructions on performing a multicast connectivity test.

Multicast-Free Clustering

By default, Coherence uses a multicast protocol to discover other nodes when forming a cluster. If multicast networking is undesirable, or unavailable in your environment, the [well-known-addresses](#) feature may be used to eliminate the need for multicast traffic.

Elements

[Table A-33](#) describes the subelements of the `multicast-listener` element.

Table A-33 *multicast-listener Subelements*

Element	Required /Optional	Description
<code><interface></code>	Optional	Specifies the IP address that a multicast socket is bound to. By default, the interface (NIC) of the unicast-listener IP address is used for the multicast socket; this option allows a different interface to be specified for multicast. Setting this address to <code>0.0.0.0</code> allows the operating system to use the unicast routing table to select the interface automatically.
<code><address></code>	Required	Specifies the multicast IP address that a Socket listens or publishes on. Legal values are from <code>224.0.0.0</code> to <code>239.255.255.255</code> . The default value depends on the release and build level and typically follows the convention of <code>{build}.{major version}.{minor version}.{patch}</code> . The preconfigured system property override is <code>tangosol.coherence.clusteraddress</code> .
<code><port></code>	Required	Specifies the port that the Socket listens or publishes on. Legal values are from 1 to 65535. The default value depends on the release and build level and typically follows the convention of <code>{version}+{{build}}</code> . The preconfigured system property override is <code>tangosol.coherence.clusterport</code> .
<code><time-to-live></code>	Required	Specifies the time-to-live setting for the multicast. This determines the maximum number of "hops" a packet may traverse, where a hop is measured as a traversal from one network segment to another by using a router. Legal values are from 0 to 255. The default value is 4. The preconfigured system property override is <code>tangosol.coherence.ttl</code> .
<code><packet-buffer></code>	Required	Specifies how many incoming packets the operating system is requested to buffer. The value may be expressed either in terms of packets or bytes.

Table A–33 (Cont.) multicast-listener Subelements

Element	Required /Optional	Description
<priority>	Required	Specifies a priority of the multicast listener execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 8.
<join-timeout-millisec onds>	Required	Specifies the number of milliseconds that a new member waits without finding any evidence of a cluster before starting its own cluster and electing itself as the senior cluster member. Legal values are from 1000 to 1000000. The default value is 3000. Note: For production use, the recommended value is 30000.
<multicast-threshold-pe rcent>	Required	Specifies the threshold percentage value used to determine whether a packet is sent by using unicast or multicast. It is a percentage value and is in the range of 1% to 100%. In a cluster of "n" nodes, a particular node sending a packet to a set of other (that is, not counting self) destination nodes of size "d" (in the range of 0 to n-1), the packet is sent multicast if and only if the following both hold true: <ol style="list-style-type: none"> 1. The packet is being sent over the network to multiple nodes, that is, ($d > 1$). 2. The number of nodes is greater than the threshold, that is, ($d > (n-1) * (\text{threshold}/100)$). <p>Setting this value to 1 allows the implementation to use multicast for basically all multi-point traffic.</p> <p>Setting it to 100 forces the implementation to use unicast for all multi-point traffic except for explicit broadcast traffic (for example, cluster heartbeat and discovery) because the 100% threshold is never exceeded. With the setting of 25 the implementation sends the packet using unicast if it is destined for less than one-fourth of all nodes, and send it using multicast if it is destined for the one-fourth or more of all nodes.</p> <p>Legal values are from 1 to 100. The default value is 25.</p> <p>Note: This element is only used if the well-known-addresses element is empty.</p>

notification-queueing

Used in: [packet-publisher](#).

Description

The `notification-queueing` element is used to specify the timing of notification packets sent to other cluster nodes. Notification packets are used to acknowledge the receipt of packets which require confirmation.

Elements

The following table describes the subelements of the `notification-queueing` element.

Table A-34 *notification-queueing Subelements*

Element	Required/ Optional	Description
<code><ack-delay-milliseconds></code>	Required	Specifies the maximum number of milliseconds that the packet publisher delays before sending an ACK packet. The ACK packet may be transmitted earlier if number of batched acknowledgments fills the ACK packet. This value should be substantially lower than the remote node's packet-delivery resend timeout, to allow ample time for the ACK to be received and processed by the remote node before the resend timeout expires. The default value is 16.
<code><nack-delay-milliseconds></code>	Required	Specifies the number of milliseconds that the packet publisher delays before sending a NACK packet. The default value is 1.

outgoing-message-handler

Used in: [cluster-config](#)

Description

The `outgoing-message-handler` element contains the outgoing message handler (also known as a dispatcher) related configuration information.

Elements

[Table A-35](#) describes the subelements of the `outgoing-message-handler` element.

Table A-35 *outgoing-message-handler Subelement*

Element	Required/ Optional	Description
<code><use-filters></code>	Optional	Specifies a list of <code><filter-name></code> elements to be used by this handler. See the <filter> element for detailed information on defining a filter.

outstanding-packets

Used in: [flow-control](#).

Description

Defines the number of unconfirmed packets that are sent to a cluster node before packets addressed to that node are deferred. This helps to prevent the sender from flooding the recipient's network buffers.

Elements

[Table A-36](#) describes the subelements of the `outstanding-packets` element.

Table A-36 *outstanding-packets* Subelements

Element	Required/ Optional	Description
<code><maximum-packets></code>	Optional	The maximum number of unconfirmed packets that are sent to a cluster node before packets addressed to that node are deferred. It is recommended that this value not be set below 256. The default value is 4096.
<code><minimum-packets></code>	Optional	The lower bound on the range for the number of unconfirmed packets that are sent to a cluster node before packets addressed to that node are deferred. It is recommended that this value not be set below 16. The default value is 64.

packet-buffer

Used in: [unicast-listener](#), [multicast-listener](#), [packet-publisher](#).

Description

Specifies the size (in packets or bytes) of the operating system buffer for datagram sockets.

Elements

[Table A-37](#) describes the subelements of the `packet-buffer` element.

Table A-37 *packet-buffer Subelements*

Element	Required/ Optional	Description
<code><maximum-packets></code>	Optional	For unicast-listener , multicast-listener and packet-publisher : Specifies the number of packets of packet-size that the datagram socket are asked to size itself to buffer. See SO_SNDBUF and SO_RCVBUF . Actual buffer sizes may be smaller if the underlying socket implementation cannot support more than a certain size. The default values are 32 for publishing, 64 for multicast listening, and 1428 for unicast listening. The <code><maximum-packets></code> element cannot be specified if the <code><size></code> element is specified.
<code><size></code>	Optional	Specifies the requested size of the underlying socket buffer in bytes rather than the number of packets. The <code><size></code> element cannot be specified if the <code><maximum-packets></code> element is specified.

packet-bundling

Used in: [packet-delivery](#).

Description

The `packet-bundling` element contains configuration information related to the bundling of multiple small packets into a single larger packet to reduce the load on the network switching infrastructure.

Elements

[Table A-38](#) describes the subelements of the `packet-bundling` element.

Table A-38 *packet-bundling Subelements*

Element	Required/Optional	Description
<code><maximum-deferral-time></code>	Optional	The maximum amount of time to defer a packet while waiting for additional packets to bundle. A value of zero results in the algorithm not waiting, and only bundling the readily accessible packets. A value greater than zero causes some transmission deferral while waiting for additional packets to become available. This value is typically set below 250 microseconds to avoid a detrimental throughput impact. If the units are not specified, nanoseconds are assumed. The default value is 1us (microsecond).
<code><aggression-factor></code>	Optional	Specifies the aggressiveness of the packet deferral algorithm. Where as the <code>maximum-deferral-time</code> element defines the upper limit on the deferral time, the <code>aggression-factor</code> influences the average deferral time. The higher the aggression value, the longer the Publisher may wait for additional packets. The factor may be expressed as a real number, and often times values between 0.0 and 1.0 allows for high packet utilization while keeping latency to a minimum. The default value is 0.

packet-delivery

Used in: [packet-publisher](#).

Description

Specifies timing and transmission rate parameters related to packet delivery.

Elements

[Table A-39](#) describes the subelements of the `packet-delivery` element.

Table A-39 *packet-delivery* Subelements

Element	Required/ Optional	Description
<code><resend-milliseconds></code>	Required	For packets which require confirmation, specifies the minimum amount of time in milliseconds to wait for a corresponding ACK packet, before resending a packet. The default value is 200.
<code><timeout-milliseconds></code>	Required	For packets which require confirmation, specifies the maximum amount of time, in milliseconds, that a packet is resent. After this timeout expires Coherence makes a determination if the recipient is to be considered terminated. This determination takes additional data into account, such as if other nodes are still able to communicate with the recipient. The default value is 300000. For production use, the recommended value is the greater of 300000 and two times the maximum expected full GC duration.
<code><heartbeat-milliseconds></code>	Required	Specifies the interval between heartbeats. Each member issues a unicast heartbeat, and the most senior member issues the cluster heartbeat, which is a broadcast message. The heartbeat is used by the tcp-ring-listener as part of fast death detection. The default value is 1000.
<code><flow-control></code>	Optional	Configures per-node packet throttling and remote GC detection.
<code><packet-bundling></code>	Optional	Configures how aggressively Coherence attempts to maximize packet utilization.

packet-publisher

Used in: [cluster-config](#).

Description

Specifies configuration information for the Packet publisher, which manages network data transmission.

Reliable packet delivery

The Packet publisher is responsible for ensuring that transmitted packets reach the destination cluster node. The publisher maintains a set of packets which are waiting to be acknowledged, and if the ACK does not arrive by the `packet-delivery` resend timeout, the packet is retransmitted (see `<packet-delivery>` subelement). The recipient node delays the ACK, to batch a series of ACKs into a single response (see `<notification-queuing>` subelement).

Elements

[Table A-40](#) describes the subelements of the `packet-publisher` element.

Table A-40 *packet-publisher Subelements*

Element	Required/Optional	Description
<code><packet-size></code>	Optional	Specifies the UDP packet sizes to use.
<code><packet-delivery></code>	Required	Specifies timing parameters related to reliable packet delivery.
<code><notification-queuing></code>	Required	Contains the notification queue related configuration info.
<code><traffic-jam></code>	Required	Specifies the maximum number of packets which can be enqueued on the publisher before client threads block.
<code><packet-buffer></code>	Required	Specifies how many outgoing packets the operating system is requested to buffer. The value may be expressed either in terms of packets or bytes.
<code><priority></code>	Required	Specifies a priority of the packet publisher execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 6.
<code><enabled></code>	Optional	Specifies if TCMP clustering is enabled. When using both Coherence*Extend and Coherence TCMP based clustering, this feature allows TCMP to be disabled to ensure that a node only connects by using the Extend protocol. Valid values are <code>true</code> and <code>false</code> . The default value is <code>true</code> . The preconfigured system property override is <code>tangosol.coherence.tcmp.enabled</code> .

packet-size

Used in: [packet-publisher](#).

Description

The packet-size element specifies the maximum and preferred UDP packet sizes. All cluster nodes must use identical maximum packet sizes.

Elements

[Table A-41](#) describes the subelements of the packet-size element.

Table A-41 *packet-size Subelement*

Element	Required/ Optional	Description
<maximum-length>	Required	Specifies the packet size, in bytes, which all cluster members can safely support. This value must be the same for all members in the cluster. A low value can artificially limit the maximum size of the cluster. This value should be at least 512, and defaults to 64KB.
<preferred-length>	Required	Specifies the preferred size, in bytes, of the DatagramPacket objects that are sent and received on the unicast and multicast sockets. This value can be larger or smaller than the <maximum-length> value, and need not be the same for all cluster members. The ideal value is one which fits within the network MTU, leaving enough space for either the UDP or TCP packet headers, which are 32, and 52 bytes respectively. The preferred length should be at least 512. The default value is based on the local nodes MTU.

packet-speaker

Used in: [cluster-config](#).

Description

Specifies configuration information for the packet speaker which is used for network data transmission when packet publisher loads are high.

Elements

[Table A-42](#) describes the subelements of the `packet-speaker` element.

Table A-42 *packet-speaker Subelements*

Element	Required/ Optional	Description
<code><enabled></code>	Optional	Specifies whether or not the packet-speaker thread is enabled. Valid values are <code>true</code> and <code>false</code> . The default value is <code>true</code> . The preconfigured system property override is <code>tangosol.coherence.speaker.enabled</code> .
<code><volume-threshold></code>	Optional	Specifies the packet load which must be present for the speaker to be activated.
<code><priority></code>	Required	Specifies a priority of the packet speaker execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 8.

pause-detection

Used in: [flow-control](#).

Description

Remote Pause detection allows Coherence to detect and react to a cluster node becoming unresponsive (likely due to a long GC). When a node is marked as paused, packets addressed to it are sent at a lower rate until the node resumes responding. This remote GC detection is used to avoid flooding a node while it is incapable of responding.

Elements

[Table A-43](#) describes the subelements of the `pause-detection` element.

Table A-43 *pause-detection* Subelements

Element	Required/ Optional	Description
<code><maximum-packets></code>	Optional	The maximum number of packets that are resent to an unresponsive cluster node after which the node is assumed to be paused. Specifying a value of 0 disables pause detection. The default value is 16.

provider

Used in: [ssl](#), [identity-manager](#), [trust-manager](#).

Description

The provider element contains the configuration information for a security provider that extends the `java.security.Provider` class.

Elements

[Table A-44](#) describes the subelements of the provider element.

Table A-44 *provider Subelements*

Element	Required/ Optional	Description
<code><name></code>	Optional	Specifies the name of a security provider that extends the <code>java.security.Provider</code> class. The class name can be entered using either this element or by using the <code><class-name></code> element or by using the <code><class-factory-name></code> element.
<code><class-name></code>	Optional	Specifies the name of a security provider that extends the <code>java.security.Provider</code> class. This element cannot be used with the <code><name></code> element or the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies a factory class for creating <code>Provider</code> instances. The instances must implement the <code>java.security.Provider</code> class. This element cannot be used with the <code><name></code> element or the <code><class-name></code> element. This element can be used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the provider implementation. This element cannot be used with the <code><name></code> element.

ramjournal-manager

Used in: [journaling-config](#)

Description

The `<ramjournal-manager>` element contains the configuration for a RAM journal resources manager, which manages memory buffers for journal-based storage in-memory. A RAM journal resource manager always uses a flash journal resource manager to store large objects and is also used as an overflow when the amount of total memory allocated to the RAM journal is reached. A RAM journal also uses a flash journal when the journal garbage collection is temporarily not able to keep up with demand. See "[flashjournal-manager](#)" on page A-20 for details on configuring a flash journal resource manager.

Elements

[Table A-45](#) describes the subelements of the `ramjournal-manager` element.

Table A-45 *ramjournal-manager Subelements*

Element	Required/Optional	Description
<code><minimum-load-factor></code>	Optional	Specifies the factor of live data below which a journal file is eligible for compaction (garbage collection).
<code><maximum-value-size></code>	Optional	Specifies the maximum size, in bytes, of binary values that are to be stored in the RAM journal. The value cannot exceed 4MB. The default value is 64KB. Binary values that exceed the maximum value size are automatically delegated to a flash journal.
<code><maximum-file-size></code>	Optional	Specifies the maximum file size of the underlying journal files. The value must be a power of two and a multiple of the block size. The value must be between 2MB and 2GB. The default value is 2MB. The maximum file size should not be changed.
<code><collector-timeout></code>	Optional	Specifies the amount of time that the journal collector can remain unresponsive prior to considering it timed out. The minimum timeout is 30s. Legal values are strings representing time intervals. The Default value is 10m.
<code><maximum-size></code>	Optional	Specifies the maximum amount of RAM that is used by the journal. The value can either be specified as a percentage of the maximum available heap or as a specific amount of memory. If the value contains a percentage sign (%), it is interpreted as a percentage of the maximum JVM heap (the JVM max heap is typically specified by the <code>-Xmx</code> argument on the java command line). If specified as a specific amount of memory, the value must be between 16MB and 64GB. The default value is 25%. That is, the RAM journal resource manager uses a maximum of 25% of the available JVM heap. A RAM journal is always backed by a flash journal and all data in excess of the maximum RAM size is automatically delegated to the flash journal. The preconfigured system property override is <code>tangosol.coherence.ramjournal.size</code> .
<code><off-heap></code>	Optional	Specifies whether to use in the virtual machine's byte buffer or off-heap NIO buffers.

reporter

Used in: [management-config](#).

Description

The Reporter provides JMX reporting capabilities. The Reporter provides out-of-the-box reports and also supports the creation of custom reports. The reports help administrators and developers manage capacity and trouble shoot problems.

Elements

[Table A-46](#) describes the subelements of the `reporter` element.

Table A-46 *reporter* Subelements

Element	Required/ Optional	Description
<code><configuration></code>	Required	Specifies the location for the report group deployment descriptor. The default file is <code>reports/report-group.xml</code> and is located in the <code>coherence.jar</code> library.
<code><autostart></code>	Required	Specifies whether the Reporter automatically starts when the node starts. Valid values are <code>true</code> and <code>false</code> . The default value is <code>false</code> .
<code><distributed></code>	Required	Specifies whether the reporter runs on multiple management nodes. Valid values are <code>true</code> and <code>false</code> . The default value is <code>false</code> .
<code><timezone></code>	Optional	Specifies the time zone to be used for timestamps that are displayed within a report. See <code>java.util.TimeZone</code> for supported time zone formats. The default, if no time zone is specified, is the local time zone.
<code><timeformat></code>	Optional	Specifies the time and date format to be used for timestamps that are displayed within a report. The value must be a pattern supported by the <code>java.text.SimpleDateFormat</code> class. The default value is <code>EEE MMM dd HH:mm:ss zzz yyyy</code> .

security-config

Used in: [coherence](#).

Elements

[Table A-47](#) describes the subelements of the `security-config` element.

Table A-47 *security-config* Subelements

Element	Required/ Optional	Description
<code><enabled></code>	Required	Specifies whether the access controller security feature is enabled. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> . The preconfigured system property override is <code>tangosol.coherence.security</code> .
<code><login-module-name></code>	Required	Specifies the name of the JAAS LoginModule that is used to authenticate the caller. This name should match a module in a configuration file is used by the JAAS (for example specified by using the <code>-Djava.security.auth.login.config</code> Java command line attribute). For details, refer to the <i>Oracle Login Module Developer's Guide</i> .
<code><access-controller></code>	Required	Contains the configuration information for the class that implements <code>com.tangosol.net.security.AccessController</code> interface, which is used by the security framework to check access rights for clustered resources and encrypt/decrypt node-to-node communications regarding those rights.
<code><callback-handler></code>	Optional	Contains the configuration information for the class that implements <code>javax.security.auth.callback.CallbackHandler</code> interlace which is called if an attempt is made to access a protected clustered resource when there is no identity associated with the caller.
<code><identity-asserter></code>	Optional	Contains the configuration information for a class that implements the <code>com.tangosol.net.security.IdentityAsserter</code> interface which is called to validate an identity token to establish a user's identity. An identity asserter is used with an identity transformer to protect connections between Coherence*Extend clients and proxies.
<code><identity-transformer></code>	Optional	Contains the configuration information for the class that implements <code>com.tangosol.net.security.IdentityTransformer</code> interface which is called to transform a <code>Subject</code> (Principal for .NET) to a token that asserts identity. An identity transformer is used with an identity asserter to protect connections between Coherence*Extend clients and proxies.
<code><subject-scope></code>	Optional	Specifies whether the remote cache or service reference is shared by subject. Valid values are <code>true</code> or <code>false</code> . Setting the value to <code>true</code> means that remote references are not globally shared; each subject gets a different reference. The default value is <code>false</code> .
<code><authorizer></code>	Optional	Contains the configuration information for a class that implements the <code>com.tangosol.net.security.Authorizer</code> interface which represents an environment-specific facility for authorizing callers to perform actions described by the corresponding permission objects. Use the <code><instance></code> element to enter the class.

serializer

Used in: [serializers](#)

Description

The `serializer` element contains a serializer class configuration. Serializer classes must implement `com.tangosol.io.Serializer`. A Java serializer and POF serializer are predefined:

```
<cluster-config>
  <serializers>
    <serializer id="java">
      <class-name>com.tangosol.io.DefaultSerializer</class-name>
    </serializer>

    <serializer id="pof">
      <class-name>com.tangosol.io.pof.ConfigurablePofContext</class-name>
      <init-params>
        <init-param>
          <param-type>String</param-type>
          <param-value>pof-config.xml</param-value>
        </init-param>
      </init-params>
    </serializer>
  </serializers>
</cluster-config>
```

Serializer definitions are referenced by individual cache scheme definitions (see "[serializer](#)" on page B-117) and can be referenced by the default serializer for services that do not explicitly define a serializer (see "[defaults](#)" on page B-31).

Additional serializers can be defined in an operational override file as required.

Elements

[Table A-48](#) describes the subelements of the `serializer` element.

Table A-48 *serializer Subelements*

Element	Required/Optional	Description
<code><class-name></code>	Optional	Specifies a class that implements <code>com.tangosol.io.Serializer</code> . This element cannot be used with the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies a factory class for creating custom serializer instances. The instances must implement <code>com.tangosol.io.Serializer</code> . This element cannot be used with the <code><class-name></code> element. This element can be used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the serializer implementation.

serializers

Used in: [cluster-config](#)

Description

The `serializers` element contains the declarative data for each serializer.

Elements

[Table A-49](#) describes the subelements of the `serializers` element.

Table A-49 *serializers Subelements*

Element	Required/ Optional	Description
<code><serializer></code>	Optional	Specifies the declarative data of a particular serializer.

service

Used in: [services](#).

Description

Specifies the configuration for Coherence services.

Service Components

The types of services which can be configured includes:

- `PartitionedService.PartitionedCache`—A cache service which evenly partitions cache entries across the cluster nodes which run the service. This service is often referred to as the distributed cache service
- `ReplicatedCache`—A cache service which maintains copies of all cache entries on all cluster nodes which run the service.
- `ReplicatedCache.Optimistic`—A version of the `ReplicatedCache` which uses optimistic locking.
- `SimpleCache` —A version of the `ReplicatedCache` which lacks concurrency control.
- `LocalCache`—A cache service for caches where all cache entries reside in a single cluster node.
- `InvocationService`—A service used for performing custom operations on remote cluster nodes.
- `ProxyService`—A service that accepts connections from Coherence*Extend clients.
- `RemoteCache`—A service that routes cache operations from Coherence*Extend clients to a cache on the cluster.
- `RemoteInvocation`— A service that routes cache invocation tasks from Coherence*Extend clients to a cache on the cluster.
- `NameService`—A service that is a specialized TCP acceptor that allows Coherence*Extend clients to connect to a proxy by specifying a proxy service name instead of a proxy service address.
- `RemoteNameService`— A `NameService` implementation that allows a JVM to use a remote `NameService` without having to join the Cluster.

Elements

[Table A-50](#) describes the subelements of the `services` element.

Table A–50 *service Subelements*

Element	Required/ Optional	Description
<code><service-type></code>	Required	Specifies the canonical name for a service, allowing the service to be referenced from the <code>service-name</code> element in cache configuration caching schemes. See " caching-schemes " on page B-27 for more information.
<code><service-component></code>	Required	Specifies either the fully qualified class name of the service or the relocatable component name relative to the base Service component. Legal values are: <ul style="list-style-type: none"> ■ <code>PartitionedService.PartitionedCache (DistributedCache)</code> ■ <code>ReplicatedCache</code> ■ <code>ReplicatedCache.Optimistic</code> ■ <code>SimpleCache</code> ■ <code>LocalCache</code> ■ <code>InvocationService</code> ■ <code>ProxyService</code> ■ <code>RemoteCache</code> ■ <code>RemoteInvocation</code> ■ <code>NameService</code>
<code><use-filters></code>	Optional	Contains the list of filter names to be used by this service. For example, specify <code>use-filter</code> as follows: <pre><use-filters> <filter-name>gzip</filter-name> </use-filters></pre> The example activates <code>gzip</code> compression for the network messages used by this service, which can help substantially with WAN and low-bandwidth networks.
<code><init-params></code>	Optional	Specifies the initialization parameters that are specific to each service. Each parameter is described below.

Initialization Parameter Settings

The `<init-param>` element in the Coherence operational configuration deployment descriptor defines initialization parameters for a service. The parameters that appear under `init-param` are different, depending on the service.

The following sections describe the parameters that can be configured for each of the services:

- [DistributedCache Service Parameters](#)
- [ReplicatedCache Service Parameters](#)
- [OptimisticCache Service Parameters](#)
- [Invocation Service Parameters](#)
- [LocalCache Service Parameters](#)
- [Proxy Service Parameters](#)
- [RemoteCache Service Parameters](#)
- [RemoteInvocation Service Parameters](#)
- [NameService Parameters](#)

- [RemoteNameService Parameters](#)

The tables in each section describes the specific <param-name>/<param-value> pairs that can be configured for each service. The **Parameter Name** column refers to the value of the <param-name> element and **Parameter Value Description** column refers to the possible values for the corresponding <param-value> element.

DistributedCache Service Parameters

A DistributedCache service supports the parameters listed in [Table A-51](#). These settings may also be specified for each service instance as part of the <distributed-scheme> element in the coherence-cache-config.xml descriptor.

Table A-51 DistributedCache Service Parameters

Parameter Name	Parameter Value Description
lease-granularity	<p>Specifies the lease ownership granularity. Legal values are:</p> <ul style="list-style-type: none"> ■ thread (default) ■ member <p>A value of <code>thread</code> means that locks are held by a thread that obtained them and can only be released by that thread. A value of <code>member</code> means that locks are held by a cluster node and any thread running on the cluster node that obtained the lock can release it.</p>
partition-count	<p>Specifies the number of distributed cache partitions. Each storage-enabled cluster member that is running the distributed cache service manages a balanced number of partitions.</p> <p>Valid values are positive integers between 1 and 32767 and should be a prime number. The default value is 257 partitions. See "Changing the Number of Partitions" on page 30-4 for additional details.</p>
local-storage	<p>Specifies whether this member of the DistributedCache service enables local storage.</p> <p>Normally this value should be left unspecified within the configuration file, and instead set on a per-process basis using the <code>tangosol.coherence.distributed.localstorage</code> system property. This allows cache clients and servers to use the same configuration descriptor. Legal values are <code>true</code> or <code>false</code>. The default value is <code>true</code>.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.localstorage</code>.</p>
transfer-threshold	<p>Specifies the threshold for the primary buckets distribution in kilobytes. When a new node joins the distributed cache service or when a member of the service leaves, the remaining nodes perform a task of bucket ownership re-distribution. During this process, the existing data gets rebalanced along with the ownership information. This parameter indicates a preferred message size for data transfer communications. Setting this value lower makes the distribution process take longer, but reduces network bandwidth utilization during this activity. Legal values are integers greater than zero. The default value is 0.5MB.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.transfer</code>.</p>
backup-count	<p>Specifies the number of members of the partitioned cache service that hold the backup data for each unit of storage in the cache. The default value is 1.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.backupcount</code>.</p>

Table A-51 (Cont.) DistributedCache Service Parameters

Parameter Name	Parameter Value Description
thread-count	<p>Specifies the number of daemon threads used by the partitioned cache service. Legal values are positive integers, 0, or -1. The value 0 indicates that all relevant tasks are performed on the service thread. The value -1 indicates that tasks are performed on the caller's thread where possible. The default value is 0.</p> <p>Set the value to 0 for scenarios with purely in-memory data (no read-through, write-through, or write-behind) and simple access (no entry processors, aggregators, and so on). For heavy compute scenarios (such as aggregators), the number of threads should be the number of available cores for that computer. For example, if you run 4 nodes on a 16 core box, then there should be roughly 4 threads in the pool. For I/O intensive scenarios (such as read through, write-through, and write-behind), the number of threads must be higher. In this case, increase the threads just to the point that the box is saturated.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.threads</code>.</p>
key-associator	<p>Specifies the name of a class that implements the <code>com.tangosol.net.partition.KeyAssociator</code> interface. This implementation must have a zero-parameter public constructor.</p>
key-partitioning	<p>Specifies the name of a class that implements the <code>com.tangosol.net.partition.KeyPartitioningStrategy</code> interface. This implementation must have a zero-parameter public constructor.</p>
partition-listener	<p>Specifies the name of a class that implements the <code>com.tangosol.net.partition.PartitionListener</code> interface. This implementation must have a zero-parameter public constructor.</p>
task-hung-threshold	<p>Specifies the amount of time in milliseconds that a task can execute before it is considered hung. Legal values are positive integers or zero (indicating no default timeout).</p> <p>Note: a posted task that has not yet started is never considered hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive).</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.task.hung</code>.</p>
task-timeout	<p>Specifies the timeout value in milliseconds for requests executing on the service worker threads. This attribute applies only if the thread pool is used (the <code>thread-count</code> value is positive) and only applies to entry processor implementations that implement the <code>PriorityTask</code> interface. The task execution time is measured on the server side and does not include the time spent waiting in a service backlog queue before being started. Legal values are positive integers or zero. If zero is specified, the default service-guardian <code><timeout-milliseconds></code> value is used.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.task.timeout</code>.</p>

Table A-51 (Cont.) DistributedCache Service Parameters

Parameter Name	Parameter Value Description
request-timeout	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>The value of this element must be in the following format: $(\backslash d)^+((\backslash d)^+)?[MS ms S s M m H h D d]?$ where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. Legal values are positive integers or zero (indicating no default timeout). The default value is 0.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.request.timeout</code>.</p>
serializer	<p>Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.</p>
backup-count-after-writebehind	<p>Specifies the number of members of the partitioned cache service that holds the backup data for each unit of storage in the cache that does <i>not</i> require write-behind, that is, data that is not vulnerable to being lost even if the entire cluster were shut down. Specifically, if a unit of storage is marked as requiring write-behind, then it is backed up on the number of members specified by the <code>backup-count</code> parameter. If the unit of storage is not marked as requiring write-behind, then it is backed up by the number of members specified by the <code>backup-count-after-writebehind</code> parameter.</p> <p>This value should be set to 0 or this setting should not be specified at all. The rationale is that since this data is being backed up to another data store, no in-memory backup is required, other than the data temporarily queued on the write-behind queue to be written. The value of 0 means that when write-behind has occurred, the backup copies of that data is discarded. However, until write-behind occurs, the data is backed up in accordance with the <code>backup-count</code> parameter.</p> <p>Recommended value is 0.</p>

Table A–51 (Cont.) DistributedCache Service Parameters

Parameter Name	Parameter Value Description
guardian-timeout	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the parameter is not specified, the default guardian timeout (as specified by the <timeout-milliseconds> operational configuration element) is used. See the service-guardian element to globally configure the service guardian for all services.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\.) (\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.guard.timeout</code>.</p>
service-failure-policy	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian. See the service-guardian element to globally configure the service guardian for all services.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ■ <code>exit-cluster</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ■ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ■ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ■ a custom class – the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
member-listener	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code>member-listener</code> is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
partitioned-quorum-policy-scheme	<p>Specifies quorum policy settings for the partitioned cache service. See "partitioned-quorum-policy-scheme" on page B-93.</p>

Table A-51 (Cont.) DistributedCache Service Parameters

Parameter Name	Parameter Value Description
partition-assignment-strategy	<p>Specifies the strategy that is used by a partitioned service to manage partition distribution.</p> <ul style="list-style-type: none"> ▪ <code>legacy</code> – (deprecated) The legacy assignment strategy indicates that partition distribution is managed individually on each cluster member. ▪ <code>simple</code> – (default) The simple assignment strategy attempts to balance partition distribution while ensuring machine-safety and is more deterministic and efficient than the legacy strategy. ▪ <code>mirror:<service-name></code> – The mirror assignment strategy attempts to co-locate the service's partitions with the partitions of the specified service. This strategy is used to increase the likelihood that key-associated, cross-service cache access remains local to a member. ▪ <code>custom</code> – a class that implements the <code>com.tangosol.net.partition.PartitionAssignmentStrategy</code> interface. <p>The preconfigured system property override is <code>tangosol.coherence.distributed.assignmentstrategy</code>.</p>
compressor	<p>Specifies whether or not backup updates should be compressed in delta form or sent whole. A delta update represents the parts of a backup entry that must be changed in order to synchronize it with the primary version of the entry. Valid values are:</p> <ul style="list-style-type: none"> ▪ <code>none</code> (default) – Disables delta backup; no compressor is used. The whole backup binary entry is replaced when the primary entry changes. ▪ <code>standard</code> – Automatically selects a delta compressor based on the serializer being used by the partitioned service. ▪ the fully qualified name of a class that implements the <code>com.tangosol.io.DeltaCompressor</code> interface. <p>The preconfigured system property override is <code>tangosol.coherence.distributed.compressor</code>.</p>
service-priority	<p>Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
event-dispatcher-priority	<p>Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>

Table A-51 (Cont.) DistributedCache Service Parameters

Parameter Name	Parameter Value Description
worker-priority	Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 5.
reliable-transport	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <code><unicast-listener></code> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram (default) – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the shared transport instance that is configured in the <code><reliable-transport></code> subelement of the <code><unicast-listener></code> element.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.transport.reliable</code>.</p>
async-backup	<p>Specifies whether the partitioned (distributed) cache service should backup changes asynchronously while concurrently responding to the client. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p> <p>The preconfigured system property override is <code>tangosol.coherence.distributed.asyncbackup</code>.</p>

ReplicatedCache Service Parameters

A ReplicatedCache service supports the parameters listed in [Table A-52](#). These settings may also be specified for each service instance as part of the `replicated-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A–52 ReplicatedCache Service Parameters

Parameter Name	Parameter Value Description
standard-lease-milliseconds	Specifies the duration of the standard lease in milliseconds. When a lease has aged past this number of milliseconds, the lock is automatically released. Set this value to zero to specify a lease that never expires. The purpose of this setting is to avoid deadlocks or blocks caused by stuck threads; the value should be set higher than the longest expected lock duration (for example, higher than a transaction timeout). It's also recommended to set this value higher than packet-delivery/timeout-milliseconds value. Legal values are from positive long numbers or zero. The default value is 0.
lease-granularity	Specifies the lease ownership granularity. Available since release 2.3. Legal values are: <ul style="list-style-type: none"> ■ thread (default) ■ member A value of <code>thread</code> means that locks are held by a thread that obtained them and can only be released by that thread. A value of <code>member</code> means that locks are held by a cluster node and any thread running on the cluster node that obtained the lock can release it.
mobile-issues	Specifies whether lease issues should be transferred to the most recent lock holders. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
request-timeout	Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following: <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client The value of this element must be in the following format: <code>(\d) + ((.) (\d) +) ? [MS ms S s M m H h D d] ?</code> where the first non-digits (from left to right) indicate the unit of time duration: <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) If the value does not contain a unit, a unit of milliseconds is assumed. Legal values are positive integers or zero (indicating no default timeout). The default value is 0. The preconfigured system property override is <code>tangosol.coherence.replicated.request.timeout</code> .
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.

Table A-52 (Cont.) ReplicatedCache Service Parameters

Parameter Name	Parameter Value Description
guardian-timeout	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the parameter is not specified, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See the service-guardian element to globally configure the service guardian for all services.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\.\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p> <p>The preconfigured system property override is <code>tangosol.coherence.replicated.guard.timeout</code>.</p>
service-failure-policy	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian. See the service-guardian element to globally configure the service guardian for all services.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ■ <code>exit-cluster</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ■ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to exit the JVM and terminate abruptly. ■ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ■ <code>a custom class</code> – the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
member-listener	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code>member-listener</code> is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>

Table A-52 (Cont.) ReplicatedCache Service Parameters

Parameter Name	Parameter Value Description
service-priority	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
event-dispatcher-priority	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
reliable-transport	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <code><unicast-listener></code> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the shared transport instance that is configured in the <code><reliable-transport></code> subelement of the <code><unicast-listener></code> element.</p> <p>The preconfigured system property override is <code>tangosol.coherence.replicated.transport.reliable</code>.</p>

OptimisticCache Service Parameters

An OptimisiticCache service supports the parameters listed in [Table A-53](#). These settings may also be specified for each service instance as part of the `optimistic-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A–53 OptimisiticCache Service Parameters

Parameter Name	Parameter Value Description
request-timeout	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> the time it takes to deliver the request to an executing node (server) the interval between the time the task is received and placed into a service queue until the execution starts the task execution time the time it takes to deliver a result back to the client <p>The value of this element must be in the following format: $(\backslash d) + ((.) (\backslash d) +) ? [MS ms S s M m H h D d] ?$ where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> MS or ms (milliseconds) S or s (seconds) M or m (minutes) H or h (hours) D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. Legal values are positive integers or zero (indicating no default timeout). The default value is 0.</p> <p>The preconfigured system property override is <code>tangosol.coherence.optimistic.request.timeout</code>.</p>
serializer	<p>Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global serializer element and then configure it for a cache within the cache configuration file.</p>
guardian-timeout	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the parameter is not specified, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See the service-guardian element to globally configure the service guardian for all services.</p> <p>The value of this element must be in the following format: $(\backslash d) + ((.) (\backslash d) +) ? [MS ms S s M m H h D d] ?$ where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> MS or ms (milliseconds) S or s (seconds) M or m (minutes) H or h (hours) D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p> <p>The preconfigured system property override is <code>tangosol.coherence.optimistic.guard.timeout</code>.</p>

Table A-53 (Cont.) OptimisiticCache Service Parameters

Parameter Name	Parameter Value Description
service-failure-policy	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian. See the service-guardian element to globally configure the service guardian for all services.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
member-listener	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code>member-listener</code> is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
service-priority	<p>Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
event-dispatcher-priority	<p>Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
reliable-transport	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <code><unicast-listener></code> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ <code>datagram</code> – UDP protocol ▪ <code>tmb</code> – TCP/IP message bus protocol ▪ <code>tmbs</code> – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ <code>sdmb</code> – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ <code>sdmbs</code> – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ <code>imb</code> (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the shared transport instance that is configured in the <code><reliable-transport></code> subelement of the <code><unicast-listener></code> element.</p> <p>The preconfigured system property override is <code>tangosol.coherence.optimistic.transport.reliable</code>.</p>

Invocation Service Parameters

An Invocation service supports the parameters listed in [Table A-54](#). These settings may also be specified for each service instance as part of the `invocation-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A-54 Invocation Service Parameters

Parameter Name	Parameter Value Description
thread-count	<p>Specifies the number of daemon threads used by the service. Legal values are positive integers, 0, or -1. The value 0 indicates that all relevant tasks are performed on the service thread. The value -1 indicates that tasks are performed on the caller's thread where possible.</p> <p>Set the value to 0 for scenarios with purely in-memory data (no read-through, write-through, or write-behind) and simple access (no entry processors, aggregators, and so on). For heavy compute scenarios (such as aggregators), the number of threads should be the number of available cores for that compute. For example, if you run 4 nodes on a 16 core box, then there should be roughly 4 threads in the pool. For I/O intensive scenarios (such as read through, write-through, and write-behind), the number of threads must be higher. In this case, increase the threads just to the point that the box is saturated.</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.threads</code>.</p>
task-hung-threshold	<p>Specifies the amount of time in milliseconds that a task can execute before it is considered "hung". Note: a posted task that has not yet started is never considered as hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive).</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.task.hung</code>.</p>
task-timeout	<p>Specifies the default task execution timeout value for requests that can time out (that is, polls and <code>PriorityTask</code> implementations), but do not explicitly specify an execution timeout value. The task execution time is measured on the server side and does not include the time spent waiting in a service backlog queue before being started. This attribute is applied only if the thread pool is used (the <code>thread-count</code> value is positive). Legal values are positive integers or zero (indicating no default timeout).</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.task.timeout</code>.</p>

Table A-54 (Cont.) Invocation Service Parameters

Parameter Name	Parameter Value Description
request-timeout	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>The value of this element must be in the following format: $(\backslash d)^+((\backslash .)(\backslash d)^+)?[MS ms S s M m H h D d]?$ where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. Legal values are positive integers or zero (indicating no default timeout). The default value is 0.</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.request.timeout</code>.</p>
serializer	<p>Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global serializer element and then configure it for a cache within the cache configuration file.</p>
guardian-timeout	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the parameter is not specified, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See the service-guardian element to globally configure the service guardian for all services.</p> <p>The value of this element must be in the following format: $(\backslash d)^+((\backslash .)(\backslash d)^+)?[MS ms S s M m H h D d]?$ where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.guard.timeout</code>.</p>

Table A-54 (Cont.) Invocation Service Parameters

Parameter Name	Parameter Value Description
service-failure-policy	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian. See the service-guardian element to globally configure the service guardian for all services.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
member-listener	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code>member-listener</code> is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
service-priority	<p>Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
event-dispatcher-priority	<p>Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
worker-priority	<p>Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 5.</p>
reliable-transport	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <code><unicast-listener></code> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances.</p> <p>Valid values are:</p> <ul style="list-style-type: none"> ▪ <code>datagram</code> – UDP protocol ▪ <code>tmb</code> – TCP/IP message bus protocol ▪ <code>tmbs</code> – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ <code>sdmb</code> – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ <code>sdmbs</code> – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ <code>imb</code> (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the shared transport instance that is configured in the <code><reliable-transport></code> subelement of the <code><unicast-listener></code> element.</p> <p>The preconfigured system property override is <code>tangosol.coherence.invocation.transport.reliable</code>.</p>

LocalCache Service Parameters

A LocalCache service supports the parameters listed in [Table A-55](#).

Table A-55 LocalCache Service Parameters

Parameter Name	Parameter Value Description
lock-enforce	Specifies whether locking is enforced for put, remove and clear operations. If the value is false, a client is responsible for calling lock and unlock explicitly. The default value is false.
lock-wait	Specifies the number of milliseconds to continue trying to obtain a lock. This parameters is only used if locking enforcement is enabled. A value of -1 blocks the calling thread until the lock can be obtained. The default value is 0.

Proxy Service Parameters

A Proxy service supports the parameters listed in [Table A-56](#). These settings may also be specified for each service instance as part of the `proxy-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A-56 Proxy Service Parameters

Parameter Name	Parameter Value Description
acceptor-config	Contains the configuration of the connection acceptor used by the service to accept connections from Coherence*Extend clients and to allow them to use the services offered by the cluster without having to join the cluster.
proxy-config	Contains the configuration of the clustered service proxies managed by this service.
thread-count	Specifies the number of daemon threads for use by the proxy service. Legal values are positive integers or 0. The default value is 0, which indicates that dynamic thread pooling is enabled and that the number of threads automatically adjusts based on proxy service load. Specifying a positive value explicitly sets the number of threads in the pool. Note: Proxy service threads perform operations on behalf of the calling application. Therefore, when explicitly setting the number of threads, set the value to as many threads as there are concurrent operations. To disable the thread pool, set the <code>thread-count-max</code> and <code>thread-count-min</code> parameters to 0. All relevant tasks are performed on the proxy service thread when the thread pool is disabled. The preconfigured system property override is <code>tangosol.coherence.proxy.threads</code> .
task-hung-threshold	Specifies the amount of time in milliseconds that a task can execute before it is considered hung. Legal values are positive integers or zero (indicating no default timeout). Note: a posted task that has not yet started is never considered hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive). The preconfigured system property override is <code>tangosol.coherence.proxy.task.hung</code> .
task-timeout	Specifies the default timeout value in milliseconds for tasks that can be timed-out (for example, implement the <code>com.tangosol.net.PriorityTask</code> interface), but do not explicitly specify the task execution timeout value. The task execution time is measured on the server side and does not include the time spent waiting in a service backlog queue before being started. This attribute is applied only if the thread pool is used (the <code>thread-count</code> value is positive). Legal values are positive integers or zero (indicating no default timeout). The preconfigured system property override is <code>tangosol.coherence.proxy.task.timeout</code> .

Table A-56 (Cont.) Proxy Service Parameters

Parameter Name	Parameter Value Description
request-timeout	Specifies the maximum amount of time a proxy waits for requests that are sent to other proxies of the same name. This parameter should not be used because requests are never sent between proxies.
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global serializer element and then configure it for a cache within the cache configuration file.
guardian-timeout	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the parameter is not specified, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See the service-guardian element to globally configure the service guardian for all services.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p> <p>The preconfigured system property override is <code>tangosol.coherence.proxy.guard.timeout</code>.</p>
service-failure-policy	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian. See the service-guardian element to globally configure the service guardian for all services.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ■ <code>exit-cluster</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ■ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ■ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ■ <code>a custom class</code> – the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
member-listener	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code>member-listener</code> is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
proxy-quorum-policy-sc heme	Specifies quorum policy settings for the Proxy service.

Table A-56 (Cont.) Proxy Service Parameters

Parameter Name	Parameter Value Description
load-balancer	<p>Specifies the default load balancing strategy that is used by a proxy service if a strategy is not explicitly configured as part of the proxy scheme. Legal values are:</p> <ul style="list-style-type: none">▪ <code>proxy</code> – (default) This strategy attempts to distribute client connections equally across proxy service members based upon existing connection count, connection limit, incoming and outgoing message backlog, and daemon pool utilization.▪ <code>client</code> – This strategy relies upon the client address provider implementation to dictate the distribution of clients across proxy service members. If no client address provider implementation is provided, the extend client tries each proxy service in a random order until a connection is successful.
service-priority	<p>Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
event-dispatcher-priority	<p>Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.</p>
worker-priority	<p>Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 5.</p>

Table A-56 (Cont.) Proxy Service Parameters

Parameter Name	Parameter Value Description
reliable-transport	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <code><unicast-listener></code> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the shared transport instance that is configured in the <code><reliable-transport></code> subelement of the <code><unicast-listener></code> element.</p> <p>The preconfigured system property override is <code>tangosol.coherence.proxy.transport.reliable</code>.</p>
thread-count-max	<p>Specifies the maximum number of daemon threads that are allowed in the dynamic thread pool. This parameter is only valid if a <code>thread-count</code> value is set to 0. Legal values are positive integers or 0. Setting a value for both this parameter and the <code>thread-count-min</code> parameter indicates that no daemon threads are created and that all client requests are handled by the proxy service thread. The default value is 4 times the number of cores.</p> <p>The preconfigured system property override is <code>tangosol.coherence.proxy.threads.max</code>.</p>
thread-count-min	<p>Specifies the minimum number of daemon threads that are allowed (and initially created) in the dynamic thread pool. This parameter is only valid if a <code>thread-count</code> value is set to 0. Legal values are positive integers or 0. Setting a value for both this parameter and the <code>thread-count-max</code> parameter indicates that no daemon threads are created and that all client requests are handled by the proxy service thread. The default value is 2 times the number of cores.</p> <p>The preconfigured system property override is <code>tangosol.coherence.proxy.threads.min</code>.</p>

RemoteCache Service Parameters

A RemoteCache service supports the parameters listed in [Table A-57](#). These settings may also be specified for each service instance as part of the `remote-cache-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A–57 RemoteCache Service Parameters

Parameter Name	Parameter Value Description
initiator-config	Contains the configuration of the connection initiator used by the service to establish a connection with the cluster.
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.
defer-key-association-check	Specifies whether key association processing is done by the extend client or deferred to the cluster side. Valid values are <code>true</code> and <code>false</code> . The default value is <code>false</code> and indicates that key association processing is done by the extend client. If the value is set to <code>true</code> , .NET and C++ clients must include a parallel Java implementation of the key class on the cluster cache servers.

RemoteInvocation Service Parameters

A RemoteInvocation service supports the parameters listed in [Table A–58](#). These settings may also be specified for each service instance as part of the `remote-invocation-scheme` element in the `coherence-cache-config.xml` descriptor.

Table A–58 RemoteInvocation Service Parameters

Parameter Name	Parameter Value Description
initiator-config	Contains the configuration of the connection initiator used by the service to establish a connection with the cluster.
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.

NameService Parameters

A NameService service supports the parameters listed in [Table A–59](#).

Table A–59 NameService Parameters

Parameter Name	Parameter Value Description
acceptor-config	Contains the configuration of a connection acceptor that is used discover proxy services that are available in the cluster for use by Coherence*Extend clients.
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.

RemoteNameService Parameters

A RemoteNameService service supports the parameters listed in [Table A–60](#).

Table A–60 RemoteNameService Parameters

Parameter Name	Parameter Value Description
initiator-config/tcp-initiator	Contains the configuration of the TCP connection initiator used by the service to establish a connection with the cluster.
serializer	Specifies a serializer class for object serialization. Serializer classes must implement the <code>com.tangosol.io.Serializer</code> interface. The preferred method for specifying a serializer is to define it within the global <code>serializer</code> element and then configure it for a cache within the cache configuration file.

service-guardian

Used in: [cluster-config](#)

Description

Specifies the configuration of the service guardian, which detects and attempts to resolve service deadlocks.

Elements

[Table A-61](#) describes the subelements of the `service-guardian` element.

Table A-61 *service-guardian* Subelements

Element	Required/ Optional	Description
<code><service-failure-policy></code>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> – (default) attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – an <code><instance></code> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<code><timeout-milliseconds></code>	Optional	<p>The timeout value used to guard against deadlocked or unresponsive services. It is recommended that <code>service-guardian/timeout-milliseconds</code> be set equal to or greater than the <code>packet-delivery/timeout-milliseconds</code> value. The default value is 305000.</p> <p>The preconfigured system property override is <code>tangosol.coherence.guard.timeout</code></p>

The content override attribute `xml-override` can be optionally used to fully or partially override the contents of this element with XML document that is external to the base document. See "[Attribute Reference](#)" on page A-100 for more information.

services

Used in: [cluster-config](#)

Description

The services element contains the declarative data for each service.

Elements

[Table A-50](#) describes the subelements of the services element.

Table A-62 *services Subelements*

Element	Required/ Optional	Description
<code><service></code>	Optional	Specifies the declarative data of a particular service.

shutdown-listener

Used in: [cluster-config](#).

Description

Specifies the action a cluster node should take upon receiving an external shutdown request. External shutdown includes the "kill" command on UNIX and Ctrl-C on Windows and UNIX.

Elements

[Table A-63](#) describes the subelements of the `shutdown-listener` element.

Table A-63 *shutdown-listener Subelements*

Element	Required/ Optional	Description
<enabled>	Required	<p>Specifies the type of action to take upon an external JVM shutdown. Legal values:</p> <ul style="list-style-type: none"> ▪ none – perform no explicit shutdown actions ▪ force – (default) perform "hard-stop" the node by calling <code>Cluster.stop()</code> ▪ graceful – perform a "normal" shutdown by calling <code>Cluster.shutdown()</code> ▪ true – same as force ▪ false – same as none <p>Note: For production use, the suggested value is none unless testing has verified that the behavior on external shutdown is exactly what is desired.</p> <p>The preconfigured system property override is <code>tangosol.coherence.shutdownhook</code>.</p>

socket-address

Used in: [well-known-addresses](#), [address-provider](#)

Description

The socket-address element specifies the address (IP, or DNS name, and port) to which a socket is bound.

Elements

[Table A-64](#) describes the subelements of the `socket-address` element.

Table A-64 *socket-address Subelements*

Element	Required/ Optional	Description
<code><address></code>	Required	Specifies the IP address that a Socket listens or publish on. Enter either an IP address or DNS name. Note: The localhost setting may not work on systems that define localhost as the loopback address; in that case, specify the computer name or the specific IP address.
<code><port></code>	Required	Specifies the port that the Socket listens or publish on. Legal values are from 1 to 65535. Note: When setting up a WKA member, the port value must match the port value that is specified for the unicast listener port. See the <unicast-listener> element.

socket-provider

Used in: [socket-providers](#), [unicast-listener](#), [ssl](#).

Description

The `<socket-provider>` element contains the configuration information for a socket and channel factory. The following socket providers are supported and referenced using their defined id attribute name.

```
<socket-providers>
  <socket-provider id="system">
    <system/>
  </socket-provider>

  <socket-provider id="tcp">
    <tcp/>
  </socket-provider>

  <socket-provider id="ssl">
    <ssl>
      <identity-manager>
        <key-store>
          <url system-property="tangosol.coherence.security.keystore">
            file:keystore.jks</url>
          <password system-property="tangosol.coherence.security.password"/>
        </key-store>
        <password system-property="tangosol.coherence.security.password"/>
      </identity-manager>
      <trust-manager>
        <algorithm>PeerX509</algorithm>
        <key-store>
          <url system-property="tangosol.coherence.security.keystore">
            file:keystore.jks</url>
          <password system-property="tangosol.coherence.security.password"/>
        </key-store>
      </trust-manager>
      <socket-provider>tcp</socket-provider>
    </ssl>
  </socket-provider>

  <socket-provider id="sdp">
    <sdp/>
  </socket-provider>
</socket-providers>
```

Alternate SSL definitions can be created to support more elaborate SSL configurations.

Elements

[Table A-65](#) describes the subelements of the `socket-provider` element.

Table A-65 *socket-provider Subelements*

Element	Required/ Optional	Description
<system>	Optional	Specifies a socket provider that produces instances of the JVM's default socket and channel implementations. This is the default socket provider.
<ssl>	Optional	Specifies a socket provider that produces socket and channel implementations which use SSL.
<tcp>	Optional	Specifies a socket provider that produces TCP-based sockets and channel implementations.
<sdp>	Optional	Specifies a socket provider that produce SDP-based sockets and channel implementations provided that the JVM and underlying network stack supports SDP.

socket-providers

Used in [cluster-config](#)

Description

The `socket-providers` element contains the declarative data for each socket provider implementation. Coherence supports the following socket providers: `system`, `tcp`, `ssl`, and `sdp`.

Elements

[Table A-66](#) describes the subelements of the `socket-providers` element.

Table A-66 *socket-providers Subelements*

Element	Required/ Optional	Description
<code><socket-provider></code>	Optional	Specifies the configuration information for a socket and channel factory.

ssl

Used in: [socket-provider](#).

Description

The `<ssl>` element contains the configuration information for a socket provider that produces socket and channel implementations which use SSL. If SSL is configured for the unicast listener, the listener must be configured to use well known addresses.

Elements

[Table A-67](#) describes the subelements of the `ssl` element.

Table A-67 *ssl Subelements*

Element	Required/ Optional	Description
<code><protocol></code>	Optional	Specifies the name of the protocol used by the socket and channel implementations produced by the SSL socket provider. The default value is TLS.
<code><provider></code>	Optional	Specifies the configuration for a security provider instance.
<code><executor></code>	Optional	Specifies the configuration information for an implementation of the <code>java.util.concurrent.Executor</code> interface. A <code><class-name></code> subelement is used to provide the name of a class that implements the <code>Executor</code> interface. As an alternative, use a <code><class-factory-name></code> subelement to specify a factory class for creating <code>Executor</code> instances and a <code><method-name></code> subelement that specifies the name of a static factory method on the factory class which performs object instantiation. Either approach can specify initialization parameters using the <code><init-params></code> element.
<code><identity-manager></code>	Optional	Specifies the configuration information for initializing an identity manager instance.
<code><trust-manager></code>	Optional	Specifies the configuration information for initializing a trust manager instance.
<code><hostname-verifier></code>	Optional	Specifies the configuration information for an implementation of the <code>javax.net.ssl.HostnameVerifier</code> interface. During the SSL handshake, if the URL's host name and the server's identification host name mismatch, the verification mechanism calls back to this instance to determine if the connection should be allowed. A <code><class-name></code> subelement is used to provide the name of a class that implements the <code>HostnameVerifier</code> interface. As an alternative, use a <code><class-factory-name></code> subelement to specify a factory class for creating <code>HostnameVerifier</code> instances and a <code><method-name></code> subelement that specifies the name of a static factory method on the factory class which performs object instantiation. Either approach can specify initialization parameters using the <code><init-params></code> element.

Table A-67 (Cont.) ssl Subelements

Element	Required/ Optional	Description
<code>cipher-suites</code>	Optional	<p>Specifies a list of ciphers. Use the name element within the <code>cipher-suites</code> element to enter a cipher. Multiple name elements can be specified.</p> <p>Use the <code>usage</code> attribute to specify whether the list of ciphers are allowed or disallowed. If the <code>usage</code> attribute value is <code>black-list</code>, then the specified ciphers are removed from the default enabled cipher list. If the <code>usage</code> attribute value is <code>white-list</code>, then the specified ciphers are the enabled ciphers. The default value if the <code>usage</code> attribute is not specified is <code>white-list</code>.</p>
<code>protocol-versions</code>	Optional	<p>Specifies a list of protocol versions. Use the name element within the <code>protocol-versions</code> element to enter a protocol version. Multiple name elements can be specified.</p> <p>Use the <code>usage</code> attribute to specify whether the list of protocol versions are allowed or disallowed. If the <code>usage</code> attribute value is <code>black-list</code>, then the specified protocol versions are removed from the default enabled protocol list. If the <code>usage</code> attribute value is <code>white-list</code>, then the specified protocol versions are the enabled protocols. The default value if the <code>usage</code> attribute is not specified is <code>white-list</code>.</p>
<code><socket-provider></code>	Optional	<p>Specifies the configuration information for a delegate provider for SSL. Valid values are <code>tcp</code> and <code>sdp</code>. The default value is <code>tcp</code>.</p>

tcp-ring-listener

Used in: [cluster-config](#).

Description

The TCP-ring provides a means for fast death detection of another node within the cluster. When enabled, the cluster nodes use a single "ring" of TCP connections spanning the entire cluster. A cluster node can use the TCP connection to detect the death of another node within a heartbeat interval (the default value is one second; see the `<heartbeat-milliseconds>` subelement of [packet-delivery](#)). If disabled, the cluster node must rely on detecting that another node has stopped responding to UDP packets for a considerably longer interval (see the `<timeout-milliseconds>` subelement of [packet-delivery](#)). When the death has been detected it is communicated to all other cluster nodes.

Elements

[Table A-68](#) describes the subelements of the `tcp-ring-listener` element.

Table A-68 *tcp-ring-listener* Subelements

Element	Required/Optional	Description
<code><enabled></code>	Optional	Specifies whether the tcp ring listener should be enabled to detect node failures faster. Valid values are <code>true</code> and <code>false</code> . The default value is <code>true</code> .
<code><ip-timeout></code>	Optional	Specifies the timeout to use for determining that a computer that is hosting cluster members has become unreachable. A number of connection attempts may be made before determining that the unreachable members should be removed. Legal values are strings representing time intervals. A timeout of 0 disables system-level monitoring and is not recommended. The default value is 5s. The values of the <code><ip-timeout></code> and <code><ip-attempts></code> elements should be high enough to insulate against allowable temporary network outages. This feature relies upon the <code>java.net.InetAddress.isReachable</code> mechanism, refer to the API documentation see for a description of how it identifies reachability.
<code><ip-attempts></code>	Optional	specifies the number of connection attempts to make before determining that a computer that is hosting cluster members has become unreachable, and that those cluster members should be removed. The values of the <code><ip-timeout></code> and <code><ip-attempts></code> elements should be high enough to insulate against allowable temporary network outages. Legal values are positive integers. The default value is 3.
<code><listen-backlog></code>	Optional	Specifies the size of the TCP/IP server socket backlog queue. Valid values are positive integers. The default value is operating system dependent.
<code><priority></code>	Required	Specifies a priority of the tcp ring listener execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 6.

traffic-jam

Used in: [packet-publisher](#).

Description

The `traffic-jam` element is used to control the rate at which client threads enqueue packets for the packet publisher to transmit on the network. When the limit is exceeded any client thread is forced to pause until the number of outstanding packets drops below the specified limit. To limit the rate at which the Publisher transmits packets see the [flow-control](#) element.

Elements

[Table A-69](#) describes the subelements of the `traffic-jam` element.

Table A-69 *traffic-jam* Subelements

Element	Required/ Optional	Description
<code><maximum-packets></code>	Required	Specifies the maximum number of pending packets that the Publisher tolerates before determining that it is clogged and must slow down client requests (requests from local non-system threads). Zero means no limit. This property prevents most unexpected out-of-memory conditions by limiting the size of the resend queue. The default value is 8192.
<code><pause-milliseconds></code>	Required	Number of milliseconds that the Publisher pauses a client thread that is trying to send a message when the Publisher is clogged. The Publisher does not allow the message to go through until the clog is gone, and repeatedly sleeps the thread for the duration specified by this property. The default value is 10.

trust-manager

Used in: [ssl](#).

Description

The <trust-manager> element contains the configuration information for initializing a `javax.net.ssl.TrustManager` instance.

A trust manager is responsible for managing the trust material that is used when making trust decisions and for deciding whether credentials presented by a peer should be accepted.

A valid trust-manager configuration contains at least one child element.

Elements

[Table A-70](#) describes the elements of the `trust-manager` element.

Table A-70 *trust-manager* Subelements

Element	Required/ Optional	Description
<algorithm>	Optional	Specifies the algorithm used by the trust manager. The default value is <code>SunX509</code> .
<provider>	Optional	Specifies the configuration for a security provider instance.
<key-store>	Optional	Specifies the configuration for a key store implementation.

unicast-listener

Used in: [cluster-config](#).

Description

Specifies the configuration information for the Unicast listener. This element is used to specify the address and port that a cluster node binds to, to listen for point-to-point cluster communications.

Multicast-Free Clustering

By default Coherence uses a multicast protocol to discover other nodes when forming a cluster. If multicast networking is undesirable, or unavailable in your environment, the [well-known-addresses](#) feature may be used to eliminate the need for multicast traffic.

Elements

[Table A-71](#) describes the subelements of the unicast-listener element.

Table A-71 unicast-listener Subelements

Element	Required/ Optional	Description
<socket-provider>	Optional	<p>Specifies either: the configuration for a socket provider, or it references a socket provider configuration that is defined within the <socket-providers> element. The following socket providers are available: <code>system</code> (default), <code>ssl</code>, <code>tcp</code>, and <code>sdp</code>. Refer to the socket provider configuration using their defined <code>id</code> attribute name. For example:</p> <pre><socket-provider>ssl</socket-provider></pre> <p>The preconfigured system property override is <code>tangosol.coherence.socketprovider</code>.</p>
<reliable-transport>	Optional	<p>Specifies the transport protocol that is used for reliable point-to-point communication. By default, all services use the configured protocol and use a shared transport instance. A service can also explicitly specify the transport protocol using a <code>reliable-transport</code> service parameter, which results in a service-specific transport instance. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ■ <code>datagram</code> (default) – UDP protocol ■ <code>tmb</code> – TCP/IP message bus protocol ■ <code>tmbs</code> – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page A-86. ■ <code>sdmb</code> – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ■ <code>sdmbs</code> – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page A-86. ■ <code>imb</code> (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The preconfigured system property override is <code>tangosol.coherence.transport.reliable</code>.</p>
<well-known-addresses>	Optional	<p>Contains a list of "well known" addresses (WKA) that are used by the cluster discovery protocol instead of using multicast broadcast to discover cluster members.</p>
<address>	Required	<p>Specifies the IP address that a Socket listens or publishes on. The address may also be entered using CIDR notation as a subnet and mask (for example, <code>192.168.1.0/24</code>), which allows runtime resolution against the available local IP addresses.</p> <p>Note: The localhost setting may not work on systems that define localhost as the loopback address; in that case, specify the computer name or the specific IP address. Also, the multicast listener, by default, binds to the same interface as defined by this address. The default value is <code>localhost</code>.</p> <p>The preconfigured system property override is <code>tangosol.coherence.localhost</code>.</p>

Table A-71 (Cont.) unicast-listener Subelements

Element	Required/ Optional	Description
<port>	Required	Specifies the ports that the Socket listens or publishes on. A second port is automatically opened and defaults to the next available port. Legal values are from 1 to 65535. The default value is 8088 for the first port and 8089 (if available) for the second port. The preconfigured system property override is <code>tangosol.coherence.localport</code> .
<port-auto-adjust>	Required	Specifies whether the unicast port is automatically incremented if the specified port cannot be bound to because it is in use. Legal values are <code>true</code> or <code>false</code> . The default value is <code>true</code> . The preconfigured system property override is <code>tangosol.coherence.localport.adjust</code> .
<packet-buffer>	Required	Specifies how many incoming packets the operating system is requested to buffer. The value may be expressed either in terms of packets or bytes.
<priority>	Required	Specifies a priority of the unicast listener execution thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 8.

volume-threshold

Used in: [packet-speaker](#)

Description

Specifies the minimum outgoing packet volume which must exist for the speaker daemon to be activated.

Performance Impact

Elements

[Table A-72](#) describes the subelements of the `packet-speaker` element.

Table A-72 *packet-speaker* Subelements

Element	Required/ Optional	Description
<code><minimum-packets></code>	Required	Specifies the minimum number of packets which must be ready to be sent for the speaker daemon to be activated. A value of 0 forces the speaker to always be used, while a very high value causes it to never be used. If unspecified (the default), it matches the packet-buffer .

well-known-addresses

Used in: [unicast-listener](#).

Note: This is not a security-related feature, and does **not** limit the addresses which are allowed to join the cluster. See the [authorized-hosts](#) element for details on limiting cluster membership.

If you are having difficulties establishing a cluster when using multicast, see *Administering Oracle Coherence* for instructions on performing a multicast connectivity test.

Description

By default, Coherence uses a multicast protocol to discover other nodes when forming a cluster. If multicast networking is undesirable, or unavailable in your environment, the Well Known Addresses feature may be used to eliminate the need for multicast traffic. When in use the cluster is configured with a relatively small list of nodes which are allowed to start the cluster, and which are likely to remain available over the cluster lifetime. There is no requirement for all WKA nodes to be simultaneously active at any point in time. This list is used by all other nodes to find their way into the cluster without the use of multicast, thus at least one node that is configured as a well-known node must be running for other nodes to be able to join.

Example

The following example configures two well-known-addresses with the default port.

```
<cluster-config>
  <unicast-listener>
    <well-known-addresses>
      <socket-address id="1">
        <address>192.168.0.100</address>
        <port>8088</port>
      </socket-address>
      <socket-address id="2">
        <address>192.168.0.101</address>
        <port>8088</port>
      </socket-address>
    </well-known-addresses>
  </unicast-listener>
</cluster-config>
```

Elements

[Table A-73](#) describes the subelements of the `well-known-addresses` element.

Table A-73 *well-known-addresses* Subelements

Element	Required/ Optional	Description
<socket-address>	Optional	<p data-bbox="651 296 1442 453">Specifies a list of WKA that are used by the cluster discovery protocol instead of using multicast broadcast. If one or more WKA is specified, for a member to join the cluster it either has to be a WKA or there has to be at least one WKA member running. Additionally, all cluster communication is performed using unicast. If empty or unspecified, multicast communications is used.</p> <p data-bbox="651 470 1442 520">The preconfigured system property overrides are <code>tangosol.coherence.wka</code> and <code>tangosol.coherence.wka.port</code>.</p>
<address-provider>	Optional	<p data-bbox="651 541 1442 667">Contains the configuration for a <code>com.tangosol.net.AddressProvider</code> implementation that supplies the WKAs. The calling component attempts to obtain the full list upon node startup, the provider must return a terminating <code>null</code> address to indicate that all available addresses have been returned.</p>

Attribute Reference

Table A-74 describes the attributes available in the operational deployment descriptor.

Table A-74 Operational Deployment Descriptor Attributes

Attribute	Required/ Optional	Description
xml-override	Optional	<p>The <code>xml-override</code> attribute allows the content of an element to be fully or partially overridden with an XML document that is external to the base document. Legal value of this attribute is the name of the XML document an should be accessible using the <code>ClassLoader.getResourceAsStream(String name)</code> by the classes contained in <code>coherence.jar</code> library. In general, the name should be prefixed with <code>'/'</code> and located in the classpath.</p> <p>The override XML document referred by this attribute does not have to exist. However, if it does exist then its root element must have the same name as the element it overrides. In cases where there are multiple elements with the same name (for example, <code><service></code>) the <code>id</code> attribute is used to identify the base element that is overridden and the override element itself. The elements of the override document that do not have a match in the base document are just appended to the base.</p> <p>The following elements can be overridden by its own XML override file: address-provider, authorized-hosts, cache-factory-builder-config, cluster-config, coherence, configurable-cache-factory-config, incoming-message-handler, logging-config, multicast-listener, outgoing-message-handler, security-config, serializer, service, service-failure-policy, shutdown-listener, tcp-ring-listener, unicast-listener, packet-speaker, packet-publisher, mbeans</p>
id	Optional	<p>The <code>id</code> attribute differentiates elements that can have multiple occurrences (for example, <code><service></code>). See "Understanding the XML Override Feature" on page 3-16.</p>
system-property	Optional	<p>This attribute is used to specify a system property name for any element. The system property is used to override the element value from the Java command line. This feature enables the same operational descriptor (and override file) to be used across all cluster nodes and customize each node using the system properties. See Appendix D, "System Property Overrides," for more information on this feature.</p>

Cache Configuration Elements

This appendix provides a detailed reference of the cache configuration deployment descriptor elements and includes a brief overview of the descriptor.

This appendix includes the following sections:

- [Cache Configuration Deployment Descriptor](#)
- [Element Reference](#)
- [Attribute Reference](#)

Cache Configuration Deployment Descriptor

The cache configuration deployment descriptor specifies the various types of caches that can be used within a cluster. The name and location of the descriptor is specified in the operational deployment descriptor and defaults to `coherence-cache-config.xml`. A sample configuration descriptor is packaged in the root of the `coherence.jar` library and is used unless a custom `coherence-cache-config.xml` file is found before the `coherence.jar` file within the application's classpath. All cluster members should use identical cache configuration descriptors if possible.

The cache configuration deployment descriptor schema is defined in the `coherence-cache-config.xsd` file, which imports the `coherence-cache-config-base.xsd` file, which, in turn, imports the `coherence-config-base.xsd` file. These XSD files are located in the root of the `coherence.jar` library and at the following Web URL:

<http://xmlns.oracle.com/coherence/coherence-cache-config/1.2/coherence-cache-config.xsd>

The `<cache-config>` element is the root element of the cache configuration descriptor and typically includes an XSD and Coherence namespace reference and the location of the `coherence-cache-config.xsd` file. For example:

```
<?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">
```

Notes:

- The schema located in the `coherence.jar` library is always used at run time even if the `xsi:schemaLocation` attribute references the Web URL.
 - The `xsi:schemaLocation` attribute can be omitted to disable schema validation.
 - When deploying Coherence into environments where the default character set is EBCDIC rather than ASCII, ensure that the deployment descriptor file is in ASCII format and is deployed into its run-time environment in the binary format.
-
-

Element Reference

Table B-1 lists all non-terminal cache configuration deployment descriptor elements.

Table B-1 Non-Terminal Cache Configuration Elements

Element	Used In
acceptor-config	proxy-scheme
address-provider	name-service-addresses, remote-addresses, tcp-acceptor
async-store-manager	external-scheme, paged-external-scheme
authorized-hosts	tcp-acceptor
back-scheme	near-scheme, overflow-scheme
backing-map-scheme	distributed-scheme, optimistic-scheme, replicated-scheme
backup-storage	distributed-scheme
bdb-store-manager	external-scheme, paged-external-scheme, async-store-manager
cache-config	<i>root element</i>
cache-mapping	caching-scheme-mapping
cache-service-proxy	proxy-config
caching-scheme-mapping	cache-config
caching-schemes	cache-config
class-scheme	caching-schemes, local-scheme, distributed-scheme, replicated-scheme, optimistic-scheme, near-scheme, overflow-scheme, read-write-backing-map-scheme, cachestore-scheme, listener
cachestore-scheme	local-scheme, read-write-backing-map-scheme
custom-store-manager	external-scheme, paged-external-scheme, async-store-manager
defaults	cache-config
distributed-scheme	caching-schemes, near-scheme, overflow-scheme
external-scheme	caching-schemes, distributed-scheme, replicated-scheme, optimistic-scheme, near-scheme, overflow-scheme, read-write-backing-map-scheme
http-acceptor	acceptor-config
identity-manager	ssl
flashjournal-scheme	back-scheme, backing-map-scheme, caching-schemes, internal-cache-scheme
front-scheme	near-scheme, overflow-scheme
incoming-message-handler	acceptor-config, initiator-config
init-param	init-params
init-params	class-scheme
initiator-config	remote-cache-scheme, remote-invocation-scheme
interceptor	interceptors

Table B-1 (Cont.) Non-Terminal Cache Configuration Elements

Element	Used In
interceptors	cache-mapping, distributed-scheme
instance	serializer, socket-provider, service-failure-policy
invocation-scheme	caching-schemes
key-associator	distributed-scheme
key-partitioning	distributed-scheme
key-store	identity-manager, trust-manager
listener	local-scheme, external-scheme, paged-external-scheme, distributed-scheme, replicated-scheme, optimistic-scheme, near-scheme, overflow-scheme, read-write-backing-map-scheme
local-address	http-acceptor, tcp-acceptor, tcp-initiator
local-scheme	caching-schemes, distributed-scheme, replicated-scheme, optimistic-scheme, near-scheme, overflow-scheme, read-write-backing-map-scheme
memcached-acceptor	acceptor-config
name-service-addresses	tcp-initiator
near-scheme	caching-schemes
nio-file-manager	external-scheme, paged-external-scheme, async-store-manager
nio-memory-manager	external-scheme, paged-external-scheme, async-store-manager
operation-bundling	cachestore-scheme, distributed-scheme, remote-cache-scheme
optimistic-scheme	caching-schemes, near-scheme, overflow-scheme
outgoing-message-handler	acceptor-config, initiator-config
overflow-scheme	caching-schemes, distributed-scheme, replicated-scheme, optimistic-scheme, read-write-backing-map-scheme
paged-external-scheme	caching-schemes, distributed-scheme, replicated-scheme, optimistic-scheme, near-scheme, overflow-scheme, read-write-backing-map-scheme
partitioned-quorum-policy-scheme	distributed-scheme
provider	identity-manager, ssl, trust-manager
proxy-config	proxy-scheme
proxy-scheme	caching-schemes
proxy-quorum-policy-scheme	proxy-scheme
ramjournal-scheme	back-scheme, backing-map-scheme, caching-schemes, internal-cache-scheme
read-write-backing-map-scheme	caching-schemes, distributed-scheme, replicated-scheme, optimistic-scheme
remote-addresses	tcp-initiator
remote-cache-scheme	cachestore-scheme, caching-schemes, near-scheme

Table B-1 (Cont.) Non-Terminal Cache Configuration Elements

Element	Used In
remote-invocation-scheme	caching-schemes
replicated-scheme	caching-schemes, near-scheme, overflow-scheme
serializer	acceptor-config, defaults, distributed-scheme, initiator-config, invocation-scheme, optimistic-scheme, replicated-scheme, transactional-scheme
socket-address	name-service-addresses, remote-addresses
socket-provider	tcp-acceptor, tcp-initiator
ssl	socket-provider
tcp-acceptor	acceptor-config
tcp-initiator	initiator-config
transactional-scheme	caching-schemes
trust-manager	ssl

acceptor-config

Used in: [proxy-scheme](#)

Description

The `acceptor-config` element specifies the configuration information for a TCP/IP or HTTP (for REST) connection acceptor. The connection acceptor is used by a proxy service to enable Coherence*Extend clients to connect to the cluster and use cluster services without having to join the cluster.

Elements

[Table B-2](#) describes the subelements of the `acceptor-config` element.

Table B-2 *acceptor-config Subelements*

Element	Required/ Optional	Description
<code><http-acceptor></code>	Optional	Specifies the configuration information for a connection acceptor that accepts connections from remote REST clients over HTTP. This element cannot be used together with the <code><tcp-acceptor></code> or <code><memcached-acceptor></code> elements.
<code><tcp-acceptor></code>	Optional	Specifies the configuration information for a connection acceptor that enables Coherence*Extend clients to connect to the cluster over TCP/IP. This element cannot be used together with the <code><http-acceptor></code> or <code><memcached-acceptor></code> elements.
<code><memcached-acceptor></code>	Optional	Specifies the configuration information for a connection acceptor that accepts connections from remote memcached clients over TCP/IP. This element cannot be used together with the <code><tcp-acceptor></code> or <code><http-acceptor></code> elements.
<code><incoming-message-handler></code>	Optional	Specifies the configuration information that is used to regulate client-to-cluster connection resource usage.
<code><outgoing-message-handler></code>	Optional	Specifies the configuration information used by the connection acceptor to detect dropped client-to-cluster connections.

Table B-2 (Cont.) acceptor-config Subelements

Element	Required/ Optional	Description
<use-filters>	Optional	<p>Contains the list of filter names to be used by this connection acceptor. For example, specifying <use-filter> as follows activates gzip compression for all network messages, which can help substantially with WAN and low-bandwidth networks.</p> <pre data-bbox="784 436 1218 520"> <use-filters> <filter-name>gzip</filter-name> </use-filters> </pre>
<serializer>	Optional	<p>Specifies the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used by the connection acceptor to serialize and deserialize user types. For example, the following configures a <code>ConfigurablePofContext</code> that uses the <code>my-pof-types.xml</code> POF type configuration file to deserialize user types to and from a POF stream:</p> <pre data-bbox="784 709 1451 1024"> <serializer> <class-name>com.tangosol.io.pof.ConfigurablePofContext </class-name> <init-params> <init-param> <param-type>string</param-type> <param-value>my-pof-types.xml</param-value> </init-param> </init-params> </serializer> </pre>
<connection-limit>	Optional	<p>The maximum number of simultaneous connections allowed by this connection acceptor. Valid values are positive integers and zero. A value of zero implies no limit. The default value is zero.</p>

address-provider

Used in: [name-service-addresses](#), [remote-addresses](#), [tcp-acceptor](#), [memcached-acceptor](#)

Description

The `address-provider` element specifies either socket address information (IP, or DNS name, and port) or an implementation of the `com.tangosol.net.AddressProvider` interface. The interface offers a programmatic way to define socket addresses.

The preferred approach is to reference an address provider definition that is included in an operational override file. This approach decouples deployment configuration from application configuration. However, socket addresses can also be configured in-line and is typical during development. For additional details on defining address providers that can be referenced, see "[address-provider](#)" on page A-6.

The following example references an address provider definition that contains the socket address to which a TCP/IP acceptor is bound.

```
<tcp-acceptor>
  <address-provider>ap2</address-provider>
</tcp-acceptor>
```

The following example references an address provider definition that contains the socket address of a TCP/IP acceptor on the cluster.

```
<tcp-initiator>
  <remote-addresses>
    <address-provider>ap3</address-provider>
  </remote-addresses>
</tcp-initiator>
```

The following example references an address provider definition that contains the socket address of a name service TCP/IP acceptor on the cluster.

```
<tcp-initiator>
  <name-service-addresses>
    <address-provider>ap4</address-provider>
  </name-service-addresses>
</tcp-initiator>
```

The following example references an address provider definition that contains the socket address to which a TCP/IP memcached acceptor is bound.

```
<memcached-acceptor>
  <address-provider>ap5</address-provider>
</memcached-acceptor>
```

Elements

[Table B-3](#) describes the subelements of the `address-provider` element.

Table B-3 *address-provider Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies the fully qualified name of a class that implements the <code>com.tangosol.net.AddressProvider</code> interface. This element cannot be used with the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies the fully qualified name of a factory class for creating address provider instances. The instances must implement the <code>com.tangosol.net.AddressProvider</code> interface. This element cannot be used with the <code><class-name></code> element and is used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Specifies initialization parameters which are accessible by implementations that include a public constructor with a matching signature. Initialization parameters can be specified for both the <code><class-name></code> element and the <code><class-factory-name></code> element.
<code><socket-address></code>	Optional	Specifies the address (IP, or DNS name, and port) to which a socket is bound. This element cannot be used if an address provider implementation is defined using the <code><class-name></code> or <code><class-factory-name></code> element.

async-store-manager

Used in: [external-scheme](#), [paged-external-scheme](#).

Description

The `async-store-manager` element adds asynchronous write capabilities to other store manager implementations. Supported store managers include:

- [custom-store-manager](#)—allows definition of custom implementations of store managers
- [bdb-store-manager](#)—uses Berkeley Database JE to implement an on disk cache
- [nio-file-manager](#)—uses NIO to implement memory-mapped file based cache
- [nio-memory-manager](#)—uses NIO to implement an off JVM heap, in-memory cache

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See "[Using the Elastic Data Feature to Store Data](#)" on page 14-7.

Implementation

This store manager is implemented by the `com.tangosol.io.AsyncBinaryStoreManager` class.

Elements

[Table B-4](#) describes the subelements of the `async-store-manager` element.

Table B-4 *async-store-manager Subelements*

Element	Required/Optional	Description
<code><class-name></code>	Optional	Specifies a custom implementation of an asynchronous store manager. Any custom implementation must extend the <code>com.tangosol.io.AsyncBinaryStoreManager</code> class and declare the exact same set of public constructors.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom <code>async-store-manager</code> implementations.
<code><bdb-store-manager></code>	Optional	Configures the external cache to use Berkeley Database JE on disk databases for cache storage.
<code><custom-store-manager></code>	Optional	Configures the external cache to use a custom storage manager implementation.

Table B-4 (Cont.) *async-store-manager* Subelements

Element	Required/ Optional	Description
<nio-file-manager>	Optional	Configures the external cache to use a memory-mapped file for cache storage.
<nio-memory-manager>	Optional	Configures the external cache to use an off JVM heap, memory region for cache storage.
<async-limit>	Optional	<p>Specifies the maximum number of bytes that are queued to be written asynchronously. Setting the value to zero indicates that the implementation default for the maximum number of bytes is used. The value of this element must be in the following format:</p> <p>$(\backslash d) + ((.)(\backslash d) +) ? [K k M m] ? [B b] ?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K (kilo, 2^{10}) ■ M (mega, 2^{20}) <p>If the value does not contain a factor, a factor of one is assumed. Valid values are any positive memory sizes and zero. The default value is 4MB.</p>

authorized-hosts

Used in: [tcp-acceptor](#).

Description

This element contains the collection of IP addresses of TCP/IP initiator hosts that are allowed to connect to the cluster using a TCP/IP acceptor. If this collection is empty no constraints are imposed. Any number of `host-address` and `host-range` elements may be specified.

Elements

[Table B-5](#) describes the subelements of the `authorized-hosts` element.

Table B-5 *authorized-hosts Subelements*

Element	Required/ Optional	Description
<code><host-address></code>	Optional	Specifies an IP address or host name. If any are specified, only hosts with specified host-addresses or within the specified host-ranges are allowed to join the cluster. The content override attributes <code>id</code> can be optionally used to fully or partially override the contents of this element with XML document that is external to the base document.
<code><host-range></code>	Optional	Specifies a range of IP addresses. If any are specified, only hosts with specified host-addresses or within the specified host-ranges are allowed to join the cluster.
<code><host-filter></code>	Optional	Specifies class configuration information for a <code>com.tangosol.util.Filter</code> implementation that is used by a TCP/IP acceptor to determine whether to accept a particular TCP/IP initiator. The <code>evaluate()</code> method is passed to the <code>java.net.InetAddress</code> of the client. Implementations should return <code>true</code> to allow the client to connect. Classes are specified using the <code><class-name></code> subelement. Any initialization parameters can be defined within an <code><init-params></code> subelement.

The content override attributes `xml-override` and `id` can be optionally used to fully or partially override the contents of this element with XML document that is external to the base document. See "[Attribute Reference](#)" on page A-100.

back-scheme

Used in: [near-scheme](#), [overflow-scheme](#)

Description

The back-scheme element specifies the back-tier cache of a composite cache.

Elements

[Table B-6](#) describes the subelements of the back-scheme element.

Table B-6 *back-scheme Subelements*

Element	Required/ Optional	Description
<distributed-scheme>	Optional	Defines a cache scheme where storage of cache entries is partitioned across the cluster nodes.
<optimistic-scheme>	Optional	Defines a replicated cache scheme which uses optimistic rather than pessimistic locking.
<replicated-scheme>	Optional	Defines a cache scheme where each cache entry is stored on all cluster nodes.
<transactional-scheme>	Optional	Defines a cache scheme where storage of cache entries is partitioned across the cluster nodes with transactional guarantees.
<local-scheme>	Optional	Local cache schemes define in-memory "local" caches. Local caches are generally nested within other cache schemes, for instance as the front-tier of a near scheme.
<external-scheme>	Optional	External schemes define caches which are not JVM heap based, allowing for greater storage capacity.
<paged-external-scheme>	Optional	As with external-scheme , paged-external-schemes define caches which are not JVM heap based, allowing for greater storage capacity.
<class-scheme>	Optional	Class schemes provide a mechanism for instantiating an arbitrary Java object for use by other schemes. The scheme which contains this element dictates what class or interface(s) must be extended.
<flashjournal-scheme>	Optional	Specifies a scheme that uses journaling to store data to flash memory.
<ramjournal-scheme>	Optional	Specifies a scheme that uses journaling to store data to RAM memory.
<remote-cache-scheme>	Optional	Defines a cache scheme that enables caches to be accessed from outside a Coherence cluster by using Coherence*Extend.

backing-map-scheme

Used in: [distributed-scheme](#), [optimistic-scheme](#), [replicated-scheme](#)

Description

Specifies what type of cache is used within the cache server to store entries.

When using an overflow-based backing map, it is important that the corresponding `backup-storage` be configured for overflow (potentially using the same scheme as the `backing-map`). See "[Partitioned Cache with Overflow](#)" on page 18-5 for an example configuration.

Note: The `partitioned` subelement is only used if the parent element is the `distributed-scheme` element.

Elements

[Table B-7](#) describes the subelements of the `backing-map-scheme` element.

Table B-7 *backing-map-scheme Subelements*

Element	Required/Optional	Description
<code><partitioned></code>	Optional	<p>Specifies whether the enclosed backing map is a <code>PartitionAwareBackingMap</code>. (This element is respected only within a distributed-scheme.) If the value is true, the scheme that is specified as the backing map is used to configure backing maps for each individual partition of the <code>PartitionAwareBackingMap</code>. If the value is false, the scheme is used for the entire backing map itself.</p> <p>The concrete implementations of the <code>PartitionAwareBackingMap</code> interface are:</p> <ul style="list-style-type: none"> ■ <code>com.tangosol.net.partition.ObservableSplittingBackingCache</code> ■ <code>com.tangosol.net.partition.PartitionSplittingBackingCache</code> ■ <code>com.tangosol.net.partition.ReadWriteSplittingBackingMap</code> <p>Valid values are true or false. The default value is false. Note: Backing maps that use RAM and Flash journaling are always partitioned.</p>
<code><local-scheme></code>	Optional	Local cache schemes define in-memory "local" caches. Local caches are generally nested within other cache schemes, for instance as the front-tier of a near scheme.
<code><external-scheme></code>	Optional	External schemes define caches which are not JVM heap based, allowing for greater storage capacity.
<code><paged-external-scheme></code>	Optional	As with external-scheme , <code>paged-external-schemes</code> define caches which are not JVM heap based, allowing for greater storage capacity.
<code><overflow-scheme></code>	Optional	The <code>overflow-scheme</code> defines a two-tier cache consisting of a fast, size limited front-tier, and slower but much higher capacity back-tier cache.

Table B-7 (Cont.) backing-map-scheme Subelements

Element	Required/ Optional	Description
<code><class-scheme></code>	Optional	Class schemes provide a mechanism for instantiating an arbitrary Java object for use by other schemes. The scheme which contains this element dictates what class or interface(s) must be extended.
<code><flashjournal-scheme></code>	Optional	Specifies a scheme that uses journaling to store data to flash memory.
<code><ramjournal-scheme></code>	Optional	Specifies a scheme that uses journaling to store data to RAM memory.
<code><read-write-backing-map-scheme></code>	Optional	The read-write-backing-map-scheme defines a backing map which provides a size limited cache of a persistent store.

backup-storage

Used in: [distributed-scheme](#).

Description

The `backup-storage` element specifies the type and configuration of backup storage for a partitioned cache.

Elements

[Table B-8](#) describes the subelements of the `backup-storage` element.

Table B-8 backup-storage Subelements

Element	Required/ Optional	Description
<type>	Optional	<p>Specifies the type of the storage used to hold the backup data. Legal values are:</p> <ul style="list-style-type: none"> ■ on-heap— (default) The corresponding implementations class is <code>java.util.HashMap</code>. ■ off-heap—The corresponding implementations class is <code>com.tangosol.io.nio.BinaryMap</code> using the <code>com.tangosol.io.nio.DirectBufferManager</code>. ■ file-mapped—The corresponding implementations class is <code>com.tangosol.io.nio.BinaryMap</code> using the <code>com.tangosol.io.nio.MappedBufferManager</code>. ■ custom—The corresponding implementations class is the class specified by the <code>class-name</code> element. ■ scheme—The corresponding implementations class is specified as a caching-scheme by the <code>scheme-name</code> element. <p>The preconfigured system property override is <code>tangosol.coherence.distributed.backup</code>.</p>
<initial-size>	Optional	<p>Specifies the initial buffer size in bytes. The class name is only applicable if the <type> element is set to <code>off-heap</code> or <code>file-mapped</code>. Specifies the initial buffer size in bytes. The value of this element must be in the following format:</p> <pre>(\d)+[K k M m G g T t]?[B b]?</pre> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1MB.</p>
<maximum-size>	Optional	<p>Specifies the initial buffer size in bytes. The class name is only applicable if the <type> element is set to <code>off-heap</code> or <code>file-mapped</code>. The value of this element must be in the following format:</p> <pre>(\d)+[K k M m G g T t]?[B b]?</pre> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1024MB.</p>

Table B-8 (Cont.) backup-storage Subelements

Element	Required/ Optional	Description
<directory>	Optional	Specifies the path name for the directory that the disk persistence manager (<code>com.tangosol.util.nio.MappedBufferManager</code>) uses as the root to store files. The directory is only applicable if the <type> element is set to <code>file-mapped</code> . If a value is not specified or a non-existent directory is specified, a temporary file in the default location is used. The default value is the default temporary directory designated by the Java run time.
<class-name>	Optional	Specifies a class name for the custom storage implementation. The class name is only applicable if the <type> element is set to <code>custom</code> .
<scheme-name>	Optional	Specifies a scheme name for the <code>ConfigurableCacheFactory</code> . The scheme name is only applicable if the <type> element is set to <code>scheme</code> .

bdb-store-manager

Used in: [external-scheme](#), [paged-external-scheme](#), [async-store-manager](#).

Note: Berkeley Database JE Java class libraries are required to use a `bdb-store-manager`, see the Berkeley Database JE product page for additional information.

<http://www.oracle.com/technology/documentation/berkeley-db/je/index.html>

Description

The BDB store manager is used to define external caches which uses Berkeley Database JE on disk embedded databases for storage. See the examples of Berkeley-based store configurations in "[Persistent Cache on Disk](#)" on page 18-4 and "[In-memory Cache with Disk Based Overflow](#)" on page 18-2.

Implementation

This store manager is implemented by the `com.tangosol.io.bdb.BerkeleyDBBinaryStoreManager` class, and produces `BinaryStore` objects implemented by the `com.tangosol.io.bdb.BerkeleyDBBinaryStore` class.

Elements

[Table B-9](#) describes the subelements of the `bdb-store-manager` element.

Table B-9 *bdb-store-manager Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies a custom implementation of the Berkeley Database <code>BinaryStoreManager</code> . Any custom implementation must extend the <code>com.tangosol.io.bdb.BerkeleyDBBinaryStoreManager</code> class and declare the exact same set of public constructors.

Table B–9 (Cont.) bdb-store-manager Subelements

Element	Required/ Optional	Description
<init-params>	Optional	<p>Specifies additional Berkeley DB configuration settings. See the Berkeley DB Configuration instructions:</p> <p>http://www.oracle.com/technology/documentation/berkeley-db/je/GettingStartedGuide/administration.html#propertyfile</p> <p>Also used to specify initialization parameters, for use in custom implementations.</p>
<directory>	Optional	<p>Specifies the path name to the root directory where the Berkeley Database JE store manager stores files. If not specified or specified with a non-existent directory, a temporary directory in the default location is used.</p>
<store-name>	Optional	<p>Specifies the name for a database table that the Berkeley Database JE store manager uses to store data in. Specifying this parameter causes the bdb-store-manager to use non-temporary (persistent) database instances. This is intended only for local caches that are backed by a cache loader from a non-temporary store, so that the local cache can be pre-populated from the disk on startup. This setting should not be enabled with replicated or distributed caches. Normally, the <store-name> element should be left unspecified, indicating that temporary storage is to be used.</p> <p>When specifying this property, it is recommended to use the {cache-name} macro. See "Using Parameter Macros" on page 13-15 for more information on the {cache-name} macro.</p>

bundle-config

Used in: [operation-bundling](#).

Description

The `bundle-config` element specifies the bundling strategy configuration for one or more bundle-able operations.

Elements

[Table B–10](#) describes the subelements of the `bundle-config` element.

Table B–10 *bundle-config Subelements*

Element	Required/Optional	Description
<code><operation-name></code>	Optional	<p>Specifies the operation name for which calls performed concurrently on multiple threads are "bundled" into a functionally analogous "bulk" operation that takes a collection of arguments instead of a single one.</p> <p>Valid values depend on the bundle configuration context. For the <code><cachestore-scheme></code> the valid operations are:</p> <ul style="list-style-type: none"> ▪ load ▪ store ▪ erase <p>For the <code><distributed-scheme></code> and <code><remote-cache-scheme></code> the valid operations are:</p> <ul style="list-style-type: none"> ▪ get ▪ put ▪ remove <p>In all cases there is a pseudo operation named <code>all</code>, referring to all valid operations. The default value is <code>all</code>.</p>
<code><preferred-size></code>	Optional	<p>Specifies the bundle size threshold. When a bundle size reaches this value, the corresponding "bulk" operation is invoked immediately. This value is measured in context-specific units.</p> <p>Valid values are zero (disabled bundling) or positive values. The default value is zero.</p>
<code><delay-millis></code>	Optional	<p>Specifies the maximum amount of time in milliseconds that individual execution requests are allowed to be deferred for a purpose of "bundling" them and passing into a corresponding bulk operation. If the preferred-size threshold is reached before the specified delay, the bundle is processed immediately.</p> <p>Valid values are positive numbers. The default value is 1.</p>
<code><thread-threshold></code>	Optional	<p>Specifies the minimum number of threads that must be concurrently executing individual (non-bundled) requests for the bundler to switch from a pass-through to a bundling mode.</p> <p>Valid values are positive numbers. The default value is 4.</p>
<code><auto-adjust></code>	Optional	<p>Specifies whether the auto adjustment of the preferred-size value (based on the run-time statistics) is allowed.</p> <p>Valid values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>

cache-config

Root Element

Description

The `cache-config` element is the root element of the cache configuration descriptor, `coherence-cache-config.xml`. For more information on this document, see "[Cache Configuration Deployment Descriptor](#)" on page B-1.

At a high level, a cache configuration consists of cache schemes and cache scheme mappings. Cache schemes describe a type of cache, for instance a database backed, distributed cache. Cache mappings define what scheme to use for a given cache name.

Elements

[Table B-11](#) describes the subelements of the `cache-config` element.

Table B-11 *cache-config* Subelements

Element	Required/ Optional	Description
<code><scope-name></code>	Optional	The use of the <code><scope-name></code> element within the <code><cache-config></code> element has been deprecated. Use the <code><scope-name></code> element within the defaults element instead.
<code><defaults></code>	Optional	Defines factory wide default settings.
<code><interceptors></code>	Optional	Specifies any number of event interceptors that process events. Specifying the <code><interceptors></code> element as a child of the <code><cache-config></code> element scopes the interceptors to the cache configuration and allows interceptors to receive events such as <code>ConfigurableCacheFactory</code> lifecycle events.
<code><caching-scheme-mapping></code>	Required	Specifies the caching-scheme that is used for caches, based on the cache's name.
<code><caching-schemes></code>	Required	Defines the available caching-schemes for use in the cluster.

cache-mapping

Used in: [caching-scheme-mapping](#)

Description

Each `cache-mapping` element specifies the [caching-schemes](#) which are to be used for a given cache name or cache name pattern used by an application.

Elements

[Table B-12](#) describes the subelements of the `cache-mapping` element.

Table B-12 *cache-mapping Subelements*

Element	Required/Optional	Description
<code><cache-name></code>	Required	<p>Specifies a cache name or name pattern. The name is unique within a cache factory. The following cache name patterns are supported:</p> <ul style="list-style-type: none"> ▪ Exact match. For example, <code>MyCache</code>. ▪ Prefix match using a wildcard (<i>prefix*</i>). For example, <code>My*</code> that matches to any cache name starting with <code>My</code>. ▪ Any match using a wildcard (<code>*</code>). Matches to any cache name. <p>If a cache name can be matched to multiple cache mappings, then exact matches are selected over wildcard matches. If no exact match is specified, then the last matching wildcard pattern (based on the order in which they are defined in the file) is selected.</p>
<code><scheme-name></code>	Required	<p>Contains the caching scheme name. The name is unique within a configuration file. Caching schemes are configured in the caching-schemes element.</p>
<code><init-params></code>	Optional	<p>Allows specifying replaceable cache scheme parameters. During cache scheme parsing, any occurrence of any replaceable parameter in format <code>param-name</code> is replaced with the corresponding parameter value. Consider the following cache mapping example:</p> <pre><cache-mapping> <cache-name>My* </cache-name> <scheme-name>my-scheme </scheme-name> <init-params> <init-param> <param-name>cache-loader </param-name> <param-value>com.acme.MyCacheLoader </param-value> </init-param> <init-param> <param-name>size-limit </param-name> <param-value>1000 </param-value> </init-param> </init-params> </cache-mapping></pre> <p>For any cache name match <code>My*</code>, any occurrence of the literal <code>cache-loader</code> in any part of the corresponding <code>cache-scheme</code> element is replaced with the string <code>com.acme.MyCacheLoader</code> and any occurrence of the literal <code>size-limit</code> is replaced with the value of <code>1000</code>.</p>
<code><interceptors></code>	Optional	<p>Specifies any number of event interceptors that process events for a specific cache.</p>

cache-service-proxy

Used in: [proxy-config](#)

Description

The `cache-service-proxy` element contains the configuration information for a cache service proxy that is managed by a proxy service.

Elements

[Table B-13](#) describes the subelements of the `cache-service-proxy` element.

Table B-13 *cache-service-proxy Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies the fully qualified name of a class that implements the <code>com.tangosol.net.CacheService</code> interface. The class acts as an interceptor between a client and a proxied cache service to implement custom processing as required. For example, the class could be used to perform authorization checks before allowing the use of the proxied cache service.
<code><init-params></code>	Optional	Contains initialization parameters for the <code>CacheService</code> implementation.
<code><enabled></code>	Optional	Specifies whether the cache service proxy is enabled. If disabled, clients are not able to access any proxied caches. Legal values are <code>true</code> or <code>false</code> . The default value is <code>true</code> .
<code><lock-enabled></code>	Optional	Specifies whether lock requests from remote clients are permitted on a proxied cache. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<code><read-only></code>	Optional	Specifies whether requests from remote clients that update a cache are prohibited on a proxied cache. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

cachestore-scheme

Used in: [local-scheme](#), [read-write-backing-map-scheme](#)

Description

Cache store schemes define a mechanism for connecting a cache to a back-end data store. The cache store scheme may use any class implementing either the `com.tangosol.net.cache.CacheStore` or `com.tangosol.net.cache.CacheLoader` interfaces, where the former offers read-write capabilities, where the latter is read-only. Custom implementations of these interfaces may be produced to connect Coherence to various data stores. See "[Cache of a Database](#)" on page 18-4 for an example of using a `cachestore-scheme`.

Elements

[Table B-14](#) describes the subelements of the `cachestore-scheme` element.

Table B-14 *cachestore-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13.
<code><class-scheme></code>	Optional	Specifies the implementation of the cache store. The specified class must implement either of the following interfaces. <ul style="list-style-type: none"> ▪ <code>com.tangosol.net.cache.CacheStore</code>—for read-write support ▪ <code>com.tangosol.net.cache.CacheLoader</code>—for read-only support ▪ <code>com.tangosol.net.cache.BinaryEntryStore</code>— similar to <code>CacheStore</code>, but operates on <code>BinaryEntry</code> objects.
<code><remote-cache-scheme></code>	Optional	Configures the <code>cachestore-scheme</code> to use <code>Coherence*Extend</code> as its cache store implementation.
<code><operation-bundling></code>	Optional	Specifies the configuration information for a bundling strategy.

caching-scheme-mapping

Used in: [cache-config](#)

Description

Defines mappings between cache names, or name patterns, and [caching-schemes](#). For instance you may define that caches whose names start with `accounts-` uses a distributed ([distributed-scheme](#)) caching scheme, while caches starting with the name `rates-` uses a [replicated-scheme](#) caching scheme.

Elements

[Table B–15](#) describes the subelement you can define within the `caching-scheme-mapping` element.

Table B–15 *caching-scheme-mapping* Subelement

Element	Required/ Optional	Description
<code><cache-mapping></code>	Required	Contains a single binding between a cache name and the caching scheme this cache uses.

caching-schemes

Used in: [cache-config](#)

Description

The `caching-schemes` element defines a series of cache scheme elements. Each cache scheme defines a type of cache, for instance a database backed partitioned cache, or a local cache with an LRU eviction policy. Scheme types are bound to actual caches using mappings (see [caching-scheme-mapping](#)).

Elements

[Table B–16](#) describes the different types of schemes you can define within the `caching-schemes` element.

Table B–16 *caching-schemes Subelements*

Element	Required/Optional	Description
<code><distributed-scheme></code>	Optional	Defines a cache scheme where storage of cache entries is partitioned across the cluster nodes.
<code><optimistic-scheme></code>	Optional	Defines a replicated cache scheme which uses optimistic rather than pessimistic locking.
<code><replicated-scheme></code>	Optional	Defines a cache scheme where each cache entry is stored on all cluster nodes.
<code><transactional-scheme></code>	Optional	Defines a cache scheme where storage of cache entries is partitioned across the cluster nodes with transactional guarantees.
<code><local-scheme></code>	Optional	Defines a cache scheme which provides on-heap cache storage.
<code><external-scheme></code>	Optional	Defines a cache scheme which provides off-heap cache storage, for instance on disk.
<code><paged-external-scheme></code>	Optional	Defines a cache scheme which provides off-heap cache storage, that is size-limited by using time based paging.
<code><overflow-scheme></code>	Optional	Defines a two tier cache scheme where entries evicted from a size-limited front-tier overflow and are stored in a much larger back-tier cache.
<code><class-scheme></code>	Optional	Defines a cache scheme using a custom cache implementation. Any custom implementation must implement the <code>java.util.Map</code> interface, and include a zero-parameter public constructor. Additionally if the contents of the <code>Map</code> can be modified by anything other than the <code>CacheService</code> itself (for example, if the <code>Map</code> automatically expires its entries periodically or size-limits its contents), then the returned object must implement the <code>com.tangosol.util.ObservableMap</code> interface.
<code><flashjournal-scheme></code>	Optional	Specifies a scheme that stores data to flash memory.
<code><ramjournal-scheme></code>	Optional	Specifies a scheme that stores data to RAM memory.
<code><near-scheme></code>	Optional	Defines a two tier cache scheme which consists of a fast local front-tier cache of a much larger back-tier cache.

Table B–16 (Cont.) caching-schemes Subelements

Element	Required/ Optional	Description
<code><invocation-scheme></code>	Optional	Defines an invocation service which can be used for performing custom operations in parallel across cluster nodes.
<code><read-write-backing-map-scheme></code>	Optional	Defines a backing map scheme which provides a cache of a persistent store.
<code><remote-cache-scheme></code>	Optional	Defines a cache scheme that enables caches to be accessed from outside a Coherence cluster by using Coherence*Extend.
<code><remote-invocation-scheme></code>	Optional	Defines an invocation scheme that enables invocations from outside a Coherence cluster by using Coherence*Extend.
<code><proxy-scheme></code>	Optional	Defines a proxy service scheme that enables remote connections to a cluster using Coherence*Extend.

class-scheme

Used in: [caching-schemes](#), [local-scheme](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [near-scheme](#), [front-scheme](#), [overflow-scheme](#), [read-write-backing-map-scheme](#), [cachestore-scheme](#), [listener](#), [eviction-policy](#), [unit-calculator](#).

Description

Class schemes provide a mechanism for instantiating an arbitrary Java object for use by other schemes. The scheme which contains this element dictates what class or interface(s) must be extended. See "[Cache of a Database](#)" on page 18-4 for an example of using a `class-scheme`.

The `class-scheme` may be configured to either instantiate objects directly by using their `class-name`, or indirectly by using a `class-factory-name` and `method-name`. The `class-scheme` must be configured with either a `class-name` or `class-factory-name` and `method-name`.

Elements

[Table B-17](#) describes the subelements of the `class-scheme` element.

Table B-17 *class-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Contains a fully specified Java class name to instantiate. This class must extend an appropriate implementation class as dictated by the containing scheme and must declare the exact same set of public constructors as the superclass. This element cannot be used with the <code><class-factory-name></code> element.
<code><class-factory-name></code>	Optional	Specifies a fully specified name of a Java class that is used as a factory for object instantiation. This element cannot be used with the <code><class-name></code> element and is used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Specifies initialization parameters which are accessible by implementations that include a public constructor with a matching signature.

custom-store-manager

Used in: [external-scheme](#), [paged-external-scheme](#), [async-store-manager](#).

Description

Used to create and configure custom implementations of a store manager for use in external caches.

Elements

[Table B–18](#) describes the subelements of the `custom-store-manager` element.

Table B–18 *custom-store-manager Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	Specifies the implementation of the store manager. The specified class must implement the <code>com.tangosol.io.BinaryStoreManager</code> interface.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom store manager implementations.

defaults

Used in: [cache-config](#)

Description

The `defaults` element defines factory wide default settings. This feature enables global configuration of serializers and socket providers used by all services which have not explicitly defined these settings.

Elements

[Table B-19](#) describes the subelements of the `defaults` element.

Table B-19 *defaults* Subelements

Element	Required/ Optional	Description
<code><scope-name></code>	Optional	Specifies the scope name for this configuration. The scope name is added (as a prefix) to all services generated by a cache factory. The name is used to isolate services when using multiple cache factories; thus, avoiding unintended joining of services with similar names from different configurations.
<code><serializer></code>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation, or it references a serializer class configuration that is defined within the <code><serializers></code> element in the operational configuration file. Two pre-defined serializers are available: <code>java</code> (default) and <code>pof</code> and are referred to using their defined <code>id</code> attribute name. For example: <code><serializer>pof</serializer></code>
<code><socket-provider></code>	Optional	Specifies either: the configuration for a socket provider, or it references a socket provider configuration that is defined within the <code><socket-providers></code> element of the operational deployment descriptor. The following socket providers are available: <code>system</code> (default), <code>tcp</code> , <code>ssl</code> , and <code>sdp</code> . Refer to the socket providers using their defined <code>id</code> attribute name. For example: <code><socket-provider>ssl</socket-provider></code> This setting only specifies the socket provider for Coherence*Extend services. The TCMP socket provider is specified within the <code><unicast-listener></code> element in the operational configuration.

distributed-scheme

Used in: [caching-schemes](#), [near-scheme](#), [overflow-scheme](#)

Description

The `distributed-scheme` defines caches where the storage for entries is partitioned across cluster nodes. See "[Understanding Distributed Caches](#)" on page 12-1 for a more detailed description of partitioned caches. See "[Partitioned Cache](#)" on page 18-5 for examples of various `distributed-scheme` configurations.

Clustered Concurrency Control

Partitioned caches support cluster wide key-based locking so that data can be modified in a cluster without encountering the classic missing update problem. Note that any operation made without holding an explicit lock is still atomic but there is no guarantee that the value stored in the cache does not change between atomic operations.

Cache Clients

The partitioned cache service supports the concept of cluster nodes which do not contribute to the overall storage of the cluster. Nodes which are not storage enabled (see `<local-storage>` subelement) are considered "cache clients".

Cache Partitions

The cache entries are evenly segmented into several logical partitions (see `<partition-count>` subelement), and each storage enabled (see `<local-storage>` subelement) cluster node running the specified partitioned service (see `<service-name>` subelement) is responsible for maintain a fair-share of these partitions.

Key Association

By default the specific set of entries assigned to each partition is transparent to the application. In some cases it may be advantageous to keep certain related entries within the same cluster node. A `key-associator` (see `<key-associator>` subelement) may be used to indicate related entries, the partitioned cache service ensures that associated entries reside on the same partition, and thus on the same cluster node. Alternatively, key association may be specified from within the application code by using keys which implement the `com.tangosol.net.cache.KeyAssociation` interface.

Cache Storage (Backing Map)

Storage for the cache is specified by using the `<backing-map-scheme>` subelement. For instance a partitioned cache which uses a [local-scheme](#) for its backing map results in cache entries being stored in-memory on the storage-enabled cluster nodes.

Failover

For the purposes of failover, a configured number of backups (see `<backup-count>` subelement) of the cache may be maintained in `backup-storage` (see `<backup-storage>` subelement) across the cluster nodes. Each backup is also divided into partitions, and when possible a backup partition does not reside on the same computer as the primary partition. If a cluster node abruptly leaves the cluster, responsibility for its partitions

are automatically reassigned to the existing backups, and new backups of those partitions are created (on remote nodes) to maintain the configured backup count.

Partition Redistribution

When a node joins or leaves the cluster, a background redistribution of partitions occurs to ensure that all cluster nodes manage a fair-share of the total number of partitions. The amount of bandwidth consumed by the background transfer of partitions is governed by the `transfer-threshold` (see `<transfer-threshold>` subelement).

Elements

[Table B-20](#) describes the subelements of the `distributed-scheme` element.

Table B-20 *distributed-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See "Using Scheme Inheritance" on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies a name for the distributed cache service instance that manages the cache that is created from this distributed scheme. The distributed cache service definition is defined within the <code><services></code> element in the <code>tangosol-coherence.xml</code> file. See "DistributedCache Service Parameters" on page A-63 for more information. Different distributed schemes can use different partitioned cache service instances to maintain separate caches. The default name if no name is specified is <code>DistributedCache</code> .
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>service-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>service-priority</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<code><event-dispatcher-priority></code> >	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>event-dispatcher-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>event-dispatcher-priority</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<code><serializer></code>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see "serializer" on page A-59).

Table B-20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmb – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the tangosol-coherence.xml descriptor. See the reliable-transport parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>
<compressor>	Optional	<p>Specifies whether or not backup updates should be compressed in delta form or sent whole. A delta update represents the parts of a backup entry that must be changed in order to synchronize it with the primary version of the entry. Deltas are created and applied using a compressor. The default value is the compressor value specified in the tangosol-coherence.xml descriptor. See the compressor parameter in "DistributedCache Service Parameters" on page A-63 for more information. Valid values are:</p> <ul style="list-style-type: none"> ▪ none – Disables delta backup; no compressor is used. The whole backup binary entry is replaced when the primary entry changes. ▪ standard – Automatically selects a delta compressor based on the serializer being used by the partitioned service. ▪ <instance> – The configuration for a class that implements the com.tangosol.io.DeltaCompressor interface.
<thread-count>	Optional	<p>Specifies the number of daemon threads used by the partitioned cache service. Legal values are positive integers, 0, or -1. The value 0 indicates that all relevant tasks are performed on the service thread. The value -1 indicates that tasks are performed on the caller's thread where possible. The default value is the thread-count value specified in the tangosol-coherence.xml descriptor. See the thread-count parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>

Table B–20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<worker-priority>	Optional	Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>worker-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>worker-priority</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<lease-granularity>	Optional	Specifies the lease ownership granularity. Legal values are: <ul style="list-style-type: none"> ■ <code>thread</code> ■ <code>member</code> A value of <code>thread</code> means that locks are held by a thread that obtained them and can only be released by that thread. A value of <code>member</code> means that locks are held by a cluster node and any thread running on the cluster node that obtained the lock can release it. The default value is the <code>lease-granularity</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>lease-granularity</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<local-storage>	Optional	Specifies whether a cluster node contributes storage to the cluster, that is, maintain partitions. When disabled the node is considered a cache client. Legal values are <code>true</code> or <code>false</code> . The default value is the <code>local-storage</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>local-storage</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<partition-count>	Optional	Specifies the number of distributed cache partitions. Each storage-enabled cluster member that is running the distributed cache service manages a balanced number of partitions. Valid values are positive integers between 1 and 32767 and should be a prime number. A list of primes can be found at http://primes.utm.edu/lists/ . The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>partition-count</code> parameter in "DistributedCache Service Parameters" on page A-63.
<transfer-threshold>	Optional	Specifies the threshold for the primary buckets distribution in kilobytes. When a new node joins the partitioned cache service or when a member of the service leaves, the remaining nodes perform a task of bucket ownership re-distribution. During this process, the existing data gets re-balanced along with the ownership information. This parameter indicates a preferred message size for data transfer communications. Setting this value lower makes the distribution process take longer, but reduces network bandwidth utilization during this activity. Legal values are integers greater than zero. The default value is the <code>transfer-threshold</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>transfer-threshold</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.
<backup-count>	Optional	Specifies the number of members of the partitioned cache service that hold the backup data for each unit of storage in the cache. A value of 0 means that for abnormal termination, some portion of the data in the cache is lost. The default value is the <code>backup-count</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See "DistributedCache Service Parameters" on page A-63 for more information.

Table B-20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<backup-count-after-write-behind>	Optional	<p>Specifies the number of members of the partitioned cache service that holds the backup data for each unit of storage in the cache that does <i>not</i> require write-behind, that is, data that is not vulnerable to being lost even if the entire cluster were shut down. Specifically, if a unit of storage is marked as requiring write-behind, then it is backed up on the number of members specified by the <backup-count> subelement. If the unit of storage is not marked as requiring write-behind, then it is backed up by the number of members specified by the <backup-count-after-writebehind> element.</p> <p>This value should be set to 0 or this setting should not be specified at all. The rationale is that since this data is being backed up to another data store, no in-memory backup is required, other than the data temporarily queued on the write-behind queue to be written. The value of 0 means that when write-behind has occurred, the backup copies of that data is discarded. However, until write-behind occurs, the data is backed up in accordance with the <backup-count> setting.</p> <p>Recommended value is 0 or this element should be omitted.</p>
<backup-storage>	Optional	Specifies the type and configuration for the partitioned cache backup storage.
<key-associator>	Optional	Specifies a class that is responsible for providing associations between keys and allowing associated keys to reside on the same partition. This implementation must have a zero-parameter public constructor.
<key-partitioning>	Optional	Specifies a class that implements the <code>com.tangosol.net.partition.KeyPartitioningStrategy</code> interface, which is responsible for assigning keys to partitions. This implementation must have a zero-parameter public constructor. If unspecified, the default key partitioning algorithm is used, which ensures that keys are evenly segmented across partitions.
<partition-assignment-strategy>	Optional	<p>Specifies the strategy that is used by a partitioned service to manage partition distribution. The default value is the <code>partition-assignment-strategy</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>partition-assignment-strategy</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p> <ul style="list-style-type: none"> ■ <code>legacy</code> – (deprecated) The legacy assignment strategy indicates that partition distribution is managed individually on each cluster member. ■ <code>simple</code> – The simple assignment strategy attempts to balance partition distribution while ensuring machine-safety and is more deterministic and efficient than the legacy strategy. ■ <code>mirror:<service-name></code> – The mirror assignment strategy attempts to co-locate the service's partitions with the partitions of the specified service. This strategy is used to increase the likelihood that key-associated, cross-service cache access remains local to a member. ■ <code>custom</code> – a class that implements the <code>com.tangosol.net.partition.PartitionAssignmentStrategy</code> interface. Enter a custom strategy using the <instance> element.

Table B–20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<partition-listener>	Optional	Specifies a class that implements the <code>com.tangosol.net.partition.PartitionListener</code> interface.
<task-hung-threshold>	Optional	Specifies the amount of time in milliseconds that a task can execute before it is considered "hung". Note: a posted task that has not yet started is never considered as hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive). Legal values are positive integers or zero (indicating no default timeout). The default value is the <code>task-hung-threshold</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>task-hung-threshold</code> parameter in " DistributedCache Service Parameters " on page A-63 for more information.
<task-timeout>	Optional	Specifies the timeout value in milliseconds for requests executing on the service worker threads. This attribute applies only if the thread pool is used (the <code>thread-count</code> value is positive) and only applies to entry processor implementations that implement the <code>PriorityTask</code> interface. If zero is specified, the default <code>service-guardian <timeout-milliseconds></code> value is used. Legal values are nonnegative integers. The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>task-timeout</code> parameter in " DistributedCache Service Parameters " on page A-63.
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>Legal values are positive integers or zero (indicating no default timeout). The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>request-timeout</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>

Table B–20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<code><guardian-timeout></code>	Optional	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See <service-guardian>.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+(.(\d+)?[MS ms S s M m H h D d])?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>
<code><service-failure-policy></code>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ■ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ■ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ■ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ■ a custom class – an <instance> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<code><member-listener></code>	Optional	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor. See the subelements for "instance" on page B-54 for the elements used to define the class.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <code><member-listener></code> element is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
<code><operation-bundling></code>	Optional	<p>Specifies the configuration information for a bundling strategy.</p>

Table B–20 (Cont.) distributed-scheme Subelements

Element	Required/ Optional	Description
<code><backing-map-scheme></code>	Optional	<p>Specifies what type of cache is used within the cache server to store the entries.</p> <p>Legal schemes are:</p> <ul style="list-style-type: none"> ▪ <code>local-scheme</code> ▪ <code>external-scheme</code> ▪ <code>paged-external-scheme</code> ▪ <code>class-scheme</code> ▪ <code>flashjournal-scheme</code> ▪ <code>ramjournal-scheme</code> ▪ <code>overflow-scheme</code> ▪ <code>read-write-backing-map-scheme</code> <p>Note that when using an off-heap backing map it is important that the corresponding <code><backup-storage></code> be configured for off-heap (potentially using the same scheme as the backing-map). Here off-heap refers to any storage where some or all entries are stored outside of the JVMs garbage collected heap space. Examples include: <code><overflow-scheme></code> and <code><external-scheme></code>. See "Partitioned Cache with Overflow" on page 18-5 for an example configuration.</p>
<code><partitioned-quorum-policy-scheme></code>	Optional	Specifies quorum policy settings for the partitioned cache service.
<code><listener></code>	Optional	Specifies an implementation of a <code>MapListener</code> which is notified of events occurring on the cache.
<code><autostart></code>	Optional	The <code>autostart</code> element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<code><interceptors></code>	Optional	Specifies any number of event interceptors that process events for all caches of a specific distributed service.
<code><async-backup></code>	Optional	Specifies whether the partitioned (distributed) cache service backs up data asynchronously while concurrently responding to the client. Asynchronous backup is often used to increase client performance. However, applications that require strict data integrity must be designed and tested to ensure that data is not at risk. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

external-scheme

Used in: [caching-schemes](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [near-scheme](#), [overflow-scheme](#), [read-write-backing-map-scheme](#)

Description

External schemes define caches which are not JVM heap based, allowing for greater storage capacity. See "[Local Caches \(accessible from a single JVM\)](#)" on page 18-1 for examples of various external cache configurations.

Implementation

This scheme is implemented by:

- `com.tangosol.net.cache.SerializationMap`—for unlimited size caches
- `com.tangosol.net.cache.SerializationCache`—for size limited caches

The implementation type is chosen based on the following rule:

- if the `<high-units>` subelement is specified and not zero then `SerializationCache` is used;
- otherwise `SerializationMap` is used.

Pluggable Storage Manager

External schemes use a pluggable store manager to store and retrieve binary key value pairs. Supported store managers include:

- a wrapper providing asynchronous write capabilities for of other store manager implementations
- allows definition of custom implementations of store managers
- uses Berkeley Database JE to implement an on disk cache
- uses NIO to implement memory-mapped file based cache
- uses NIO to implement an off JVM heap, in-memory cache

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See "[Using the Elastic Data Feature to Store Data](#)" on page 14-7.

Size Limited Cache

The cache may be configured as size-limited, which means that when it reaches its maximum allowable size (that is, the `<high-units>` subelement) it prunes itself.

Note: Eviction against disk-based caches can be expensive, consider using a [paged-external-scheme](#) for such cases.

Entry Expiration

External schemes support automatic expiration of entries based on the age of the value, as configured by the `<expiry-delay>` subelement.

Persistence (long-term storage)

External caches are generally used for temporary storage of large data sets, for example as the back-tier of an [overflow-scheme](#). The Berkly database JE implementation does however support persistence for non-clustered caches, see the `<store-name>` subelement of [bdb-store-manager](#). Clustered persistence should be configured by using a [read-write-backing-map-scheme](#) on a [distributed-scheme](#).

Elements

[Table B-21](#) describes the subelements of the `external-scheme` element.

Table B-21 *external-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information
<code><class-name></code>	Optional	Specifies a custom implementation of the external cache. Any custom implementation must extend either of the following classes: <ul style="list-style-type: none"> ■ <code>com.tangosol.net.cache.SerializationCache</code>—for size limited caches ■ <code>com.tangosol.net.cache.SerializationMap</code>—for unlimited size caches ■ <code>com.tangosol.net.cache.SimpleSerializationMap</code>—for unlimited size caches ■ <code>com.tangosol.net.cache.CompactSerializationCache</code>—for compact on-heap footprint and declare the exact same set of public constructors as the superclass.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom external cache implementations.
<code><async-store-manager></code>	Optional	Configures the external cache to use an asynchronous storage manager wrapper for any other storage manager. See " Pluggable Storage Manager " on page B-40
<code><bdb-store-manager></code>	Optional	Configures the external cache to use Berkeley Database JE on disk databases for cache storage.
<code><custom-store-manager></code>	Optional	Configures the external cache to use a custom storage manager implementation.
<code><nio-file-manager></code>	Optional	Configures the external cache to use a memory-mapped file for cache storage.
<code><nio-memory-manager></code>	Optional	Configures the external cache to use an off JVM heap, memory region for cache storage.

Table B–21 (Cont.) external-scheme Subelements

Element	Required/ Optional	Description
<high-units>	Optional	<p>Specifies the size limit of the cache. The value represents the maximum number of units that can be placed in the cache before pruning occurs. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When this limit is exceeded, the cache begins the pruning process, evicting the least recently used entries until the number of units is brought below this limit. The scheme's <code>class-name</code> element may be used to provide custom extensions to <code>SerializationCache</code>, which implement alternative eviction policies. Legal values are positive integers between 0 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 0 and implies no limit.</p> <p>Note: The value is limited to approximately 2GB by default. To specify higher values, use the <unit-factor> element to change the factor by which the <high-units> value is multiplied.</p>
<unit-calculator>	Optional	<p>Specifies the type of unit calculator to use. A unit calculator is used to determine the cost (in "units") of a given object. This element is used only if the <high-units> element is set to a positive number. Legal values are:</p> <ul style="list-style-type: none"> ■ <code>FIXED</code> – A unit calculator that assigns an equal weight of 1 to all cached objects. ■ <code>BINARY</code> (default) – A unit calculator that assigns an object a weight equal to the number of bytes of memory that are required to cache the object. This calculator is used for partitioned caches that cache data in a binary serialized form. See <code>com.tangosol.net.cache.BinaryMemoryCalculator</code> for additional details. ■ <code><class-scheme></code> – A custom unit calculator, specified as a class scheme. The class specified within this scheme must implement the <code>com.tangosol.net.cache.ConfigurableCacheMap.UnitCalculator</code> interface.

Table B–21 (Cont.) external-scheme Subelements

Element	Required/ Optional	Description
<unit-factor>	Optional	<p>Specifies the factor by which the <low-units> and <high-units> settings are adjusted. Using a BINARY unit calculator, for example, the factor of 1048576 could be used to count megabytes instead of bytes.</p> <p>Note: This element was introduced only to avoid changing the type of the <low-units> and <high-units> settings from 32-bit values to 64-bit values and is only used if the <high-units> element is set to a positive number.</p> <p>Valid values are positive integers. The default value is 1.</p>
<expiry-delay>	Optional	<p>Specifies the amount of time since the last update that entries are kept by the cache before being expired. Entries that have expired are not be accessible and are evicted the next time a client accesses the cache.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. A value of zero implies no expiry. The default value is 0.</p> <p>Note: The expiry delay parameter (<code>cExpiryMillis</code>) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed <code>Integer.MAX_VALUE</code> (2147483647) milliseconds or approximately 24 days.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>

flashjournal-scheme

Used in: back-scheme, [backing-map-scheme](#), [caching-schemes](#), internal-cache-scheme

Description

The flashjournal-scheme element contains the configuration information for a scheme that stores data to external block-based file stores (flash). A flash journal resource manager controls flash journal behavior. See "[flashjournal-manager](#)" on page A-20 for additional details on configuring flash journal behavior.

This scheme uses the `com.tangosol.net.cache.CompactSerializationCache` class as the backing map implementation and the `com.tangosol.io.journal.JournalBinaryStore` to store and retrieve binary key value pairs to a journal.

Elements

[Table B-22](#) describes the subelements of the flashjournal-scheme element.

Table B-22 flashjournal-scheme Subelements

Element	Required/Optional	Description
<scheme-name>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<scheme-ref>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<class-name>	Optional	Specifies a custom implementation of the simple serialization map cache. Any custom implementation must extend the <code>com.tangosol.net.cache.CompactSerializationCache</code> class and declare the exact same set of public constructors as the superclass.
<init-params>	Optional	Specifies the initialization parameters for a custom serialization map cache.
<eviction-policy>	Optional	Specifies the type of eviction policy to use. Legal values are: <ul style="list-style-type: none"> ▪ LRU – Least Recently Used eviction policy chooses which entries to evict based on how recently they were last accessed, evicting those that were not accessed for the longest period first. ▪ LFU – Least Frequently Used eviction policy chooses which entries to evict based on how often they are being accessed, evicting those that are accessed least frequently first. ▪ HYBRID (default) – Hybrid eviction policy chooses which entries to evict based on the combination (weighted score) of how often and recently they were accessed, evicting those that are accessed least frequently and were not accessed for the longest period first. ▪ <class-scheme> – A custom eviction policy, specified as a class scheme. The class specified within this scheme must implement the <code>ConfigurableCacheMap.EvictionPolicy</code> interface or extend the <code>AbstractEvictionPolicy</code> class.

Table B–22 (Cont.) flashjournal-scheme Subelements

Element	Required/ Optional	Description
<high-units>	Optional	<p>Specifies the size limit of the cache. The value represents the maximum number of units that can be placed in the cache before pruning occurs. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When this limit is exceeded, the cache begins the pruning process and evicts entries according to the eviction policy. Legal values are positive integers between 0 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 0 and implies no limit.</p> <p>Note: The value is limited to approximately 2GB by default. To specify higher values, use the <unit-factor> element to change the factor by which the <high-units> value is multiplied.</p>
<low-units>	Optional	<p>Specifies the lowest number of units that a cache is pruned down to when pruning takes place. A pruning does not necessarily result in a cache containing this number of units; however, a pruning never results in a cache containing less than this number of units. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When pruning occurs entries continue to be evicted according to the eviction policy until this size. Legal values are positive integers or zero. Zero implies the default. The default value is 80% of the <high-units> setting (that is, for a <high-units> setting of 1000 the default <low-units> is 800).</p>
<unit-calculator>	Optional	<p>Specifies the type of unit calculator to use. A unit calculator is used to determine the cost (in "units") of a given object. This element is used only if the <high-units> element is set to a positive number. Legal values are:</p> <ul style="list-style-type: none"> ■ FIXED – A unit calculator that assigns an equal weight of 1 to all cached objects. ■ BINARY (default) – A unit calculator that assigns an object a weight equal to the number of bytes of memory that are required to cache the object. This calculator is used for partitioned caches that cache data in a binary serialized form. See <code>com.tangosol.net.cache.BinaryMemoryCalculator</code> for additional details. ■ <class-scheme> – A custom unit calculator, specified as a class scheme. The class specified within this scheme must implement the <code>com.tangosol.net.cache.ConfigurableCacheMap.UnitCalculator</code> interface.

Table B–22 (Cont.) flashjournal-scheme Subelements

Element	Required/ Optional	Description
<unit-factor>	Optional	<p>Specifies the factor by which the <low-units> and <high-units> settings are adjusted. Using a BINARY unit calculator, for example, the factor of 1048576 could be used to count megabytes instead of bytes.</p> <p>Note: This element was introduced only to avoid changing the type of the <low-units> and <high-units> settings from 32-bit values to 64-bit values and is only used if the <high-units> element is set to a positive number.</p> <p>Valid values are positive integers. The default value is 1.</p>
<expiry-delay>	Optional	<p>Specifies the amount of time since the last update that entries are kept by the cache before being expired. Entries that have expired are not accessible and are evicted the next time a client accesses the cache.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. A value of zero implies no expiry. The default value is 0.</p> <p>Note: The expiry delay parameter (<code>cExpiryMillis</code>) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed <code>Integer.MAX_VALUE</code> (2147483647) milliseconds or approximately 24 days.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>

front-scheme

Used in: [near-scheme](#), [overflow-scheme](#)

Description

The front-scheme element specifies the front-tier cache of a composite cache.

Elements

[Table B-23](#) describes the subelements of the `front-scheme` element.

Table B-23 *front-scheme Subelements*

Element	Required/ Optional	Description
<code><local-scheme></code>	Optional	Local cache schemes define in-memory "local" caches. Local caches are generally nested within other cache schemes, for instance as the front-tier of a near scheme.
<code><class-scheme></code>	Optional	Class schemes provide a mechanism for instantiating an arbitrary Java object for use by other schemes. The scheme which contains this element dictates what class or interface(s) must be extended.

http-acceptor

Used in [acceptor-config](#)

Description

The http-acceptor element specifies an acceptor for connections from remote REST clients over HTTP.

Elements

[Table B–24](#) describes the subelements of the http-acceptor element.

Table B–24 *http-acceptor subelements*

Elements	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies an HTTP server class that implements the <code>com.tangosol.coherence.rest.server.HttpServer</code> interface. The HTTP server class handles inbound HTTP requests. Coherence REST provides two implementations out of the box: <code>com.tangosol.coherence.rest.server.DefaultHttpServer</code> (backed by Oracle's lightweight HTTP server) and <code>com.tangosol.coherence.rest.server.GrizzlyHttpServer</code> (backed by Grizzly). The default value if no value is specified is <code>com.tangosol.coherence.rest.server.DefaultHttpServer</code> .
<code><init-params></code>	Optional	Contains class initialization parameters for the HTTP server class.
<code><socket-provider></code>	Optional	Specifies the configuration for a socket and channel factory.
<code><local-address></code>	Required	Specifies the local address (IP, or DNS name, and port) on which the HTTP server socket is bound.
<code><resource-config></code>	Optional	Specifies a Jersey resource configuration class that is used by the HTTP acceptor to load resource and provider classes.
<code><auth-method></code>	Optional	Specifies the authentication mechanism for the HTTP server. A client must have authenticated using the configured mechanism as a prerequisite to gaining access to any resources exposed by the server. Legal values are: <ul style="list-style-type: none"> ▪ <code>basic</code> – This method requires the client to be authenticated using HTTP basic authentication. ▪ <code>cert</code> – This method requires the client to be authenticated using client-side SSL certificate-based authentication. The certificate must be passed to the server to authenticate. An SSL-based socket provider must be configured using the <code><socket-provider></code> element. ▪ <code>cert+basic</code> – This method requires the client to be authenticated using both client-side SSL certificate and HTTP basic authentication. ▪ <code>none (default)</code> – This method does not require the client to be authenticated.

identity-manager

Used in: [ssl](#).

Description

The <identity-manager> element contains the configuration information for initializing a `javax.net.ssl.KeyManager` instance.

The identity manager is responsible for managing the key material which is used to authenticate the local connection to its peer. If no key material is available, the connection cannot present authentication credentials.

Elements

[Table B–25](#) describes the elements you can define within the `identity-manager` element.

Table B–25 *identity-manager* Subelements

Element	Required/ Optional	Description
<algorithm>	Optional	Specifies the algorithm used by the identity manager. The default value is <code>SunX509</code> .
<provider>	Optional	Specifies the configuration for a security provider instance.
<key-store>	Optional	Specifies the configuration for a key store implementation.
<password>	Required	Specifies the private key password.

incoming-message-handler

Used in: [acceptor-config](#), [initiator-config](#).

Description

The <incoming-message-handler> element contains the configuration information that is used to regulate client-to-cluster connection resource usage. Connection initiators and acceptors use this information to proactively detect and release connections that use excessive resources.

Elements

[Table B–25](#) describes the elements you can define within the incoming-message-handler element.

Table B–26 *incoming-message-handler Subelements*

Element	Required/ Optional	Description
max-message-size	Optional	<p>Specifies the size limit of messages being sent over Coherence*Extend connections. The value of this element must be in the following format:</p> <pre>(\d)+[K k M m G g T t]?[B b]?</pre> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2¹⁰) ■ M or m (mega, 2²⁰) ■ G or g (giga, 2³⁰) ■ T or t (tera, 2⁴⁰) <p>If the value does not contain a factor, a factor of kilo is assumed. Legal values are positive integers between 0 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 0 and indicates that there is no limit on the message size.</p>

initiator-config

Used in: [remote-cache-scheme](#), [remote-invocation-scheme](#).

Description

The `initiator-config` element specifies the configuration information for a TCP/IP connection initiator. A connection initiator allows a Coherence*Extend client to connect to a cluster (by using a connection acceptor) and use the clustered services offered by the cluster without having to first join the cluster.

Elements

Table B-27 describes the subelements of the `initiator-config` element.

Table B-27 *initiator-config* Subelements

Element	Required/Optional	Description
<code><tcp-initiator></code>	Optional	Specifies the configuration information for a connection initiator that connects to the cluster over TCP/IP.
<code><incoming-message-handler></code>	Optional	Specifies the configuration information that is used to regulate client-to-cluster connection resource usage.
<code><outgoing-message-handler></code>	Optional	Specifies the configuration information used by the connection initiator to detect dropped client-to-cluster connections.
<code><use-filters></code>	Optional	<p>Contains the list of filter names to be used by this connection acceptor. For example, specifying <code><use-filter></code> as follows activates gzip compression for all network messages, which can help substantially with WAN and low-bandwidth networks.</p> <pre><use-filters> <filter-name>gzip</filter-name> </use-filters></pre>
<code><serializer></code>	Optional	<p>Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see "serializer" on page A-59).</p>
<code><connect-timeout></code>	Optional	<p>Specifies the maximum amount of time to wait while establishing a connection with a connection acceptor. The value of this element must be in the following format:</p> <pre>(\d)+((\.\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. The default value is an infinite timeout.</p>

init-param

Used in: [init-params](#).

Description

Defines an individual initialization parameter.

Elements

[Table B–28](#) describes the subelements of the `init-param` element.

Table B–28 *init-param Subelements*

Element	Required/Optional	Description
<code><param-name></code>	Optional	<p>Specifies the name of the initialization parameter. For example:</p> <pre><init-param> <param-name>sTableName</param-name> <param-value>EmployeeTable</param-value> </init-param></pre> <p>The <code><param-name></code> element cannot be specified if the <code><param-type></code> element is specified.</p>
<code><param-type></code>	Optional	<p>Specifies the Java type of the initialization parameter. The following standard types are supported:</p> <ul style="list-style-type: none"> ▪ <code>java.lang.String</code> (string) ▪ <code>java.lang.Boolean</code> (boolean) ▪ <code>java.lang.Integer</code> (int) ▪ <code>java.lang.Long</code> (long) ▪ <code>java.lang.Double</code> (double) ▪ <code>java.math.BigDecimal</code> ▪ <code>java.io.File</code> ▪ <code>java.sql.Date</code> ▪ <code>java.sql.Time</code> ▪ <code>java.sql.Timestamp</code> <p>For example:</p> <pre><init-param> <param-type>java.lang.String</param-type> <param-value>EmployeeTable</param-value> </init-param></pre> <p>The <code><param-type></code> element cannot be specified if the <code><param-name></code> element is specified.</p>
<code><param-value></code>	Required	<p>Specifies the value of the initialization parameter. The value is in the format specific to the Java type of the parameter.</p>
<code><description></code>	Optional	<p>Specifies a description for the initialization parameter.</p>

init-params

Used in: [class-scheme](#), [cache-mapping](#).

Description

Defines a series of initialization parameters as name-value pairs. See "[Partitioned Cache of a Database](#)" on page 18-6 for an example of using `init-params`.

Elements

[Table B-29](#) describes the subelements of the `init-params` element.

Table B-29 *init-params* Subelements

Element	Required/ Optional	Description
<code><init-param></code>	Optional	Defines an individual initialization parameter.

instance

Used in: [interceptor](#), [serializer](#), service-failure-policy, load-balancer, and partition-assignment-strategy

Description

The <instance> element contains the configuration of an implementation class or class factory that is used to plug in custom functionality.

Elements

[Table B-30](#) describes the subelements of the instance element.

Table B-30 instance Subelements

Element	Required/ Optional	Description
<class-name>	Optional	Specifies the fully qualified name of an implementation class. This element cannot be used with the <class-factory-name> element.
<class-factory-name>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <class-name> element and is used with the <method-name> element.
<method-name>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<init-params>	Optional	Contains class initialization parameters for the implementation class.

interceptor

Used in: [interceptors](#)

Description

The `interceptor` element defines the configuration associated with an event interceptor that is responsible for processing live events. Event interceptors extend the `com.tangosol.net.events.AbstractConfigurableEventInterceptor` class. The base class provides the ability to restrict an event interceptor to a specific cache or service. The base class also provides support for the `@Interceptor` annotation, which allows an implementation to register for a subset of events based on event types and to configure an event interceptor identifier and the ordering of event interceptors. Specifying an interceptor's identifier and ordering within the `interceptor` element overrides the settings in the base class.

Elements

[Table B-31](#) describes the subelements of the `interceptor` element.

Table B-31 *interceptor Subelements*

Element	Required/ Optional	Description
<code><name></code>	Optional	Specifies a unique identifier for the interceptor.
<code><order></code>	Optional	Specifies whether the interceptor is the first interceptor in a chain of interceptors. The legal values are <code>LOW</code> and <code>HIGH</code> . A value of <code>HIGH</code> indicates that the interceptor is first in the chain of interceptors. A value of <code>LOW</code> indicates no order preference. The default value is <code>LOW</code> .
<code><instance></code>	Required	Specifies the interceptor class to instantiate. The interceptor class must extend the <code>AbstractConfigurableEventInterceptor</code> class.

interceptors

Used in: [cache-mapping](#) and [distributed-scheme](#)

Description

The `interceptors` element contains any number of event interceptor definitions.

Elements

[Table B-32](#) describes the subelements of the `interceptors` element.

Table B-32 *interceptors Subelements*

Element	Required/ Optional	Description
<code><interceptor></code>	Optional	Specifies an event interceptor implementation.

invocation-scheme

Used in: [caching-schemes](#).

Description

Defines an Invocation Service. The invocation service may be used to perform custom operations in parallel on any number of cluster nodes. See the `com.tangosol.net.InvocationService` API for additional details.

Elements

[Table B-33](#) describes the subelements of the `invocation-scheme` element.

Table B-33 *invocation-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service which manages invocations from this scheme.
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>service-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>service-priority</code> parameter in " Invocation Service Parameters " on page A-74.
<code><event-dispatcher-priority></code>	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>event-dispatcher-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>event-dispatcher-priority</code> parameter in " Invocation Service Parameters " on page A-74.
<code><serializer></code>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see " serializer " on page A-59).

Table B-33 (Cont.) invocation-scheme Subelements

Element	Required/Optional	Description
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the tangosol-coherence.xml descriptor. See the reliable-transport parameter in "Invocation Service Parameters" on page A-74 for more information.</p>
<thread-count>	Optional	<p>Specifies the number of daemon threads used by the invocation service. Legal values are positive integers, 0, or -1. The value 0 indicates that all relevant tasks are performed on the service thread. The value -1 indicates that tasks are performed on the caller's thread where possible. The default value is the thread-count value specified in the tangosol-coherence.xml descriptor. See "Invocation Service Parameters" on page A-74 for more information.</p>
<worker-priority>	Optional	<p>Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the worker-priority value specified in the tangosol-coherence.xml descriptor. See the worker-priority parameter in "Invocation Service Parameters" on page A-74.</p>
<task-hung-threshold>	Optional	<p>Specifies the amount of time in milliseconds that a task can execute before it is considered "hung". Note: a posted task that has not yet started is never considered as hung. This attribute is applied only if the Thread pool is used (the thread-count value is positive). Legal values are positive integers or zero (indicating no default timeout). The default value is the task-hung-threshold value specified in the tangosol-coherence.xml descriptor. See the task-hung-threshold parameter in "Invocation Service Parameters" on page A-74.</p>

Table B-33 (Cont.) invocation-scheme Subelements

Element	Required/ Optional	Description
<task-timeout>	Optional	<p>Specifies the default timeout value for tasks that can time out (for example, implement the <code>com.tangosol.net.PriorityTask</code> interface), but do not explicitly specify the task execution timeout value. The task execution time is measured on the server side and does not include the time spent waiting in a service backlog queue before being started. This attribute is applied only if the thread pool is used (the <code>thread-count</code> value is positive). If zero is specified, the default service-guardian <code><timeout-milliseconds></code> value is used. Legal values are nonnegative integers. The default value is the <code>task-timeout</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>task-timeout</code> parameter in "Invocation Service Parameters" on page A-74.</p>
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>Legal values are positive integers or zero (indicating no default timeout). The default value is the <code>request-timeout</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>request-timeout</code> parameter in "Invocation Service Parameters" on page A-74.</p>
<guardian-timeout>	Optional	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See <service-guardian>.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+(.(\d+)?[MS ms S s M m H h D d]?)</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>

Table B–33 (Cont.) invocation-scheme Subelements

Element	Required/ Optional	Description
<service-failure-policy>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – an <instance> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<member-listener>	Optional	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives service lifecycle events. The <member-listener> element is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
<autostart>	Optional	<p>The autostart element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether this service should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>

invocation-service-proxy

Used in: [proxy-config](#)

Description

The `invocation-service-proxy` element contains the configuration information for an invocation service proxy managed by a proxy service.

Elements

[Table B-34](#) describes the subelements of the `invocation-service-proxy` element.

Table B-34 *invocation-service-proxy Subelement*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies the fully qualified name of a class that implements the <code>com.tangosol.net.InvocationService</code> interface. The class acts as an interceptor between a client and a proxied invocation service to implement custom processing as required. For example, the class could be used to perform authorization checks before allowing the use of the proxied invocation service.
<code><init-params></code>	Optional	Contains initialization parameters for the <code>InvocationService</code> implementation.
<code><enabled></code>	Optional	Specifies whether the invocation service proxy is enabled. If disabled, clients are not able to execute <code>Invocable</code> objects on the proxy service JVM. Legal values are <code>true</code> or <code>false</code> . The default value is <code>true</code> .

key-associator

Used in: [distributed-scheme](#)

Description

Specifies an implementation of a `com.tangosol.net.partition.KeyAssociator` which is used to determine associations between keys, allowing related keys to reside on the same partition.

Alternatively the cache's keys may manage the association by implementing the `com.tangosol.net.cache.KeyAssociation` interface.

Elements

[Table B-35](#) describes the subelements of the `key-associator` element.

Table B-35 *key-associator Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	The name of a class that implements the <code>com.tangosol.net.partition.KeyAssociator</code> interface. This implementation must have a zero-parameter public constructor. The default value is the value of the <code>key-associator</code> parameter specified in the <code>tangosol.coherence.xml</code> descriptor. See " DistributedCache Service Parameters " on page A-63 for more information.
<code><class-factory-name></code>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <code><class-name></code> element and is used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the implementation class.

key-partitioning

Used in: [distributed-scheme](#)

Description

Specifies an implementation of a `com.tangosol.net.partition.KeyPartitioningStrategy` which is used to determine the partition in which a key resides.

Elements

[Table B-36](#) describes the subelements of the `key-partitioning` element.

Table B-36 *key-partitioning Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	The name of a class that implements the <code>com.tangosol.net.partition.KeyPartitioningStrategy</code> interface. This implementation must have a zero-parameter public constructor. The default value is the value of the <code>key-partitioning</code> parameter specified in the <code>tangosol-coherence.xml</code> descriptor. See " DistributedCache Service Parameters " on page A-63 for more information.
<code><class-factory-name></code>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <code><class-name></code> element and is used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the implementation class.

key-store

Used in: [identity-manager](#), [trust-manager](#).

Description

The `key-store` element specifies the configuration for a key store implementation to use when implementing SSL. The key store implementation is an instance of the `java.security.KeyStore` class.

Elements

[Table B-37](#) describes the elements you can define within the `key-store` element.

Table B-37 *key-store Subelements*

Element	Required/ Optional	Description
<url>	Required	Specifies the Uniform Resource Locator (URL) to a key store.
<password>	Optional	Specifies the password for the key store.
<type>	Optional	Specifies the type of a <code>java.security.KeyStore</code> instance. The default value is JKS.

listener

Used in: [local-scheme](#), [external-scheme](#), [paged-external-scheme](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [near-scheme](#), [overflow-scheme](#), [read-write-backing-map-scheme](#)

Description

The Listener element specifies an implementation of a `com.tangosol.util.MapListener` which is notified of events occurring on a cache.

Elements

[Table B-38](#) describes the subelements of the `listener` element.

Table B-38 *listener* Subelement

Element	Required/ Optional	Description
<code><class-scheme></code>	Required	Specifies the full class name of the listener implementation to use. The specified class must implement the <code>com.tangosol.util.MapListener</code> interface.

local-address

Used in: [http-acceptor](#), [tcp-acceptor](#), [tcp-initiator](#)

Description

The `local-address` element specifies the local address (IP, or DNS name, and port) to which a socket is bound.

A local address for the `<tcp-acceptor>` element specifies a TCP/IP server socket that is used by the proxy service to accept connections from Coherence*Extend clients. A local address for the `<http-acceptor>` element specifies a HTTP server socket that is used to accept connections from REST clients. The following example binds a server socket to `192.168.0.2:9099`.

```
<local-address>
  <address>192.168.0.2</address>
  <port>9099</port>
</local-address>
```

A local address for the `<tcp-initiator>` element specifies a TCP/IP client socket that is used by remote services to connect to a proxy service on the cluster. The following example binds the client socket to `192.168.0.1` on port `9099`:

```
<local-address>
  <address>192.168.0.1</address>
  <port>9099</port>
</local-address>
```

Note: A socket addresses for the TCP/IP acceptor can also be defined using an `address-provider` element. For details, see "[address-provider](#)" on page B-8.

Elements

[Table B-65](#) describes the subelements of the `local-address` element.

Table B-39 *local-address Subelements*

Element	Required/Optional	Description
<code><address></code>	Optional	Specifies the address (IP or DNS name) on which a socket listens and publishes. If the address is a bind address, then the address may also be entered using CIDR notation as a subnet and mask (for example, <code>192.168.1.0/24</code>), which allows runtime resolution against the available local IP addresses.
<code><port></code>	Optional	Specifies the port on which a TCP/IP socket listens and publishes. The legal values are from 1 to 65535.

local-scheme

Used in: [caching-schemes](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [near-scheme](#), [front-scheme](#), [overflow-scheme](#), [read-write-backing-map-scheme](#), [backing-map-scheme](#)

Description

Local cache schemes define in-memory "local" caches. Local caches are generally nested within other cache schemes, for instance as the front-tier of a [near-scheme](#). See "Near Cache" on page 18-8 for examples of various local cache configurations.

Implementation

Local caches are implemented by the `com.tangosol.net.cache.LocalCache` class.

Cache of an External Store

A local cache may be backed by an external cache store (see "[cachestore-scheme](#)" on page B-25). Cache misses are read-through to the back end store to retrieve the data. If a writable store is provided, cache writes are also propagate to the cache store. For optimizing read/write access against a cache store, see the "[read-write-backing-map-scheme](#)" on page B-104.

Size Limited Cache

The cache may be configured as size-limited, which means that when it reaches its maximum allowable size (see the `<high-units>` subelement) it prunes itself back to a specified smaller size (see the `<low-units>` subelement), choosing which entries to evict according to its `<eviction-policy>` subelement). The entries and size limitations are measured in terms of units as calculated by the scheme's unit calculator (see the `<unit-calculator>` subelement).

Entry Expiration

The local cache supports automatic expiration of entries based on the age of the value (see the `<expiry-delay>` subelement).

Elements

[Table B-40](#) describes the subelements of the `local-scheme` element.

Table B-40 *local-scheme* Subelements

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the local cache. Any custom implementation must extend the <code>com.tangosol.net.cache.LocalCache</code> class and declare the exact same set of public constructors.

Table B–40 (Cont.) local-scheme Subelements

Element	Required/ Optional	Description
<service-name>	Optional	Specifies the name of the service which manages caches created from this scheme. Services are configured from within the <services> element in the tangosol-coherence.xml descriptor. See Appendix A, "Operational Configuration Elements" for more information.
<init-params>	Optional	Specifies initialization parameters, for use in custom local cache implementations.
<eviction-policy>	Optional	Specifies the type of eviction policy to use. Legal values are: <ul style="list-style-type: none"> ▪ LRU – Least Recently Used eviction policy chooses which entries to evict based on how recently they were last accessed, evicting those that were not accessed for the longest period first. ▪ LFU – Least Frequently Used eviction policy chooses which entries to evict based on how often they are being accessed, evicting those that are accessed least frequently first. ▪ HYBRID (default) – Hybrid eviction policy chooses which entries to evict based on the combination (weighted score) of how often and recently they were accessed, evicting those that are accessed least frequently and were not accessed for the longest period first. ▪ <class-scheme> – A custom eviction policy, specified as a class scheme. The class specified within this scheme must implement the ConfigurableCacheMap.EvictionPolicy interface or extend the AbstractEvictionPolicy class.
<high-units>	Optional	Specifies the size limit of the cache. The value represents the maximum number of units that can be placed in the cache before pruning occurs. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When this limit is exceeded, the cache begins the pruning process and evicts entries according to the eviction policy. Legal values are positive integers between 0 and Integer.MAX_VALUE (2147483647). The default value is 0 and implies no limit. Note: The value is limited to approximately 2GB by default. To specify higher values, use the <unit-factor> element to change the factor by which the <high-units> value is multiplied.
<low-units>	Optional	Specifies the lowest number of units that a cache is pruned down to when pruning takes place. A pruning does not necessarily result in a cache containing this number of units; however, a pruning never results in a cache containing less than this number of units. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When pruning occurs entries continue to be evicted according to the eviction policy until this size. Legal values are positive integers or zero. Zero implies the default. The default value is 80% of the <high-units> setting (that is, for a <high-units> setting of 1000 the default <low-units> is 800).

Table B-40 (Cont.) local-scheme Subelements

Element	Required/ Optional	Description
<unit-calculator>	Optional	<p>Specifies the type of unit calculator to use. A unit calculator is used to determine the cost (in "units") of a given object. This element is used only if the <high-units> element is set to a positive number. Legal values are:</p> <ul style="list-style-type: none"> ■ <code>FIXED</code> – A unit calculator that assigns an equal weight of 1 to all cached objects. ■ <code>BINARY</code> (default) – A unit calculator that assigns an object a weight equal to the number of bytes of memory that are required to cache the object. This calculator is used for partitioned caches that cache data in a binary serialized form. See <code>com.tangosol.net.cache.BinaryMemoryCalculator</code> for additional details. ■ <code><class-scheme></code> – A custom unit calculator, specified as a class scheme. The class specified within this scheme must implement the <code>com.tangosol.net.cache.ConfigurableCacheMap.UnitCalculator</code> interface.
<unit-factor>	Optional	<p>Specifies the factor by which the <low-units> and <high-units> settings are adjusted. Using a <code>BINARY</code> unit calculator, for example, the factor of 1048576 could be used to count megabytes instead of bytes.</p> <p>Note: This element was introduced only to avoid changing the type of the <low-units> and <high-units> settings from 32-bit values to 64-bit values and is only used if the <high-units> element is set to a positive number.</p> <p>Valid values are positive integers. The default value is 1.</p>
<expiry-delay>	Optional	<p>Specifies the amount of time since the last update that entries are kept by the cache before being expired. Entries that have expired are not accessible and are evicted the next time a client accesses the cache. When using a cache store, any attempt to read an expired entry results in a reloading of the entry from the configured cache store (see <cachestore-scheme>).</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ <code>MS</code> or <code>ms</code> (milliseconds) ■ <code>S</code> or <code>s</code> (seconds) ■ <code>M</code> or <code>m</code> (minutes) ■ <code>H</code> or <code>h</code> (hours) ■ <code>D</code> or <code>d</code> (days) <p>If the value does not contain a unit, a unit of seconds is assumed. A value of zero implies no expiry. The default value is 0.</p> <p>Note: The expiry delay parameter (<code>cExpiryMillis</code>) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed <code>Integer.MAX_VALUE</code> (2147483647) milliseconds or approximately 24 days.</p>

Table B–40 (Cont.) local-scheme Subelements

Element	Required/ Optional	Description
<code><cachestore-scheme></code>	Optional	Specifies the store which is being cached. If unspecified the cached data only resides in memory, and only reflects operations performed on the cache itself.
<code><pre-load></code>	Optional	Specifies whether a cache pre-loads data from its CacheLoader (or CacheStore) object. Valid values are true and false. The default value is false.
<code><listener></code>	Optional	Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.

memcached-acceptor

Used in: [acceptor-config](#)

Description

The `memcached-acceptor` element contains the configuration information for an acceptor that accepts connections from remote memcached clients over TCP/IP. The acceptor allows memcached clients to use a Coherence cache over the memcached binary protocol.

Elements

[Table B–41](#) describes the subelements of the `memcached-acceptor` element.

Table B–41 *memcached-acceptor Subelements*

Element	Required/ Optional	Description
<code><cache-name></code>	Required	Specifies the cache that is used by memcached clients that connect to the memcached acceptor. The cache name is resolved to an actual cache scheme using cache mappings. See " cache-mapping " on page B-23 for details. The cache name must resolve to a partitioned cache scheme.
<code><interop-enabled></code>	Optional	Specifies whether the memcached acceptor can by-pass the configured cache service serializer while storing the values in the cache. This is only required when sharing data between Coherence*Extend and memcached clients. The assumption is that memcached clients are using a Coherence serializer, like the POF serializer, to convert the objects into <code>byte[]</code> and the cache service is also using the same serializer. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<code><memcached-auth-method></code>	Optional	Specifies the authentication mechanism for the memcached acceptor. A client must authenticate using the configured mechanism to gain access to any resources exposed by the server. Legal values are <code>plain</code> (SASL PLAIN) and <code>none</code> . The default value is <code>none</code> .
<code><socket-provider></code>	Optional	Specifies the configuration for a socket and channel factory.
<code><address-provider></code>	Required	Specifies either the local address (IP, or DNS name, and port) on which the TCP/IP server socket is bound or an implementation of the <code>com.tangosol.net.AddressProvider</code> interface that programmatically provides a socket address. The <code>address-provider</code> element also supports socket address references.

name-service-addresses

Used in: [tcp-initiator](#)

Description

The `name-service-addresses` element contains the address (IP, or DNS name, and port) of one or more name service TCP/IP acceptors. A TCP/IP initiator uses this information to establish a connection with a remote cluster. The TCP/IP initiator attempts to connect to the addresses in a random order until either the list is exhausted or a connection is established. See *Developing Remote Clients for Oracle Coherence* for additional details and example configurations.

Elements

[Table B-42](#) describes the subelements of the `name-service-addresses` element.

Table B-42 *name-service-addresses* Subelements

Element	Required/ Optional	Description
<code><socket-address></code>	Optional	Specifies the address (IP, or DNS name, and port) on which a name service TCP/IP acceptor is listening. Multiple <code><socket-address></code> elements can be defined.
<code><address-provider></code>	Optional	Specifies the address (IP, or DNS name, and port) on which a name service TCP/IP acceptor is listening or the configuration for a <code>com.tangosol.net.AddressProvider</code> implementation that supplies the address. The <code>address-provider</code> element also supports socket address references. A <code><name-services-addresses></code> element can include either a <code><socket-address></code> element or an <code><address-provider></code> element but not both.

near-scheme

Used in: [caching-schemes](#).

Description

The `near-scheme` defines a two-tier cache consisting of a front-tier which caches a subset of a back-tier cache. The front-tier is generally a fast, size limited cache, while the back-tier is slower, but much higher capacity cache. A typical deployment might use a local cache for the front-tier, and a distributed cache for the back-tier. The result is that a portion of a large partitioned cache is cached locally in-memory allowing for very fast read access. See "[Understanding Near Caches](#)" on page 12-8 for a more detailed description of near caches, and "[Near Cache](#)" on page 18-8 for an example of near cache configurations.

Implementation

The near scheme is implemented by the `com.tangosol.net.cache.NearCache` class.

Front-tier Invalidation

The `<invalidation-strategy>` subelement defines a strategy that is used to keep the front tier of the near cache synchronized with the back tier. Depending on that strategy, a near cache is configured to listen to certain events occurring on the back tier and automatically update (or invalidate) the front portion of the near cache.

Elements

[Table B-43](#) describes the subelements of the `near-scheme` element.

Table B-43 *near-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the near cache. Any custom implementation must extend the <code>com.tangosol.net.cache.NearCache</code> class and declare the exact same set of public constructors.
<code><init-params></code>	Optional	Specifies initialization parameters for custom near cache implementations.
<code><front-scheme></code>	Required	Specifies the cache to use as the front-tier cache.
<code><back-scheme></code>	Required	Specifies the cache to use as the front-tier cache.

Table B-43 (Cont.) near-scheme Subelements

Element	Required/ Optional	Description
<invalidation-strategy>	Optional	<p>Specifies the strategy used keep the front-tier in-sync with the back-tier. Please see <code>com.tangosol.net.cache.NearCache</code> for more details. Legal values are:</p> <ul style="list-style-type: none"> ■ <code>auto</code> (default) – This strategy is identical to the <code>present</code> strategy. ■ <code>none</code> – instructs the cache not to listen for invalidation events at all. This is the best choice for raw performance and scalability when business requirements permit the use of data which might not be absolutely current. Freshness of data can be guaranteed by use of a sufficiently brief eviction policy. The worst case performance is identical to a standard Distributed cache. ■ <code>present</code> – instructs the near cache to listen to the back map events related only to the items currently present in the front map. This strategy works best when cluster nodes have sticky data access patterns (for example, HTTP session management with a sticky load balancer). ■ <code>all</code> – instructs the near cache to listen to all back map events. This strategy is optimal for read-heavy access patterns where there is significant overlap between the front caches on each cluster member. ■ <code>logical</code> – instructs a near cache to listen to all backing map events that are not synthetic deletes. A synthetic delete event could be emitted as a result of eviction or expiration. With this invalidation strategy, it is possible for the front map to contain cache entries that have been synthetically removed from the backing map. Any subsequent re-insertion of the entries to the backing map causes the corresponding entries in the front map to be invalidated.
<listener>	Optional	Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.
<autostart>	Optional	The <code>autostart</code> element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

nio-file-manager

Used in: [external-scheme](#), [paged-external-scheme](#), [async-store-manager](#).

Description

Configures an external store which uses memory-mapped file for storage.

Implementation

This store manager is implemented by the `com.tangosol.io.nio.MappedStoreManager` class. The `BinaryStore` objects created by this class are instances of the `com.tangosol.io.nio.BinaryMapStore`.

Elements

[Table B-44](#) describes the subelements of the `nio-file-manager` element.

Table B-44 *nio-file-manager* Subelements

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies a custom implementation of the local cache. Any custom implementation must extend the <code>com.tangosol.io.nio.MappedStoreManager</code> class and declare the exact same set of public constructors.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom <code>nio-file-manager</code> implementations.

Table B–44 (Cont.) nio-file-manager Subelements

Element	Required/ Optional	Description
<initial-size>	Optional	<p>Specifies the initial buffer size in megabytes. The value of this element must be in the following format:</p> <p>$(\backslash d) + [K k M m G g T t]?[B b]?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ▪ K or k (kilo, 2^{10}) ▪ M or m (mega, 2^{20}) ▪ G or g (giga, 2^{30}) ▪ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1MB.</p>
<maximum-size>	Optional	<p>Specifies the maximum buffer size in bytes. The value of this element must be in the following format:</p> <p>$(\backslash d) + [K k M m G g T t]?[B b]?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ▪ K or k (kilo, 2^{10}) ▪ M or m (mega, 2^{20}) ▪ G or g (giga, 2^{30}) ▪ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1024MB.</p>
<directory>	Optional	<p>Specifies the path name for the root directory that the manager uses to store files in. If not specified or specifies a non-existent directory, a temporary file in the default location is used.</p>

nio-memory-manager

Used in: [external-scheme](#), [paged-external-scheme](#), [async-store-manager](#).

Description

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See ["Using the Elastic Data Feature to Store Data"](#) on page 14-7.

Configures a store-manager which uses an off JVM heap, memory region for storage, which means that it does not affect the Java heap size and the related JVM garbage-collection performance that can be responsible for application pauses. See ["NIO In-memory Cache"](#) on page 18-3 for an example of an NIO cache configuration.

Note: JVMs require the use of a command line parameter if the total NIO buffers is greater than 64MB. For example:
`-XX:MaxDirectMemorySize=512M`

Implementation

Implemented by the `com.tangosol.io.nio.DirectStoreManager` class. The `BinaryStore` objects created by this class are instances of the `com.tangosol.io.nio.BinaryMapStore`.

Elements

[Table B-45](#) describes the subelements of the `nio-memory-manager` element.

Table B-45 *nio-memory-manager Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Optional	Specifies a custom implementation of the local cache. Any custom implementation must extend the <code>com.tangosol.io.nio.DirectStoreManager</code> class and declare the exact same set of public constructors.

Table B–45 (Cont.) nio-memory-manager Subelements

Element	Required/ Optional	Description
<init-params>	Optional	Specifies initialization parameters, for use in custom nio-memory-manager implementations.
<initial-size>	Optional	<p>Specifies the initial buffer size in bytes. The value of this element must be in the following format:</p> <p>$(\backslash d) + [K k M m G g T t]? [B b]?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1MB.</p>
<maximum-size>	Optional	<p>Specifies the maximum buffer size in bytes. The value of this element must be in the following format:</p> <p>$(\backslash d) + [K k M m G g T t]? [B b]?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of mega is assumed. Legal values are positive integers between 1 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 1024MB.</p>

operation-bundling

Used in: [cachestore-scheme](#), [distributed-scheme](#), [remote-cache-scheme](#).

Description

The `operation-bundling` element specifies the configuration information for a particular bundling strategy.

Bundling is a process of coalescing multiple individual operations into "bundles". It could be beneficial when

- there is a continuous stream of operations on multiple threads in parallel;
- individual operations have relatively high latency (network or database-related); and
- there are functionally analogous "bulk" operations that take a collection of arguments instead of a single one without causing the latency to grow linearly (as a function of the collection size).

Note:

- As with any bundling algorithm, there is a natural trade-off between the resource utilization and average request latency. Depending on a particular application usage pattern, enabling this feature may either help or hurt the overall application performance.
 - Operation bundling affects cache store operations. If operation bundling is configured, the `CacheStore.storeAll()` method is always called even if there is only one ripe entry.
-
-

See `com.tangosol.net.cache.AbstractBundler` for additional implementation details.

Elements

[Table B-46](#) describes the subelement for the `operation-bundling` element.

Table B-46 *operation-bundling Subelement*

Element	Required/ Optional	Description
<code><bundle-config></code>	Required	Describes one or more bundle-able operations.

optimistic-scheme

Used in: [caching-schemes](#), [near-scheme](#), [overflow-scheme](#)

The optimistic scheme defines a cache which fully replicates all of its data to all cluster nodes that run the service (see `<service-name>` subelement). See "[Understanding Optimistic Caches](#)" on page 12-7 for a more detailed description of optimistic caches.

Optimistic Locking

Unlike the [replicated-scheme](#) and [distributed-scheme](#) caches, optimistic caches do not support concurrency control (locking). Individual operations against entries are atomic but there is no guarantee that the value stored in the cache does not change between atomic operations. The lack of concurrency control allows optimistic caches to support very fast write operations.

Cache Storage (Backing Map)

Storage for the cache is specified by using the `<backing-map-scheme>` subelement). For instance, an optimistic cache which uses a [local-scheme](#) for its backing map results in cache entries being stored in-memory.

Elements

[Table B-47](#) describes the subelements of the `optimistic-scheme` element.

Table B-47 *optimistic-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service which manages caches created from this scheme. Services are configured from within the <code><services></code> parameter in <code>tangosol-coherence.xml</code> . See Appendix A, "Operational Configuration Elements" for more information.
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
<code><event-dispatcher-priority></code>	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
<code><serializer></code>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see " serializer " on page A-59).

Table B-47 (Cont.) optimistic-scheme Subelements

Element	Required/ Optional	Description
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmb – SDP message bus with SSL support. SDMB is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the tangosol-coherence.xml descriptor. See the reliable-transport parameter in "OptimisticCache Service Parameters" on page A-71 for more information.</p>
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ▪ the time it takes to deliver the request to an executing node (server) ▪ the interval between the time the task is received and placed into a service queue until the execution starts ▪ the task execution time ▪ the time it takes to deliver a result back to the client <p>Legal values are positive integers or zero (indicating no default timeout). The default value is the value specified in the tangosol-coherence.xml descriptor. See the request-timeout parameter in "ReplicatedCache Service Parameters" on page A-68 for more information.</p>

Table B-47 (Cont.) optimistic-scheme Subelements

Element	Required/ Optional	Description
<guardian-timeout>	Optional	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <timeout-milliseconds> operational configuration element) is used. See <service-guardian>.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+(.)?[\d]+?[\d]+?[\d]+?[\d]+?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>
<service-failure-policy>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ■ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ■ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ■ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ■ a custom class – an <instance> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<member-listener>	Optional	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <member-listener> element is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>

Table B–47 (Cont.) optimistic-scheme Subelements

Element	Required/ Optional	Description
<code><backing-map-scheme></code>	Optional	<p>Specifies what type of cache is used within the cache server to store the entries. Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>local-scheme</code> ▪ <code>external-scheme</code> ▪ <code>paged-external-scheme</code> ▪ <code>overflow-scheme</code> ▪ <code>class-scheme</code> ▪ <code>flashjournal-scheme</code> ▪ <code>ramjournal-scheme</code> <p>To ensure cache coherence, the backing-map of an optimistic cache must not use a read-through pattern to load cache entries. Either use a cache-aside pattern from outside the cache service, or switch to the <code>distributed-scheme</code>, which supports read-through clustered caching.</p>
<code><listener></code>	Optional	Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.
<code><autostart></code>	Optional	The <code>autostart</code> element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

outgoing-message-handler

Used in: [acceptor-config](#), [initiator-config](#).

Description

The `outgoing-message-handler` specifies the configuration information used to detect dropped client-to-cluster connections. For connection initiators and acceptors that use connectionless protocols, this information is necessary to detect and release resources allocated to dropped connections. Connection-oriented initiators and acceptors can also use this information as an additional mechanism to detect dropped connections.

Elements

[Table B-48](#) describes the subelements of the `outgoing-message-handler` element.

Table B-48 *outgoing-message-handler Subelements*

Element	Required/ Optional	Description
<heartbeat-interval>	Optional	<p data-bbox="776 300 1448 380">Specifies the interval between ping requests. A ping request is used to ensure the integrity of a connection. The value of this element must be in the following format:</p> <pre data-bbox="776 394 1268 422">(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p data-bbox="776 457 1448 510">where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul data-bbox="776 527 1079 709" style="list-style-type: none"> <li data-bbox="776 527 1079 552">■ MS or ms (milliseconds) <li data-bbox="776 562 1079 588">■ S or s (seconds) <li data-bbox="776 598 1079 623">■ M or m (minutes) <li data-bbox="776 634 1079 659">■ H or h (hours) <li data-bbox="776 669 1079 695">■ D or d (days) <p data-bbox="776 720 1448 802">If the value does not contain a unit, a unit of milliseconds is assumed. A value of zero disables ping requests. The default value is zero.</p>

Table B-48 (Cont.) outgoing-message-handler Subelements

Element	Required/Optional	Description
<heartbeat-timeout>	Optional	<p>Specifies the maximum amount of time to wait for a response to the heartbeat ping request before closing the underlying connection. The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [MS ms S s M m H h D d] ?$ <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>
<max-message-size>	Optional	<p>Specifies the size limit of messages being sent over Coherence*Extend connections. The value of this element must be in the following format:</p> $(\backslash d) + [K k M m G g T t] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2¹⁰) ■ M or m (mega, 2²⁰) ■ G or g (giga, 2³⁰) ■ T or t (tera, 2⁴⁰) <p>If the value does not contain a factor, a factor of kilo is assumed. Legal values are positive integers between 0 and Integer.MAX_VALUE (2147483647). The default value is 0 and indicates that there is no limit on the message size.</p>
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response message before abandoning the request. The connection is not closed until the <heartbeat-timeout> value is reached.</p> <p>Note: This element is not used by a proxy service acceptor, because proxies never send requests to extend clients.</p> <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [MS ms S s M m H h D d] ?$ <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. The default value is an infinite timeout (0s).</p>

overflow-scheme

Used in: [caching-schemes](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [read-write-backing-map-scheme](#)

Description

The `overflow-scheme` defines a two-tier cache consisting of a fast, size limited front-tier, and slower but much higher capacity back-tier cache. When the size limited front fills up, evicted entries are transparently moved to the back. In the event of a cache miss, entries may move from the back to the front. A typical deployment might use a [local-scheme](#) for the front-tier, and a [external-scheme](#) for the back-tier, allowing for fast local caches with capacities larger than the JVM heap allows. In such a deployment, the `local-scheme` element's `high-units` and `eviction-policy` controls the transfer (eviction) of entries from the front to back caches.

Note: Relying on overflow for normal cache storage is not recommended. It should only be used to help avoid eviction-related data loss in the case where the storage requirements temporarily exceed the configured capacity. In general, the overflow's on-disk storage should remain empty.

Implementation

Implemented by either `com.tangosol.net.cache.OverflowMap` or `com.tangosol.net.cache.SimpleOverflowMap`, see `expiry-enabled` for details.

Entry Expiration

Overflow supports automatic expiration of entries based on the age of the value, as configured by the `<expiry-delay>` subelement.

Elements

[Table B-49](#) describes the subelements of the `overflow-scheme` element.

Table B-49 *overflow-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the overflow cache. Any custom implementation must extend either the <code>com.tangosol.net.cache.OverflowMap</code> or <code>com.tangosol.net.cache.SimpleOverflowMap</code> class, and declare the exact same set of public constructors.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom overflow cache implementations.
<code><front-scheme></code>	Required	Specifies the cache to use as the front-tier cache.
<code><back-scheme></code>	Required	Specifies the cache-scheme to use in creating the back-tier cache.

Table B–49 (Cont.) overflow-scheme Subelements

Element	Required/ Optional	Description
<miss-cache-scheme>	Optional	<p>Specifies a cache-scheme for maintaining information on cache misses. For caches which are not expiry-enabled (see <expiry-enabled> subelement), the miss-cache is used track keys which resulted in both a front and back tier cache miss. The knowledge that a key is not in either tier allows some operations to perform faster, as they can avoid querying the potentially slow back-tier. A size limited scheme may be used to control how many misses are tracked. If unspecified, no cache-miss data is maintained. Legal values are:</p> <ul style="list-style-type: none"> ■ <code>local-scheme</code>
<expiry-enabled>	Optional	<p>Turns on support for automatically-expiring data, as provided by the <code>com.tangosol.net.cache.CacheMap</code> API. When enabled, the overflow-scheme is implemented using <code>com.tangosol.net.cache.OverflowMap</code>, rather than <code>com.tangosol.net.cache.SimpleOverflowMap</code>. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>
<expiry-delay>	Optional	<p>Specifies the amount of time since the last update that entries are kept by the cache before being expired. Entries that have expired are not be accessible and are evicted the next time a client accesses the cache.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\.\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. A value of zero implies no expiry. The default value is 0.</p> <p>Note: The expiry delay parameter (<code>cExpiryMillis</code>) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed <code>Integer.MAX_VALUE</code> (2147483647) milliseconds or approximately 24 days.</p>
<autostart>	Optional	<p>The autostart element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>

paged-external-scheme

Used in: [caching-schemes](#), [distributed-scheme](#), [replicated-scheme](#), [optimistic-scheme](#), [near-scheme](#), [overflow-scheme](#), [read-write-backing-map-scheme](#)

Description

As with [external-scheme](#), `paged-external-schemes` define caches which are not JVM heap based, allowing for greater storage capacity. The `paged-external` scheme optimizes LRU eviction by using a paging approach. See [Chapter 16, "Serialization Paged Cache,"](#) for a detailed description of the paged cache functionality.

Implementation

This scheme is implemented by the `com.tangosol.net.cache.SerializationPagedCache` class.

Paging

Cache entries are maintained over a series of pages, where each page is a separate `com.tangosol.io.BinaryStore`, obtained from the configured storage manager (see ["Pluggable Storage Manager"](#)). When a page is created it is considered to be the current page and all write operations are performed against this page. On a configured interval (see `<page-duration>` subelement), the current page is closed and a new current page is created. Read operations for a given key are performed against the last page in which the key was stored. When the number of pages exceeds a configured maximum (see `<page-limit>` subelement), the oldest page is destroyed and those items which were not updated since the page was closed are evicted.

For example, configuring a cache with a duration of ten minutes per page, and a maximum of six pages, results in entries being cached for at most an hour. Paging improves performance by avoiding individual delete operations against the storage manager as cache entries are removed or evicted. Instead, the cache simply releases its references to those entries and relies on the eventual destruction of an entire page to free the associated storage of all page entries in a single operation.

Pluggable Storage Manager

External schemes use a pluggable store manager to create and destroy pages, and to access entries within those pages. Supported store-managers include:

- [async-store-manager](#)—a wrapper providing asynchronous write capabilities for other store-manager implementations
- [custom-store-manager](#)—allows definition of custom implementations of store-managers
- [bdb-store-manager](#)—uses Berkeley Database JE to implement an on disk cache
- [nio-file-manager](#)—uses NIO to implement memory-mapped file based cache
- [nio-memory-manager](#)—uses NIO to implement an off JVM heap, in-memory cache

Note: The NIO memory manager implementation is deprecated. Current implementation should use a journal binary store instead. See ["Using the Elastic Data Feature to Store Data"](#) on page 14-7.

Persistence (long-term storage)

Paged external caches are used for temporary storage of large data sets, for example as the back-tier of an [overflow-scheme](#). These caches are not used for long-term storage (persistence) and do not survive beyond the life of the JVM. Clustered persistence should be configured by using a [read-write-backing-map-scheme](#) on a [distributed-scheme](#). If a non-clustered persistent cache is what is needed, refer to "Persistence (long-term storage)" on page B-41.

Elements

[Table B-50](#) describes the subelements of the `paged-external-scheme` element.

Table B-50 *paged-external-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the external paged cache. Any custom implementation must extend the <code>com.tangosol.net.cache.SerializationPagedCache</code> class and declare the exact same set of public constructors.
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom external paged cache implementations.
<code><async-store-manager></code>	Optional	Configures the paged external cache to use an asynchronous storage manager wrapper for any other storage manager. See " Pluggable Storage Manager " on page B-40 for more information.
<code><bdb-store-manager></code>	Optional	Configures the paged external cache to use Berkeley Database JE on disk databases for cache storage.
<code><custom-store-manager></code>	Optional	Configures the paged external cache to use a custom storage manager implementation.
<code><nio-file-manager></code>	Optional	Configures the paged external cache to use a memory-mapped file for cache storage.
<code><nio-memory-manager></code>	Optional	Configures the paged external cache to use an off JVM heap, memory region for cache storage.

Table B-50 (Cont.) paged-external-scheme Subelements

Element	Required/ Optional	Description
<page-limit>	Optional	Specifies the maximum number of pages that the cache manages before older pages are destroyed. Legal values are zero or positive integers between 2 and 3600. The default value is zero.
<page-duration>	Optional	<p>Specifies the length of time, in seconds, that a page in the cache is current. After the duration is exceeded, the page is closed and a new current page is created. The value of this element must be in the following format:</p> <p>$(\backslash d)^+((\backslash d)^+)?[MS ms S s M m H h D d]?$</p> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. Legal values are zero or values between 5 and 604800 seconds (one week). The default value is zero.</p>
<listener>	Optional	Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.

partition-listener

Used in: [distributed-scheme](#)

Description

Specifies an implementation of a `com.tangosol.net.partition.PartitionListener` interface, which allows receiving partition distribution events.

Elements

[Table B-51](#) describes the subelements of the `partition-listener` element.

Table B-51 *partition-listener Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	The name of a class that implements the <code>PartitionListener</code> interface. This implementation must have a zero-parameter public constructor. The default value is the value specified in the <code>partition-listener</code> parameter in the <code>tangosol-coherence.xml</code> descriptor. See " DistributedCache Service Parameters " on page A-63 for more information.
<code><class-factory-name></code>	Optional	Specifies the fully qualified name of a factory class for creating implementation class instances. This element cannot be used with the <code><class-name></code> element and is used with the <code><method-name></code> element.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the implementation class.

partitioned-quorum-policy-scheme

Used in: [distributed-scheme](#)

Description

The `partitioned-quorum-policy-scheme` element contains quorum policy settings for the partitioned cache service.

Elements

[Table B-52](#) describes the subelements of the `partitioned-quorum-policy-scheme` element.

Table B-52 *partitioned-quorum-policy-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><distribution-quorum></code>	Optional	Specifies the minimum number of ownership-enabled members of a partitioned service that must be present to perform partition distribution. The value must be a nonnegative integer.
<code><restore-quorum></code>	Optional	Specifies the minimum number of ownership-enabled members of a partitioned service that must be present to restore lost primary partitions from backup. The value must be a nonnegative integer.
<code><read-quorum></code>	Optional	specifies the minimum number of storage members of a cache service that must be present to process "read" requests. A "read" request is any request that does not mutate the state or contents of a cache. The value must be a nonnegative integer.
<code><write-quorum></code>	Optional	specifies the minimum number of storage members of a cache service that must be present to process "write" requests. A "write" request is any request that may mutate the state or contents of a cache. The value must be a nonnegative integer.
<code><class-name></code>	Optional	Specifies a class that provides custom quorum policies. This element cannot be used with the default quorum elements or the <code><class-factory-name></code> element. The class must implement the <code>com.tangosol.net.ActionPolicy</code> interface. Initialization parameters can be specified using the <code><init-params></code> element.
<code><class-factory-name></code> <code>></code>	Optional	Specifies a factory class for creating custom action policy instances. This element cannot be used with the default quorum elements or the <code><class-name></code> element. This element is used with the <code><method-name></code> element. The action policy instances must implement the <code>com.tangosol.net.ActionPolicy</code> interface.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the implementation class.

provider

Used in: [ssl](#), [identity-manager](#), [trust-manager](#).

Description

The provider element contains the configuration information for a security provider that extends the `java.security.Provider` class.

Elements

[Table B-53](#) describes the subelements you can define within the provider element.

Table B-53 *provider Subelements*

Element	Required/Optional	Description
<name>	Optional	Specifies the name of a security provider that extends the <code>java.security.Provider</code> class. The class name can be entered using either this element or by using the <class-name> element or by using the <class-factory-name> element.
<class-name>	Optional	Specifies the name of a security provider that extends the <code>java.security.Provider</code> class. This element cannot be used with the <name> element or the <class-factory-name> element.
<class-factory-name>	Optional	Specifies a factory class for creating <code>Provider</code> instances. The instances must implement the <code>java.security.Provider</code> class. This element cannot be used with the <name> element or the <class-name> element. This element can be used with the <method-name> element.
<method-name>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<init-params>	Optional	Contains class initialization parameters for the provider implementation. This element cannot be used with the <name> element.

proxy-config

Used in: [proxy-scheme](#).

Description

The `proxy-config` element specifies the configuration information for the clustered service proxies managed by a proxy service. A service proxy is an intermediary between a remote client (connected to the cluster by using a connection acceptor) and a clustered service used by the remote client.

Elements

[Table B-54](#) describes the subelements of the `proxy-config` element.

Table B-54 *proxy-config* Subelements

Element	Required/ Optional	Description
<code><cache-service-proxy></code>	Optional	Specifies the configuration information for a cache service proxy managed by the proxy service.
<code><invocation-service-proxy></code>	Optional	Specifies the configuration information for an invocation service proxy managed by the proxy service.

proxy-scheme

Used in: [caching-schemes](#).

Description

The `proxy-scheme` element contains the configuration information for a clustered service that allows Coherence*Extend clients to connect to the cluster and use clustered services without having to join the cluster.

Elements

[Table B-55](#) describes the subelements of the `proxy-scheme` element.

Table B-55 *proxy-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See "Using Scheme Inheritance" on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service.
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10. The default value is the value specified in the <code>service-priority</code> parameter in the <code>tangosol-coherence.xml</code> descriptor. See "Proxy Service Parameters" on page A-77 for more information.
<code><event-dispatcher-priority></code>	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the value specified in the <code>event-dispatcher-priority</code> parameter in the <code>tangosol-coherence.xml</code> descriptor. See "Proxy Service Parameters" on page A-77 for more information.

Table B-55 (Cont.) proxy-scheme Subelements

Element	Required/ Optional	Description
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the tangosol-coherence.xml descriptor. See the reliable-transport parameter in "Proxy Service Parameters" on page A-77 for more information.</p>
<thread-count>	Optional	<p>Specifies the number of daemon threads for use by the proxy service. Specifying a value creates a thread pool that contains the exact number of threads. Proxy service threads perform operations on behalf of the calling application. Therefore, when explicitly setting the number of threads, set the value to as many threads as there are concurrent operations.</p> <p>Note: The default proxy service configuration uses a dynamic thread pool that automatically adjusts the number of threads based on proxy service load. Dynamic thread pooling is generally recommended. Do <i>not</i> use this element if you want to use dynamic thread pooling. To adjust dynamic thread pool thresholds, use the thread-count-max and thread-count-min elements. See "Proxy Service Parameters" on page A-77 for more additional details.</p> <p>To disable a thread pool and force all tasks to be performed on the proxy service thread, do <i>not</i> use this element and set the thread-count-max and thread-count-min parameters to 0. This configuration is typically not recommended.</p>
<thread-count-max>	Optional	<p>Specifies the maximum number of daemon threads that are allowed in a dynamic thread pool. This element is only valid if the <thread-count> element is <i>not</i> used. Legal values are positive integers or 0. Specifying a value of 0 for both this element and the <thread-count-min> element indicates that no daemon threads are created and that all client requests are handled by the proxy service thread. The default value is the value specified in the thread-count-max parameter of the tangosol-coherence.xml descriptor. See "Proxy Service Parameters" on page A-77 for more information.</p>

Table B-55 (Cont.) proxy-scheme Subelements

Element	Required/Optional	Description
<thread-count-min>	Optional	Specifies the minimum number of daemon threads that are allowed (and initially created) in a dynamic thread pool. This element is only valid if the <thread-count> element is <i>not</i> used. Legal values are positive integers or 0. Specifying a value of 0 for both this element and the <thread-count-max> element indicates that no daemon threads are created and that all client requests are handled by the proxy service thread. The default value is the value specified in the thread-count-min parameter of the tangosol-coherence.xml descriptor. See "Proxy Service Parameters" on page A-77 for more information.
<worker-priority>	Optional	Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the value specified in the worker-priority parameter in the tangosol-coherence.xml descriptor. See "Proxy Service Parameters" on page A-77 for more information.
<task-hung-threshold>	Optional	Specifies the amount of time in milliseconds that a task can execute before it is considered hung. Note that a posted task that has not yet started is never considered as hung. This attribute is applied only if the thread pool is used (the thread-count value is positive). Legal values are positive integers or zero (indicating no default timeout). The default value is the value specified in the tangosol-coherence.xml descriptor. See the task-hung-threshold parameter in "Proxy Service Parameters" on page A-77 for more information.
<task-timeout>	Optional	Specifies the timeout value in milliseconds for requests executing on the service worker threads. This attribute is applied only if the thread pool is used (the thread-count value is positive). If zero is specified, the default service-guardian <timeout-milliseconds> value is used. Legal values are nonnegative integers. The default value is the value specified in the tangosol-coherence.xml descriptor. See the task-timeout parameter in "Proxy Service Parameters" on page A-77.
<request-timeout>	Optional	Specifies the maximum amount of time a proxy waits for requests that are sent to other proxies of the same name. This element should not be used because requests are never sent between proxies.
<guardian-timeout>	Optional	Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <timeout-milliseconds> operational configuration element) is used. See < service-guardian >. <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [MS ms S s M m H h D d] ?$ <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>

Table B–55 (Cont.) proxy-scheme Subelements

Element	Required/ Optional	Description
<code><service-failure-policy></code>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – an <code><instance></code> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<code><member-listener></code>	Optional	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives service lifecycle events. The <code><member-listener></code> element is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
<code><acceptor-config></code>	Required	<p>Contains the configuration of the connection acceptor used by the service to accept connections from Coherence*Extend clients and to allow them to use the services offered by the cluster without having to join the cluster.</p>
<code><proxy-config></code>	Optional	<p>Contains the configuration of the clustered service proxies managed by this service.</p>
<code><load-balancer></code>	Optional	<p>Specifies a pluggable strategy used by the proxy service to distribute client connections across the set of clustered proxy service members.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>proxy</code> – (default) This strategy attempts to distribute client connections equally across proxy service members based upon existing connection count, connection limit, incoming and outgoing message backlog, and daemon pool utilization. ▪ <code>client</code> – This strategy relies upon the client address provider implementation to dictate the distribution of clients across proxy service members. If no client address provider implementation is provided, the extend client tries each proxy service in a random order until a connection is successful. ▪ a custom class – an <code><instance></code> subelement is used to provide the configuration information for a class that implements the <code>com.tangosol.net.proxy.ProxyServiceLoadBalancer</code> interface.
<code><proxy-quorum-policy-scheme></code>	Optional	<p>Specifies quorum policy settings for the Proxy service.</p>
<code><autostart></code>	Optional	<p>The <code>autostart</code> element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether this service should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>

proxy-quorum-policy-scheme

Used in: [proxy-scheme](#)

Description

The `proxy-quorum-policy-scheme` element contains quorum policy settings for the Proxy service.

Elements

[Table B-55](#) describes the subelements of the `proxy-quorum-policy-scheme` element.

Table B-56 *proxy-quorum-policy-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><connect-quorum></code>	Optional	specifies the minimum number of members of a proxy service that must be present to allow client connections. The value must be a nonnegative integer.
<code><class-name></code>	Optional	Specifies a class that provides custom quorum policies. This element cannot be used with the <code><connect-quorum></code> element or the <code><class-factory-name></code> element. The class must implement the <code>com.tangosol.net.ActionPolicy</code> interface. Initialization parameters can be specified using the <code><init-params></code> element.
<code><class-factory-name></code>	Optional	Specifies a factory class for creating custom action policy instances. This element cannot be used with the <code><connect-quorum></code> element or the <code><class-name></code> element. This element is used with the <code><method-name></code> element. The action policy instances must implement the <code>com.tangosol.net.ActionPolicy</code> interface.
<code><method-name></code>	Optional	Specifies the name of a static factory method on the factory class which performs object instantiation.
<code><init-params></code>	Optional	Contains class initialization parameters for the implementation class.

ramjournal-scheme

Used in: `back-scheme`, `backing-map-scheme`, `caching-schemes`, `internal-cache-scheme`

Description

The `ramjournal-scheme` element contains the configuration information for a scheme that stores data to buffers (journal files) in-memory. A RAM journal resource manager controls RAM journal behavior. See "[ramjournal-manager](#)" on page A-56 for additional details on configuring RAM journal behavior.

This scheme uses the `com.tangosol.net.cache.CompactSerializationClass` class as the backing map implementation and the `com.tangosol.io.journal.JournalBinaryStore` to store and retrieve binary key value pairs to a journal.

Elements

[Table B-57](#) describes the subelements of the `ramjournal-scheme` element.

Table B-57 *ramjournal-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the simple serialization map cache. Any custom implementation must extend the <code>com.tangosol.net.cache.CompactSerializationCache</code> class and declare the exact same set of public constructors as the superclass.
<code><init-params></code>	Optional	Specifies the initialization parameters for a custom serialization map cache.
<code><eviction-policy></code>	Optional	Specifies the type of eviction policy to use. Legal values are: <ul style="list-style-type: none"> ▪ LRU – Least Recently Used eviction policy chooses which entries to evict based on how recently they were last accessed, evicting those that were not accessed for the longest period first. ▪ LFU – Least Frequently Used eviction policy chooses which entries to evict based on how often they are being accessed, evicting those that are accessed least frequently first. ▪ HYBRID (default) – Hybrid eviction policy chooses which entries to evict based on the combination (weighted score) of how often and recently they were accessed, evicting those that are accessed least frequently and were not accessed for the longest period first. ▪ <code><class-scheme></code> – A custom eviction policy, specified as a class scheme. The class specified within this scheme must implement the <code>ConfigurableCacheMap.EvictionPolicy</code> interface or extend the <code>AbstractEvictionPolicy</code> class.

Table B-57 (Cont.) ramjournal-scheme Subelements

Element	Required/ Optional	Description
<high-units>	Optional	<p>Specifies the size limit of the cache. The value represents the maximum number of units that can be placed in the cache before pruning occurs. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When this limit is exceeded, the cache begins the pruning process and evicts entries according to the eviction policy. Legal values are positive integers between 0 and <code>Integer.MAX_VALUE</code> (2147483647). The default value is 0 and implies no limit.</p> <p>Note: The value is limited to approximately 2GB by default. To specify higher values, use the <unit-factor> element to change the factor by which the <high-units> value is multiplied.</p>
<low-units>	Optional	<p>Specifies the lowest number of units that a cache is pruned down to when pruning takes place. A pruning does not necessarily result in a cache containing this number of units; however, a pruning never results in a cache containing less than this number of units. An entry is the unit of measurement, unless it is overridden by an alternate unit calculator (see the <unit-calculator> subelement). When pruning occurs entries continue to be evicted according to the eviction policy until this size. Legal values are positive integers or zero. Zero implies the default. The default value is 80% of the high-units setting (that is, for a <high-units> setting of 1000 the default <low-units> is 800).</p>
<unit-calculator>	Optional	<p>Specifies the type of unit calculator to use. A unit calculator is used to determine the cost (in "units") of a given object. This element is used only if the <high-units> element is set to a positive number. Legal values are:</p> <ul style="list-style-type: none"> ■ <code>FIXED</code> – A unit calculator that assigns an equal weight of 1 to all cached objects. ■ <code>BINARY</code> (default) – A unit calculator that assigns an object a weight equal to the number of bytes of memory that are required to cache the object. This calculator is used for partitioned caches that cache data in a binary serialized form. See <code>com.tangosol.net.cache.BinaryMemoryCalculator</code> for additional details. ■ <code><class-scheme></code> – A custom unit calculator, specified as a class scheme. The class specified within this scheme must implement the <code>com.tangosol.net.cache.ConfigurableCacheMap.UnitCalculator</code> interface.

Table B-57 (Cont.) ramjournal-scheme Subelements

Element	Required/ Optional	Description
<unit-factor>	Optional	<p>Specifies the factor by which the <low-units> and <high-units> settings are adjusted. Using a BINARY unit calculator, for example, the factor of 1048576 could be used to count megabytes instead of bytes.</p> <p>Note: This element was introduced only to avoid changing the type of the <low-units> and <high-units> settings from 32-bit values to 64-bit values and is only used if the <high-units> element is set to a positive number.</p> <p>Valid values are positive integers. The default value is 1.</p>
<expiry-delay>	Optional	<p>Specifies the amount of time since the last update that entries are kept by the cache before being expired. Entries that have expired are not accessible and are evicted the next time a client accesses the cache.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+((\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. A value of zero implies no expiry. The default value is 0.</p> <p>Note: The expiry delay parameter (<code>cExpiryMillis</code>) is defined as an integer and is expressed in milliseconds. Therefore, the maximum amount of time can never exceed <code>Integer.MAX_VALUE</code> (2147483647) milliseconds or approximately 24 days.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>

read-write-backing-map-scheme

Used in: [caching-schemes](#), [distributed-scheme](#).

Description

The read-write-backing-map-scheme defines a backing map which provides a size limited cache of a persistent store. See [Chapter 15, "Caching Data Sources"](#) for more details.

Implementation

The read-write-backing-map-scheme is implemented by the `com.tangosol.net.cache.ReadWriteBackingMap` class.

Cache of an External Store

A read write backing map maintains a cache backed by an external persistent cache store (see `<cachestore-scheme>` subelement). Cache misses are read-through to the back-end store to retrieve the data. If a writable store is provided, cache writes are also propagate to the cache store.

Refresh-Ahead Caching

When enabled (see `<refreshahead-factor>` subelement) the cache watches for recently accessed entries which are about to expire, and asynchronously reload them from the cache store. This insulates the application from potentially slow reads against the cache store, as items periodically expire.

Write-Behind Caching

When enabled (see `<write-delay>` subelement), the cache delays writes to the back-end cache store. This allows for the writes to be batched (see `<write-batch-factor>` subelement) into more efficient update blocks, which occur asynchronously from the client thread.

Elements

[Table B-58](#) describes the subelements of the `read-write-backing-map-scheme` element.

Table B-58 *read-write-backing-map-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See "Using Scheme Inheritance" on page 13-13 for more information.
<code><class-name></code>	Optional	Specifies a custom implementation of the read write backing map. Any custom implementation must extend the <code>com.tangosol.net.cache.ReadWriteBackingMap</code> class and declare the exact same set of public constructors.

Table B–58 (Cont.) read-write-backing-map-scheme Subelements

Element	Required/ Optional	Description
<code><init-params></code>	Optional	Specifies initialization parameters, for use in custom read write backing map implementations.
<code><internal-cache-scheme></code>	Required	Specifies a cache-scheme which is used to cache entries. Legal values are: <ul style="list-style-type: none"> ▪ <code>local-scheme</code> ▪ <code>external-scheme</code> ▪ <code>paged-external-scheme</code> ▪ <code>overflow-scheme</code> ▪ <code>class-scheme</code> ▪ <code>flashjournal-scheme</code> ▪ <code>ramjournal-scheme</code>
<code><write-max-batch-size></code>	Optional	Specifies the maximum number of entries to write in a single <code>storeAll</code> operation. Valid values are positive integers or zero. The default value is 128 entries. This value has no effect if write behind is disabled.
<code><miss-cache-scheme></code>	Optional	Specifies a cache-scheme for maintaining information on cache misses. The miss-cache is used track keys which were not found in the cache store. The knowledge that a key is not in the cache store allows some operations to perform faster, as they can avoid querying the potentially slow cache store. A size-limited scheme may be used to control how many misses are cached. If unspecified no cache-miss data is maintained. Legal values are: <ul style="list-style-type: none"> ▪ <code>local-scheme</code>
<code><cachestore-scheme></code>	Optional	Specifies the store to cache. If unspecified the cached data only resides within the internal cache (see <code><internal-cache-scheme></code> subelement), and only reflect operations performed on the cache itself.
<code><read-only></code>	Optional	Specifies if the cache is read only. If <code>true</code> the cache loads data from cachestore for read operations and do not perform any writing to the cachestore when the cache is updated. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

Table B-58 (Cont.) read-write-backing-map-scheme Subelements

Element	Required/ Optional	Description
<write-delay>	Optional	<p>Specifies the time interval to defer asynchronous writes to the cachestore for a write-behind queue. The value of this element must be in the following format:</p> <p>$(\backslash d) + ((.)(\backslash d) +) ? [MS ms S s M m H h D d] ?$</p> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of seconds is assumed. If zero, synchronous writes to the cachestore (without queuing) take place, otherwise the writes are asynchronous and deferred by specified time interval after the last update to the value in the cache. The default value is zero.</p> <p>This element cannot be used with the <write-delay-seconds> element.</p>
<write-delay-seconds>	Optional	<p>Specifies the number of seconds to defer asynchronous writes to the cachestore for a write-behind queue. If zero, synchronous writes to the cachestore (without queueing) take place; otherwise, the writes are asynchronous and deferred by the number of seconds after the last update to the value in the cache.</p> <p>This element cannot be used with the <write-delay> element.</p>

Table B–58 (Cont.) read-write-backing-map-scheme Subelements

Element	Required/ Optional	Description
<write-batch-factor>	Optional	<p>The <code>write-batch-factor</code> element is used to calculate the "soft-ripe" time for write-behind queue entries. A queue entry is considered to be "ripe" for a write operation if it has been in the write-behind queue for no less than the write-delay interval. The "soft-ripe" time is the point in time before the actual ripe time after which an entry is included in a batched asynchronous write operation to the <code>CacheStore</code> (along with all other ripe and soft-ripe entries). In other words, a soft-ripe entry is an entry that has been in the write-behind queue for at least the following duration:</p> $D' = (1.0 - F) * D$ <p>where D = write-delay interval and F = write-batch-factor.</p> <p>Conceptually, the write-behind thread uses the following logic when performing a batched update:</p> <ol style="list-style-type: none"> 1. The thread waits for a queued entry to become ripe. 2. When an entry becomes ripe, the thread dequeues all ripe and soft-ripe entries in the queue. 3. The thread then writes all ripe and soft-ripe entries either by using <code>store()</code> (if there is only the single ripe entry) or <code>storeAll()</code> (if there are multiple ripe/soft-ripe entries). Note: if operation bundling (<operation-bundling>) is configured, then <code>storeAll()</code> is always called even if there is only a single ripe entry. 4. The thread then repeats (1). <p>This element is only applicable if asynchronous writes are enabled (that is, the value of the write-delay element is greater than zero) and the <code>CacheStore</code> implements the <code>storeAll()</code> method. The value of the element is expressed as a percentage of the write-delay interval. Legal values are nonnegative doubles less than or equal to 1.0. The default value is zero.</p>
<write-requeue-threshold>	Optional	<p>Specifies the size of the write-behind queue at which additional actions could be taken. If zero, write-behind requeuing is disabled. Otherwise, this value controls the frequency of the corresponding log messages. For example, a value of 100 produces a log message every time the size of the write queue is a multiple of 100. Legal values are positive integers or zero. The default value is zero.</p>
<refresh-ahead-factor>	Optional	<p>The <code>refresh-ahead-factor</code> element is used to calculate the "soft-expiration" time for cache entries. Soft-expiration is the point in time before the actual expiration after which any access request for an entry schedules an asynchronous load request for the entry. This attribute is only applicable if the internal cache is a <code>local-scheme</code>, configured with the <expiry-delay> subelement. The value is expressed as a percentage of the internal <code>LocalCache</code> expiration interval. If zero, refresh-ahead scheduling is disabled. If 1.0, then any get operation immediately triggers an asynchronous reload. Legal values are nonnegative doubles less than or equal to 1.0. The default value is zero.</p>

Table B–58 (Cont.) read-write-backing-map-scheme Subelements

Element	Required/ Optional	Description
<cachestore-timeout>	Optional	<p>Specifies the timeout interval to use for CacheStore read and write operations. If a CacheStore operation times out, the executing thread is interrupted and may ultimately lead to the termination of the cache service. Timeouts of asynchronous CacheStore operations (for example, refresh-ahead, write-behind) do not result in service termination. The value of this element must be in the following format:</p> <pre data-bbox="760 512 1252 537">(\d)+((\.\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul data-bbox="760 646 1062 831" style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. If 0 is specified, the default service-guardian <timeout-milliseconds> value is used. The default value if none is specified is 0.</p>
<rollback-cachestore-failures>	Optional	<p>Specifies whether exceptions caught during synchronous cachestore operations are rethrown to the calling thread (possibly over the network to a remote member). Legal values are true or false. If the value of this element is false, an exception caught during a synchronous cachestore operation is logged locally and the internal cache is updated. If the value is true, the exception is rethrown to the calling thread and the internal cache is not changed. If the operation was called within a transactional context, this would have the effect of rolling back the current transaction. The default value is true.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>

remote-addresses

Used in: [tcp-initiator](#)

Description

The `remote-addresses` element contains the address (IP, or DNS name, and port) of one or more TCP/IP acceptors. A TCP/IP initiator uses this information to establish a connection with a proxy service on a remote cluster. TCP/IP acceptors are configured within the [proxy-scheme](#) element. The TCP/IP initiator attempts to connect to the addresses in a random order until either the list is exhausted or a connection is established. See *Developing Remote Clients for Oracle Coherence* for additional details and example configurations.

Note: The `name-service-addresses` element can also be used to establish a connection with a proxy service on a remote cluster. For details, see "[name-service-addresses](#)" on page B-72.

The following example configuration instructs the initiator to connect to 192.168.0.2:9099 and 192.168.0.3:9099 in a random order:

```
<remote-addresses>
  <socket-address>
    <address>192.168.0.2</address>
    <port>9099</port>
  </socket-address>
  <socket-address>
    <address>192.168.0.3</address>
    <port>9099</port>
  </socket-address>
</remote-addresses>
```

Elements

[Table B-59](#) describes the subelements of the `remote-addresses` element.

Table B-59 *remote-addresses* Subelements

Element	Required/ Optional	Description
<socket-address>	Optional	Specifies the address (IP, or DNS name, and port) on which a TCP/IP acceptor is listening. Multiple <code><socket-address></code> elements can be used within a <code><remote-addresses></code> element.
<address-provider>	Optional	Specifies the address (IP, or DNS name, and port) on which a TCP/IP acceptor is listening or the configuration for a <code>com.tangosol.net.AddressProvider</code> implementation that supplies the address. The <code>address-provider</code> element also supports socket address references. A <code><remote-addresses></code> element can include either a <code><socket-address></code> element or an <code><address-provider></code> element but not both.

remote-cache-scheme

Used in: [cachestore-scheme](#), [caching-schemes](#), [near-scheme](#).

Description

The `remote-cache-scheme` element contains the configuration information necessary to use a clustered cache from outside the cluster by using Coherence*Extend.

Elements

[Table B-60](#) describes the subelements of the `remote-cache-scheme` element.

Table B-60 *remote-cache-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service which manages caches created from this scheme.
<code><proxy-service-name></code>	Optional	Specifies the proxy service name to which this remote service connects. This element is only used if this remote service uses a name service to lookup a proxy service. For details on configuring a name service, see " name-service-addresses " on page B-72. The value must match the <code><service-name></code> value of the proxy service. This element can be omitted if the <code><service-name></code> value of this remote service matches the <code><service-name></code> value of the proxy service. For details on defining proxy services, see " proxy-scheme " on page B-96.
<code><operation-bundling></code>	Optional	Specifies the configuration information for a bundling strategy.
<code><initiator-config></code>	Required	Contains the configuration of the connection initiator used by the service to establish a connection with the cluster.
<code><defer-key-association-check></code>	Optional	Specifies whether key association processing is done by the extend client or deferred to the cluster side. Valid values are <code>true</code> and <code>false</code> . A value of <code>false</code> indicates that key association processing is done by the extend client. If the value is set to <code>true</code> , then .NET and C++ clients must include a parallel Java implementation of the key class on the cluster cache servers. The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See " RemoteCache Service Parameters " on page A-80 for more information.
<code><listener></code>	Optional	Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.

remote-invocation-scheme

Used in: [caching-schemes](#)

Description

The `remote-invocation-scheme` element contains the configuration information necessary to execute tasks within a cluster without having to first join the cluster. This scheme uses Coherence*Extend to connect to the cluster.

Elements

[Table B-61](#) describes the subelements of the `remote-invocation-scheme` element.

Table B-61 *remote-invocation-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service.
<code><proxy-service-name></code>	Optional	Specifies the proxy service name to which this remote service connects. This element is only used if this remote service uses a name service to lookup a proxy service. For details on configuring a name service, see " name-service-addresses " on page B-72. The value must match the <code><service-name></code> value of the proxy service. This element can be omitted if the <code><service-name></code> value of this remote service matches the <code><service-name></code> value of the proxy service. For details on defining proxy services, see " proxy-scheme " on page B-96.
<code><initiator-config></code>	Required	Contains the configuration of the connection initiator used by the service to establish a connection with the cluster.

replicated-scheme

Used in: [caching-schemes](#), [near-scheme](#), [overflow-scheme](#)

Description

The replicated scheme defines caches which fully replicate all their cache entries on each cluster nodes running the specified service. See "[Understanding Replicated Caches](#)" on page 12-5 for a detailed description of replicated caches.

Clustered Concurrency Control

Replicated caches support cluster wide key-based locking so that data can be modified in a cluster without encountering the classic missing update problem. Note that any operation made without holding an explicit lock is still atomic but there is no guarantee that the value stored in the cache does not change between atomic operations.

Cache Storage (Backing Map)

Storage for the cache is specified by using the backing-map scheme (see `<backing-map>` subelement). For instance, a replicated cache which uses a [local-scheme](#) for its backing map results in cache entries being stored in-memory.

Elements

[Table B-62](#) describes the subelements of the `replicated-scheme` element.

Table B-62 *replicated-scheme Subelements*

Element	Required/ Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See " Using Scheme Inheritance " on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service which manages caches created from this scheme. Services are configured from within the <code><services></code> element in the <code>tangosol-coherence.xml</code> file. See Appendix A, "Operational Configuration Elements" for more information.
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>service-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See " ReplicatedCache Service Parameters " on page A-68 for more information.
<code><event-dispatcher-priority></code>	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is the <code>event-dispatcher-priority</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See " ReplicatedCache Service Parameters " on page A-68 for more information.

Table B-62 (Cont.) replicated-scheme Subelements

Element	Required/ Optional	Description
<serializer>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see "serializer" on page A-59).
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbs – SDP message bus with SSL support. SDMBS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>reliable-transport</code> parameter in "ReplicatedCache Service Parameters" on page A-68 for more information.</p>
<standard-lease-milliseconds>	Optional	<p>Specifies the duration of the standard lease in milliseconds. When a lease has aged past this number of milliseconds, the lock is automatically released. Set this value to zero to specify a lease that never expires. The purpose of this setting is to avoid deadlocks or blocks caused by stuck threads; the value should be set higher than the longest expected lock duration (for example, higher than a transaction timeout). It's also recommended to set this value higher than</p> <p><code>packet-delivery/timeout-milliseconds</code> value. Legal values are from positive long numbers or zero. The default value is the value specified for <code>packet-delivery/timeout-milliseconds</code> in the <code>tangosol-coherence.xml</code> descriptor. See "ReplicatedCache Service Parameters" on page A-68 for more information.</p>

Table B–62 (Cont.) replicated-scheme Subelements

Element	Required/ Optional	Description
<lease-granularity>	Optional	<p>Specifies the lease ownership granularity. Legal values are:</p> <ul style="list-style-type: none"> ■ thread ■ member <p>A value of thread means that locks are held by a thread that obtained them and can only be released by that thread. A value of member means that locks are held by a cluster node and any thread running on the cluster node that obtained the lock can release it. The default value is the lease-granularity value specified in the tangosol-coherence.xml descriptor. See "ReplicatedCache Service Parameters" on page A-68 for more information.</p>
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>Legal values are positive integers or zero (indicating no default timeout). The default value is the value specified in the tangosol-coherence.xml descriptor. See the request-timeout parameter in "ReplicatedCache Service Parameters" on page A-68 for more information.</p>
<guardian-timeout>	Optional	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <timeout-milliseconds> operational configuration element) is used. See <service-guardian>.</p> <p>The value of this element must be in the following format:</p> <p>(\d)+(.(\d+)?[MS ms S s M m H h D d]?)</p> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>

Table B-62 (Cont.) replicated-scheme Subelements

Element	Required/Optional	Description
<service-failure-policy>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – an <instance> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<member-listener>	Optional	<p>Specifies the configuration information for a class that implements the <code>com.tangosol.net.MemberListener</code> interface. The implementation must have a public default constructor.</p> <p>The <code>MemberListener</code> implementation receives cache service lifecycle events. The <member-listener> element is used as an alternative to programmatically adding a <code>MapListener</code> on a service.</p>
<backing-map-scheme>	Optional	<p>Specifies what type of cache is used within the cache server to store the entries. Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>local-scheme</code> ▪ <code>external-scheme</code> ▪ <code>paged-external-scheme</code> ▪ <code>overflow-scheme</code> ▪ <code>class-scheme</code> ▪ <code>flashjournal-scheme</code> ▪ <code>ramjournal-scheme</code> <p>To ensure cache coherence, the backing-map of a replicated cache must not use a read-through pattern to load cache entries. Either use a cache-aside pattern from outside the cache service, or switch to the <code>distributed-scheme</code>, which supports read-through clustered caching.</p>
<listener>	Optional	<p>Specifies an implementation of a <code>com.tangosol.util.MapListener</code> which is notified of events occurring on the cache.</p>
<autostart>	Optional	<p>The <code>autostart</code> element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code>. The default value is <code>false</code>.</p>

resource-config

Used in: [http-acceptor](#)

Description

The `resource-config` element contains the configuration information for a class that extends the `com.sun.jersey.api.core.ResourceConfig` class. The instance is used by the HTTP acceptor to load resource and provider classes for the Coherence REST application that is mapped to the specified context path. Multiple resource configuration classes can be configured and mapped to different context paths.

Elements

[Table B-63](#) describes the subelements of the `resource-config` element.

Table B-63 *resource-config Subelements*

Element	Required/Optional	Description
<code><context-path></code>	Optional	Specifies a root URI path for a REST application. The first character of the path must be <code>/</code> . The default value is <code>/</code> .
<code><instance></code>	Optional	Contains the configuration information for a class that extends the <code>com.sun.jersey.api.core.ResourceConfig</code> class. The default instance is the <code>com.tangosol.coherence.rest.server.DefaultResourceConfig</code> class.

serializer

Used in: [acceptor-config](#), [defaults](#), [distributed-scheme](#), [initiator-config](#), [invocation-scheme](#), [optimistic-scheme](#), [replicated-scheme](#), [transactional-scheme](#),

Description

The `serializer` element contains the class configuration information for a `com.tangosol.io.Serializer` implementation.

The `serializer` element accepts either a reference to a serializer configuration or a full serializer configuration. The best practice is to reference a configuration which is defined in the operational configuration file. The operational configuration file contains two pre-defined serializer class configuration: one for Java (default) and one for POF. See "[serializer](#)" on page A-59.

The following example demonstrates referring to the POF serializer definition that is in the operational configuration file:

```
...
<serializer>pof</serializer>
...
```

The following example demonstrates a full serializer class configuration:

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

Elements

[Table B-64](#) describes the subelements of the `serializer` element.

Table B-64 *serializer Subelements*

Element	Required/ Optional	Description
<code><instance></code>	Optional	Contains the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation.

socket-address

Used in: [address-provider](#), [remote-addresses](#)

Description

The `socket-address` element specifies the address and port on which a TCP/IP acceptor is listening.

Elements

[Table B-65](#) describes the subelements of the `socket-address` element.

Table B-65 *socket-address Subelements*

Element	Required/ Optional	Description
<address>	Required	Specifies the IP address (IP or DNS name) on which a TCP/IP acceptor socket is listening. If the address is a bind address, then the address may also be entered using CIDR notation as a subnet and mask (for example, 192.168.1.0/24), which allows runtime resolution against the available local IP addresses.
<port>	Required	Specifies the port on which a TCP/IP acceptor socket is listening. Legal values are from 1 to 65535.

socket-provider

Used in: [tcp-acceptor](#), [tcp-initiator](#), [defaults](#), [ssl](#), [memcached-acceptor](#).

Description

The `<socket-provider>` element contains the configuration information for a socket and channel factory. The socket providers that are configured within the `<tcp-acceptor>` and `<tcp-initiator>` elements are for use with Coherence*Extend. A socket provider that is configured within the `<http-acceptor>` element is used by Coherence REST. A socket provider that is configured within the `<memcached-acceptor>` element is used by memcached clients. Socket providers for TCMP are configured in an operational override within the `<unicast-listener>` element.

The `<socket-provider>` element accepts either a reference to a socket provider configuration or a full socket provider configuration. The best practice is to reference a configuration which is defined in the operational configuration file. See "[socket-provider](#)" on page A-86. The following socket providers are available: `system` (default), `ssl`, `tcp`, and `sdp`. Socket provider configurations are referred to using their `id` attribute name. The following example refers to the pre-defined SSL socket provider configuration:

```
<socket-provider>ssl</socket-provider>
```

The preconfigured override is `tangosol.coherence.socketprovider`.

Elements

[Table B-66](#) describes the subelements you can define within the `socket-provider` element.

Table B-66 *socket-provider Subelements*

Element	Required/ Optional	Description
<code><system></code>	Optional	Specifies a socket provider that produces instances of the JVM's default socket and channel implementations.
<code><ssl></code>	Optional	Specifies a socket provider that produces socket and channel implementations which use SSL.
<code><tcp></code>	Optional	Specifies a socket provider that produces TCP-based sockets and channel implementations.
<code><sdp></code>	Optional	Specifies a socket provider that produce SDP-based sockets and channel implementations provided that the JVM and underlying network stack supports SDP.

ssl

Used in: [socket-provider](#).

Description

The `<ssl>` element contains the configuration information for a socket provider that produces socket and channel implementations which use SSL.

Elements

[Table B–67](#) describes the elements you can define within the `ssl` element.

Table B–67 *ssl Subelements*

Element	Required/ Optional	Description
<code><protocol></code>	Optional	Specifies the name of the protocol used by the socket and channel implementations produced by the SSL socket provider. The default value is TLS.
<code><provider></code>	Optional	Specifies the configuration for a security provider instance.
<code><executor></code>	Optional	Specifies the configuration information for an implementation of the <code>java.util.concurrent.Executor</code> interface. A <code><class-name></code> subelement is used to provide the name of a class that implements the <code>Executor</code> interface. As an alternative, a <code><class-factory-name></code> subelement can specify a factory class for creating <code>Executor</code> instances and a <code><method-name></code> subelement that specifies the name of a static factory method on the factory class which performs object instantiation. Either approach can specify initialization parameters using the <code><init-params></code> element.
<code><identity-manager></code>	Optional	Specifies the configuration information for initializing an identity manager instance.
<code><trust-manager></code>	Optional	Specifies the configuration information for initializing a trust manager instance.
<code><hostname-verifier></code>	Optional	Specifies the configuration information for an implementation of the <code>javax.net.ssl.HostnameVerifier</code> interface. During the SSL handshake, if the URL's host name and the server's identification host name mismatch, the verification mechanism calls back to this instance to determine if the connection should be allowed. A <code><class-name></code> subelement is used to provide the name of a class that implements the <code>HostnameVerifier</code> interface. As an alternative, a <code><class-factory-name></code> subelement can specify a factory class for creating <code>HostnameVerifier</code> instances and a <code><method-name></code> subelement that specifies the name of a static factory method on the factory class which performs object instantiation. Either approach can specify initialization parameters using the <code><init-params></code> element.
<code><socket-provider></code>	Optional	Specifies the configuration information for a delegate provider for SSL. Valid values are <code>tcp</code> and <code>sdp</code> . The default value is <code>tcp</code> .

tcp-acceptor

Used in: [acceptor-config](#).

Description

The `tcp-acceptor` element specifies the configuration information for a connection acceptor that accepts connections from Coherence*Extend clients over TCP/IP. See *Developing Remote Clients for Oracle Coherence* for additional details and example configurations.

Elements

[Table B–68](#) describes the subelements of the `tcp-acceptor` element.

Table B–68 *tcp-acceptor Subelements*

Element	Required/ Optional	Description
<code><socket-provider></code>	Optional	Specifies the configuration for a socket and channel factory.
<code><local-address></code>	Optional	Specifies the local address (IP, or DNS name, and port) on which the TCP/IP server socket (opened by the connection acceptor) is bound.
<code><address-provider></code>	Optional	Specifies either the local address (IP, or DNS name, and port) on which the TCP/IP server socket is bound or an implementation of the <code>com.tangosol.net.AddressProvider</code> interface that programmatically provides a socket address. The <code>address-provider</code> element also supports socket address references. A <code><tcp-acceptor></code> element can include either a <code><local-address></code> or an <code><address-provider></code> element but not both.
<code><reuse-address></code>	Optional	Specifies whether a TCP/IP socket can be bound to an in-use or recently used address. This setting is deprecated because the resulting behavior is significantly different across operating system implementations. The JVM, in general, selects a reasonable default which is safe for the target operating system. Valid values are <code>true</code> and <code>false</code> . The default value depends on the operating system.
<code><keep-alive-enabled></code>	Optional	Indicates whether the <code>SO_KEEPALIVE</code> option is enabled on a TCP/IP socket. The <code>SO_KEEPALIVE</code> option detects idle sockets and determines whether the socket should be closed. Valid values are <code>true</code> and <code>false</code> . The default value is <code>true</code> .
<code><tcp-delay-enabled></code>	Optional	Indicates whether TCP delay (Nagle's algorithm) is enabled on a TCP/IP socket. Valid values are <code>true</code> and <code>false</code> . TCP delay is disabled by default.

Table B-68 (Cont.) tcp-acceptor Subelements

Element	Required/Optional	Description
<receive-buffer-size>	Optional	<p>Configures the size of the underlying TCP/IP socket network receive buffer. Increasing the receive buffer size can increase the performance of network I/O for high-volume connections, while decreasing it can help reduce the backlog of incoming data. The value of this element must be in the following format:</p> <p>$(\backslash d) + ((.) (\backslash d) +) ? [K k M m G g] ? [B b] ?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is operating system dependent.</p>
<send-buffer-size>	Optional	<p>Configures the size of the underlying TCP/IP socket network send buffer. The value of this element must be in the following format:</p> <p>$(\backslash d) + ((.) (\backslash d) +) ? [K k M m G g] ? [B b] ?$</p> <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is operating system dependent.</p>
<listen-backlog>	Optional	<p>Configures the size of the TCP/IP server socket backlog queue. Valid values are positive integers. The default value is operating system dependent.</p>
<linger-timeout>	Optional	<p>Specifies a value for the <code>SO_LINGER</code> option on a TCP/IP socket. The <code>SO_LINGER</code> option controls how long to wait before a socket is forcefully closed. The value of this element must be in the following format:</p> <p>$(\backslash d) + ((.) (\backslash d) +) ? [MS ms S s M m H h D d] ?$</p> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. The default value is <code>-1</code>, which disables the linger timeout. A linger timeout is only set if the value is greater than zero.</p>
<authorized-hosts>	Optional	<p>A collection of IP addresses of TCP/IP initiator hosts that are allowed to connect to this TCP/IP acceptor.</p>
<suspect-protocol-enabled>	Optional	<p>Specifies whether the suspect protocol is enabled to detect and close rogue Coherence*Extend client connections. The suspect protocol is enabled by default.</p> <p>Valid values are <code>true</code> and <code>false</code>.</p>

Table B–68 (Cont.) tcp-acceptor Subelements

Element	Required/ Optional	Description
<suspect-buffer-size>	Optional	<p>Specifies the outgoing connection backlog (in bytes) after which the corresponding client connection is marked as suspect. A suspect client connection is then monitored until it is no longer suspect or it is closed to protect the proxy server from running out of memory.</p> <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g T t] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is 10000000.</p>
<suspect-buffer-length>	Optional	<p>Specifies the outgoing connection backlog (in messages) after which the corresponding client connection is marked as suspect. A suspect client connection is then monitored until it is no longer suspect or it is closed to protect the proxy server from running out of memory. The default value is 10000.</p>
<nominal-buffer-size>	Optional	<p>Specifies the outgoing connection backlog (in bytes) at which point a suspect client connection is no longer considered to be suspect.</p> <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g T t] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) ■ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is 2000000.</p>

Table B–68 (Cont.) tcp-acceptor Subelements

Element	Required/ Optional	Description
<nominal-buffer-length>	Optional	Specifies the outgoing connection backlog (in messages) at which point a suspect client connection is no longer considered to be suspect. The default value is 2000.
<limit-buffer-size>	Optional	<p>Specifies the outgoing connection backlog (in bytes) at which point the corresponding client connection must be closed to protect the proxy server from running out of memory.</p> <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g T t] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ▪ K or k (kilo, 2^{10}) ▪ M or m (mega, 2^{20}) ▪ G or g (giga, 2^{30}) ▪ T or t (tera, 2^{40}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is 100000000.</p>
<limit-buffer-length>	Optional	Specifies the outgoing connection backlog (in messages) at which point the corresponding client connection must be closed to protect the proxy server from running out of memory. The default value is 60000.

tcp-initiator

Used in: [initiator-config](#).

Description

The `tcp-initiator` element specifies the configuration information for a connection initiator that enables Coherence*Extend clients to connect to a remote cluster by using TCP/IP. See *Developing Remote Clients for Oracle Coherence* for additional details and example configurations.

Elements

Table B–69 describes the subelements of the `tcp-initiator` element.

Table B–69 *tcp-initiator Subelements*

Element	Required/ Optional	Description
<code><socket-provider></code>	Optional	Specifies the configuration for a socket and channel factory.
<code><local-address></code>	Optional	Specifies the local address (IP, or DNS name, and port) on which the TCP/IP client socket (opened by the TCP/IP initiator) is bound.
<code><name-service-addresses></code>	Optional	Contains the address (IP, or DNS name, and port) of one or more name service TCP/IP acceptors. The TCP/IP connection initiator uses this information to establish a connection with a remote cluster. This element cannot be used if the <code>remote-addresses</code> element is used to configure remote addresses.
<code><remote-addresses></code>	Optional	Contains the address (IP, or DNS name, and port) of one or more TCP/IP connection acceptors. The TCP/IP connection initiator uses this information to establish a connection with a remote cluster. This element cannot be used if the <code>name-service-addresses</code> element is used.
<code><reuse-address></code>	Optional	Specifies whether a TCP/IP socket can be bound to an in-use or recently used address. This setting is deprecated because the resulting behavior is significantly different across operating system implementations. The JVM, in general, selects a reasonable default which is safe for the target operating system. Valid values are <code>true</code> and <code>false</code> . The default value depends on the operating system.
<code><keep-alive-enabled></code>	Optional	Indicates whether the <code>SO_KEEPALIVE</code> option is enabled on a TCP/IP socket. The <code>SO_KEEPALIVE</code> option detects idle sockets and determines whether the socket should be closed. Valid values are <code>true</code> and <code>false</code> . The default value is <code>true</code> .
<code><tcp-delay-enabled></code>	Optional	Indicates whether TCP delay (Nagle's algorithm) is enabled on a TCP/IP socket. Valid values are <code>true</code> and <code>false</code> . TCP delay is disabled by default.

Table B–69 (Cont.) tcp-initiator Subelements

Element	Required/ Optional	Description
<receive-buffer-size>	Optional	<p>Configures the size of the underlying TCP/IP socket network receive buffer. Increasing the receive buffer size can increase the performance of network I/O for high-volume connections, while decreasing it can help reduce the backlog of incoming data. The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is operating system dependent.</p>
<send-buffer-size>	Optional	<p>Configures the size of the underlying TCP/IP socket network send buffer. The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2^{10}) ■ M or m (mega, 2^{20}) ■ G or g (giga, 2^{30}) <p>If the value does not contain a factor, a factor of one is assumed. The default value is operating system dependent.</p>
<connect-timeout>	Optional	<p>Deprecated. The <connect-timeout> element is now specified within the <initiator-config> element.</p>
<linger-timeout>	Optional	<p>Specifies a value for the <code>SO_LINGER</code> option on a TCP/IP socket. The <code>SO_LINGER</code> option controls how long to wait before a socket is forcefully closed. The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [MS ms S s M m H h D d] ?$ <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed. The default value is -1, which disables the linger timeout. A linger timeout is only set if the value is greater than zero.</p>

transactional-scheme

Used in [caching-schemes](#)

Description

The `transactional-scheme` element defines a transactional cache, which is a specialized distributed cache that provides transactional guarantees. Multiple `transactional-scheme` elements may be defined to support different configurations. Applications use transactional caches in one of three ways:

- Applications use the `CacheFactory.getCache()` method to get an instance of a transactional cache. In this case, there are implicit transactional guarantees when performing cache operations. However, default transaction behavior cannot be changed.
- Applications explicitly use the Transaction Framework API to create a `Connection` instance that uses a transactional cache. In this case, cache operations are performed within a transaction and the application has full control to change default transaction behavior as required.
- Java EE applications use the Coherence Resource Adapter to create a Transaction Framework API `Connection` instance that uses a transactional cache. In this case, cache operations are performed within a transaction that can participate as part of a distributed (global) transaction. Applications can change some default transaction behavior.

Elements

[Table B-70](#) describes the subelements of the `transactional-scheme` element.

Table B-70 *transactional-scheme Subelements*

Element	Required/Optional	Description
<code><scheme-name></code>	Optional	Specifies the scheme's name. The name must be unique within a configuration file.
<code><scheme-ref></code>	Optional	Specifies the name of another scheme to inherit from. See "Using Scheme Inheritance" on page 13-13 for more information.
<code><service-name></code>	Optional	Specifies the name of the service which manages caches created from this scheme. The default service name if no service name is provided is <code>TransactionalCache</code> .
<code><service-priority></code>	Optional	Specifies the priority for the service thread. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
<code><event-dispatcher-priority></code> >	Optional	Specifies the priority for the event dispatcher thread for each service. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 10.
<code><serializer></code>	Optional	Specifies either: the class configuration information for a <code>com.tangosol.io.Serializer</code> implementation used to serialize and deserialize user types, or it references a serializer class configuration that is defined in the operational configuration file (see "serializer" on page A-59).

Table B-70 (Cont.) transactional-scheme Subelements

Element	Required/ Optional	Description
<reliable-transport>	Optional	<p>Specifies the transport protocol used by this service for reliable point-to-point communication. Specifying a value results in the use of a service-specific transport instance rather than the shared transport instance that is defined by the <unicast-listener> element. A service-specific transport instance can result in higher performance but at the cost of increased resource consumption and should be used sparingly for select, high priority services. In general, a shared transport instance uses less resource consumption than service-specific transport instances. Valid values are:</p> <ul style="list-style-type: none"> ▪ datagram – UDP protocol ▪ tmb – TCP/IP message bus protocol ▪ tmbs – TCP/IP message bus protocol with SSL support. TMBS requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ sdmb – Socket Direct Protocol (SDP) message bus. SDMB is only available for Oracle Exalogic systems. ▪ sdmbms – SDP message bus with SSL support. SDMBMS is only available for Oracle Exalogic systems and requires the use of an SSL socket provider. See "socket-provider" on page B-119. ▪ imb (default on Exalogic) – InfiniBand message bus. IMB is only available for Oracle Exalogic systems and is automatically used as long as TCMP has not been configured with SSL. <p>The default value is the <reliable-transport> value specified in the tangosol-coherence.xml descriptor. See the reliable-transport parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>
<thread-count>	Optional	<p>Specifies the number of daemon threads used by the partitioned cache service. Legal values are positive integers, 0, or -1. The value 0 indicates that all relevant tasks are performed on the service thread. The value -1 indicates that tasks are performed on the caller's thread where possible. The default value is the thread-count value specified in the tangosol-coherence.xml descriptor. See the thread-count parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p> <p>Specifying a thread count changes the default behavior of the Transactional Framework's internal transaction caches that are used for transactional storage and recovery.</p>
<worker-priority>	Optional	<p>Specifies the priority for the worker threads. Legal values are from 1 to 10 where 10 is the highest priority. The default value is 5.</p>

Table B-70 (Cont.) transactional-scheme Subelements

Element	Required/ Optional	Description												
<local-storage>	Optional	<p>Specifies whether a cluster node contributes storage to the cluster, that is, maintain partitions. When disabled the node is considered a cache client.</p> <p>Normally this value should be left unspecified within the configuration file, and instead set on a per-process basis using the <code>tangosol.coherence.distributed.localstorage</code> system property. This allows cache clients and servers to use the same configuration descriptor.</p> <p>Legal values are <code>true</code> or <code>false</code>. The default value is the <code>local-storage</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>local-storage</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>												
<partition-count>	Optional	<p>Specifies the number of partitions that a partitioned (distributed) cache is "chopped up" into. Each member running the partitioned cache service that has the <code>local-storage</code> (<local-storage> subelement) option set to <code>true</code> manages a "fair" (balanced) number of partitions.</p> <p>The number of partitions should be a prime number and sufficiently large such that a given partition is expected to be no larger than 50MB.</p> <p>The following are good defaults for sample service storage sizes:</p> <table border="1"> <thead> <tr> <th>service storage</th> <th>partition-count</th> </tr> </thead> <tbody> <tr> <td>100M</td> <td>257</td> </tr> <tr> <td>1G</td> <td>509</td> </tr> <tr> <td>10G</td> <td>2039</td> </tr> <tr> <td>50G</td> <td>4093</td> </tr> <tr> <td>100G</td> <td>8191</td> </tr> </tbody> </table> <p>A list of first 1,000 primes can be found at http://primes.utm.edu/lists/</p> <p>Valid values are positive integers. The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>partition-count</code> parameter "DistributedCache Service Parameters" on page A-63 for more information.</p>	service storage	partition-count	100M	257	1G	509	10G	2039	50G	4093	100G	8191
service storage	partition-count													
100M	257													
1G	509													
10G	2039													
50G	4093													
100G	8191													
<high-units>	Optional	<p>Specifies the transaction storage size. Once the transactional storage size is reached, an eviction policy is used that removes 25% of eligible entries from storage.</p> <p>The value of this element must be in the following format:</p> $(\backslash d) + ((.)(\backslash d) +) ? [K k M m G g T t] ? [B b] ?$ <p>where the first non-digit (from left to right) indicates the factor with which the preceding decimal value should be multiplied:</p> <ul style="list-style-type: none"> ■ K or k (kilo, 2¹⁰) ■ M or m (mega, 2²⁰) ■ G or g (giga, 2³⁰) ■ T or t (tera, 2⁴⁰) <p>If the value does not contain a factor, a factor of one is assumed. The default value is 10MB.</p>												

Table B-70 (Cont.) transactional-scheme Subelements

Element	Required/ Optional	Description
<transfer-threshold>	Optional	Specifies the threshold for the primary buckets distribution in kilo-bytes. When a new node joins the partitioned cache service or when a member of the service leaves, the remaining nodes perform a task of bucket ownership re-distribution. During this process, the existing data gets re-balanced along with the ownership information. This parameter indicates a preferred message size for data transfer communications. Setting this value lower makes the distribution process take longer, but reduces network bandwidth utilization during this activity. Legal values are integers greater than zero. The default value is the <code>transfer-threshold</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>transfer-threshold</code> parameter in " DistributedCache Service Parameters " on page A-63 for more information.
<backup-count>	Optional	Specifies the number of members of the partitioned cache service that hold the backup data for each unit of storage in the cache. A value of 0 means that for abnormal termination, some portion of the data in the cache is lost. The default value is the <code>backup-count</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>backup-count</code> parameter in value specified in the <code>tangosol-coherence.xml</code> descriptor. See " DistributedCache Service Parameters " on page A-63 for more information.
<partition-assignment-strategy>	Optional	Specifies the strategy that is used by a partitioned service to manage partition distribution. Valid values are <code>legacy</code> , <code>simple</code> , or a class that implements the <code>com.tangosol.net.partition.PartitionAssignmentStrategy</code> interface. The <code>legacy</code> assignment strategy indicates that partition distribution is managed individually on each cluster member. The <code>simple</code> strategy is a centralized distribution strategy that attempts to balance partition distribution, while ensuring machine-safety and is more deterministic and efficient than the <code>legacy</code> strategy. The default value is <code>simple</code> . Enter the custom strategy using the <code><instance></code> element.
<task-hung-threshold>	Optional	Specifies the amount of time in milliseconds that a task can execute before it is considered "hung". Note: a posted task that has not yet started is never considered as hung. This attribute is applied only if the Thread pool is used (the <code>thread-count</code> value is positive). Legal values are positive integers or zero (indicating no default timeout). The default value is the <code>task-hung-threshold</code> value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>task-hung-threshold</code> parameter in " DistributedCache Service Parameters " on page A-63 for more information.
<task-timeout>	Optional	Specifies the timeout value in milliseconds for requests executing on the service worker threads. This attribute is applied only if the thread pool is used (the <code>thread-count</code> value is positive). If zero is specified, the default <code>service-guardian <timeout-milliseconds></code> value is used. Legal values are nonnegative integers. The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>task-timeout</code> parameter in " DistributedCache Service Parameters " on page A-63.

Table B-70 (Cont.) transactional-scheme Subelements

Element	Required/ Optional	Description
<request-timeout>	Optional	<p>Specifies the maximum amount of time a client waits for a response before abandoning the original request. The request time is measured on the client side as the time elapsed from the moment a request is sent for execution to the corresponding server node(s) and includes the following:</p> <ul style="list-style-type: none"> ■ the time it takes to deliver the request to an executing node (server) ■ the interval between the time the task is received and placed into a service queue until the execution starts ■ the task execution time ■ the time it takes to deliver a result back to the client <p>Legal values are positive integers or zero (indicating no default timeout). The default value is the value specified in the <code>tangosol-coherence.xml</code> descriptor. See the <code>request-timeout</code> parameter in "DistributedCache Service Parameters" on page A-63 for more information.</p>
<guardian-timeout>	Optional	<p>Specifies the guardian timeout value to use for guarding the service and any dependent threads. If the element is not specified for a given service, the default guardian timeout (as specified by the <code><timeout-milliseconds></code> operational configuration element) is used. See <code><service-guardian></code>.</p> <p>The value of this element must be in the following format:</p> <pre>(\d)+(.(\d)+)?[MS ms S s M m H h D d]?</pre> <p>where the first non-digits (from left to right) indicate the unit of time duration:</p> <ul style="list-style-type: none"> ■ MS or ms (milliseconds) ■ S or s (seconds) ■ M or m (minutes) ■ H or h (hours) ■ D or d (days) <p>If the value does not contain a unit, a unit of milliseconds is assumed.</p>

Table B–70 (Cont.) transactional-scheme Subelements

Element	Required/ Optional	Description
<code><service-failure-policy></code>	Optional	<p>Specifies the action to take when an abnormally behaving service thread cannot be terminated gracefully by the service guardian.</p> <p>Legal values are:</p> <ul style="list-style-type: none"> ▪ <code>exit-cluster</code> (default) – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy causes the local node to stop the cluster services. ▪ <code>exit-process</code> – attempts to recover threads that appear to be unresponsive. If the attempt fails, an attempt is made to stop the associated service. If the associated service cannot be stopped, this policy cause the local node to exit the JVM and terminate abruptly. ▪ <code>logging</code> – causes any detected problems to be logged, but no corrective action to be taken. ▪ a custom class – an <code><instance></code> subelement is used to provide the class configuration information for a <code>com.tangosol.net.ServiceFailurePolicy</code> implementation.
<code><partitioned-quorum-policy-scheme></code>	Optional	Specifies quorum policy settings for the partitioned cache service.
<code><autostart></code>	Optional	The element is intended to be used by cache servers (that is, <code>com.tangosol.net.DefaultCacheServer</code>). It specifies whether the cache services associated with this cache scheme should be automatically started at a cluster node. Legal values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .

trust-manager

Used in: [ssl](#).

Description

The `<trust-manager>` element contains the configuration information for initializing a `javax.net.ssl.TrustManager` instance.

A trust manager is responsible for managing the trust material that is used when making trust decisions and for deciding whether credentials presented by a peer should be accepted.

A valid `trust-manager` configuration contains at least one child element.

Elements

[Table B-71](#) describes the elements you can define within the `trust-manager` element.

Table B-71 *trust-manager* Subelements

Element	Required/ Optional	Description
<code><algorithm></code>	Optional	Specifies the algorithm used by the trust manager. The default value is <code>SunX509</code> .
<code><provider></code>	Optional	Specifies the configuration for a security provider instance.
<code><key-store></code>	Optional	Specifies the configuration for a key store implementation.

Attribute Reference

[Table B-72](#) describes the system property attribute that is available in the cache configuration deployment descriptor.

Table B-72 *Cache Configuration Deployment Descriptor Attribute*

Attribute	Required/ Optional	Description
system-property	Optional	This attribute is used to specify a system property name for any element. The system property is used to override the element value from the Java command line. This feature enables the same operational descriptor (and override file) to be used across all cluster nodes and customize each node using the system properties. See Appendix D, "System Property Overrides," for more information on this feature.

POF User Type Configuration Elements

This appendix provides a detailed reference of the POF configuration deployment descriptor and includes a brief overview of the descriptor. See [Appendix E, "The PIF-POF Binary Format,"](#) for details of the binary format.

This appendix includes the following sections:

- [POF Configuration Deployment Descriptor](#)
- [Element Index](#)

POF Configuration Deployment Descriptor

The POF configuration deployment descriptor is used to specify non-intrinsic types, referred to as User Types, for objects that are being serialized and deserialized using POF. The name and location of the POF configuration deployment descriptor is specified in the operational deployment descriptor and defaults to `pof-config.xml`. A sample POF configuration deployment descriptor is located in the root of the `coherence.jar` library and is used unless a custom `pof-config.xml` file is found before the `coherence.jar` library within the application's classpath. All cluster members should use identical POF configuration deployment descriptors.

The POF configuration deployment descriptor schema is defined in the `coherence-pof-config.xsd` file. This XSD file is located in the root of the `coherence.jar` library and at the following Web URL:

<http://xmlns.oracle.com/coherence/coherence-pof-config/1.2/coherence-pof-config.xsd>

The `<pof-config>` element is the root element of the POF configuration deployment descriptor and typically includes an XSD and Coherence namespace reference and the location of the `coherence-pof-config.xsd` file. For example:

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

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

Notes:

- The schema located in the `coherence.jar` library is always used at run time even if the `xsi:schemaLocation` attribute references the Web URL.
 - The `xsi:schemaLocation` attribute can be omitted to disable schema validation.
 - When deploying Coherence into environments where the default character set is EBCDIC rather than ASCII, ensure that the deployment descriptor file is in ASCII format and is deployed into its run-time environment in the binary format.
-

Coherence-specific user types are defined in the `coherence-pof-config.xml` file that is also located in the root of the `coherence.jar` library. This file should always be referenced as follows when creating a `pof-config.xml` file:

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

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

Element Index

[Table C-1](#) lists all non-terminal POF configuration deployment descriptor elements.

Table C-1 *POF Configuration Elements*

Element	Used In
<code>default-serializer</code>	<code>pof-config</code>
<code>init-param</code>	<code>init-params</code>
<code>init-params</code>	<code>serializer</code>
<code>pof-config</code>	<i>root element</i>
<code>serializer</code>	<code>user-type</code>
<code>user-type</code>	<code>user-type-list</code>
<code>user-type-list</code>	<code>pof-config</code>

default-serializer

Used in: [pof-config](#)

Description

This element specifies a `PofSerializer` to use when serializing and deserializing all user types defined within the `pof-config` element. If a serializer is specified within a `user-type`, then that serializer is used for that user-type instead of the default serializer.

If the default serializer element is omitted, the serializer defined for the specific user type is used. If the serializer for the user type is also omitted, then the user type is assumed to implement the `PortableObject` interface, and the `PortableObjectSerializer` implementation is used as the `PofSerializer`.

If the `init-params` element is omitted from the default serializer element, then the following four constructors are attempted on the specific `PofSerializer` implementation, and in this order:

- `(int nTypeId, Class clz, ClassLoader loader)`
- `(int nTypeId, Class clz)`
- `(int nTypeId)`
- `()`

Elements

[Table C-2](#) describes the subelements of the `default-serializer` element.

Table C-2 *default-serializer Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	Specifies the fully qualified name of the <code>PofSerializer</code> implementation.
<code><init-params></code>	Optional	Specifies zero or more arguments (each as an <code>init-param</code>) that correspond to the parameters of a constructor of the class that is being configured.

init-param

Used in: [init-params](#)

Description

The `init-param` element provides a type for a configuration parameter and a corresponding value to pass as an argument.

Elements

[Table C-3](#) describes the subelements of the `init-param` element.

Table C-3 *init-param Subelements*

Element	Required/ Optional	Description
<code><param-type></code>	Required	<p>The <code>param-type</code> element specifies the Java type of initialization parameter. Supported types are:</p> <ul style="list-style-type: none"> ▪ <code>string</code>—indicates that the value is a <code>java.lang.String</code> ▪ <code>boolean</code>—indicates that the value is a <code>java.lang.Boolean</code> ▪ <code>int</code>—indicates that the value is a <code>java.lang.Integer</code> ▪ <code>long</code>—indicates that the value is a <code>java.lang.Long</code> ▪ <code>double</code>—indicates that the value is a <code>java.lang.Double</code> ▪ <code>decimal</code>—indicates that the value is a <code>java.math.BigDecimal</code> ▪ <code>file</code>—indicates that the value is a <code>java.io.File</code> ▪ <code>date</code>—indicates that the value is a <code>java.sql.Date</code> ▪ <code>time</code>—indicates that the value is a <code>java.sql.Timestamp</code> ▪ <code>datetime</code>—indicates that the value is a <code>java.sql.Timestamp</code> ▪ <code>xml</code>—indicates that the value is the entire <code>init-param</code> <code>XmlElement</code>. <p>The value is converted to the specified type, and the target constructor or method must have a parameter of that type for the instantiation to succeed.</p>
<code><param-value></code>	Required	<p>The <code>param-value</code> element specifies a value of the initialization parameter. The value is in a format specific to the type of the parameter. There are four reserved values that can be specified. Each of these values is replaced at run time with a value before the constructor is invoked:</p> <ul style="list-style-type: none"> ▪ <code>{type-id}</code>—replaced with the Type ID of the User Type; ▪ <code>{class-name}</code>—replaced with the name of the class for the User Type; ▪ <code>{class}</code>—replaced with the Class for the User Type; ▪ <code>{class-loader}</code>—replaced with the <code>ConfigurablePofContext</code>'s <code>ContextClassLoader</code>.

init-params

Used in: [serializer](#), [default-serializer](#)

Description

The `init-params` element contains zero or more arguments (each as an `init-param`) that correspond to the parameters of a constructor of the class that is being configured.

Elements

[Table C-4](#) describes the subelements of the `init-params` element.

Table C-4 *init-params* Subelements

Element	Required/ Optional	Description
<code><init-param></code>	Required	The <code>init-param</code> element provides a type for a configuration parameter and a corresponding value to pass as an argument.

pof-config

root element

Description

The `pof-config` element is the root element of the POF user type configuration descriptor.

Elements

Table C-5 describes the subelements of the `pof-config` element.

Table C-5 *pof-config* Subelements

Element	Required/ Optional	Description
<code><user-type-list></code>	Required	The <code>user-type-list</code> element contains zero or more <code>user-type</code> elements. Each POF user type that is used must be listed in the <code>user-type-list</code> . The <code>user-type-list</code> element may also contain zero or more <code>include</code> elements. Each <code>include</code> element is used to add <code>user-type</code> elements defined in another <code>pof-config</code> file.
<code><allow-interfaces></code>	Optional	The <code>allow-interfaces</code> element indicates whether the <code>user-type class-name</code> can specify Java interface types in addition to Java class types. Valid values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<code><allow-subclasses></code>	Optional	The <code>allow-subclasses</code> element indicates whether the <code>user-type class-name</code> can specify a Java class type that is abstract, and whether sub-classes of any specified <code>user-type class-name</code> is permitted at run time and automatically mapped to the specified super-class for purposes of obtaining a serializer. Valid values are <code>true</code> or <code>false</code> . The default value is <code>false</code> .
<code><enable-references></code>	Optional	The <code>enable-references</code> element indicates whether or not Identity/Reference type support is enabled. Valid values are <code>true</code> or <code>false</code> . Default value is <code>false</code> .
<code><default-serializer></code>	Optional	The <code>default-serializer</code> specifies what serializer to use to serialize and deserialize all user types defined in the POF configuration file. If a <code>user-type</code> defines a specific serializer, then that serializer is used instead of the default serializer.

serializer

Used in: [user-type](#)

Description

The `serializer` element specifies what POF serializer to use to serialize and deserialize a specific user type. A `PofSerializer` implementation is used to serialize and deserialize user type values to and from a POF stream.

If the `serializer` element is omitted, then the user type is assumed to implement the `PortableObject` interface and the `PortableObjectSerializer` implementation is used as the POF serializer. If POF annotations are used, then the `PofAnnotationSerializer` implementation is used as the POF serializer.

If the `init-params` element is omitted, then the following four constructors are attempted (in this order) on the specific `PofSerializer` implementation:

- `(int nTypeId, Class clz, ClassLoader loader)`
- `(int nTypeId, Class clz)`
- `(int nTypeId)`
- `()`

Elements

[Table C-6](#) describes the subelements of the `serializer` element.

Table C-6 *serializer Subelements*

Element	Required/ Optional	Description
<code><class-name></code>	Required	Specifies the fully qualified name of the <code>PofSerializer</code> implementation.
<code><init-params></code>	Optional	The <code>init-params</code> element contains zero or more arguments (each as an <code>init-param</code>) that correspond to the parameters of a constructor of the class that is being configured.

user-type

Used in: [user-type-list](#)

Description

The `user-type` element contains the declaration of a POF user type. A POF user type is a uniquely identifiable, portable, versionable object class that can be communicated among systems regardless of language, operating system, hardware and location.

Within the `user-type` element, the `type-id` element is optional, but its use is strongly suggested to support schema versioning and evolution.

Within the `user-type` element, the `class-name` element is required, and specifies the fully qualified name of the Java class or interface that all values of the user type are type-assignable to.

If the `serializer` element is omitted, then the user type is assumed to implement the `PortableObject` interface, and the `PortableObjectSerializer` implementation is used as the `PofSerializer`.

Elements

[Table C-7](#) describes the subelements of the `user-type` element.

Table C-7 *user-type Subelements*

Element	Required/ Optional	Description
<code><type-id></code>	Optional	The <code>type-id</code> element specifies an integer value ($n \geq 0$) that uniquely identifies the user type. If none of the <code>user-type</code> elements contains a <code>type-id</code> element, then the type IDs for the user types are based on the order in which they appear in the <code>user-type-list</code> , with the first user type being assigned the type ID 0, the second user type being assigned the type ID 1, and so on. However, it is strongly recommended that user types IDs always be specified, to support schema versioning and evolution. The first 1000 IDs are reserved for Coherence internal use and cannot be used.
<code><class-name></code>	Required	The <code>class-name</code> element specifies the fully qualified name of a Java class or interface that all values of the user type are type-assignable to.
<code><serializer></code>	Optional	<p>The <code>serializer</code> element specifies what <code>PofSerializer</code> to use to serialize and deserialize a specific user type. A <code>PofSerializer</code> is used to serialize and deserialize user type values to and from a POF stream. Within the <code>serializer</code> element, the <code>class-name</code> element is required, and zero or more constructor parameters can be defined within an <code>init-params</code> element.</p> <p>If the <code>serializer</code> element is omitted, then the user type is assumed to implement the <code>PortableObject</code> interface, and the <code>PortableObjectSerializer</code> implementation is used as the <code>PofSerializer</code>.</p> <p>If the <code>init-params</code> element is omitted from the <code>serializer</code> element, then the following four constructors are attempted on the specific <code>PofSerializer</code> implementation, and in this order:</p> <ul style="list-style-type: none"> ▪ <code>(int nTypeId, Class clz, ClassLoader loader)</code> ▪ <code>(int nTypeId, Class clz)</code> ▪ <code>(int nTypeId)</code> ▪ <code>()</code>

user-type-list

Used in: [pof-config](#)

Description

The `user-type-list` element contains zero or more `user-type` elements. Each POF user type that is used must be listed in the `user-type-list`.

The `user-type-list` element may also contain zero or more `include` elements. Each `include` element is used to add `user-type` elements defined in another `pof-config` file.

Elements

[Table C-8](#) describes the subelements of the `user-type-list` element.

Table C-8 *user-type-list Subelements*

Element	Required/ Optional	Description
<code><user-type></code>	Optional	<p>The <code>user-type</code> element contains the declaration of a POF user type. A POF user type is a uniquely identifiable, portable, versionable object class that can be communicated among systems regardless of language, operating system, hardware and location. Any number of <code><user-type></code> elements may be specified.</p> <p>Within the <code>user-type</code> element, the <code>type-id</code> element is optional, but its use is strongly suggested to support schema versioning and evolution.</p> <p>Within the <code>user-type</code> element, the <code>class-name</code> element is required, and specifies the fully qualified name of the Java class or interface that all values of the user type are type-assignable to.</p> <p>If the <code>serializer</code> element is omitted, then the user type is assumed to implement the <code>PortableObject</code> interface, and the <code>PortableObjectSerializer</code> implementation is used as the <code>PofSerializer</code>.</p>
<code><include></code>	Optional	<p>The <code>include</code> element specifies the location of a POF configuration file to load <code>user-type</code> elements from. The value is a locator string (either a valid path or URL) that identifies the location of the target file. Any number of <code><include></code> elements may be specified.</p>

System Property Overrides

This appendix describes the system property override feature and lists many of the predefined system properties that are used to change the default settings in Coherence.

This appendix contains the following sections:

- [Overview of System Property Overrides](#)
- [Override Example](#)
- [Preconfigured Override Values](#)

Overview of System Property Overrides

Both the Coherence Operational Configuration deployment descriptor `tangosol-coherence.xml` and the Coherence Cache Configuration deployment descriptor `coherence-cache-config.xml` can assign a Java command line option name to any element defined in the descriptor. Some elements have predefined overrides. You can create your own or change the predefined ones.

This feature is useful when you want to change the settings for a single JVM, or to be able to start different applications with different settings without making them use different descriptors. The most common application is passing a different multicast address, or port, or both to allow different applications to create separate clusters.

To create a Command Line Setting Override, add a `system-property` attribute, specifying the string you would like to assign as the name for the java command line option to the element you want to create an override to. Then, specify it in the Java command line, prefixed with "-D".

Override Example

For example, to create an override for the IP address of the multi-home server to avoid using the default `localhost`, and instead specify a specific IP address for the interface (for instance, `192.168.0.301`). Call this override `tangosol.coherence.localhost`.

First, add a `system-property` to the `cluster-config`, `unicast-listener`, or `address` element. for example:

```
<address system-property="tangosol.coherence.localhost">localhost</address>
```

Then use it by modifying the Java command line and specifying an IP address instead of the default `localhost`:

```
java -Dtangosol.coherence.localhost=192.168.0.301 -jar coherence.jar
```

Preconfigured Override Values

Table D–1 lists all of the preconfigured override values:

Table D–1 Preconfigured System Property Override Values

Override Option	Setting
<code>tangosol.coherence.cacheconfig</code>	Cache configuration descriptor filename. See "configurable-cache-factory-config" on page A-16.
<code>tangosol.coherence.cluster</code>	Cluster name. See "member-identity" on page A-41.
<code>tangosol.coherence.clusteraddress</code>	Cluster (multicast) IP address. See <code><multicast-listener-address></code> subelement of "multicast-listener" on page A-43
<code>tangosol.coherence.clusterport</code>	Cluster (multicast) IP port. See <code><multicast-listener-port></code> subelement of "multicast-listener" on page A-43.
<code>tangosol.coherence.distributed.backup</code>	Data backup storage location. See <code>backup-storage/type</code> subelement in "DistributedCache Service Parameters" on page A-63.
<code>tangosol.coherence.distributed.backupcount</code>	Number of data backups. See <code>backup-count</code> subelement in "DistributedCache Service Parameters" on page A-63.
<code>tangosol.coherence.distributed.localstorage</code>	Local partition management enabled. See <code>local-storage</code> subelement in "DistributedCache Service Parameters" on page A-63.
<code>tangosol.coherence.distributed.threads</code>	Thread pool size. See <code>thread-count</code> subelement in "DistributedCache Service Parameters" on page A-63.
<code>tangosol.coherence.distributed.transfer</code>	Partition transfer threshold. See <code>transfer-threshold</code> subelement in "DistributedCache Service Parameters" on page A-63.
<code>tangosol.coherence.edition</code>	Product edition. See "license-config" on page A-33.
<code>tangosol.coherence.invocation.threads</code>	Invocation service thread pool size. See <code>thread-count</code> subelement in "Invocation Service Parameters" on page A-74.
<code>tangosol.coherence.localhost</code>	Unicast IP address. See <code><unicast-listener-address></code> subelement in "unicast-listener" on page A-94.
<code>tangosol.coherence.localport</code>	Unicast IP port. See <code><unicast-listener-port></code> subelement in "unicast-listener" on page A-94.
<code>tangosol.coherence.localport.adjust</code>	Unicast IP port auto assignment. See <code><unicast-listener-auto></code> subelement in "unicast-listener" on page A-94.
<code>tangosol.coherence.log</code>	Logging destination. See <code><logging-config-destination></code> subelement in "logging-config" on page A-34.
<code>tangosol.coherence.log.level</code>	Logging level. See <code><logging-config-level></code> subelement in "logging-config" on page A-34.
<code>tangosol.coherence.log.limit</code>	Log output character limit. See <code><logging-config-limit></code> subelement in "logging-config" on page A-34.
<code>tangosol.coherence.machine</code>	The computer's name as defined by the <code>machine-name</code> element. See "member-identity" on page A-41.

Table D-1 (Cont.) Preconfigured System Property Override Values

Override Option	Setting
<code>tangosol.coherence.management</code>	JMX management mode. See " management-config " on page A-35.
<code>tangosol.coherence.management.readonly</code>	JMX management read-only flag. See " management-config " on page A-35.
<code>tangosol.coherence.management.remote</code>	Remote JMX management enabled flag. See " management-config " on page A-35.
<code>tangosol.coherence.member</code>	Member name. See " member-identity " on page A-41.
<code>tangosol.coherence.mode</code>	Operational mode. See " license-config " on page A-33.
<code>tangosol.coherence.override</code>	Deployment configuration override filename.
<code>tangosol.coherence.priority</code>	Priority. See " member-identity " on page A-41.
<code>tangosol.coherence.process</code>	Process name " member-identity " on page A-41.
<code>tangosol.coherence.proxy.threads</code>	Coherence*Extend service thread pool size. See <code>thread-count</code> subelement in " Proxy Service Parameters " on page A-77.
<code>tangosol.coherence.rack</code>	Rack name. See " member-identity " on page A-41.
<code>tangosol.coherence.role</code>	Role name. See " member-identity " on page A-41.
<code>tangosol.coherence.security</code>	Cache access security enabled flag. See " security-config " on page A-58.
<code>tangosol.coherence.security.keystore</code>	Security access controller keystore file name. See " security-config " on page A-58.
<code>tangosol.coherence.security.permissions</code>	Security access controller permissions file name. See " security-config " on page A-58.
<code>tangosol.coherence.shutdownhook</code>	Shutdown listener action. See " shutdown-listener " on page A-84.
<code>tangosol.coherence.site</code>	Site name. See " member-identity " on page A-41.
<code>tangosol.coherence.tcmp.enabled</code>	TCMP enabled flag. See <code><packet-publisher-enabled></code> subelement in " packet-publisher " on page A-51.
<code>tangosol.coherence.ttl</code>	Multicast packet time to live (TTL). See <code><multicast-listener-ttl></code> subelement in " multicast-listener " on page A-43.
<code>tangosol.coherence.wka</code>	Well known IP address. See " well-known-addresses " on page A-98.
<code>tangosol.coherence.wka.port</code>	Well known IP port. See " well-known-addresses " on page A-98.

The PIF-POF Binary Format

This appendix describes the binary streams for the Portable Object Format (POF) and the Portable Invocation Format (PIF) that are used to serialize objects in a platform and language neutral way.

This appendix includes the following sections:

- [Overview of the PIF-POF Binary Format](#)
- [Stream Format](#)
- [Binary Formats for Predefined Types](#)
- [Binary Format for User Types](#)

Overview of the PIF-POF Binary Format

The Portable Object Format (POF) allows object values to be encoded into a binary stream in such a way that the platform/language origin of the object value is both irrelevant and unknown. The Portable Invocation Format (PIF) allows method invocations to be similarly encoded into a binary stream. These two formats (referred to as PIF-POF) are derived from a common binary encoding substrate. The binary format is provided here for informative purposes and is not a requirement for using PIF-POF. See [Chapter 20, "Using Portable Object Format,"](#) for more information on using PIF-POF.

Stream Format

The PIF-POF stream format is octet-based; a PIF-POF stream is a sequence of octet values. For the sake of clarity, this documentation treats all octets as unsigned 8-bit integer values in the range 0x00 to 0xFF (decimal 0 to 255). Byte-ordering is explicitly not a concern since (in PIF-POF) a given octet value that is represented by an unsigned 8-bit integer value is always written and read as the same unsigned 8-bit integer value.

A PIF stream contains exactly one Invocation. An Invocation consists of an initial POF stream that contains an Integer Value for the remaining length of the Invocation, immediately followed by a POF stream that contains an Integer Value that is the conversation identifier, immediately followed by a POF stream that contains a User Type value that is the message object. The remaining length indicates the total number of octets used to encode the conversation identifier and the message object; the remaining length is provided so that a process receiving an Invocation can determine when the Invocation has been fully received. The conversation identifier is used to support multiple logical clients and services multiplexed through a single connection, just as TCP/IP provides multiple logical port numbers for a given IP address. The message object is defined by the particular high-level conversational protocol.

A POF stream contains exactly one Value. The Value contains a Type Identifier, and if the Type Identifier does not imply a value, then it is immediately trailed by a data structure whose format is defined by the Type Identifier.

Integer Values

The stream format relies extensively on the ability to encode integer values in a compact form. Coherence refers to this integer binary format as a *packed integer*. This format uses an initial octet and one or more trailing octets as necessary; it is a variable-length format.

[Table E-1](#) describes the three regions in the first octet.

Table E-1 Regions in the First Octet of a Packed Integer

Region Mask	Description
0x80	Continuation indicator
0x40	Negative indicator
0x3F	integer value (6 binary LSDs)

[Table E-2](#) describes the two regions in the trailing octets.

Table E-2 Regions in the Trailing Octet of a Packed Integer

Region Mask	Description
0x80	Continuation indicator
0x7F	integer value (next 7 binary LSDs)

[Example E-1](#) illustrates writing a 32-bit integer value to an octet stream as supported in Coherence.

Example E-1 Writing a 32-bit Integer Value to an Octet Stream

```
public static void writeInt(DataOutput out, int n)
    throws IOException
{
    int b = 0;
    if (n < 0)
    {
        b = 0x40;
        n = ~n;
    }
    b |= (byte) (n & 0x3F);
    n >>= 6;
    while (n != 0)
    {
        b |= 0x80;
        out.writeByte(b);
        b = (n & 0x7F);
        n >>= 7;
    }
    out.writeByte(b);
}
```

[Example E-2](#) illustrates reading a 32-bit integer value from an octet stream as supported in Coherence.

Example E-2 Reading a 32-bit Integer Value from an Octet Stream

```

public static int readInt(DataInput in)
    throws IOException
{
    int b = in.readUnsignedByte();
    int n = b & 0x3F;
    int cBits = 6;
    boolean fNeg = (b & 0x40) != 0;
    while ((b & 0x80) != 0)
    {
        b = in.readUnsignedByte();
        n |= ((b & 0x7F) << cBits);
        cBits += 7;
    }
    if (fNeg)
    {
        n = ~n;
    }
    return n;
}

```

Integer values used within this documentation without an explicit Type Identifier are assumed to be 32-bit signed integer values that have a decimal range of -2^{31} to $2^{31}-1$.

[Table E-3](#) illustrates some integer value examples.

Table E-3 Binary Formats for Integer Values Without a Type Identifier

Value	Binary Format
0	0x00
1	0x01
2	0x02
99	0xA301
9999	0x8F9C01
-1	0x40
-2	0x41
-99	0xE201
-9999	0xCE9C01

Type Identifiers

A Type Identifier is encoded in the binary stream as an Integer Value. Type Identifiers greater than or equal to zero are user Type Identifiers. Type Identifiers less than zero are predefined ("intrinsic") type identifiers.

[Table E-4](#) lists the predefined identifiers.

Table E-4 Predefined Type Identifiers

Type ID	Description
-1 (0x40)	int16
-2 (0x41)	int32
-3 (0x42)	int64

Table E-4 (Cont.) Predefined Type Identifiers

Type ID	Description
-4 (0x43)	int128*
-5 (0x44)	float32
-6 (0x45)	float64
-7 (0x46)	float128*
-8 (0x47)	decimal32*
-9 (0x48)	decimal64*
-10 (0x49)	decimal128*
-11 (0x4A)	boolean
-12 (0x4B)	octet
-13 (0x4C)	octet-string
-14 (0x4D)	char
-15 (0x4E)	char-string
-16 (0x4F)	date
-17 (0x50)	year-month-interval*
-18 (0x51)	time
-19 (0x52)	time-interval*
-20 (0x53)	datetime
-21 (0x54)	day-time-interval*
-22 (0x55)	collection
-23 (0x56)	uniform-collection
-24 (0x57)	array
-25 (0x58)	uniform-array
-26 (0x59)	sparse-array
-27 (0x5A)	uniform-sparse-array
-28 (0x5B)	map
-29 (0x5C)	uniform-keys-map
-30 (0x5D)	uniform-map
-31 (0x5E)	identity
-32 (0x5F)	reference

Type Identifiers less than or equal to -33 are a combination of a type and a value. This form is used to reduce space for these commonly used values.

[Table E-5](#) lists the type identifiers that combine type and value.

Table E-5 Type Identifiers that Combine a Type and a Value

Type ID	Description
-33 (0x60)	boolean:false
-34 (0x61)	boolean:true

Table E-5 (Cont.) Type Identifiers that Combine a Type and a Value

Type ID	Description
-35 (0x62)	string:zero-length
-36 (0x63)	collection:empty
-37 (0x64)	reference:null
-38 (0x65)	floating-point:+infinity
-39 (0x66)	floating-point:-infinity
-40 (0x67)	floating-point:NaN
-41 (0x68)	int:-1
-42 (0x69)	int:0
-43 (0x6A)	int:1
-44 (0x6B)	int:2
-45 (0x6C)	int:3
-46 (0x6D)	int:4
-47 (0x6E)	int:5
-48 (0x6F)	int:6
-49 (0x70)	int:7
-50 (0x71)	int:8
-51 (0x72)	int:9
-52 (0x73)	int:10
-53 (0x74)	int:11
-54 (0x75)	int:12
-55 (0x76)	int:13
-56 (0x77)	int:14
-57 (0x78)	int:15
-58 (0x79)	int:16
-59 (0x7A)	int:17
-60 (0x7B)	int:18
-61 (0x7C)	int:19
-62 (0x7D)	int:20
-63 (0x7E)	int:21
-64 (0x7F)	int:22

Binary Formats for Predefined Types

This section describes the binary formats for the predefined ("intrinsic") type identifiers that are supported with PIF-POF. The types are: int, Decimal, Floating Point, Boolean, Octet, Octet String, Char, Char String, Date, Year-Month Interval, Time, Time Interval, Date-Time, Date-Time Interval, Collections, Arrays, Sparse Arrays, Key-Value Maps (Dictionaries), Identity, and Reference.

Int

Four signed integer types are supported: `int16`, `int32`, `int64`, and `int128`. If a type identifier for an integer type is encountered in the stream, it is immediately followed by an Integer Value.

The four signed integer types vary only by the length that is required to support the largest value of the type using the common "twos complement" binary format. The Type Identifier, one of `int16`, `int32`, `int64`, or `int128` is followed by an Integer Value in the stream. If the Integer Value is outside of the range supported by the type (-2^{15} to $2^{15}-1$ for `int16`, -2^{31} to $2^{31}-1$, for `int32`, -2^{63} to $2^{63}-1$ for `int64`, or -2^{127} to $2^{127}-1$ for `int128`.) then the result is undefined and may be bitwise truncation or an exception.

Additionally, there are some Type Identifiers that combine the `int` designation with a value into a single byte for purpose of compactness. As a result, these Type Identifiers are not followed by an Integer Value in the stream, since the value is included in the Type Identifier.

Table E-6 illustrates these type identifiers.

Table E-6 Type Identifiers that Combine an int Data Type with a Value

Value	int16	int32	int64	int128
0	0x69	0x69	0x69	0x69
1	0x6A	0x6A	0x6A	0x6A
2	0x6B	0x6B	0x6B	0x6B
99	0x40A301	0x41A301	0x42A301	0x43A301
9999	0x408F9C01	0x418F9C01	0x428F9C01	0x438F9C01
-1	0x68	0x68	0x68	0x68
-2	0x4041	0x4141	0x4241	0x4341
-99	0x40E201	0x41E201	0x42E201	0x43E201
-9999	0x40CE9C01	0x41CE9C01	0x42CE9C01	0x43CE9C01

The Java type equivalents are `short` (`int16`), `int` (`int32`), `long` (`int64`) and `BigInteger` (`int128`). Since `BigInteger` can represent much larger values, it is not possible to encode all `BigInteger` values in the `int128` form; values out of the `int128` range are basically unsupported, and would result in an exception or would use a different encoding, such as a string encoding.

Coercion of Integer Types

To enable the efficient representation of numeric data types, an integer type is coerced into any of the following types by a stream recipient:

Table E-7 Type IDs of Integer Types that can be Coerced into Other Types

Type ID	Description
-1 (0x40)	<code>int16</code>
-2 (0x41)	<code>int32</code>
-3 (0x42)	<code>int64</code>
-4 (0x43)	<code>int128</code>
-5 (0x44)	<code>float32</code>

Table E-7 (Cont.) Type IDs of Integer Types that can be Coerced into Other Types

Type ID	Description
-6 (0x45)	float64
-7 (0x46)	float128
-8 (0x47)	decimal32
-9 (0x48)	decimal64
-10 (0x49)	decimal128
-12 (0x4B)	octet
-14 (0x4D)	char

In other words, if the recipient reads any of the above types from the stream and it encounters an encoded integer value, it automatically converts that value into the expected type. This capability allows a set of common (that is, small-magnitude) octet, character, integer, decimal and floating-point values to be encoded using the single-octet integer form (Type Identifiers in the range -41 to -64).

For purposes of unsigned types, the integer value -1 is translated to 0xFF for the octet type, and to 0xFFFF for the char type. (In the case of the char type, this does unfortunately seem to imply a UTF-16 platform encoding; however, it does not violate any of the explicit requirements of the stream format.)

Decimal

There are three floating-point decimal types supported: `decimal32`, `decimal64`, and `decimal128`. If a type identifier for a decimal type is encountered in the stream, it is immediately followed by two packed integer values. The first integer value is the unscaled value, and the second is the scale. These values are equivalent to the parameters to the constructor of Java's `BigDecimal` class:

```
java.math.BigDecimal(BigInteger unscaledVal, int scale).
```

In addition to the coercion of integer values into decimal values supported as described in "[Coercion of Integer Types](#)" on page E-6, the constant type+value identifiers listed in [Table E-8](#) are used to indicate special values supported by IEEE 754r.

Table E-8 Type Identifiers that can Indicate Decimal Values

Type ID	Description
-38 (0x65)	floating-point:+infinity
-39 (0x66)	floating-point:-infinity
-40 (0x67)	floating-point:NaN

Java does not provide a standard (that is, portable) decimal type; rather, it has the awkward `BigDecimal` implementation that was intended originally for internal use in Java's cryptographic infrastructure. In Java, the decimal values for positive and negative infinity, and not-a-number (NaN), are not supported.

Floating Point

Three base-2 floating point types are supported: `float32`, `float64`, and `float128`. If a type identifier for a floating point type is encountered in the stream, it is immediately

followed by a fixed-length floating point value, whose binary form is defined by IEEE 754/IEEE754r. IEEE 754 format is used to write floating point numbers to the stream, and IEEE 754r format is used for the `float128` type.

In addition to the coercion of integer values into decimal values as described in ["Coercion of Integer Types"](#) on page E-6, the constants in [Table E-9](#) are used to indicate special values supported by IEEE-754

Table E-9 Type Identifiers that can Indicate IEEE 754 Special Values

Type ID	Description
-38 (0x65)	floating-point:+infinity
-39 (0x66)	floating-point:-infinity
-40 (0x67)	floating-point:NaN

Other special values defined by IEEE-754 are encoded using the full 32-bit, 64-bit or 128-bit format, and may not be supported on all platforms. Specifically, by not providing any means to differentiate among them, Java only supports one NaN value.

Boolean

If the type identifier for Boolean occurs in the stream, it is followed by an integer value, which represents the Boolean value `false` for the integer value of zero, or `true` for all other integer values.

While it is possible to encode Boolean values as described in ["Coercion of Integer Types"](#) on page E-6, the only values for the Boolean type are `true` and `false`. As such, the only expected binary formats for Boolean values are the predefined (and compact) forms described in [Table E-10](#).

Table E-10 Type Identifiers that can Indicate Boolean Values

Type ID	Description
-33 (0x60)	boolean:false
-34 (0x61)	boolean:true

Octet

If the type identifier for Octet occurs in the stream, it is followed by the octet value itself, which is by definition in the range 0 to 255 (0x00 to 0xFF). As described in ["Coercion of Integer Types"](#) on page E-6, the compact form of integer values can be used for Octet values, with the integer value -1 being translated as 0xFF.

[Table E-11](#) lists the integer values that may be used as Octet values.

Table E-11 Integer Values that may be Used for Octet Values

Value	Octet
0 (0x00)	0x69
1 (0x01)	0x6A
2 (0x02)	0x6B
99 (0x63)	0x4B63
254 (0xFE)	0x4BFE
255 (0xFF)	0x68

Octet String

If the type identifier for Octet String occurs in the stream, it is followed by an Integer Value for the length n of the string, and then n octet values.

An Octet String of zero length is encoded using the "string:zero-length" Type Identifier.

Char

If the type identifier for Char occurs in the stream, it is followed by a UTF-8 encoded character. As described in the section on "[Coercion of Integer Types](#)" on page E-6, the compact form of integer values may be used for Char values, with the integer value -1 being translated as 0xFFFF.

Note: POF optimizes the storage of String data by using only one byte for each character when possible. Custom POF character codecs (ASCII for example) are not required and do not result in better performance.

[Example E-3](#) illustrates writing a character value to an octet stream.

Example E-3 Writing a Character Value to an Octet Stream

```
public static void writeChar(DataOutput out, int ch)
    throws IOException
{
    if (ch >= 0x0001 && ch <= 0x007F)
    {
        // 1-byte format: 0xxx xxxx
        out.write((byte) ch);
    }
    else if (ch <= 0x07FF)
    {
        // 2-byte format: 110x xxxx, 10xx xxxx
        out.write((byte) (0xC0 | ((ch >>> 6) & 0x1F)));
        out.write((byte) (0x80 | ((ch >>) & 0x3F)));
    }
    else
    {
        // 3-byte format: 1110 xxxx, 10xx xxxx, 10xx xxxx
        out.write((byte) (0xE0 | ((ch >>> 12) & 0x0F)));
        out.write((byte) (0x80 | ((ch >>> 6) & 0x3F)));
        out.write((byte) (0x80 | ((ch >>) & 0x3F)));
    }
}
```

[Example E-4](#) illustrates reading a character value from an octet stream.

Example E-4 Reading a Character Value from an Octet Stream

```
public static char readChar(DataInput in)
    throws IOException
{
    char ch;

    int b = in.readUnsignedByte();
    switch ((b & 0xF0) >>> 4)
    {
        case 0x0: case 0x1: case 0x2: case 0x3:
```

```

    case 0x4: case 0x5: case 0x6: case 0x7:
        // 1-byte format: 0xxx xxxx
        ch = (char) b;
        break;

    case 0xC: case 0xD:
        {
            // 2-byte format: 110x xxxx, 10xx xxxx
            int b2 = in.readUnsignedByte();
            if ((b2 & 0xC0) != 0x80)
            {
                throw new UTFDataFormatException();
            }
            ch = (char) (((b & 0x1F) << 6) | b2 & 0x3F);
            break;
        }

    case 0xE:
        {
            // 3-byte format: 1110 xxxx, 10xx xxxx, 10xx xxxx
            int n = in.readUnsignedShort();
            int b2 = n >>> 8;
            int b3 = n & 0xFF;
            if ((b2 & 0xC0) != 0x80 || (b3 & 0xC0) != 0x80)
            {
                throw new UTFDataFormatException();
            }
            ch = (char) (((b & 0x0F) << 12) |
                ((b2 & 0x3F) << 6) |
                b3 & 0x3F);
            break;
        }

    default:
        throw new UTFDataFormatException(
            "illegal leading UTF byte: " + b);
}

return ch;
}

```

Char String

If the type identifier for Char String occurs in the stream, it is followed by an Integer Value for the length n of the UTF-8 representation string **in octets**, and then n octet values composing the UTF-8 encoding described above. Note that the format length-encodes the octet length, not the character length.

A Char String of zero length is encoded using the `string:zero-length` Type Identifier. [Table E-12](#) illustrates the Char String formats.

Table E-12 Values for Char String Formats

Values	Char String Format
	0x62 (or 0x4E00)
"ok"	0x4E026F6B

Date

Date values are passed using ISO8601 semantics. If the type identifier for Date occurs in the stream, it is followed by three Integer Values for the year, month and day, in the ranges as defined by ISO8601.

Year-Month Interval

If the type identifier for Year-Month Interval occurs in the stream, it is followed by two Integer Values for the number of years and the number of months in the interval.

Time

Time values are passed using ISO8601 semantics. If the type identifier for Time occurs in the stream, it is followed by five Integer Values, which may be followed by two more Integer Values. The first four Integer Values are the hour, minute, second and fractional second values. Fractional seconds are encoded in one of three ways:

- 0 indicates no fractional seconds.
- [1..999] indicates the number of milliseconds.
- [-1..-999999999] indicates the negated number of nanoseconds.

The fifth Integer Value is a time zone indicator, encoded in one of three ways:

- 0 indicates no time zone.
- 1 indicates Universal Coordinated Time (UTC).
- 2 indicates a time zone offset, which is followed by two more Integer Values for the hour offset and minute offset, as described by ISO8601.

The encoding for variable fractional and time zone does add complexity to the parsing of a Time Value, but provide for much more complete support of the ISO8601 standard and the variability in the precision of clocks, while achieving a high degree of binary compactness. While time values tend to have no fractional encoding or millisecond encoding, the trend over time is toward higher time resolution.

Time Interval

If the type identifier for Time Interval occurs in the stream, it is followed by four Integer Values for the number of hours, minutes, seconds and nanoseconds in the interval.

Date-Time

Date-Time values are passed using ISO8601 semantics. If the type identifier for Date-Time occurs in the stream, it is followed by eight or ten Integer Values, which correspond to the Integer Values that compose the Date and Time values.

Coercion of Date and Time Types

Date Value can be coerced into a Date-Time Value. Time Value can be coerced into a Date-Time Value. Date-Time Value can be coerced into either a Date Value or a Time Value.

Day-Time Interval

If the type identifier for Day-Time Interval occurs in the stream, it is followed by five Integer Values for the number of days, hours, minutes, seconds and nanoseconds in the interval.

Collections

A collection of values, such as a bag, a set, or a list, are encoded in a POF stream using the Collection type. Immediately following the Type Identifier, the stream contains the Collection Size, an Integer Value indicating the number of values in the Collection, which is greater than or equal to zero. Following the Collection Size, is the first value in the Collection (if any), which is itself encoded as a Value. The values in the Collection are contiguous, and there is exactly n values in the stream, where n equals the Collection Size.

If all the values in the Collection have the same type, then the Uniform Collection format is used. Immediately following the Type Identifier (uniform-collection), the uniform type of the values in the collection writes to the stream, followed by the Collection Size n as an Integer Value, followed by n values **without their Type Identifiers**. Note that values in a Uniform Collection cannot be assigned an identity, and that (as a side-effect of the explicit type encoding) an empty Uniform Collection has an explicit content type.

[Table E-13](#) illustrates examples of Collection and Uniform Collection formats for several values.

Table E-13 Collection and Uniform Collection Formats for Various Values

Values	Collection Format	Uniform Collection Format
	0x63 (or 0x5500)	n/a
1	0x55016A	0x56410101
1,2,3	0x55036A6B6C	0x564103010203
1, "ok"	0x55026A4E026F6B	n/a

Arrays

An indexed array of values is encoded in a POF stream using the Array type. Immediately following the Type Identifier, the stream contains the Array Size, an Integer Value indicating the number of elements in the Array, which must be greater than or equal to zero. Following the Array Size is the value of the first element of the Array (the zero index) if there is at least one element in the array which is itself encoded using as a Value. The values of the elements of the Array are contiguous, and there must be exactly n values in the stream, where n equals the Array Size.

If all the values of the elements of the Array have the same type, then the Uniform Array format is used. Immediately following the Type Identifier (uniform-array), the uniform type of the values of the elements of the Array writes the stream, followed by the Array Size n as an Integer Value, followed by n values **without their Type Identifiers**. Note that values in a Uniform Array cannot be assigned an identity, and that (as a side-effect of the explicit type encoding) an empty Uniform Array has an explicit array element type.

[Table E-14](#) illustrates examples of Array and Uniform Array formats for several values.

Table E-14 Array and Uniform Array Formats for Various Values

Values	Array Format	Uniform Array Format
	0x63 (or 0x5700)	0x63 (or 0x584100) – This example assumes an element type of Int32.
1	0x57016A	0x58410101
1,2,3	0x57036A6B6C	0x584103010203
1, "ok"	0x57026A4E026F6B	n/a

Sparse Arrays

For arrays whose element values are sparse, the Sparse Array format allows indexes to be explicitly encoded, implying that any missing indexes have a default value. The default value is false for the Boolean type, zero for all numeric, octet and char types, and null for all reference types. The format for the Sparse Array is the Type Identifier (sparse-array), followed by the Array Size n as an Integer Value, followed by not more than n index/value pairs, each of which is composed of an array index encoded as an Integer Value i ($0 \leq i < n$) whose value is greater than the previous element's array index, and an element value encoded as a Value; the Sparse Array is finally terminated with an illegal index of -1.

If all the values of the elements of the Sparse Array have the same type, then the Uniform Sparse Array format is used. Immediately following the Type Identifier (uniform-sparse-array), the uniform type of the values of the elements of the Sparse Array writes the stream, followed by the Array Size n as an Integer Value, followed by not more the n index/value pairs, each of which is composed of an array index encoded as an Integer Value i ($0 \leq i < n$) whose value is greater than the previous element's array index, and a element value encoded as a Value **without a Type Identifier**; the Uniform Sparse Array is finally terminated with an illegal index of -1. Note that values in a Uniform Sparse Array cannot be assigned an identity, and that (as a side-effect of the explicit type encoding) an empty Uniform Sparse Array has an explicit array element type.

Table E-15 illustrates examples of Sparse Array and Uniform Sparse Array formats for several values.

Table E-15 Sparse Array and Uniform Sparse Array Formats for Various Values

Values	Sparse Array format	Uniform Sparse Array format
	0x63 (or 0x590040)	0x63 (or 0x5A410040) – This example assumes an element type of Int32.
1	0x5901006A40	0x5A4101000140
1,2,3	0x5903006A016B026C40	0x5A410300010102020340
1,,,,5,,,,9	0x5909006A046E087240	0x5A410900010405080940
1,,,,"ok"	0x5905006A044E026F6B40	n/a

Key-Value Maps (Dictionaries)

For key/value pairs, a Key-Value Map (also known as Dictionary data structure) format is used. There are three forms of the Key-Value Map binary encoding:

- The generic map encoding is a sequence of keys and values;
- The uniform-keys-map encoding is a sequence of keys of a uniform type and their corresponding values;

- The `uniform-map` encoding is a sequence of keys of a uniform type and their corresponding values of a uniform type.

The format for the Key-Value Map is the Type Identifier (`map`), followed by the Key-Value Map Size n as an Integer Value, followed by n key/value pairs, each of which is composed of a key encoded as Value, and a corresponding value encoded as a Value.

[Table E–16](#) illustrates several examples of key/value pairs and their corresponding binary format.

Table E–16 Binary Formats for Key/Value Pairs

Values	Binary format
	0x63 (or 0x5B00)
1="ok"	0x5B016A4E026F6B
1="ok", 2="no"	0x5B026A4E026F6B6B4E026E6F

If all of the keys of the Key-Value Map are of a uniform type, then the encoding uses a more compact format, starting with the Type Identifier (`uniform-keys-map`), followed by the Type Identifier for the uniform type of the keys of the Key-Value Map, followed by the Key-Value Map Size n as an Integer Value, followed by n key/value pairs, each of which is composed of a key encoded as a Value **without a Type Identifier**, and a corresponding value encoded as a Value.

[Table E–17](#) illustrates several examples of the binary formats for Key/Value pairs where the Keys are of uniform type.

Table E–17 Binary Formats for Key/Value Pairs where Keys are of Uniform Type

Values	Binary format
	0x63 (or 0x5C4100)
1="ok"	0x5C4101014E026F6B
1="ok", 2="no"	0x5C4102014E026F6B024E026E6F

If all of the keys of the Key-Value Map are of a uniform type, and all the corresponding values of the map are also of a uniform type, then the encoding uses a more compact format, starting with the Type Identifier (`uniform-map`), followed by the Type Identifier for the uniform type of the keys of the Key-Value Map, followed by the Type Identifier for the uniform type of the values of the Key-Value Map, followed by the Key-Value Map Size n as an Integer Value, followed by n key/value pairs, each of which is composed of a key encoded as a Value **without a Type Identifier**, and a corresponding value encoded as a Value **without a Type Identifier**.

[Table E–18](#) illustrates several examples of the binary formats for Key/Value pairs where the Keys and Values are of uniform type.

Table E–18 Binary Formats for Key/Value Pairs where Keys and Values are of Uniform Type

Values	Binary format
	0x63 (or 0x5D414E00)
1="ok"	0x5D414E0101026F6B
1="ok", 2="no"	0x5D414E0201026F6B02026E6F

Identity

If the type identifier for Identity occurs in the stream, it is followed by an Integer Value, which is the Identity. Following the Identity is the value that is being identified, which is itself encoded as a Value.

Any value within a POF stream that occurs multiple times, is labeled with an Identity, and subsequent instances of that value within the same POF stream are replaced with a Reference. For platforms that support "by reference" semantics, the identity represents a serialized form of the actual object identity.

An Identity is an Integer Value that is greater than or equal to zero. A value within the POF stream has at most one Identity. Values within a uniform data structure can be assigned an identity.

Reference

A Reference is a pointer to an Identity that has been encountered inside the current POF stream, or a null pointer.

For platforms that support "by reference" semantics, the reference in the POF stream becomes a reference in the realized (deserialized) object, and a null reference in the POF stream becomes a null reference in the realized object. For platforms that do not support "by reference" semantics, and for cases in which a null reference is encountered in the POF stream for a non-reference value (for example, a primitive property in Java), the default value for the type of value is used.

[Table E-19](#) illustrates examples of binary formats for several "by reference" semantics.

Table E-19 Binary Formats for "By Reference" Semantics

Value	Binary Format
Id #1	0x5F01
Id #350	0x5F9E05
null	0x60

Support for forward and outer references is not required by POF. In POF, both the identity that is referenced and the value that is being referenced by the identity have occurred within the POF stream. In the first case, a reference is not made to an identity that has not yet been encountered, and in the second case, a reference is not made within a complex value (such as a collection or a user type) to that complex value itself.

Binary Format for User Types

All non-intrinsic types are referred to as User Types. User Types are composed of zero or more indexed values (also known as fields, properties, and attributes), each of which has a Type Identifier. Furthermore, User Types are versioned, supporting both forward and backward compatibility.

User Types have a Type Identifier with a value greater than or equal to zero. The Type Identifier has no explicit or self-describing meaning within the stream itself; in other words, a Value does not contain a type (or "class") definition. Instead, the encoder (the sender) and the decoder (the receiver) share an implicit understanding, called a *Context*, which includes the necessary metadata, including the user type definitions.

The binary format for a User Type is very similar to that of a Sparse Array; conceptually, a User Type can be considered a Sparse Array of property values. The format for User Types is the Type Identifier (an Integer Value greater than or equal to zero), followed by the Version Identifier (an Integer Value greater than or equal to zero), followed by index/value pairs, each of which is composed of a Property Index encoded as an Integer Value i ($0 \leq i$) whose value is greater than the previous Property Index, and a Property Value encoded as a Value; the User Type is finally terminated with an illegal Property Index of -1.

Like the Sparse Array, any property that is not included as part of the User Type encoding is assumed to have a default value. The default value is false for the Boolean type, zero for all numeric, octet and char types, and null for all reference types.

Versioning of User Types

Versioning of User Types supports the addition of properties to a User Type, but not the replacement or removal of properties that existed in previous versions of the User Type. By including the versioning capability as part of the general binary contract, it is possible to support both backward and forward compatibility.

When a sender sends a User Type value of a version $v1$ to a receiver that supports version $v2$ of the same User Type, the receiver uses default values for the additional properties of the User Type that exist in $v2$ but do not exist in $v1$.

When a sender sends a User Type value of a version $v2$ to a receiver that only supports version $v1$ of the same User Type, the receiver treats the additional properties of the User Type that exist in $v2$ but do not exist in $v1$ as opaque. If the receiver must store the value (persistently), or if the possibility exists that the value is ever sent at a later point, then the receiver stores those additional opaque properties for later encoding. Sufficient type information is included to allow the receiver to store off the opaque property values in either a typed or binary form; when the receiver re-encodes the User Type, it must do so using the Version Indicator $v2$, since it is including the unaltered $v2$ properties.