Oracle® WebLogic Server

Developing Manageable Applications with JMX

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Contents

Introduction and Roadmap

As an application developer, you can greatly reduce the cost of operating and maintaining your applications by building management facilities into your applications. The simplest facility is message logging, which reports events within your applications as they occur and writes messages to a file or other repository. Depending on the criticality of your application, the complexity of the production environment, and the types of monitoring systems your organization uses in its operations center, your needs might be better served by building richer management facilities based on Java Management Extensions (JMX). JMX enables a generic management system to monitor your application; raise notifications when the application needs attention; and change the configuration or runtime state of your application to remedy problems.

This document describes how to use JMX to make your applications manageable.

The following sections describe the contents and organization of this guide—*Developing Custom Management Utilities with JMX*.

Document Scope and Audience

This document is a resource for software developers who develop management services for Java EE applications. It also contains information that is useful for business analysts and system architects who are evaluating WebLogic Server or considering the use of JMX for a particular application.

It is assumed that the reader is familiar with Java EE and general application management concepts.

The information in this document is relevant during the design and development phases of a software project. This document does not address production phase administration, monitoring, or performance tuning topics. For links to WebLogic Server documentation and resources related to these topics, see "Related Documentation" on page 1-3.

This document emphasizes a hands-on approach to developing a limited but useful set of JMX management services. For information on applying JMX to a broader set of management problems, refer to the JMX specification or other documents listed in "Related Documentation" on page 1-3.

Guide to this Document

- This chapter, Introduction and Roadmap, describes the scope and organization of this guide.
- Chapter 2, "Understanding JMX," gives an overview of JMX and describes how Java EE application developers can use JMX.
- Chapter 3, "Designing Manageable Applications," recommends design patterns for making Java EE applications manageable through JMX.
- Chapter 4, "Instrumenting and Registering Custom MBeans," describes how to create your own MBeans (custom MBeans), which enable you to promote your application to the status of a managed object within a larger management system.
- Chapter 5, "Using the WebLogic Server JMX Timer Service," describes how to configure your JMX client to carry out a task at a specified time or a regular time interval by using WebLogic Server's implementation of the JMX timer service.
- Chapter 6, "Accessing Custom MBeans," describes options for accessing your MBeans (other than through JMX).

Related Documentation

The Sun Developer Network includes a Web site that provides links to books, white papers, and additional information on JMX: http://java.sun.com/products/JavaManagement/.

To view the JMX 1.2 specification, download it from http://jcp.org/aboutJava/communityprocess/final/jsr003/index3.html.

To view the JMX Remote API 1.0 specification, download it from http://jcp.org/aboutJava/communityprocess/final/jsr160/index.html.

You can view the API reference for the `javax.management*` packages from: http://java.sun.com/j2se/1.5.0/docs/api/overview-summary.html.

For guidelines on developing other types of management services for WebLogic Server applications, see the following documents:

- *Using WebLogic Logging Services for Application Logging* describes WebLogic support for internationalization and localization of log messages and shows you how to use the templates and tools provided with WebLogic Server to create or edit message catalogs that are locale-specific.
- *Configuring and Using the WebLogic Diagnostic Framework* describes how system administrators can collect application monitoring data that has not been exposed through JMX, logging, or other management facilities.

For guidelines on developing and tuning WebLogic Server applications, see *Developing Applications with WebLogic Server*.

Samples for the JMX Developer

In addition to this document, Oracle provides two JMX code samples in the Avitek Medical Records Application (MedRec). MedRec is an end-to-end sample Java EE application shipped with WebLogic Server that simulates an independent, centralized medical record management system. The MedRec application provides a framework for patients, doctors, and administrators to manage patient data using a variety of different clients.

The JMX code in MedRec exemplifies the following management tasks:

- Monitoring an application with JMX.

  One of the session EJBs in MedRec is instrumented for management through JMX. The EJB keeps track of how many times it writes to the database and exposes this counter as an MBean attribute.

- Using JMX to extend a security realm.

  A JSP and supporting Java classes in the MedRec application invoke JMX APIs to add a new Administrator user to the MedRec security realm. The JSP provides the interface for collecting the new user information and the supporting classes validate the information and insert the new user into the realm.

For information about the JMX code examples in MedRec, do the following:

1. Start MedRec server.

   See Sample Application and Code Examples for WebLogic Server (`http://edocs.bea.com/wls/docs103/samples.html`).

2. When MedRec server starts, it displays its home page in a Web browser. On the MedRec home page, click the **More Samples** link.

   MedRec displays the WebLogic Server Code Examples viewer.

3. In the Code Examples viewer, in the left pane, do either of the following:

   – Expand **Avitek Medical Records Sample Application** > **Features** > **JMX**. Then select the **Monitoring an Application with JMX** topic.

   – Expand **Avitek Medical Records Sample Application** > **Features** > **Security**. Then select the **Extending a Realm Using JMX** topic.

New and Changed Features in This Release

For a comprehensive listing of the new WebLogic Server features introduced in this release, see What's New in WebLogic Server in the *Release Notes*.

Understanding JMX

Java Management Extensions (JMX) is a specification for monitoring and managing Java applications. It enables a generic management system to monitor your application; raise notifications when the application needs attention; and change the state of your application to remedy problems. Like SNMP and other management standards, JMX is a public specification and many vendors of commonly used monitoring products support it.

WebLogic Server uses the Java Management Extensions (JMX) 1.2 implementation that is included in JDK 1.5. The following sections describe how Java applications can use JMX to expose runtime metrics and control points to management systems:

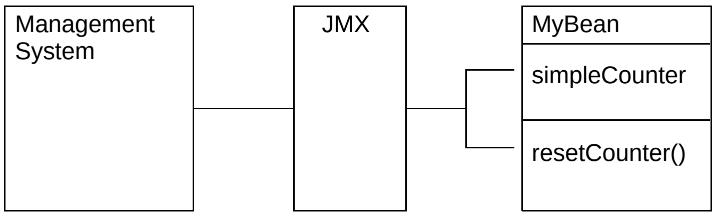
- "What Management Services Can You Develop with JMX?" on page 2-2
- "Creating Management-Aware Applications" on page 2-2
- "When Is It Appropriate to Use JMX?" on page 2-3
- "JMX Layers" on page 2-3
- "JMX Layers" on page 2-3
- "Indirection and Introspection" on page 2-4
- "Notifications and Monitor MBeans" on page 2-5

For information about other APIs and utilities that you can use to manage Java EE applications on WebLogic Server, refer to "Overview of WebLogic Server System Administration" in *Introduction to WebLogic Server*.

What Management Services Can You Develop with JMX?

When used to monitor and manage applications, JMX typically provides management applications access to properties in your Java classes that collect management data (see Figure 2-1). Often, these class properties are simple counters that keep track of the resources your application is consuming. JMX can also provide access to methods in your Java classes that start or stop processes in the application or reset the value of the class properties. Any class that exposes management data through JMX is called a managed bean (MBean). Class properties that are exposed through MBeans are called attributes and methods that are exposed through MBeans are called operations.

Figure 2-1 JMX Provides Access to Management Properties



Once you provide this type of access to JMX-enabled management utilities, system administrators or the operations staff can integrate the data into their overall view of the system. They can use a JMX management utility to view the current value of an MBean attribute, or they can set up JMX monitors to periodically poll the value of your MBean attributes and emit notifications to the management utility only when the values exceed specific thresholds.

Creating Management-Aware Applications

Instead of placing all management responsibility on system administrators or the operations staff, you can create management-aware applications that monitor MBeans and then perform some automated task. For example:

- An application that monitors connection pools and grows or shrinks the pools to meet demand.
- A portal application that monitors the set of deployed applications. If a new application is deployed, the portal application automatically displays it as a new portlet.
- An application that listens for deployments of connector modules and then configures itself to use newly deployed modules.

When Is It Appropriate to Use JMX?

Any critical Java EE application that is a heavy consumer of resources, such as database or JMS connections or caches, should provide some facility for monitoring the application's resource consumption. For these kinds of applications, which might be writing or reading from a database many times each minute, it is not feasible to use logging facilities to output messages with each write and read operation. Using JMX for this type of monitoring enables you to write management (instrumentation) code that is easy to maintain and that optimizes your use of network resources.

If you want to monitor basic runtime metrics for your application, WebLogic Server already provides a significant number of its own MBeans that you can use (see Best Practices: Listening for WebLogic Server Events in *Developing Custom Management Utilities with JMX*). For example, you can use existing WebLogic Server MBeans to track the hit rate on your application's servlets and the amount of time it takes to process servlet requests.

Although WebLogic Server MBeans can indicate to an operations center the general state of resources, it cannot provide detailed information about how a specific application is using the resources. For example, WebLogic Server MBeans can indicate how many connections are being used in a connection pool, but they do not indicate which applications are using the connection pools. If your domain contains several active applications and you notice that some connections are always in use, consider creating MBeans that monitor when each application session gets and releases a connection. You could also include a management operation that ends sessions that appear to be stuck.

In addition, if your application creates and maintains its own cache or writes to a data repository that is outside the control of the application container, consider creating MBeans to monitor the size of the cache or the amount of data written to the repository.

JMX Layers

Like most of Java EE, JMX is a component-based technology in which different types of software vendors provide different types of components. This division of labor enables each type of vendor to focus on providing only the software that falls within its area of expertise. JMX organizes its components into the following layers:

- Instrumentation

  Consists of applications that you write, resources, and other manageable objects. In this layer, application developers create managed beans (MBeans), which contain the properties (attributes) and methods (operations) that they want to expose to external management systems.

- Agent

  Consists of the JVM and application servers such as WebLogic Server. This layer includes a registry of MBeans and standard interfaces for creating, destroying, and accessing MBeans.

  The agent layer also provides services for remote clients as well as a monitoring and a timer service. See "Using the WebLogic Server JMX Timer Service" on page 5-1 and Using Notifications and Monitor MBeans in *Developing Custom Management Utilities with JMX*.

- Distributed Services

  Consists of Management consoles or other Java EE applications. A management application sends or receives requests from the agent layer. Often this layer is available as a plug-in or as an adapter that enables a management console to support a variety of management protocols, such as JMX and SNMP.

Indirection and Introspection

Two key concepts for understanding JMX are indirection and introspection, which enable a JMX application to manage proprietary resources without requiring access to proprietary class definitions.

The general model for JMX is that applications in the distributed services layer never interact directly with classes in the instrumentation layer. Instead, under this model of indirection, the JMX agent layer provides standard interfaces, such as `javax.management.MBeanServerConnection`, that:

- Expose a class management interface to management clients in the distributed services layer
- Receive requests from management clients, such as a request to get the value of a property that a class is exposing through JMX
- Interact with the class to carry out the request and return the result to the management client

Each class describes to the MBean server the set of properties and methods that it wants to expose through JMX. A property that a class exposes through JMX is called an MBean **attribute**, and a method that it exposes is called an **operation**. JMX specifies multiple techniques (design patterns) that a class can use to describe its attributes and operations, and these design patterns are formalized as the following MBean types: standard, dynamic, model, and open.

A class that instruments the standard MBean type describes its management interface in way that is most like Java programming: a developer creates a JMX interface file that contains getter and setter methods for each class property that is to be exposed through JMX. The interface file also contains a wrapper method for each class method that is to be exposed. Then the class declares the name of its JMX interface. When you register a standard MBean with the MBean server, the MBean server introspects the class and its JMX interface to determine which attributes and operations it will expose to the distributed services layer. The MBean server also creates an object, `MBeanInfo`, that describes the interface. Management clients inspect this `MBeanInfo` object to learn about a class's management interface.

A class that instruments the model MBean type describes its management interface by constructing its own `MBeanInfo` object, which is a collection of metadata objects that describe the properties and methods to expose through JMX. When you register a model MBean with the MBean server, the MBean server uses the existing `MBeanInfo` object instead of introspecting the class.

Notifications and Monitor MBeans

JMX provides two ways to monitor changes in MBeans: MBeans can emit notifications when specific events occur (such as a change in an attribute value), or monitor MBeans can poll an MBean periodically to retrieve the value of an attribute.

The following sections describe JMX notifications and monitor MBeans:

- "How JMX Notifications Are Broadcast and Received" on page 2-5
- "Active Polling with Monitor MBeans" on page 2-7

How JMX Notifications Are Broadcast and Received

As part of MBean creation, you can implement the `javax.management.NotificationEmitter` interface, which enables the MBean to emit notifications when different types of events occur. For example, you create an MBean that manages your application's use of a connection pool. You can configure the MBean to emit a notification when the application creates a connection and another notification when the application drops a connection.

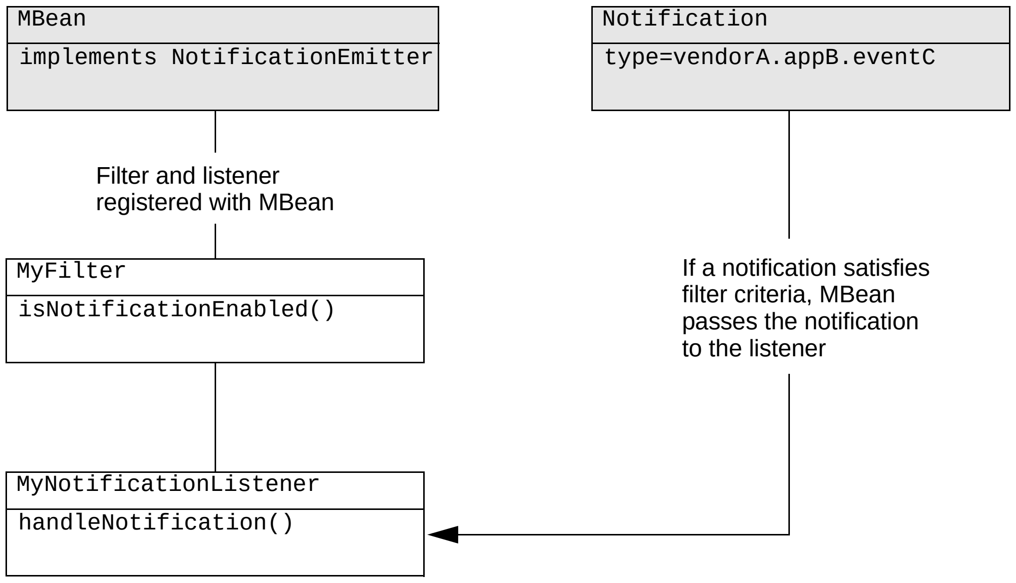
To listen for notifications, you create a listener class that implements the `javax.management.NotificationListener.handleNotification()` method. Your implementation of this method includes the logic that causes the listener to carry out an action when it receives a notification. After you create the listener class, you create another class that registers the listener with an MBean.

By default, an MBean broadcasts all its notifications to all its registered listeners. However, you can create and register a filter for a listener. A filter is a class that implements the `javax.management.NotificationFilter.isNotificationEnabled()` method. The implementation of this method specifies one or more notification types. (In this case, **type** refers to a unique string within a notification object that identifies an event, such as `vendorA.appB.eventC`.) When an event causes an MBean to generate a notification, the MBean invokes a filter's `isNotificationEnabled()` method before it sends the notification to the listener. If the notification type matches one of the types specified in `isNotificationEnabled()`, then the filter returns `true` and the MBean broadcasts the message to the associated listener.

For information on creating and registering listeners and filters, see Listening for Notifications from WebLogic Server MBeans: Main Steps in *Developing Custom Management Utilities with JMX*. For a complete description of JMX notifications, refer to the JMX 1.2 specification. See "Related Documentation" on page 1-3.

Figure 2-2 shows a basic system in which a notification listener receives only a subset of the notifications that an MBean broadcasts.

Figure 2-2 Receiving Notifications from an MBean


MBean
implements NotificationEmitter
Notification
type=vendorA.appB.eventC
Filter and listener registered with MBean
MyFilter
isNotificationEnabled()
If a notification satisfies filter criteria, MBean passes the notification to the listener
MyNotificationListener
handleNotification()

Active Polling with Monitor MBeans

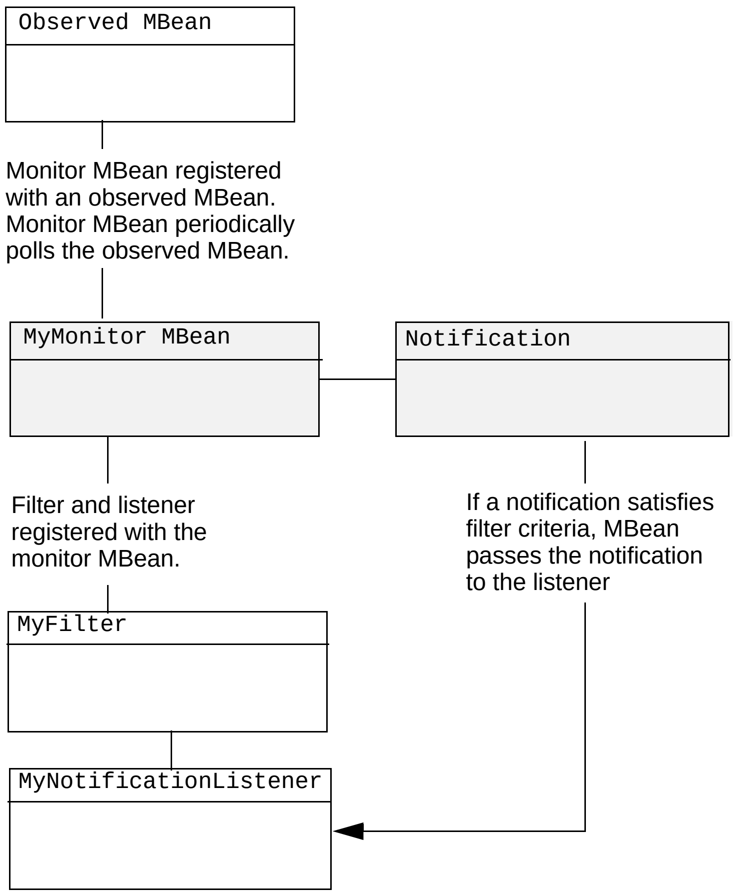
JMX includes specifications for a type of MBeans called **monitor MBeans**, which can be instantiated and configured to periodically observe other MBeans. Monitor MBeans emit JMX notifications only if a specific MBean attribute has changed beyond a specific threshold. A monitor MBean can observe the exact value of an attribute in an MBean, or optionally, the difference between two consecutive values of a numeric attribute. The value that a monitor MBean observes is called the **derived gauge**.

When the value of the derived gauge satisfies a set of conditions, the monitor MBean emits a specific notification type. Monitors can also send notifications when certain error cases are encountered while monitoring an attribute value.

To use monitor MBeans, you configure a monitor MBean and register it with the MBean you want to observe. Then you create a listener class and register the class with the **monitor MBean**. Because monitor MBeans emit only very specific types of notification, you usually do not use filters when listening for notifications from monitor MBeans.

Figure 2-3 shows a basic system in which a monitor MBean is registered with an MBean. A `NotificationListener` is registered with the monitor MBean, and it receives notifications when the conditions within the monitor MBean are satisfied.

Figure 2-3 Monitor MBeans


Observed MBean
Monitor MBean registered with an observed MBean. Monitor MBean periodically polls the observed MBean.
MyMonitor MBean
Notification
Filter and listener registered with the monitor MBean.
If a notification satisfies filter criteria, MBean passes the notification to the listener
MyFilter
MyNotificationListener

CHAPTER 3

Designing Manageable Applications

Several viable JMX design patterns and deployment options can make your application more manageable. The following sections describe Oracle best practices for designing manageable applications. The last section, "Additional Design Considerations" on page 3-6, provides alternatives to some Oracle recommendations and discusses additional design considerations.

Benefits of Oracle Best Practices

The design patterns that Oracle recommends are based on the assumption that the instrumentation of your Java classes should:

- Use as few system resources as possible; management functions must not interfere with business functions.
- Be separate from your business code whenever possible.
- Deploy along with the business code and share its life cycle; you should not require the operations staff to take additional steps to enable the management of your application.

Use Standard MBeans

Of the many design patterns that JMX defines, Oracle recommends that you use standard MBeans, which are the easiest to code. To use the simplest design pattern for standard MBeans:

1. Create an interface for the management properties and operations that you want to expose.
2. Implement the interface in your Java class.
3. Create and register the MBean in the WebLogic Server Runtime MBean Server by invoking the Runtime MBean Server's `javax.management.MBeanServerConnection.createMBean()` method and passing your management interface in the method's parameter.

   When you invoke the `createMBean()` method, the Runtime MBean Server introspects your interface, finds the implementation, and registers the interface and implementation as an MBean.

In this design pattern, the management interface and its implementation must follow strict naming conventions so that the MBean server can introspect your interface. You can circumvent the naming requirements by having your Java class extend `javax.management.StandardMBean`. See `StandardMBean` in the *J2SE 5.0 API Specification*.

Registering Custom MBeans in the WebLogic Server Runtime MBean Server

A JVM can contain multiple MBean servers, and another significant design decision is which MBean server you use to register your custom MBeans.

Oracle recommends that you register custom MBeans in the WebLogic Server Runtime MBean Server. (Each WebLogic Server instance contains its own instance of the Runtime MBean Server. See MBean Servers in *Developing Custom Management Utilities with JMX*.) With this option:

- Your MBeans exist in the same MBean server as WebLogic Server MBeans. Remote JMX clients need to maintain only a single connection to monitor your application's MBeans and WebLogic Server MBeans.
- JMX clients must authenticate and be authorized through the WebLogic Server security framework to access your custom MBeans and WebLogic Server MBeans.

The WebLogic Server Runtime MBean Server registers its `javax.management.MBeanServer` interface in the JNDI tree. See Make Local Connections to the Runtime MBean Server in *Developing Custom Management Utilities with JMX*.

Alternative: Register Custom MBeans in the JVM's Platform MBean Server

As of JDK 1.5, processes within a JVM (local processes) can instantiate a platform MBean server, which is provided by the JDK and contains MBeans for monitoring the JVM itself.

Your local processes can register custom MBeans in this MBean server, but the custom MBeans will not be protected by the WebLogic Server security framework and JMX clients must connect to multiple MBean servers to monitor your application's MBeans and WebLogic Server MBeans. If it is essential that JMX clients be able to monitor your custom MBeans, WebLogic Server MBeans, and the JVM's platform MBeans through a single MBean server, you can configure the runtime MBean server to be the JVM platform MBean server. See "Registering MBeans in the JVM Platform MBean Server" on page 3-6.

Use ApplicationLifecycleListener to Register Application MBeans

If you are creating MBeans for EJBs, servlets within Web Applications, or other modules that are deployed, and if you want your MBeans to be available as soon as you deploy your application, listen for notifications from the deployment service. When you deploy an application (and when you start a server on which you have already deployed an application), the WebLogic Server deployment service emits notifications at specific stages of the deployment process. When you receive a notification that the application has been deployed, you can create and register your MBeans.

There are two steps for listening to deployment notifications with `ApplicationLifecycleListener`:

1. Create a class that extends `weblogic.application.ApplicationLifecycleListener`. Then implement the `ApplicationLifecycleListener.postStart` method to create and register your MBean in the MBean server. The class invokes your `postStart()` method only after it receives a `postStart` notification from the deployment service. See Programming Application Life Cycle Events in *Developing Applications with WebLogic Server.*
2. In the `weblogic-application.xml` deployment descriptor, register your class as an application listener class.

If you do not want to use proprietary WebLogic Server classes and deployment descriptors to register application MBeans, see “Registering Application MBeans by Using Only JDK Classes” on page 3-7.

Unregister Application MBeans When Applications Are Undeployed

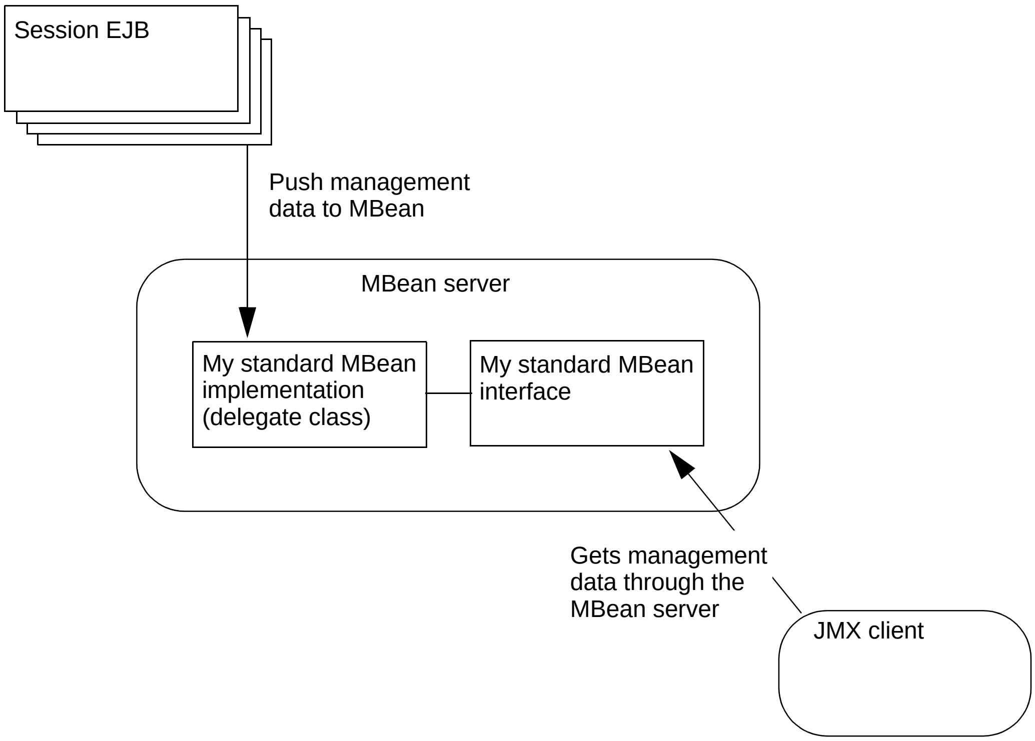
Regardless of how you create your MBeans, Oracle recommends that you unregister your MBeans whenever you receive a deployment notification that your application has been undeployed. Failure to do so introduces a potential memory leak.

If you create a class that extends `ApplicationLifecycleListener`, you can implement the `ApplicationLifecycleListener.preStop` method to unregister your MBeans. For information on implementing the `preStop` method, see “Register the MBean” on page 4-7.

Place Management Logic for EJBs and Servlets in a Delegate Class

If you want to expose management attributes or operations for any type of EJB (session, entity, message-driven) or servlet, Oracle recommends that you implement the management attributes and operations in a separate, delegate class so that your EJB or servlet implementation classes contain only business logic, and so that their business interfaces present only business logic. See Figure 3-1.

Figure 3-1 Place Management Properties and Operations in a Delegate Class


Session EJB
Push management data to MBean
MBean server
My standard MBean implementation (delegate class)
My standard MBean interface
Gets management data through the MBean server
JMX client

In Figure 3-1, business methods in the EJB push their data to the delegate class. For example, each time a specific business method is invoked, the method increments a counter in the delegate class, and the MBean interface exposes the counter value as an attribute. For an example of this technique, see the MedRec example server.

This separation of business logic from management logic might be less efficient than combining the logic into the same class, especially if the counter in the delegate class is incremented frequently. However, in practice, most JVMs can optimize the method calls so that the potential inefficiency is negligible.

If this negligible difference is not acceptable for your application, your business class in the EJB can contain the management value and the delegate class can retrieve the value whenever a JMX client requests it.

Use Open MBean Data Types

If a remote JMX client will access your custom MBeans, Oracle recommends that you limit the data types of your MBean attributes and the data types that your operations return to those defined in `javax.management.openmbean.OpenType`. All JVMs have access to these basic types. See `OpenType` in the *J2SE 5.0 API Specification*.

If your MBeans expose other data types, the types must be serializable and the remote JMX clients must include your types on their class paths.

Emit Notifications Only When Necessary

Each time an MBean emits a notification, it uses memory and network resources. For MBean attributes whose values change frequently, such memory and resource uses might be unacceptable.

Instead of configuring your MBeans to emit notifications each time its attributes change, Oracle recommends that you use monitor MBeans to poll your custom MBeans periodically to determine whether attributes have changed. You can configure the monitor MBean to emit a notification only after an attribute changes in a specific way or reaches a specific threshold.

For more information, see Best Practices: Listening Directly Compared to Monitoring in *Developing Custom Management Utilities with JMX*.

Additional Design Considerations

In addition to Oracle best practices, bear in mind the following considerations when designing manageable applications.

Registering MBeans in the JVM Platform MBean Server

If it is essential that JMX clients be able to monitor your custom MBeans, WebLogic Server MBeans, and the JVM’s platform MBeans through a single MBean server, you can configure the runtime MBean server to be the JVM platform MBean server. With this option:

- Local applications can access all of the MBeans through the `MBeanServer` interface that `java.lang.management.ManagementFactory.getPlatformMBeanServer()` returns.

  WARNING: With this local access, there are no WebLogic Server security checks to make sure that only authorized users can access WebLogic Server MBeans. Any application that is running in the JVM can access any of the WebLogic Server MBeans in the Runtime MBean Server or JDK platform MBean Server. **Do not use this configuration if you cannot control or cannot trust the applications that are running within a JVM**.

- If you want to enable remote JMX clients to access custom MBeans, JMX MBeans, and WebLogic Server MBeans, consider the following configuration:
  - The WebLogic Server Runtime MBean Server is configured to be the platform MBean server.
  - Remote access to the platform MBean server is not enabled.

    Remote access to the platform MBean server can be secured only by standard JDK 1.5 security features (see http://java.sun.com/j2se/1.5.0/docs/guide/management/agent.html#remote). If you have configured the WebLogic Server Runtime MBean Server to be the platform MBean server, enabling remote access to the platform MBean server creates an access path to WebLogic Server MBeans that is not secured through the WebLogic Server security framework.
  - Remote JMX clients access JVM MBeans by connecting to the Runtime MBean Server.

To configure the WebLogic Runtime MBean Server to be the JDK platform MBean server, set the WebLogic `JMXMBean` `PlatformMBeanServerEnabled` attribute to true and restart the servers in the domain. See `JMXMBean` in the *WebLogic Server MBean Reference*.

Registering Application MBeans by Using Only JDK Classes

Using Oracle's `ApplicationLifecycleListener` is the easiest technique for making an MBean share the life cycle of its parent application. If you do not want to use proprietary WebLogic Server classes and deployment descriptor elements for managing a servlet or an EJB, you can do the following:

- For a servlet, configure a `javax.servlet.Filter` that creates and registers your MBean when a servlet calls a specific method or when the servlet itself is instantiated. See `Filter` in the *J2SE 5.0 API Specification*.

For an EJB, implement its `javax.ejb.EntityBean.ejbActivate()` method to create and register your MBean. For a session EJB whose instances share a single MBean instance, include logic that creates and registers your MBean only if it does not already exist. See `EntityBean` in the *J2SE 5.0 API Specification*.

Organizing Managed Objects and Business Objects

While you might design one managed object for each business object, there is no requirement for how your management objects should relate to your business objects. One management object could aggregate information from multiple business objects or conversely, you could split information from one business object into multiple managed objects.

For example, if a servlet uses multiple helper classes and you want one MBean to represent the servlet, each helper class should push its management data into a single MBean implementation class.

The organization that you choose depends on the number of MBeans you want to provide to the system administrator or operations staff contrasted with the difficulty of maintaining a complex management architecture.

Packaging and Accessing Management Classes

If you package your management classes in an application's `APP-INF` directory, all other classes in the application can access them. If you package the classes in a module's archive file, then only the module can access the management classes.

For example, consider an application that contains multiple Web applications, each of which contains its own copy of a session EJB named EJB1. If you want one MBean to collect information for all instances of the session EJB across all applications, you must package the MBean's classes in the `APP-INF` directory. If you want each Web application's copy of the EJB to maintain its own copy of the MBean, then package the MBean's classes in the EJB's JAR file. (If you package the classes in the EJB's JAR, then you distribute the MBean classes to each Web application when you copy the JAR to the Web application.)

Securing Custom MBeans with Roles and Policies

If you register your MBeans in the WebLogic Server Runtime MBean Server, in addition to limiting access only to users who have authenticated and been authorized through the WebLogic Server security framework, you can further restrict access by creating roles and polices. A security **role**, like a security group, grants an identity to a user. Unlike a group, however, membership in a role can be based on a set of conditions that are evaluated at runtime. A security **policy** is another set of runtime conditions that specify which users, groups, or roles can access a resource.

Note the following restrictions to securing custom MBeans with roles and policies:

- Your MBean's object name must include a "`Type=`*`value`*" key property.
- You must describe your roles and policy in a XACML 2.0 document and then use the WebLogic Scripting Tool to add the data to your realm.
- If your XACML document describes authorization policies, your security realm must use either the WebLogic Server XACML Authorization Provider or some other provider that implements the `weblogic.management.security.authorization.PolicyStoreMBean` interface.
- If your XACML document describes role assignments, your security realm must use either the WebLogic Server XACML Role Mapping Provider or some other provider that implements the `weblogic.management.security.authorization.PolicyStoreMBean` interface.

For information about creating XACML roles policies and adding them to your realm, see Using XACML Documents to Secure WebLogic Resources in *Securing WebLogic Server Resource with Roles and Policies*.

CHAPTER 4

Instrumenting and Registering Custom MBeans

The following sections describe how to instrument and register standard MBeans for application modules:

Overview of the MBean Development Process

Figure 4-1 illustrates the MBean development process. The steps in the process, and the results of each are described in Table 4-1. Subsequent sections detail each step in the process.

Figure 4-1 Standard MBean Development Overview

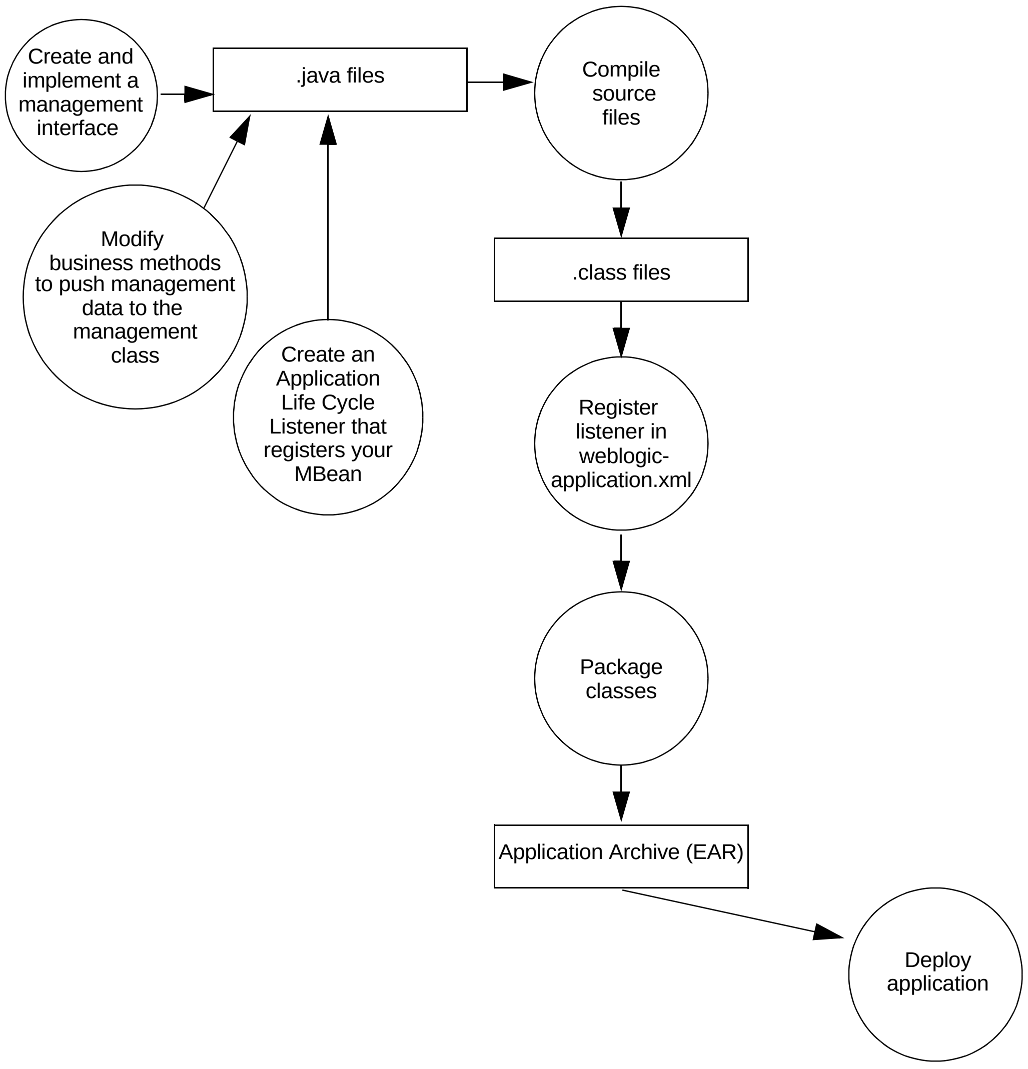

Create and implement a management interface
.java files
Compile source files
Modify business methods to push management data to the management class
Create an Application Life Cycle Listener that registers your MBean
.class files
Register listener in weblogic-application.xml
Package classes
Application Archive (EAR)
Deploy application

Table 4-1 Model MBean Development Tasks and Results

Step	Description	Result
1. "Create and Implement a Management Interface" on page 4-3	Create a standard Java interface that describes the properties (management attributes) and operations you want to expose to JMX clients. Create a Java class that implements the interface. Because management logic should be separate from business logic, the implementation should not be in the same class that contains your business methods.	Source files that describe and implement your management interface.
2. "Modify Business Methods to Push Data" on page 4-6	If your management attributes contain data about the number of times a business method has been invoked, or if you want management attributes to contain the same value as a business property, modify your business methods to push (update) data into the management implementation class. For example, if you want to keep track of how frequently your business class writes to the database, modify the business method that is responsible for writing to the database to also increment a counter property in your management implementation class. This design pattern enables you to insert a minimal amount of management code in your business code.	A clean separation between business logic and management logic.
3."Register the MBean" on page 4-7	If you want to instantiate your MBeans as part of application deployment, create a WebLogic Server `ApplicationLifecycleListener` class to register your MBean.	A Java class and added entries in `weblogic-application.xml`.
4. "Package Application and MBean Classes" on page 4-9	Package your compiled classes into a single archive.	A JAR, WAR, EAR file or other deployable archive file.

Create and Implement a Management Interface

One of the main advantages to the standard MBeans design pattern is that you define and implement management properties (attributes) as you would any Java property (using `get`*`xxx`*, `set`*`xxx`*, and `is`*`xxx`* methods); similarly, you define and implement management methods (operations) as you would any Java method.

When you register the MBean, the MBean server examines the MBean interface and determines how to represent the data to JMX clients. Then, JMX clients use the `MBeanServerConnection.getAttribute()` and `setAttribute()` methods to get and set the values of attributes in your MBean and they use `MBeanServerConnection.invoke()` to invoke its operations. See `MBeanServerConnection` in the *J2SE 5.0 API Specification*.

To create an interface for your standard MBean:

1. Declare the interface as public.
2. Oracle recommends that you name the interface as follows:
   `Business-object``MBean.java`

   where *`Business-object`* is the object that is being managed.

   Oracle's recommended design pattern for standard MBeans enables you to follow whatever naming convention you prefer. In other standard MBean design patterns (patterns in which the MBean's implementation file does not extend `javax.management.StandardMBean`), the file name must follow this pattern: *`Impl-file`*`MBean.java` where *`Impl-file`* is the name of the MBean's implementation file.
3. For each read-write attribute that you want to make available in your MBean, define a getter and setter method that follows this naming pattern:

   `get`*`Attribute-name`*
   `set`*`Attribute-name`*

   where *`Attribute-name`* is a case-sensitive name that you want to expose to JMX clients.

   If your coding conventions prefer that you use an `is`*`Attribute-name`* as the getter method for attributes of type `Boolean`, you may do so. However, JMX clients use the `MBeanServerConnection.getAttribute()` method to retrieve an attribute's value regardless of the attribute's data type; there is no `MBeanServerConnection.isAttribute()` method.
4. For each read-only attribute that you want to make available, define only an `is` or a getter method.

   For each write-only attribute, define only a setter method.
5. Define each management operation that you want to expose to JMX clients.

Listing 4-1 is an MBean interface that defines a read-only attribute of type `int` and an operation that JMX clients can use to set the value of the attribute to `0`.

Listing 4-1 Management Interface

```
package com.bea.medrec.controller;

public interface RecordSessionEJBMBean {
   public int getTotalRx();
   public void resetTotalRx();
}
```

To implement the interface:

1. Create a public class.

   Oracle recommends the following pattern as a naming convention for implementation files: *`MBean-Interface`*`Impl.java`.

2. Extend `javax.management.StandardMBean` to enable this flexibility in the naming requirements.

   See `StandardMBean` in the *J2SE 5.0 API Specification*.

3. Implement the `StandardMBean(Object implementation, Class mbeanInterface)` constructor.

   With Oracle's recommended design pattern in which you separate the management logic into a delegate class, you must provide a public constructor that implements the `StandardMBean(Object implementation, Class mbeanInterface)` constructor.

4. Implement the methods that you defined in the management interface.

   Follow these guidelines:

   – If you are using Oracle's recommended design pattern, in which business objects push management data into the management object, provide a method in this implementation class that the business methods use to set the value of the management attribute. In Listing 4-2, the `incrementTotalRx()` method is available to business methods but it is not part of the management interface.

– If multiple instances of an EJB, servlet, or other class can set the value of a management attribute, make sure to increment the property atomically and do not make its getter and setter (or increment method) synchronized. While synchronizing guarantees the accuracy of management data, it blocks business threads until the management operation has completed.

Listing 4-2 MBean Implementation

```
package com.bea.medrec.controller;

import javax.management.StandardMBean;
import com.bea.medrec.controller.RecordSessionEJBMBean;

public class RecordSessionEJBMBeanImpl extends StandardMBean
   implements RecordSessionEJBMBean {

   public RecordSessionEJBMBeanImpl() throws
      javax.management.NotCompliantMBeanException {
         super(RecordSessionEJBMBean.class);
   }

   public int TotalRx = 0;
   public int getTotalRx() {
        return TotalRx;
   }
   public void incrementTotalRx() {
      TotalRx++;
   }
   public void resetTotalRx() {
       TotalRx = 0;
   }
}
```

Modify Business Methods to Push Data

If your management attributes contain data about the number of times a business method has been invoked, or if you want management attributes to contain the same value as a business property, modify your business methods to push (update) data into the management implementation class.

Listing 4-3 shows a method in an EJB that increments the integer in the `TotalRx` property each time the method is invoked.

Listing 4-3 EJB Method That Increments the Management Attribute

```
private Collection addRxs(Collection rXs, RecordLocal recordLocal)
   throws CreateException, Exception {
   ...
   com.bea.medrec.controller.RecordSessionEJBMBeanImpl.incrementTotalRx();
   ...
}
```

Register the MBean

If you want to instantiate your MBeans as part of application deployment, create an `ApplicationLifecycleListener` that registers your MBean when the application deploys (see "Use ApplicationLifecycleListener to Register Application MBeans" on page 3-3):

1. Create a class that extends `weblogic.application.ApplicationLifecycleListener`.
2. In this `ApplicationLifecycleListener` class, implement the `ApplicationLifecycleListener.postStart(ApplicationLifecycleEvent evt)` method.

   In your implementation of this method:

   a. Construct an object name for your MBean.

      Oracle recommends this naming convention:
      `*your.company*:Name=*Parent-module*,Type=*MBean-interface-classname*`

      To get the name of the parent module, use `ApplicationLifecycleEvent` to get an `ApplicationContext` object. Then use `ApplicationContext` to get the module's identification.

   b. Access the WebLogic Server Runtime MBean Server through JNDI.

      If the classes for the JMX client are part of a Java EE module, such as an EJB or Web application, then the JNDI name for the Runtime MBeanServer is:
      `java:comp/env/jmx/runtime`

If the classes for the JMX client are not part of a Java EE module, then the JNDI name for the Runtime MBean Server is:
`java:comp/jmx/runtime`

For example:

```
InitialContext ctx = new InitialContext();
MBeanServer server = (MBeanServer)
     ctx.lookup("java:comp/env/jmx/runtime");
```

See Make Local Connections to the Runtime MBean Server in *Developing Custom Management Utilities with JMX*.

c. Register your MBean using `MBeanServer.registerMBean(Object` *`object`*`, ObjectName` *`name`*`)` where:

   `object` is an instance of your MBean implementation class.

   `name` is the JMX object name for your MBean.

When your application deploys, the WebLogic deployment service emits `ApplicationLifecycleEvent` notifications to all of its registered listeners. When the listener receives a `postStart` notification, it invokes its `postStart` method. See Programming Application Life Cycle Events in *Developing Applications with WebLogic Server.*

3. In the same class, implement the `ApplicationLifecycleListener.preStop(ApplicationLifecycleEvent evt)` method.

   In your implementation of this method, invoke the `javax.management.MBeanServer.unregister(ObjectName` *`MBean-name`*`)` method to unregister your MBean.

4. Register your class as an `ApplicationLifecycleListener` by adding the following element to your application's `weblogic-application.xml` file:

```
<listener>
   <listener-class>
      fully-qualified-class-name
   </listener-class>
</listener>
```

For an example of this technique, see the MedRec example server.

Package Application and MBean Classes

Package your MBean classes in the application's `APP-INF` directory or in a module's JAR, WAR or other type of archive file depending on the access that you want to enable for the MBean. See "Additional Design Considerations" on page 3-6.

Using the WebLogic Server JMX Timer Service

The following sections describe how to use the WebLogic Server JMX timer service:

Overview of the WebLogic Server JMX Timer Service

If you need your JMX client to carry out a task at a specified time or a regular time interval, you can configure a JMX timer service to emit notifications, and a listener that responds to the notifications with a specified action.

For example, you want a JMX monitor to run between 9am and 9pm each day. You configure the JMX timer service to emit a notification daily at 9am, which triggers a JMX listener to start your monitor. The timer service emits another notification at 9pm, which triggers the listener to stop the monitor MBean.

The JDK includes an implementation of the JMX timer service (see `javax.management.timer.Timer` in the *J2SE 5.0 API Specification*); however, listeners for this timer service run in their own thread in a server's JVM.

WebLogic Server includes an extension of the standard timer service that causes timer listeners to run in a thread that WebLogic Server manages and within the security context of a WebLogic Server user account.

Creating the Timer Service: Main Steps

You construct and manage instances of the timer service for each JMX client. WebLogic Server does not provide a centralized timer service that all JMX clients use. Each time you restart a server instance, each JMX client must re-instantiate any timer service configurations it needs.

To create the WebLogic Server timer service:

1. Create a JMX listener class in your application.

   For general instructions on creating a JMX listener, see Creating a Notification Listener in *Developing Custom Management Utilities in JMX*.

2. Create a class that does the following:

   a. Configures an instance of `weblogic.management.timer.TimerMBean` to emit `javax.management.timer.TimerNotification` notifications at a specific time or at a recurring interval. See `TimerNotification` in the *J2SE 5.0 API Specification*.

      For each notification that you configure, include a `String` in the notification's `Type` attribute that identifies the event that caused the timer to emit the notification.

      See "Configuring a Timer MBean to Emit Notifications" on page 5-3.

   b. Registers your listener and an optional filter with the timer MBean that you configured.

   c. Starts the timer in the timer MBean that you configured.

      For general instructions, see Configuring a Notification Filter and Registering a Notification Listener and Filter in *Developing Custom Management Utilities in JMX*.

   d. Unregisters the timer MBean and closes its connection to the MBean server when it finishes using the timer service.

3. Package and deploy the listener and other JMX classes to WebLogic Server. See Packaging and Deploying Listeners on WebLogic Server in *Developing Custom Management Utilities in JMX*.

Configuring a Timer MBean to Emit Notifications

To configure a `Timer` MBean instance to emit a notification:

1. Initialize a connection to the Domain Runtime MBean Server.

   See Connect to an MBean Server in *Developing Custom Management Utilities in JMX*.

2. Create an `ObjectName` for your timer MBean instance.

   See `javax.management.ObjectName` in the *J2SE 5.0 API Specification*.

   Oracle recommends that your object name start with the name of your organization and include key properties that clearly identify the purpose of the timer MBean instance.

   For example, `"mycompany:Name=myDailyTimer,Type=weblogicTimer"`

3. Create and register the timer MBean.

   Use `javax.management.MBeanServerConnection.createMBean(String` *`classname`* `ObjectName` *`name`*`)` method where:

   – *`classname`* is `weblogic.management.timer.Timer`

   – *`name`* is the object name that you created for the timer MBean instance.

   Note: The timer MBean that you create runs in the JMX agent on WebLogic Server (it does not run in a client JVM even if you create the timer MBean from a remote JMX client).

4. Configure the timer MBean to emit a notification.

   Invoke the MBean's `addNotification` operation. Table 5-1 describes each parameter of the `addNotification` operation. For more information, see `weblogic.management.timer.Timer` in the *WebLogic Server API Reference*.

   The `addNotification` operation creates a `TimerNotification` object and returns a handback object of type `Integer`, which contains an integer that uniquely identifies the `TimerNotification` object.

5. Repeat step 4 for each timer notification that your JMX client needs to receive.

6. Start the timers in your timer MBean by invoking the timer MBean's `start()` operation.

When the time that you specify arrives, the timer service emits the `TimerNotification` object along with a reference to the handback object.

Table 5-1 Parameters of the addNotification Operation

Parameter	Description
`java.lang.String type`	A string that you use to identify the event that triggers this notification to be broadcast. For example, you can specify `midnight` for a notification that you configure to be broadcast each day at midnight.
`java.lang.String message`	Specifies the value of the `TimerNotification` object's `message` attribute.
`java.lang.Object userData`	Specifies the name of an object that contains whatever data you want to send to your listeners. Usually, you specify a reference to the class that registered the notification, which functions as a callback.
`java.util.Date startTime`	Specifies a `Date` object that contains the time and day at which the timer emits your notification. See "Creating Date Objects" on page 5-4.
`long period`	(Optional) Specifies the interval in milliseconds between notification occurrences. Repeating notifications are not enabled if this parameter is zero or is not defined (`null`).
`long nbOccurences`	(Optional) Specifies the total number of times that the notification will occur. If the value of this parameter is zero or is not defined (`null`) and if the period is not zero or null, then the notification will repeat indefinitely. If you specify this parameter, each time the Timer MBean emits the associated notification, it decrements the number of occurrences by one. You can use the timer MBean's `getNbOccurrences` operation to determine the number of occurrences that remain. When the number of occurrences reaches zero, the timer MBean removes the notification from its list of configured notifications.

Creating Date Objects

The constructor for the `java.util.Date` object initializes the object to represent the time at which you created the `Date` object measured to the nearest millisecond. To specify a different time or date:

1. Create an instance of `java.util.Calendar`.

2. Configure the fields in the `Calendar` object to represent the time or date.
3. Invoke the `Calendar` object's `getTime()` method, which returns a `Date` object that represents the time in the `Calendar` object.

For example, the following code configures a `Date` object that represents midnight:

```
java.util.Calendar cal = java.util.Calendar.getInstance();
cal.set(java.util.Calendar.HOUR_OF_DAY, 24);
java.util.Date morning = cal.getTime();
```

See `java.util.Calendar` in the *J2SE 5.0 API Specification*.

Example: Generating a Notification Every Five Minutes After 9 AM

The code in Listing 5-1 creates an instance of `weblogic.management.timer.Timer` that emits a notification every 5 minutes after 9am.

Note the following about the code:

- It creates and registers the timer MBean in the WebLogic Server Runtime MBean Server, under the assumption that the JMX client runs alongside applications that are deployed on multiple server instances. In this case, your JMX client would register a timer MBean in each Runtime MBean Server in the domain.
- Even though it creates an instance of the WebLogic Server timer MBean, the class does not import WebLogic Server classes. Only the MBean server needs access to the WebLogic Server `Timer` class, not the JMX client.
- Any generic JMX listener can be used to listen for timer notifications, because all timer notifications extend `javax.management.Notification`.

Listing 5-1 Create, Register, and Configure a Timer MBean

```
import java.util.Hashtable;
import java.io.IOException;
import java.net.MalformedURLException;

import javax.management.MBeanServerConnection;
import javax.management.ObjectName;
import javax.management.MalformedObjectNameException;
import javax.management.remote.JMXConnector;
import javax.management.remote.JMXConnectorFactory;
import javax.management.remote.JMXServiceURL;
import javax.naming.Context;

import javax.management.NotificationFilterSupport;

public class RegisterTimer  {
   private static MBeanServerConnection connection;
   private static JMXConnector connector;
   private static final ObjectName service;

   // Initialize the object name for RuntimeServiceMBean
   // so it can be used throughout the class.
   static {
      try {
         service = new ObjectName(
         "com.bea:Name=RuntimeService,Type=weblogic.management.mbeanservers.ru
          ntime.RuntimeServiceMBean");
      }catch (MalformedObjectNameException e) {
         throw new AssertionError(e.getMessage());
      }
   }

   /*
    * Initialize connection to the Runtime MBean Server.
    * This MBean is the root of the runtime MBean hierarchy, and
    * each server in the domain hosts its own instance.
    */
   public static void initConnection(String hostname, String portString,
      String username, String password) throws IOException,
      MalformedURLException {
      String protocol = "t3";
      Integer portInteger = Integer.valueOf(portString);
      int port = portInteger.intValue();
      String jndiroot = "/jndi/";
      String mserver = "weblogic.management.mbeanservers.runtime";

      JMXServiceURL serviceURL = new JMXServiceURL(protocol, hostname, port,
         jndiroot + mserver);

      Hashtable h = new Hashtable();
      h.put(Context.SECURITY_PRINCIPAL, username);
      h.put(Context.SECURITY_CREDENTIALS, password);
      h.put(JMXConnectorFactory.PROTOCOL_PROVIDER_PACKAGES,
         "weblogic.management.remote");
      connector = JMXConnectorFactory.connect(serviceURL, h);
      connection = connector.getMBeanServerConnection();
   }

   public static void main(String[] args) throws Exception {
      String hostname = args[0];
String portString = args[1];
String username = args[2];
String password = args[3];

try {
   /* Invokes a custom method that establishes a connection to the
    * Runtime MBean Server and uses an instance of
    * MBeanServerConnection to represents the connection. The custom
    * method assigns the MBeanServerConnection to a class-wide, static
    * variable named "connection".
   */
   initConnection(hostname, portString, username, password);

   //Creates and registers the timer MBean.
   ObjectName timerON = new
      ObjectName("mycompany:Name=myDailyTimer,Type=weblogicTimer");
   String classname = "weblogic.management.timer.Timer";
   connection.createMBean(classname, timerON);
   System.out.println("===> created timer mbean "+timerON);

   // Configures the timer MBean to emit a morning notification.
   // Assigns the return value of addNotification to a variable so that
   // it will be possible to invoke other operations for this specific
   // notification.
   java.util.Calendar cal = java.util.Calendar.getInstance();
   cal.set(java.util.Calendar.HOUR_OF_DAY, 9);
   java.util.Date morning = cal.getTime();
   String myData = "Timer notification";
   Integer morningTimerID = (Integer) connection.invoke(timerON,
      "addNotification",
      new Object[] { "mycompany.timer.notification.after9am" ,
      "After 9am!", myData, morning, new Long(60000) },
      new String[] {"java.lang.String", "java.lang.String",
      "java.lang.Object", "java.util.Date", "long" });

   //Instantiates your listener class and configures a filter to
   // forward only timer messages.
   MyListener listener = new MyListener();
   NotificationFilterSupport filter = new NotificationFilterSupport();
   filter.enableType("mycompany.timer");

   //Uses the MBean server's addNotificationListener method to
   //register the listener and filter with the timer MBean.
   System.out.println("===> ADD NOTIFICATION LISTENER TO "+ timerON);
   connection.addNotificationListener(timerON, listener, filter, null);
   System.out.println("\n[myListener]: Listener registered ...");

   //Starts the timer.
   connection.invoke(timerON, "start", new Object[] { }, new String[] {});
```

```
         //Keeps the remote client active.
         System.out.println("Pausing. Press Return to end..........");
         System.in.read();
      } catch(Exception e) {
         System.out.println("Exception: " + e);
         e.printStackTrace();
      }
   }
}
```

Removing Notifications

The timer MBean removes notifications from its list when either of the following occurs:

- A non-repeating notification is emitted.
- A repeating notification exhausts its number of occurrences.

The timer MBean also provides the following operations to remove notifications:

- `removeAllNotifications()`, which removes all notifications that are registered with the timer MBean instance.
- `removeNotification(java.lang.Integer id)`, which removes the notification whose handback object contains the integer value that you specify. The `addNotification` method returns this handback object when you invoke it (see step 4 in "Configuring a Timer MBean to Emit Notifications" on page 5-3.
- `removeNotifications(java.lang.String type)`, which removes all notifications whose type corresponds to the type that you specify. You define a notification's type value when you create the notification object. See Table 5-1.

For more information, see `weblogic.management.timer.Timer` in the *WebLogic Server API Reference*.

Accessing Custom MBeans

Besides programmatic JMX access to your custom MBeans, you can use any JMX-compliant management system to access your MBeans. For information, see "JMX Layers" on page 2-3 and the Sun Developer Network Web site, which provides links to books, white papers, and other information on JMX: http://java.sun.com/products/JavaManagement/.

The following sections describe additional ways to access your custom MBeans:

- "Accessing Custom MBeans from JConsole" on page 6-1
- "Accessing Custom MBeans from WebLogic Scripting Tool" on page 6-2
- "Accessing Custom MBeans from an Administration Console Extension" on page 6-3

Accessing Custom MBeans from JConsole

The JDK includes JConsole, a Swing-based JMX client that you can use to browse MBeans. You can browse the MBeans in any WebLogic Server MBean server and in the JVM platform MBean server. Sun recommends that you use JConsole only in a development environment; it consumes significant amounts of resources. See Using JConsole to Monitor Applications at http://java.sun.com/developer/technicalArticles/J2SE/jconsole.html.

To access custom MBeans from JConsole:

1. Enable the IIOP protocol for the WebLogic Server instance that hosts your MBeans. Configure the default IIOP user to be a WebLogic Server user with Administrator privileges.

   See Enable and Configure IIOP in *Administration Console Online Help*.

2. From a command prompt, make sure that JDK 1.5 or its equivalent is on the path.
3. In the command prompt, enter the following command: `jconsole`
4. If your custom MBeans are registered in the JVM platform MBean server (or if you have configured the WebLogic Server Runtime MBean Server to be the JVM platform MBean server):
   a. In the JConsole window, select Connection > New Connection.
   b. In the Connect to Agent window, select the Local tab and click Connect.
5. If your custom MBeans are registered in the WebLogic Server Runtime MBean Server, and if you have not configured the Runtime MBean Server to be the platform MBean server:
   a. In the JConsole window, select Connection > New Connection.
   b. In the Connect to Agent window, select the Advanced tab.
   c. On the Advanced tab, in the JMX URL box, enter:

      ```
      service:jmx:rmi:///jndi/iiop://host:port/weblogic.management.mbeanse
      rvers.runtime
      ```

      where *`host:port`* is the host name and port of the WebLogic Server instance that hosts your MBeans.

      For example:
      ```
      service:jmx:iiop:///jndi/iiop://localhost:7001/weblogic.management.m
      beanservers.runtime
      ```
   d. In the User Name and Password boxes, enter the default IIOP user name and password.
   e. Click Connect.

Accessing Custom MBeans from WebLogic Scripting Tool

If you register your MBeans in the Runtime MBean Sever, you can use WebLogic Scripting Tool to access your custom MBeans. See Accessing Custom MBeans in *WebLogic Scripting Tool*.

Accessing Custom MBeans from an Administration Console Extension

You can extend the WebLogic Server Administration Console by creating Java Server Pages (JSPs) that conform to a specific template. Your JSP can include JMX code that connects to the JVM platform MBean server or the WebLogic Server Runtime MBean Server and looks up your MBeans.

For more information, see *Extending the Administration Console*.