cat is a very popular web server for hosting Java web applications. In contrast to a al development scenario in which you deploy your Java web applications on a standalone Tomcat instance, you can integrate the server runtime directly within your applications, resulting in some interesting, convenient ways of using Tomcat.

In this article, we will share with you some ways of embedding Tomcat server into Java applications.

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1. Why Using Embedded Tomcat? Maven Dependencies for Embedded Tomcat

Basically, we want to use embedded Tomcat for the following purposes:

- Rapid unit testing for web components like Java servlets: instead of starting/stopping Tomcat server and opening a web browser for manual unit testing, it is possible to use embedded Tomcat to automate unit testing.

- Delivering a Java web application as a standalone Java application: the end users now can run a JAR file which starts the embedded server which hosts the web application. No need to download and install Tomcat and deploy the web application manually.

- Programmatic control of the server: integrating an embedded server allows you to have more control of the server in programmatic ways, and automate manual steps.

- Whatever you can imagine.

2. Maven Dependencies for Embedded Tomcat

In order to use embedded Tomcat and pack its runtime with your Java web applications, add the following dependencies in Maven’s `pom.xml` file:

```
<dependency>
    <groupId>org.apache.tomcat.embed</groupId>
    <artifactId>tomcat-embed-core</artifactId>
    <version>${tomcat.version}</version>
</dependency>
<dependency>
    <groupId>org.apache.tomcat.embed</groupId>
    <artifactId>tomcat-embed-jasper</artifactId>
    <version>${tomcat.version}</version>
</dependency>
<dependency>
    <groupId>org.apache.tomcat.embed</groupId>
    <artifactId>tomcat-embed-logging-juli</artifactId>
    <version>${tomcat.version}</version>
</dependency>
```

Where `tomcat.version` is a property that points to the actual version of Tomcat:

```
<properties>
    <tomcat.version>8.0.48</tomcat.version>
</properties>
```

In case you don't use Maven, download and add the following JAR files to your project's classpath:

- `ecj-3.12.3.jar`
- `tomcat-annotations-api-8.0.48.jar`
- `tomcat-embed-core-8.0.48.jar`
- `tomcat-embed-el-8.0.48.jar`
- `tomcat-embed-jasper-8.0.48.jar`
- `tomcat-embed-logging-juli-8.0.48.jar`

Note that the version numbers may differ than it is shown here.

3. The Tomcat Embed API

The central class is `org.apache.catalina.startup.Tomcat` that lets you control almost everything of an embedded server: create new instance, configure server, add web applications, add servlets, start and stop the server, etc.

For example, the following code creates and starts an embedded Tomcat instance running on port number 8080:

```
Tomcat tomcat = new Tomcat();
tomcat.setPort(8080);

// configure the server
// configure web applications

tomcat.start();
```

You can use following methods to configure the server:

- **`setBaseDir(String baseDir)`**: sets the base directory for the server to work. This should be the first method called. By default, Tomcat attempts to use these system properties in this order: `catalina.base` , `catalina.home`, and `user.dir`.

- `etHostname(String name)`: sets the hostname of the default host. Default is ocalhost'.
- `setPort(int port)`: sets the port number for the default connector.

To create a web application programmatically, use the following method to add a context to the server:

`addContext(String contextPath, String docBase)`

Where `contextPath` is the web application name, `docBase` is the base directory of the application. This method returns a **`Context`**object that represents an individual web application. You can use this `Context` object to configure various aspects of the web applications, for example:

```java
// add context initialization parameters
context.addParameter("param1", "value1");
context.addParameter("param2", "value2");

context.addErrorPage(new ErrorPage());
context.setCookies(true);
context.setSessionTimeout(30);
```

To configure the server for an existing web application, use the following `Tomcat`'s method:

`addWebapp(String contextPath, String baseDir)`

Where `contextPath` is the web application name and `baseDir` is the base directory of the application. `baseDir` can refer to an external WAR file, or to a web application directory in the same project.

To add an existing Java servlet to a web application, you can use the following method:

`addServlet(String contextPath, String servletName, Servlet servlet)`

Or use the following static method:

`Tomcat.addServlet(Context context, String servletName, Servlet servlet)`

To configure URL mapping for a servlet, you can use the following method of the `Context` class:

`addServletMappingDecoded(String urlPattern, String servletName)`

To start, stop and destroy the server:

`tomcat.start()`

`tomcat.stop()`

`tomcat.destroy()`

And to cause the current thread to wait until the server is shutdown, use the following statement:

```
tomcat.getServer().await();
```

For complete reference, read the Javadocs of Tomcat and Context classes.

4. Embedding Tomcat server for a Programmatic Java Web Application

In this approach, you create a whole Java web application programmatically from scratch. There's no existing web application, no existing servlet.

For example, the following program `SimpleWebApp` creates an instance of embedded Tomcat, a web application under the root context path ("/"), a Java servlet named "Servlet1", and maps this servlet to the URL pattern "/go":

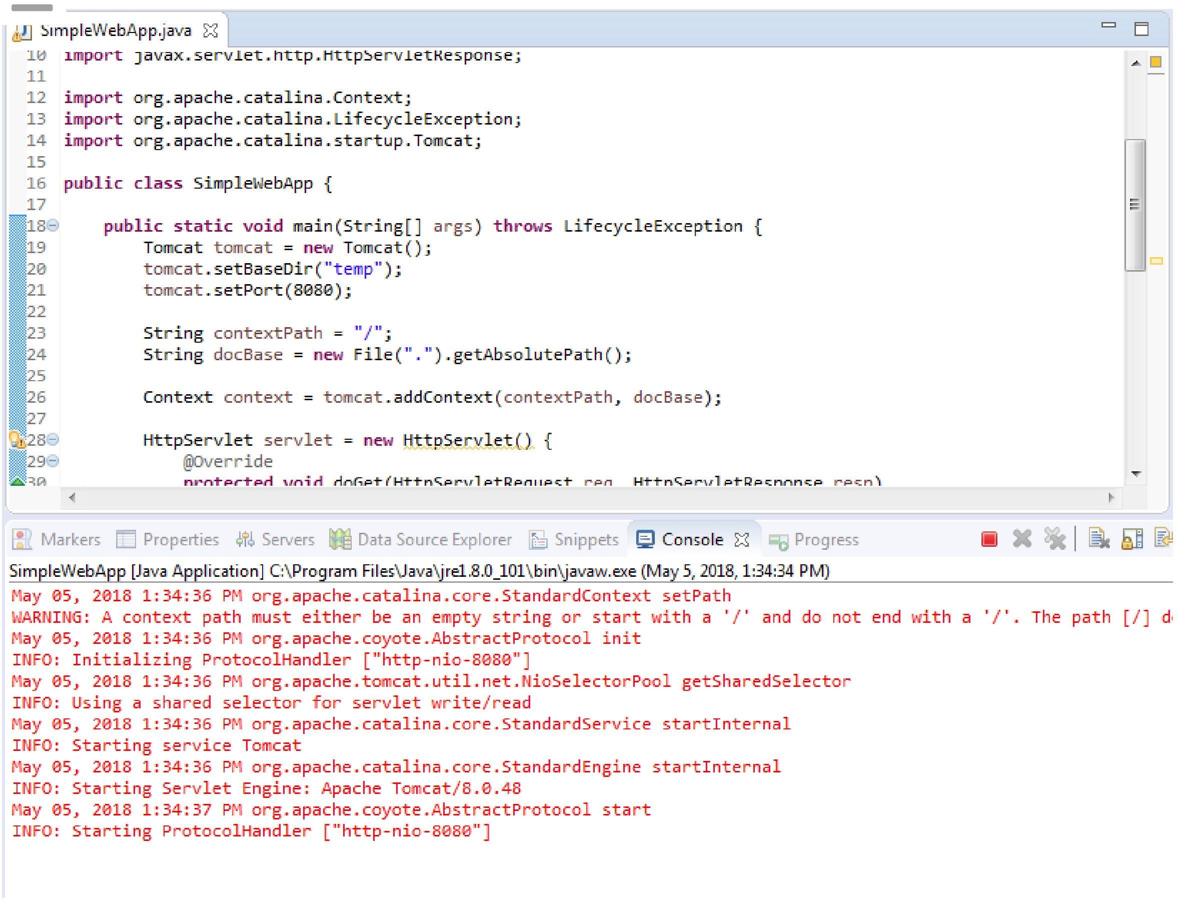
```java
package net.codejava;

import java.io.File;
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

import org.apache.catalina.Context;
import org.apache.catalina.LifecycleException;
import org.apache.catalina.startup.Tomcat;

public class SimpleWebApp {

    public static void main(String[] args) throws LifecycleException {
        Tomcat tomcat = new Tomcat();
        tomcat.setBaseDir("temp");
        tomcat.setPort(8080);

        String contextPath = "/";
        String docBase = new File(".").getAbsolutePath();

        Context context = tomcat.addContext(contextPath, docBase);

        HttpServlet servlet = new HttpServlet() {
            @Override
            protected void doGet(HttpServletRequest req, HttpServletResponse
                    throws ServletException, IOException {
                PrintWriter writer = resp.getWriter();

                writer.println("<html><title>Welcome</title><body>");
                writer.println("<h1>Have a Great Day!</h1>");
                writer.println("</body></html>");
            }
        };

        String servletName = "Servlet1";
        String urlPattern = "/go";

        tomcat.addServlet(contextPath, servletName, servlet);
        context.addServletMappingDecoded(urlPattern, servletName);

        tomcat.start();
        tomcat.getServer().await();
    }
}
```

As you can see, a Java servlet is created “on the fly”, which overrides the `doGet()` method:

```java
HttpServlet servlet = new HttpServlet() {
    @Override
    protected void doGet(HttpServletRequest req, HttpServletResponse resp)
            throws ServletException, IOException {
        PrintWriter writer = resp.getWriter();

        writer.println("<html><title>Welcome</title><body>");
        writer.println("<h1>Have a Great Day!</h1>");
        writer.println("</body></html>");
    }
};
```

This servlet sends a simple HTML page to the client, with a heading “Have a Great Day!”.

this program in Eclipse and you can see the server's log in the Console view:



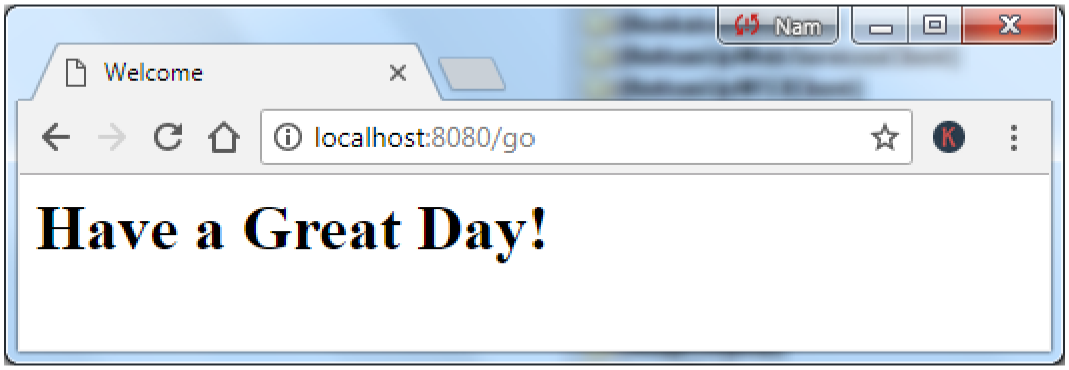
```
import javax.servlet.http.HttpServletResponse;

import org.apache.catalina.Context;
import org.apache.catalina.LifecycleException;
import org.apache.catalina.startup.Tomcat;

public class SimpleWebApp {

    public static void main(String[] args) throws LifecycleException {
        Tomcat tomcat = new Tomcat();
        tomcat.setBaseDir("temp");
        tomcat.setPort(8080);

        String contextPath = "/";
        String docBase = new File(".").getAbsolutePath();

        Context context = tomcat.addContext(contextPath, docBase);

        HttpServlet servlet = new HttpServlet() {
            @Override
            protected void doGet(HttpServletRequest req, HttpServletResponse resp)
```

```
SimpleWebApp [Java Application] C:\Program Files\Java\jre1.8.0_101\bin\javaw.exe (May 5, 2018, 1:34:34 PM)
May 05, 2018 1:34:36 PM org.apache.catalina.core.StandardContext setPath
WARNING: A context path must either be an empty string or start with a '/' and do not end with a '/'. The path [/] d
May 05, 2018 1:34:36 PM org.apache.coyote.AbstractProtocol init
INFO: Initializing ProtocolHandler ["http-nio-8080"]
May 05, 2018 1:34:36 PM org.apache.tomcat.util.net.NioSelectorPool getSharedSelector
INFO: Using a shared selector for servlet write/read
May 05, 2018 1:34:36 PM org.apache.catalina.core.StandardService startInternal
INFO: Starting service Tomcat
May 05, 2018 1:34:36 PM org.apache.catalina.core.StandardEngine startInternal
INFO: Starting Servlet Engine: Apache Tomcat/8.0.48
May 05, 2018 1:34:37 PM org.apache.coyote.AbstractProtocol start
INFO: Starting ProtocolHandler ["http-nio-8080"]
```

The server is listening on port 8080, so type the following URL in your web browser:

http://localhost:8080/go

And you can see the result looks like this:



Have a Great Day!

That means the server and web application are up and running.

You can also write a Servlet in a separate class (`AddServlet.java`) like this:

```java
package net.codejava;

import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

public class AddServlet extends HttpServlet {
    @Override
    protected void doGet(HttpServletRequest req, HttpServletResponse resp)
            throws ServletException, IOException {
        int a = Integer.parseInt(req.getParameter("a"));
        int b = Integer.parseInt(req.getParameter("b"));
        int sum = a + b;

        String result = String.format("%d + %d = %d", a, b, sum);

        PrintWriter writer = resp.getWriter();
        writer.println("<html><title>Addition</title><body>");
        writer.println("<h1>" + result + "</h1");
        writer.println("</body></html>");
    }
}
```

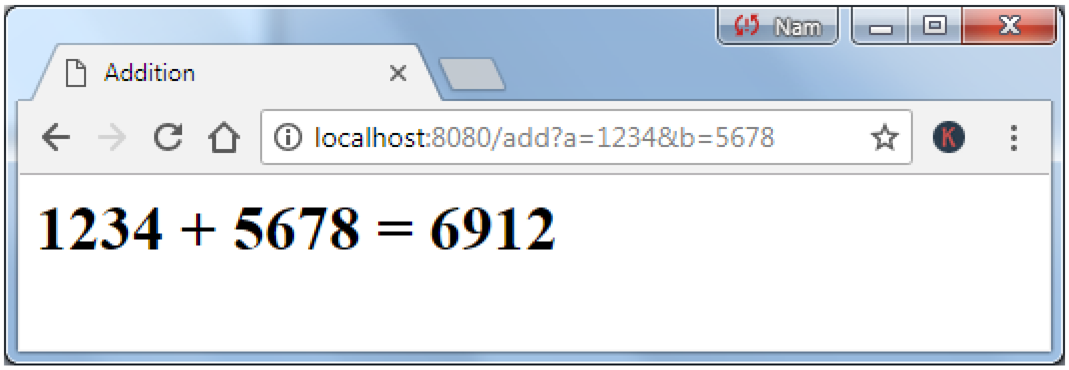
This servlet returns sum of two numbers passed from query parameters. And add this servlet to the web application like this:

```java
AddServlet addServlet = new AddServlet();
servletName = "AddServlet";
urlPattern = "/add";

tomcat.addServlet(contextPath, servletName, addServlet);
context.addServletMappingDecoded(urlPattern, servletName);
```

Call the servlet from the web browser:

http://localhost:8080/add?a=1234&b=5678

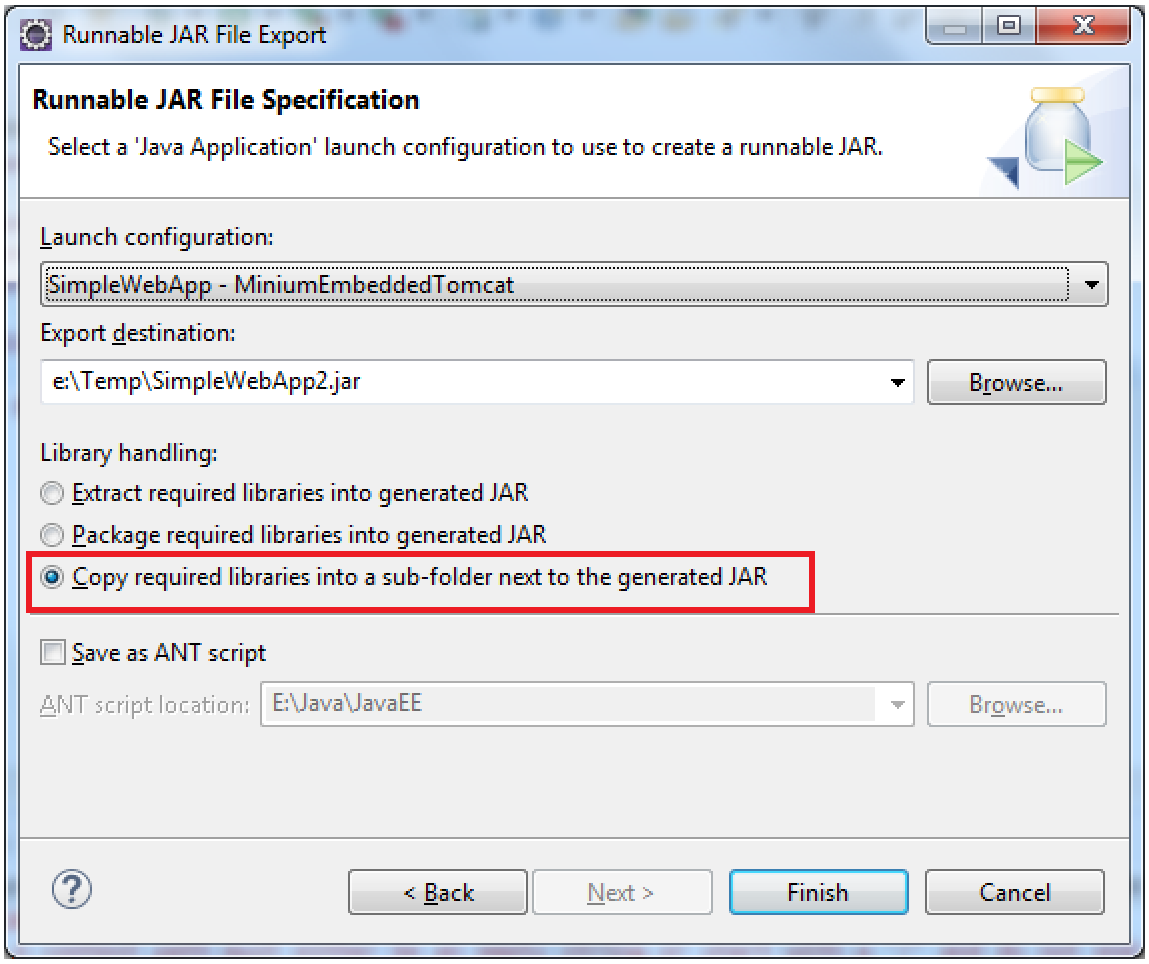
And result:



1234 + 5678 = 6912

In this programmatic mode, there is no JSP support. This approach is suitable for creating a minimum, simple, lightweight web application with an embedded Tomcat server.

To create an executable JAR file for this kind of application in Eclipse IDE, click **File > Export…** In the *Export* dialog, select **Java > Runnable JAR file** and click **Next**. In the ıable JAR File Export* screen, remember to choose the option “Copy required libraries ı sub-folder next to the generated JAR”, as shown in the following screenshot:


Runnable JAR File Export

Runnable JAR File Specification

Select a 'Java Application' launch configuration to use to create a runnable JAR.

Launch configuration: SimpleWebApp - MiniumEmbeddedTomcat

Export destination: e:\Temp\SimpleWebApp2.jar

Library handling:

( ) Extract required libraries into generated JAR

( ) Package required libraries into generated JAR

[✓ Copy required libraries into a sub-folder next to the generated JAR]

[ ] Save as ANT script

ANT script location: E:\Java\JavaEE

Click **Finish**, and eclipse generate the executable JAR file along with the required JAR files for embedded Tomcat in a directory next to the generated JAR. Then you can run the application using java command like this:

```
java -jar SimpleWebApp2.jar
```

Then you can see the server is started and ready to accept client’s requests.

5. Using Embedded Tomcat server for a WAR File

An interesting feature of embedded Tomcat is that you can programmatically starts the server for running a Java web application which is packed in a Web Archive (WAR) file.

Suppose you have a Java web application packed in `Bookstore.war` file, the following program creates a Tomcat instance and adds a web application from the WAR file:

```
package net.codejava;

import javax.servlet.ServletException;

import org.apache.catalina.LifecycleException;
import org.apache.catalina.startup.Tomcat;

public class RunWarExample {

    public static void main(String[] args) throws ServletException, Lifecycle
        Tomcat tomcat = new Tomcat();
tomcat.setBaseDir("temp");
        tomcat.setPort(8080);

        String contextPath = "/Bookstore";
        String warFilePath = "D:\\Web\\Website\\Bookstore.war";

        tomcat.getHost().setAppBase(".");

        tomcat.addWebapp(contextPath, warFilePath);

        tomcat.start();
        tomcat.getServer().await();
    }
}
```

Run this program and you can see the content of the WAR file is extracted to the base directory, and you can access the web application using the specified context path.

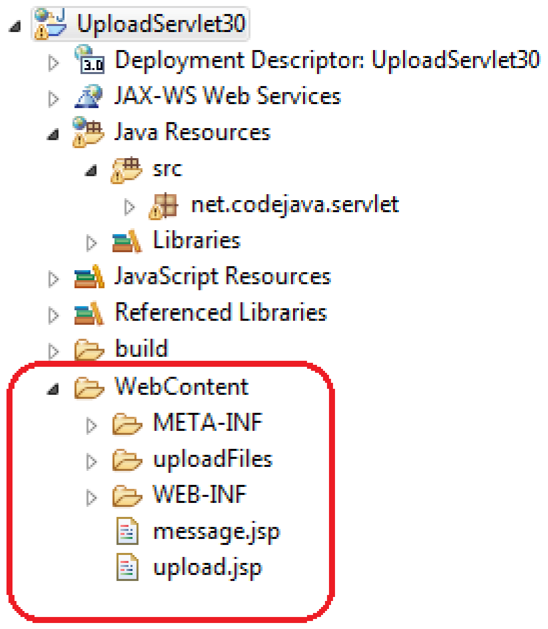
This approach is very convenient for testing existing web applications which are packed in WAR files, and you don't have to touch their code.

For this kind of application, generate the executable JAR file in the same way as described in the programmatic web application.

6. Embedding Tomcat server for an Existing Java Web Application

Perhaps this is the most frequently used feature of embedded Tomcat. This is the scenario: You're developing a Java web application and now you want to embed Tomcat for the purpose of unit testing or deliver the web application as a standalone Java program. So how to make it?

Suppose that your web application's files are stored in a directory named **WebContent** that looks like this:



```
UploadServlet30
  Deployment Descriptor: UploadServlet30
  JAX-WS Web Services
  Java Resources
    src
      net.codejava.servlet
    Libraries
  JavaScript Resources
  Referenced Libraries
  build
  WebContent
    META-INF
    uploadFiles
    WEB-INF
    message.jsp
    upload.jsp
```

The following program starts an embedded Tomcat instance to run the web application:

```java
package net.codejava.servlet;

import java.io.File;

import javax.servlet.ServletException;

import org.apache.catalina.LifecycleException;
import org.apache.catalina.startup.Tomcat;

public class EmbeddedTomcatTest {

    public static void main(String[] args) throws LifecycleException, Servlet
        String contextPath = "/UploadApp";
        String webappDir = new File("WebContent").getAbsolutePath();

        Tomcat tomcat = new Tomcat();
        tomcat.setBaseDir("temp");
        tomcat.setPort(8080);

        tomcat.addWebapp(contextPath, webappDir);

        tomcat.start();
        tomcat.getServer().await();
    }
}
```

Now you can use your browser to access the web application using the specified port number and context path in the program above:

http://localhost:8080/UploadApp/upload.jsp

To generate executable JAR file for this kind of application, you need to use Tomcat Maven plugin as described here.

References:

Class **Tomcat** Javadoc