This guide describes the Timer and Work Manager API and demonstrates how to implement it within an application in WebLogic Server 12.1.3.
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Preface

This preface describes the document accessibility features and conventions used in this guide—Developing CommonJ Applications for Oracle WebLogic Server 12.1.3.

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.

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Conventions
The following text conventions are used in this document:

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<tr>
<th>Convention</th>
<th>Meaning</th>
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<tr>
<td><strong>boldface</strong></td>
<td>Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.</td>
</tr>
<tr>
<td><em>italic</em></td>
<td>Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.</td>
</tr>
<tr>
<td><strong>monospace</strong></td>
<td>Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.</td>
</tr>
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</table>
This chapter describes the contents and audience for this guide—*Developing CommonJ Applications for Oracle WebLogic Server 12.1.3*. This guide describes the Timer and Work Manager API and demonstrates how to implement it within an application.

This chapter includes the following sections:

- Section 1.1, "Document Scope and Audience"
- Section 1.2, "Guide to This Document"
- Section 1.3, "New and Changed Features in this Release"

### 1.1 Document Scope and Audience

This document describes the Timer and Work Manager API. This document is a resource for system administrators and operators responsible for monitoring and managing a WebLogic Server installation. It is relevant to all phases of a software project, from development through test and production phases.

### 1.2 Guide to This Document

This document is organized as follows:

- This chapter, "Introduction and Roadmap," provides a roadmap for this guide and describes the audience for this guide.

- Chapter 2, "Using the Timer and Work Manager API," introduces and describes the Timer and Work Manager API, often referred to as CommonJ.

### 1.3 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 Oracle WebLogic Server*. 

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1. Introduction and Roadmap

   This chapter describes the contents and audience for this guide—*Developing CommonJ Applications for Oracle WebLogic Server 12.1.3*. This guide describes the Timer and Work Manager API and demonstrates how to implement it within an application.

   This chapter includes the following sections:

   - Section 1.1, "Document Scope and Audience"
   - Section 1.2, "Guide to This Document"
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---
This chapter provides an overview of the Timer and Work Manager API and demonstrates how to implement it within an application in WebLogic Server 12.1.3. This chapter includes the following sections:

- Section 2.1, "Overview"
- Section 2.2, "Timer API Overview"
- Section 2.3, "Using the Timer API"
- Section 2.4, "Using the Job Scheduler"
- Section 2.5, "Work Manager API"
- Section 2.6, "Work Manager Example"

2.1 Overview

The Timer and Work Manager API is defined in a specification created jointly by Oracle and IBM. This API enables concurrent programming of EJBs and Servlets within a Java EE application. This API is often referred to as CommonJ.

The CommonJ API contains the following components:

- Timer API
  
The Timer API allows applications to schedule and receive timer notification callbacks for a specific listener defined within an application. Timers allow you to schedule and perform work at specific times or intervals. See Section 2.2, "Timer API Overview."

  You implement this API by importing the commonj.timer package.

- Work Manager API
  
The Work Manager API allows an application to prioritize work within an EJB or servlet. Applications can programmatically execute multiple work items within a container. See Section 2.5, "Work Manager API."

  You implement this API by importing the commonj.work package.

In addition to the CommonJ Work Manager API, WebLogic Server includes server-level Work Managers that provide prioritization and thread management. These can be configured globally or for a specific module in an application.

Although commonj.timer and commonj.work are part of the same API, each provides different functionality. Which one you implement depends on the specific needs of your application. The CommonJ Timer API is ideal for scheduling work at specific
intervals; for example, when you know that a certain job should run at a specific time. The CommonJ Work API is ideal for handling work based on priority. For example, you may not be able to predict exactly when a specific job will occur, but when it does you want it to be given a higher (or lower) priority.

The following sections describe the CommonJ APIs in detail.

## 2.2 Timer API Overview

The Timer API consist of three interfaces:

- TimerManager
- TimerListener
- Timer

The TimerManager interface provides the framework for creating and using timers within a managed environment. The TimerListener receives timer notifications. The TimerManager.schedule method is used to schedule the TimerListener to run at a specific time or interval.

For a detailed description of how to implement Timers, see Section 2.3, "Using the Timer API."

### 2.2.1 TimerManager Interface

The TimerManager interface provides the general scheduling framework within an application. A managed environment can support multiple TimerManager instances. Within an application you can have multiple instances of a TimerManager.

#### 2.2.1.1 Creating and Configuring a TimerManager

A TimerManager is configured during deployment by means of deployment descriptors. The TimerManager definition may also contain additional implementation-specific configuration information.

Once a TimerManager is defined in a deployment descriptor, instances of it can be accessed using a JNDI lookup in the local Java environment. Each invocation of the JNDI lookup() on a TimerManager returns a new logical instance of a TimerManager.

The TimerManager interface is thread-safe.

For more information about using JNDI, see Developing JNDI Applications for Oracle WebLogic Server.

#### 2.2.1.2 Suspending a TimerManager

You can suspend and resume a TimerManager using the suspend and resume methods. When a TimerManager is suspended, all pending timers are deferred until the TimerManager is resumed.

#### 2.2.1.3 Stopping a TimerManager

You can stop a TimerManager using the stop method. After the stop method is invoked, all active Timers are stopped and the TimerManager instance stops monitoring all TimerListener instances.
2.2.2 The TimerListener Interface

All applications using the commonj.timers package are required to implement the TimerListener interface.

2.2.3 The Timer Interface

Instances of the Timer interface are returned when timers are scheduled through the TimerManager.

2.3 Using the Timer API

This section explains the steps required for using the Timer API within an application. Before deploying your application, ensure that you have created a deployment descriptor that contains a resource reference for the TimerManager. This allows the TimerManager to be accessed using JNDI. For more information about JNDI lookup, see Developing JNDI Applications for Oracle WebLogic Server.

2.3.1 Implementing the Timer API

To implement the Timer API, complete the following steps:

1. Import the commonj.timers.* packages.
2. Create an InitialContext that allows the TimerManager to be looked up in JNDI. For example:

   ```java
   InitialContext inctxt = new InitialContext();
   ```

   See Developing JNDI Applications for Oracle WebLogic Server for more information about JNDI lookup.

3. Create a new TimerManager based on the JNDI lookup of the TimerManager. For example:

   ```java
   TimerManager mgr = (TimerManager)ctx.lookup('java:comp/env/timer/MyTimer');
   ```

   In this statement, the result of the JNDI lookup is cast to a TimerManager.

4. Implement a TimerListener to receive timer notifications. For example:

   ```java
   TimerListener listener = new StockQuoteTimerListener('abc', 'example');
   ```

5. Invoke the TimerManager.schedule method. For example:

   ```java
   mgr.schedule(listener, 0, 1000*60)
   ```

   The schedule method returns a Timer object.

6. Implement the timerExpired method. For example:

   ```java
   public void timerExpired(Timer timer) {
     //Business logic is executed
     //in this method
   }
   ```

   Implementing the Timer API for cluster-wide timers has additional requirements, described in Section 2.4.1, "Life Cycle of Timers."
2.3.2 Timer Manager Example

```java
package examples.servlets;
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import commonj.timers.*;

/**
 * TimerServlet demonstrates a simple use of commonj timers
 */
public class TimerServlet extends HttpServlet {

    /**
     * A very simple implementation of the service method,
     * which schedules a commonj timer.
     */
    public void service(HttpServletRequest req, HttpServletResponse res)
        throws IOException {
        res.setContentType("text/html");
        PrintWriter out = res.getWriter();
        try {
            InitialContext ic = new InitialContext();
            TimerManager tm = (TimerManager)ic.lookup("java:comp/env/tm/default");
            // Execute timer every 10 seconds starting immediately
            tm.schedule(new MyTimerListener(), 0, 10*1000);
            out.println("<h4>Timer scheduled!</h4>");
        } catch (NamingException ne) {
            ne.printStackTrace();
            out.println("<h4>Timer schedule failed!</h4>");
        }
    }

    private static class MyTimerListener implements TimerListener {
        public void timerExpired(Timer timer) {
            System.out.println("timer expired called on " + timer);
            // some useful work here ...
            // let's just cancel the timer
            System.out.println("cancelling timer ...");
            timer.cancel();
        }
    }
}
```

2.4 Using the Job Scheduler

This section explains how to use the Job Scheduler functionality. The Job Scheduler allows you to implement the commonj.timer API within a clustered environment.

The Job Scheduler is essentially an implementation of the commonj.timer API package that can be used within a cluster. In this context, a job is defined as a
commonj.timers.TimerListener instance that is submitted to the Job Scheduler for execution.

This section includes the following topics:

- Life Cycle of Timers
- Implementing and Configuring Job Schedulers
- Unsupported Methods and Interfaces

2.4.1 Life Cycle of Timers

When you implement the commonj.timer API within an application, you can configure two possible life cycles for a timer:

- Local timer
  A local timer is scheduled within a single server JVM and is handled within this JVM throughout its life cycle. The timer continues running as long as the JVM is running and fails when the JVM exits. The application is responsible for rescheduling the timer after server startup.
  
  This is the basic implementation of the commonj.timers package.

- Cluster-wide timer
  A cluster-wide timer is aware of the other JVMs containing each server within the cluster and is therefore able to perform load balancing and failover. The life cycle of a cluster-wide timer is not bound to the server that created it, but continues to function throughout the life cycle of the cluster. If at least one cluster member is alive, the timer continues to function. This functionality is referred to as the Job Scheduler.

  Implementing the Timer API for a Job Scheduler has the following requirements in addition to those listed in Section 2.3.1, "Implementing the Timer API":
  
  - The Timer Listener class must be serializable.
  - The Timer Listener class must be present in the server system classpath.
  - The minimum time for recurring execution of a timer is 30 seconds because Job Schedulers pick up timers for execution every 30 seconds.

  Each timer has its own advantages and disadvantages. Local timers can process jobs with much smaller time intervals between jobs. Due to the persistence requirements within a cluster, Job Schedulers cannot handle jobs with as much precision. On the other hand, Job Schedulers are better suited for tasks that must be performed even if the initial server that created the task has failed.

2.4.2 Implementing and Configuring Job Schedulers

This section describes the basic procedure for implementing Job Schedulers within an application and for configuring your WebLogic Server environment to utilize them. The following topics are included:

- Database Configuration
- Data Source Configuration
- Leasing
- JNDI Access within a Job Scheduler
- Canceling Jobs
Debugging

2.4.2.1 Database Configuration
To maintain persistence and make timers cluster-aware, Job Schedulers require a database connection. The Job Scheduler functionality supports the same databases that are supported by server migration.

For convenience, you can use the same database used for session persistence, server migration, and so on. For example, see "Configure server migration in a cluster" in the Oracle WebLogic Server Administration Console Online Help for information about how to create or select a data source for server migration.

In the database, you must create a table named WEBLOGIC_TIMERS. Schemas for creating this table are in the following location:

WL_HOME/server/db/dbname/scheduler.ddl

In the preceding path, dbname represents the name of the database.

2.4.2.2 Data Source Configuration
After you create a table with the required schema, you must define a data source that is referenced from within the cluster configuration. Job Scheduler functionality is available only if a valid data source is defined in the ClusterMBean.DataSourceForJobScheduler attribute. For information about how to use the WebLogic Server Administration Console to configure this attribute, see "Configure a data source for a job scheduler" in the Oracle WebLogic Server Administration Console Online Help.

The following config.xml excerpt shows how this is defined:

```xml
<domain>
  ...
  <cluster>
    <name>Cluster-0</name>
    <multicast-address>239.192.0.0</multicast-address>
    <multicast-port>7466</multicast-port>
    <data-source-for-job-scheduler>JDBC Data Source-0</data-source-for-job-scheduler>
  </cluster>
  ...
  <jdbc-system-resource>
    <name>JDBC Data Source-0</name>
    <target>myserver,server-0</target>
    <descriptor-file-name>jdbc/JDBC_Data_Source-0-3407-jdbc.xml</descriptor-file-name>
  </jdbc-system-resource>
  ...
</domain>
```

2.4.2.3 Leasing
Leasing must be enabled for Job Schedulers. You can use either high-availability database leasing or non-database consensus leasing. When using high-availability database leasing, you must create the leasing table in the database.

Schemas for creating this table are in the following location:

WL_HOME/server/db/dbname/leasing.ddl

In the preceding path, dbname represents the name of the database.
For more information, see "Leasing" in Administering Clusters for Oracle WebLogic Server.

2.4.2.4 JNDI Access within a Job Scheduler
The procedure for performing JNDI lookup within a clustered timer is different from that used in the general commonj.timer API. The following code snippet shows how to cast a JNDI lookup to a TimerManager.

```java
InitialContext ic = new InitialContext();
commonj.timers.TimerManager jobScheduler = (common.timers.TimerManager) ic.lookup
    ("weblogic.JobScheduler");
commonj.timers.TimerListener timerListener = new MySerializableTimerListener();
jobScheduler.schedule(timerListener, 0, 30*1000);
// execute this job every 30 seconds
```

2.4.2.5 Canceling Jobs
You can cancel jobs programmatically or by using the WebLogic Server Administration Console.

To cancel a job programmatically, invoke the cancel method of the job's corresponding JobRuntimeMBean. You can access a JobRuntimeMBean using either of the following ways:

- **Invoke** JobSchedulerRuntimeMBean.getJob(id) with the ID of a scheduled job. To get the ID, invoke the JobScheduler.schedule method to return a Timer object, then use the Timer's toString method to return the ID.
- **Invoke** JobSchedulerRuntimeMBean.getExecutedJobs() to return an array of JobRunTimes for all jobs that have been executed at least once.

You cannot invoke the cancel method to cancel a scheduled job that has not executed at least once.

For information about how to use the WebLogic Server Administration Console to cancel jobs, see "Cancel jobs" in Oracle WebLogic Server Administration Console Online Help.

2.4.2.6 Debugging
The following debugging flags enable more verbose output:

-Dweblogic.debug.DebugSingletonServices=true  -Dweblogic.JobScheduler=true

2.4.3 Unsupported Methods and Interfaces
The following methods and interfaces in the commonj.timer package are not supported in the Job Scheduler environment:

- **CancelTimerListener interface**
- **StopTimerListener interface**
- The following methods of the TimerManager interface:
  - suspend
  - resume
  - scheduleAtFixedRate
  - stop
  - waitForStop
2.5 Work Manager API

The Work Manager API, commonj.work, provides a set of interfaces that allows an application to execute multiple work items concurrently within a container. Essentially this API provides a container-managed alternative to the java.lang.Thread API. The latter should not be used within applications that are hosted in a managed Java EE environment. In such environments, the Work Manager API is a better choice because it allows the container to have full visibility and control over all executing threads.

Note: The Work Manager API provides no failover or persistence mechanisms. If the Managed Server environment fails or is shut down, any current work is lost.

2.5.1 Work Manager Interfaces

This section summarizes the interfaces in the Work Manager API. For details about using these interfaces, see commonj.work in the Java API Reference for Oracle WebLogic Server.

The Work Manager API contains the following interfaces:

- **WorkManager** - Provides a set of scheduling methods that are used to schedule work for execution.
  
  A WorkManager is defined by system administrators at the server level. A WorkManager instance is obtained by performing a JNDI lookup. A managed environment can support multiple WorkManager instances. You configure WorkManagers during deployment as resource-refs. See Section 2.5.2, "Work Manager Deployment."

  At the application level, each instance of WorkManager returns a WorkItem. For more information about implementing a WorkManager within an application, see WorkManager in the Java API Reference for Oracle WebLogic Server.

  For information about JNDI, see Developing JNDI Applications for Oracle WebLogic Server.

- **Work** - Allows you to run application code asynchronously. By creating a class that implements this interface, you can create blocks of code that can be scheduled to run at a specific time or at defined intervals. In other words, this is the "work" that is handled within the Work Manager API.

- **WorkItem** - Determines the status of a completed Work instance. A WorkItem is returned by a WorkManager after a Work instance has been submitted to that WorkManager.

  For more information, see Work in the Java API Reference for Oracle WebLogic Server.

- **WorkListener** - Provides communication between the WorkManager and the scheduled work defined within the Work instance. WorkListener is a callback interface.

  You can use WorkListener to determine the current status of the Work item. For more information, see WorkListener in the Java API Reference for Oracle WebLogic Server.
Note: WorkListener instances are always executed in the same JVM as the original thread used to schedule the Work by means of the WorkManager.

- **WorkEvent** - A WorkEvent is sent to a WorkListener as Work is processed by a WorkManager.

  For more information, see WorkEvent in the Java API Reference for Oracle WebLogic Server.

- **RemoteWorkItem** - The RemoteWorkItem interface is an extension of the WorkItem interface that allows work to be executed remotely. This interface allows serializable work to be executed on any member of a cluster.

  For more information, see RemoteWorkItem in the Java API Reference for Oracle WebLogic Server.

### 2.5.2 Work Manager Deployment

Work Managers are defined at the server level by means of a resource-ref in the appropriate deployment descriptor. This can be `web.xml` or `ejb-jar.xml`, among others.

The following deployment descriptor snippet shows the configuration of a WorkManager:

```xml
...<resource-ref>
  <res-ref-name>wm/MyWorkManager</res-ref-name>
  <res-type>commonj.work.WorkManager</res-type>
  <res-auth>Container</res-auth>
  <res-sharing-scope>Shareable</res-sharing-scope>
</resource-ref>...
```

Note: The recommended prefix for the JNDI namespace for WorkManager objects is `java:comp/env/wm`.

### 2.6 Work Manager Example

The following example shows using a CommonJ Work Manager within an HTTP servlet.

```java
import java.io.IOException;
import java.io.PrintWriter;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import weblogic.work.ExecuteThread;
import commonj.work.WorkManager;
import commonj.work.Work;
import commonj.work.WorkException;

public class HelloWorldServlet extends HttpServlet {

```
public void service(HttpServletRequest req, HttpServletResponse res)
    throws IOException
{
    res.setContentType("text/html");
    PrintWriter out = res.getWriter();

    try {
        InitialContext ic = new InitialContext();
        System.out.println("## [servlet] executing in: "+
            ((ExecuteThread)Thread.currentThread()).getWorkManager()
                .getName());
        WorkManager wm = (WorkManager)ic.lookup
            ("java:comp/env/foo-servlet");
        System.out.println("## got Java EE work manager !!!!");
        wm.schedule(new Work(){
            public void run() {
                ExecuteThread th = (ExecuteThread) Thread.currentThread();
                System.out.println("## [servlet] self-tuning workmanager: " +
                    th.getWorkManager().getName());
            }
            public void release() {}
            public boolean isDaemon() {return false;}
        });
    } catch (NamingException ne) {
        ne.printStackTrace();
    } catch (WorkException e) {
        e.printStackTrace();
    }

    out.println("<h4>Hello World!</h4>");
    // Do not close the output stream - allow the servlet engine to close it
    // to enable better performance.
    System.out.println("finished execution");
}