Wildfly

Java® EE Development with WildFly®

Sundar

Alchemy

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Table of Contents

- Setting the environment for an application
- Creating sample data
- Running a sample application

In *Module1*, *Getting Started with EJB 3.x*, we discuss developing an EJB 3.0/JPA-based application with WildFly 8.1.0. According to the 2012 report, JPA (at 44 percent) and EJB 3.0 (at 23 percent) are the two most commonly used Java EE standards.

In *Module2*, *Developing Object/Relational Mapping with Hibernate 4*, we discuss using Hibernate 4 with WildFly 8.1.0. According to the 2012 report, Hibernate (at 54 percent) is one of the most commonly used application frameworks. According to the 2014 report, Hibernate (at 67.5 percent) is the top object/relational mapping framework.

What you need for this Program

We have used WildFly 8.1.0 in the program. Download WildFly 8.1.0 Final from `http://wildfly.org/downloads/`. In some of the chapters, we have used MySQL

5.6 Database-Community Edition, which can be downloaded from `http://dev.mysql.com/downloads/mysql/`. You also need to download and install the Eclipse IDE for Java EE Developers from

`http://www.eclipse.org/downloads/`. Eclipse Luna 4.4.1is used, but a later version can also be used. Also, install JBoss Tools (version 4.2.0 used) as a plugin to Eclipse. Apache Maven (version 3.05 or later) is also required to be installed and can be downloaded from `http://maven.apache.org/download. cgi`. We have used Windows OS, but if you have Linux installed, the Program can still be used (though the
source code and samples have not been tested with Linux).

Slight modifications may be required with the Linux install; for example, the directory paths on Linux would be different than the Windows directory paths. You also need to install Java for Java-based chapters; Java SE 7 is used in the Program.

Conventions

In this Program, you will find a number of styles of text that distinguish between different kinds of information. Here are some examples of these styles, and anexplanation of their meaning.

Code words in text, database table names, folder names, filenames, file extensions, pathnames, dummy URLs, user input, and Twitter handles are shown as follows: "Configuring the `jboss-ejb3-ejb` subproject."

A block of code is set as follows:

```
<module xmlns="urn:jboss:module:1.1" name="mysql" slot="main">
  <resources>
    <resource-root path="mysql-connector-java-5.1.33-bin.jar"/>
  </resources>
  <dependencies>
    <module name="javax.api"/>
  </dependencies>
</module>
```

New terms and **important words** are shown in bold. Words that you see on the screen, in menus or dialog boxes for example, appear in the text like this: "Select **Window** | **Preferences** in Eclipse. In **Preferences**, select **Server** | **Runtime Environment**."

1

Getting Started with EJB 3.x

The objective of the EJB 3.x specification is to simplify its development by improving the EJB architecture. This simplification is achieved by providing metadata annotations to replace XML configuration. It also provides default configuration values by making entity and session beans **POJOs** (**Plain Old Java Objects**) and

by making component and home interfaces redundant. The EJB 2.x entity beans is replaced with EJB 3.x entities. EJB 3.0 also introduced the **Java Persistence API** (**JPA**) for object-relational mapping of Java objects.

WildFly 8.x supports EJB 3.2 and the JPA 2.1 specifications from Java EE 7. While

EJB 3.2 is supported, the sample application in this Moduledoes not make use of the new features of EJB 3.2 (such as the new TimerService API and the ability to disable passivation of stateful session beans). The sample application is based on Java EE 6 and EJB 3.1. The configuration of EJB 3.x with Java EE 7 is also discussed, and the sample application can be used or modified to run on a Java EE 7 project. We have used a Hibernate 4.3 persistence provider. Unlike some of the other persistence providers, the Hibernate persistence provider supports automatic generation of relational database tables, including the joining of tables.
In this chapter, we will create an EJB 3.x project and build and deploy this project to WildFly 8.1 using Maven. We will cover following sections:

- Setting up the environment
- Creating a WildFly runtime
- Creating a Java EE project
- Configuring a data source with MySQL database
- Creating entities
- Creating a JPA persistence configuration file

- Creating a Session Bean Facade
- Creating a JSP client

[1]

- Configuring the `jboss-ejb3-ejb` subproject
- Configuring the `jboss-ejb3-web` subproject
- Configuring the `jboss-ejb3-ear` subproject
- Deploying the EAR Module
- Running the JSP Client
- Configuring a Java EE 7 Maven Project

Setting up the Environment

We need to download and install the following software:

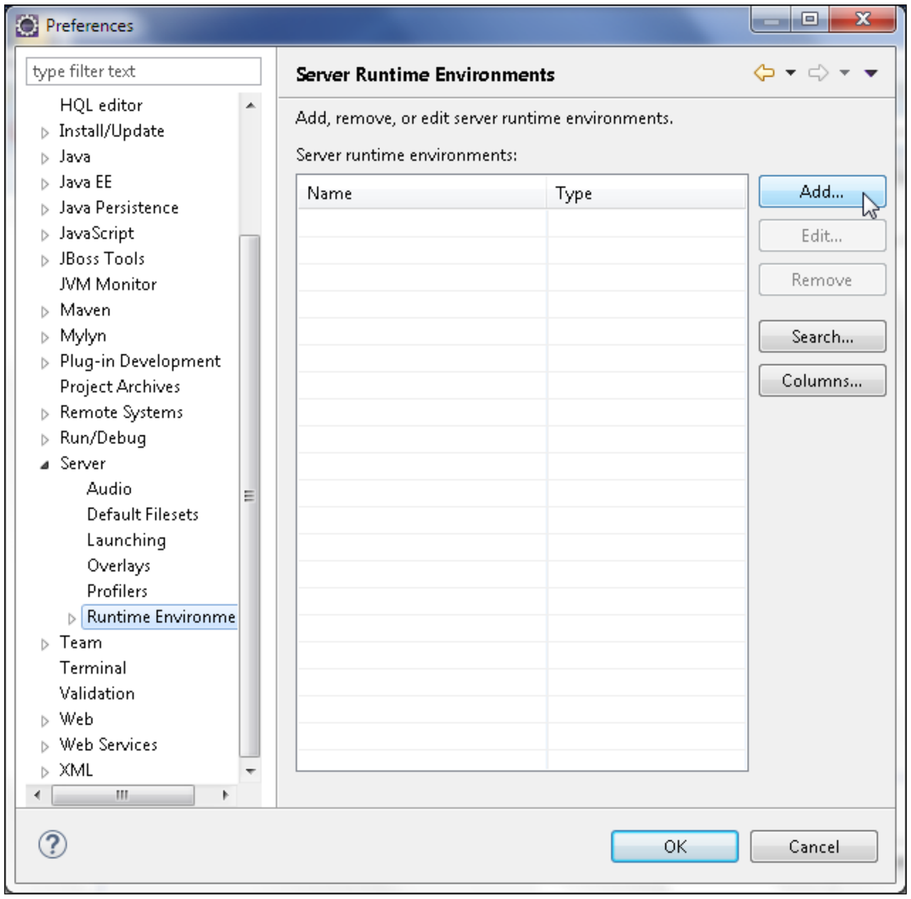
- **WildFly 8.1.0.Final**: Download `wildfly-8.1.0.Final.zip` from `http://wildfly.org/downloads/`.
- **MySQL 5.6 Database-Community Edition**: Download this edition from `http://dev.mysql.com/downloads/mysql/`. When installing MySQL, also install **Connector/J**.
- **Eclipse IDE for Java EE Developers**: Download Eclipse Luna from `https://www.eclipse.org/downloads/packages/release/Luna/SR1`.
- **JBoss Tools (Luna) 4.2.0.Final**: Install this as a plug-in to Eclipse from the Eclipse Marketplace (`http://tools.jboss.org/downloads/installation.html`). The latest version from Eclipse Marketplace is likely to be different than 4.2.0.
- **Apache Maven**: Download version 3.05 or higher from `http://maven.apache.org/download.cgi`.
- **Java 7**: Download Java 7 from `http://www.oracle.com/technetwork/java/javase/downloads/index.html?ssSourceSiteId=ocomcn`.

Set the environment variables: `JAVA_HOME`, `JBOSS_HOME`, `MAVEN_HOME`, and `MYSQL _ HOME`. Add `%JAVA_HOME%/bin`, `%MAVEN_HOME%/bin`, `%JBOSS_HOME%/bin`, and `%MYSQL_HOME%/bin` to the `PATH` environment variable. The environment settings used are `C:\wildfly-8.1.0.Final` for `JBOSS_HOME`, `C:\Program Files\MySQL\MySQL Server 5.6.21` for `MYSQL_HOME`, `C:\maven\apache-maven-3.0.5` for `MAVEN_HOME`, and `C:\Program Files\Java\jdk1.7.0_51` for `JAVA_HOME`. Run the `add-user. bat` script from the `%JBOSS_HOME%/bin` directory to create a user for the WildFly administrator console. When prompted **What type of user do you wish to add?**, select **a) Management User**. The other option is **b) Application User**.

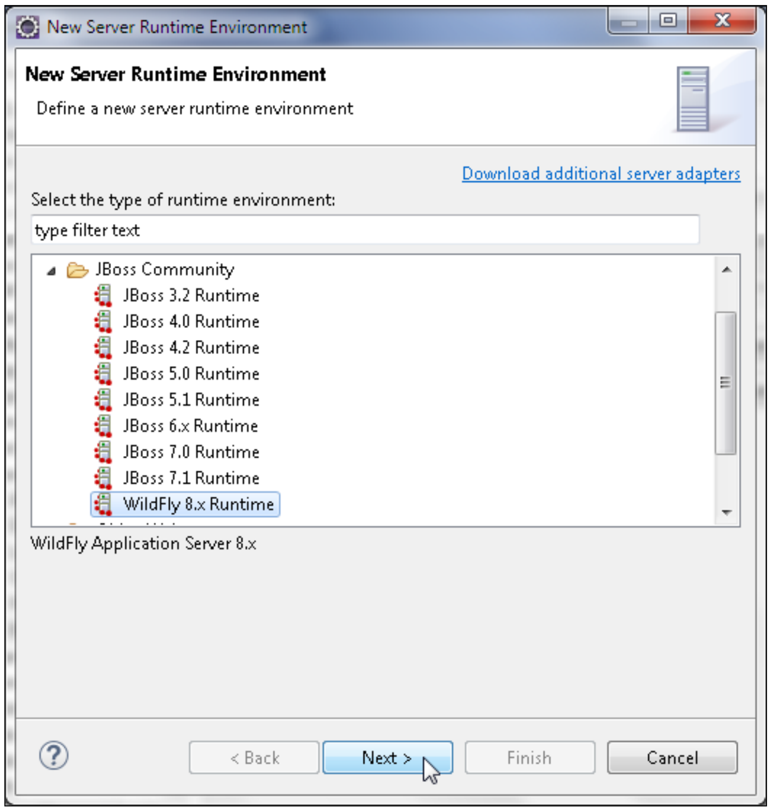
Management User is used to log in to **Administration Console**, and **Application User** is used to access applications. Subsequently, specify the **Username** and **Password** for the new user. When prompted with the question, **Is this user going to be used for one AS process to connect to another AS..?**, enter the answer as `no`. When installing and configuring the MySQL database, specify a password for the root user (the password `mysql` is used in the sample application).

Creating a WildFly runtime

As the application is run on WildFly 8.1, we need to create a runtime environment for WildFly 8.1 in Eclipse. Select Window | Preferences in Eclipse. In Preferences, select Server | Runtime Environment. Click on the Add button to add a new runtime environment, as shown in the following screenshot:



In **New Server Runtime Environment**, select **JBoss Community | WildFly 8 Runtime**. Click on **Next**:


New Server Runtime Environment

New Server Runtime Environment

Define a new server runtime environment

Download additional server adapters

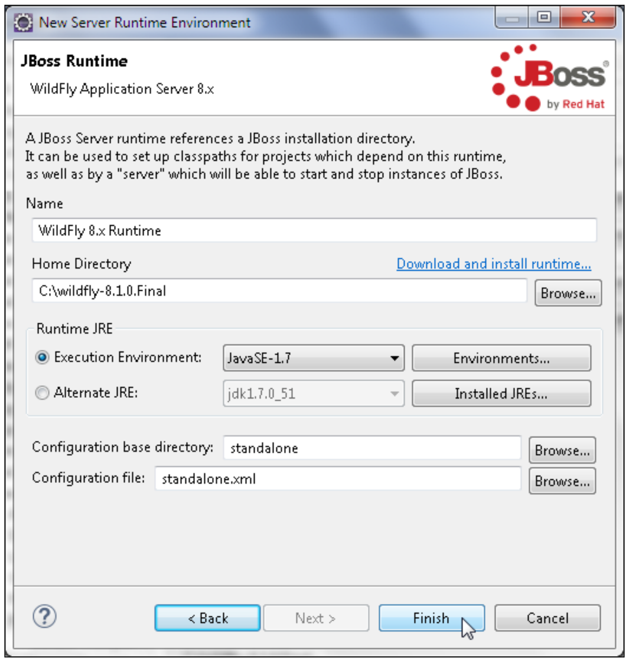
Select the type of runtime environment:

type filter text

- JBoss Community
  - JBoss 3.2 Runtime
  - JBoss 4.0 Runtime
  - JBoss 4.2 Runtime
  - JBoss 5.0 Runtime
  - JBoss 5.1 Runtime
  - JBoss 6.x Runtime
  - JBoss 7.0 Runtime
  - JBoss 7.1 Runtime
  - WildFly 8.x Runtime

WildFly Application Server 8.x

In **WildFly Application Server 8.x**, which appears below **New Server Runtime Environment**, specify a Name for the new runtime or choose the default name, which is `WildFly 8.x Runtime`. Select the Home Directory for the WildFly 8.x server using the Browse button. The Home Directory is the directory where WildFly 8.1 is installed. The default path is C:\wildfly-8.1.0.Final for this Module and 8.2 subsequent chapters. Select the Runtime JRE as `JavaSE-1.7`. If the JDK location is not added to the runtime list, first add it from the JRE preferences screen in Eclipse. In **Configuration base directory**, select `standalone` as the default setting. In Configuration file, select `standalone.xml` as the default setting. Click on Finish:


New Server Runtime Environment

JBoss Runtime

WildFly Application Server 8.x

A JBoss Server runtime references a JBoss installation directory.
It can be used to set up classpaths for projects which depend on this runtime,
as well as by a "server" which will be able to start and stop instances of JBoss.

Name: WildFly 8.x Runtime

Home Directory: C:\wildfly-8.1.0.Final

Runtime JRE

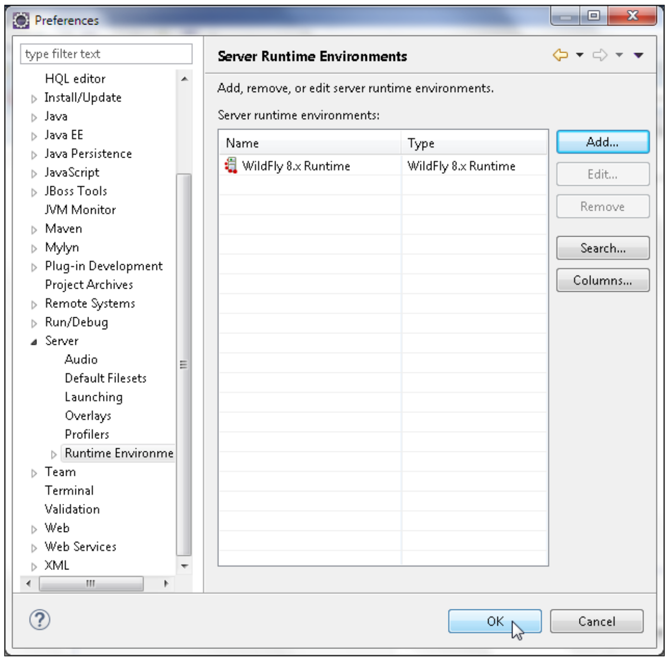
Execution Environment: JavaSE-1.7

Alternate JRE: jdk1.7.0_51

Configuration base directory: standalone

Configuration file: standalone.xml

A new server runtime environment for WildFly 8.x Runtime gets created, as shown in the following screenshot. Click on **OK**:


Preferences

Server Runtime Environments

Add, remove, or edit server runtime environments.

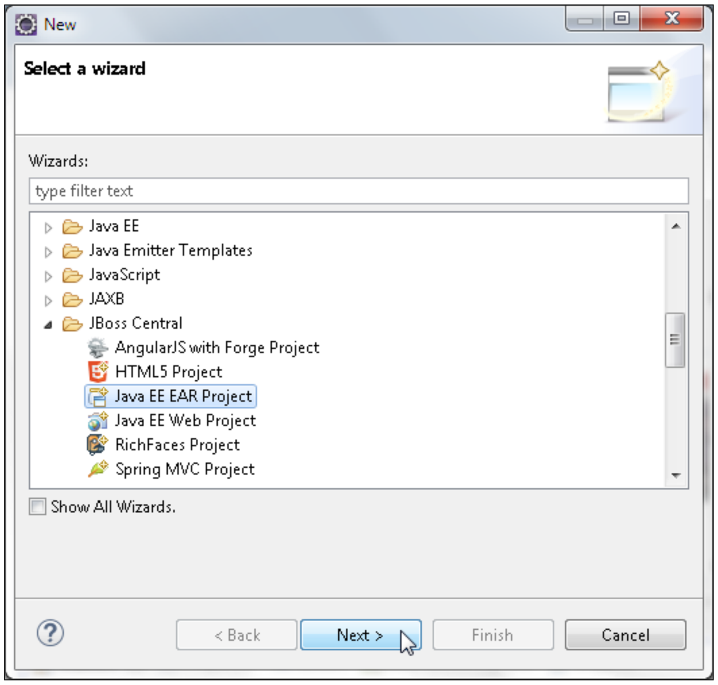
Server runtime environments:

Name	Type
WildFly 8.x Runtime	WildFly 8.x Runtime

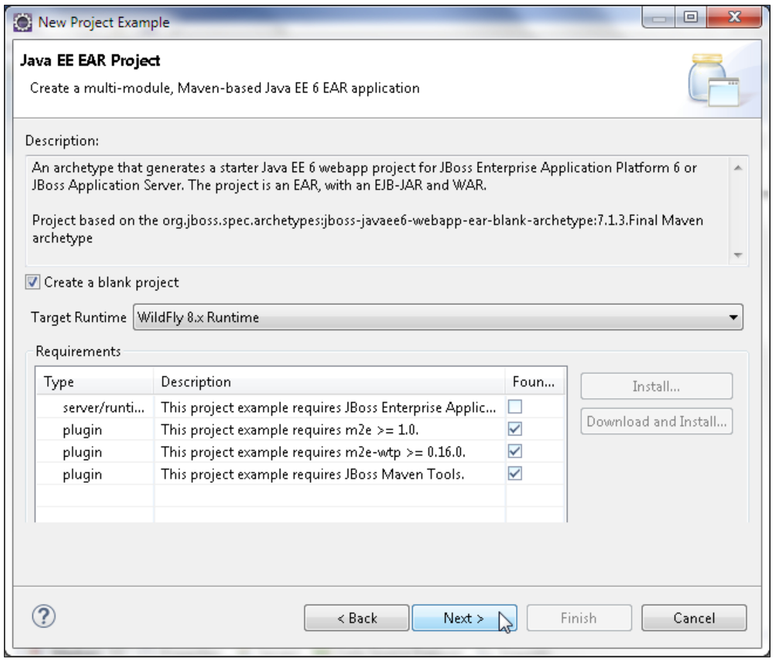
Creating a **Server Runtime Environment** for WildFly 8.x is not a prerequisite fr creating a Java EE project in Eclipse. In the next section, we will create a new Java EE project for an EJB 3.x application.

Creating a Java EE project

JBoss Tools provides project templates for different types of JBoss projects. In this section, we will create a Java EE project for an EJB 3.x application. Select **File** | **New** | **Other** in Eclipse IDE. In the **New** wizard, select the **JBoss Central** | **Java EE EAR Project** wizard. Click on the **Next** button:



The **Java EE EAR Project** wizard gets started. By default, a Java EE 6 project is created. A Java EE EAR Project is a Maven project. The **New Project Example** window lists the requirements and runs a test for the requirements. The JBoss AS runtime is required and some plugins (including the JBoss Maven Tools plugin) are required for a Java EE project. Select **Target Runtime** as `WildFly 8.x Runtime`, which was created in the preceding section. Then, check the **Create a blank project** checkbox. Click on the **Next** button:



New Project Example

Java EE EAR Project

Create a multi-module, Maven-based Java EE 6 EAR application

Description:

An archetype that generates a starter Java EE 6 webapp project for JBoss Enterprise Application Platform 6 or JBoss Application Server. The project is an EAR, with an EJB-JAR and WAR.

Project based on the org.jboss.spec.archetypes:jboss-javaee6-webapp-ear-blank-archetype:7.1.3.Final Maven archetype

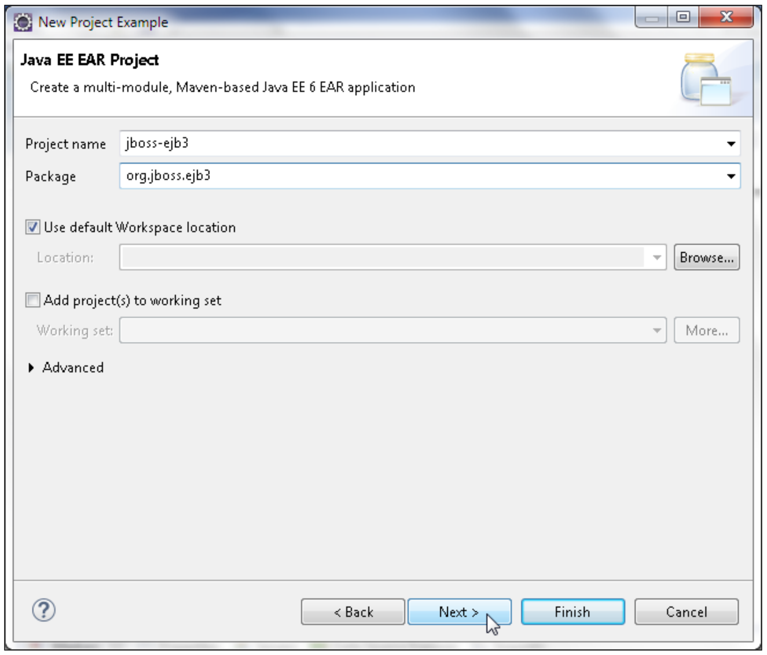
☑ Create a blank project

Target Runtime: WildFly 8.x Runtime

Requirements

Type	Description	Foun...
server/runti...	This project example requires JBoss Enterprise Applic...	☐
plugin	This project example requires m2e >= 1.0.	✓
plugin	This project example requires m2e-wtp >= 0.16.0.	✓
plugin	This project example requires JBoss Maven Tools.	✓

Specify **Project name** as `jboss-ejb3`, **Package** as `org.jboss.ejb3`, and tick the **Use default Workspace location** box. Click on the **Next** button:



New Project Example

Java EE EAR Project

Create a multi-module, Maven-based Java EE 6 EAR application

Project name: jboss-ejb3

Package: org.jboss.ejb3

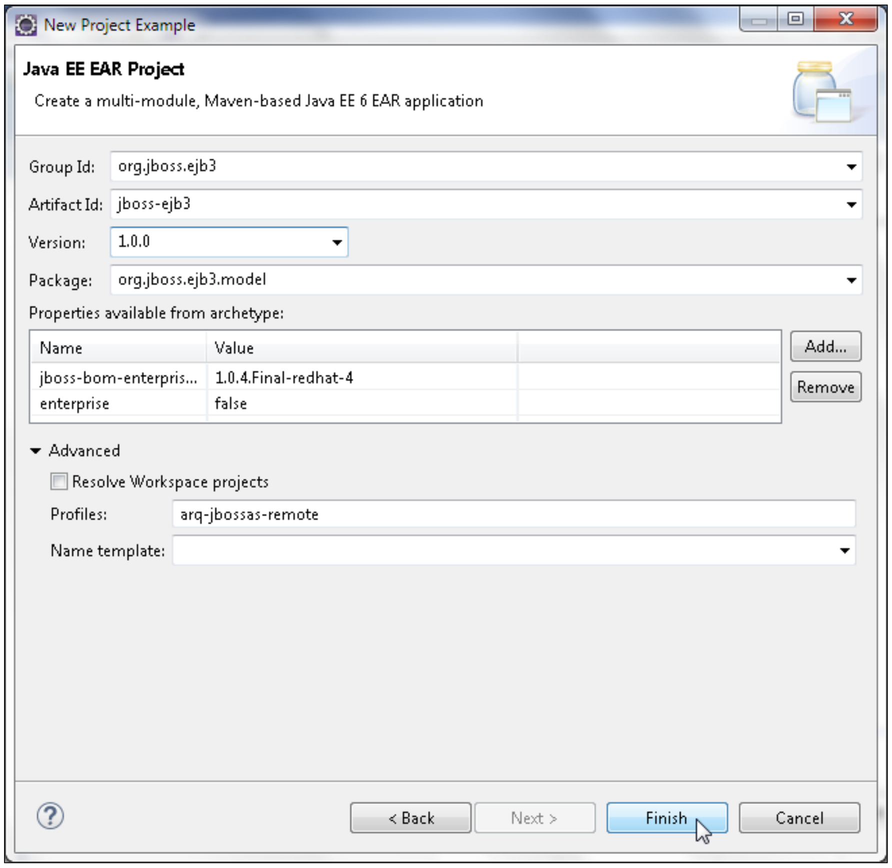
☑ Use default Workspace location

Location:

☐ Add project(s) to working set

Working set:

Specify Group Id as `org.jboss.ejb3`, Artifact Id as `jboss-ejb3`, Version as `1.0.0`, and Package as `org.jboss.ejb3.model`. Click on Finish:


New Project Example
Java EE EAR Project
Create a multi-module, Maven-based Java EE 6 EAR application

Group Id: org.jboss.ejb3

Artifact Id: jboss-ejb3

Version: 1.0.0

Package: org.jboss.ejb3.model

Properties available from archetype:

Name	Value
jboss-bom-enterpris...	1.0.4.Final-redhat-4
enterprise	false

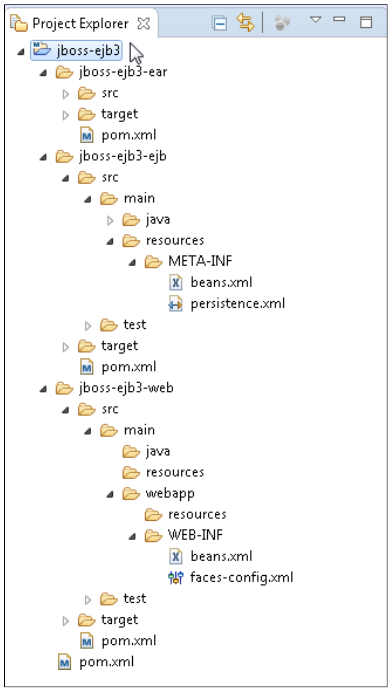
Advanced

Resolve Workspace projects: unchecked

Profiles: arq-jbossas-remote

Name template:

A Java EE project gets created, as shown in the following Project Explorer window. Delete the `jboss-ejb3/jboss-ejb3-ear/src/main/application/META-INF/jboss-ejb3-ds.xml` configuration file. The jboss-ejb3 project consists of three subprojects: `jboss-ejb3-ear`, `jboss-ejb3-ejb`, and `jboss-ejb3-web`. Each subproject consists of a pom.xml file for Maven. Initially the subprojects indicate errors with red error markers, but these would get fixed when the main project is built later in the chapter. Initially the subprojects might indicate errors with red error markers, but these would get fixed when the main project is built later in the chapter. We will configure a data source with the MySQL database in a later section. The `jboss-ejb3-ejb` subproject consists of a META-INF/persistence.xml file within the src/main/resources source folder for the JPA database persistence configuration.



```
jboss-ejb3
  jboss-ejb3-ear
    src
    target
    pom.xml
  jboss-ejb3-ejb
    src
      main
        java
        resources
          META-INF
            beans.xml
            persistence.xml
      test
    target
    pom.xml
  jboss-ejb3-web
    src
      main
        java
        resources
        webapp
          resources
          WEB-INF
            beans.xml
            faces-config.xml
      test
    target
    pom.xml
  pom.xml
```

We will use MySQL as the database for data for the EJB application. In the next section, we will create a data source in the MySQL database.

Configuring a data source with MySQL database

The default data source in WildFly 8.1 is configured with the H2 database engine. There are several options available for a database. The top four most commonly used relational databases are Oracle database, MySQL database, SQL Server, and PostgreSQL Server. Oracle database and SQL Server are designed for enterprise level applications and are not open source. Oracle database offers more features to facilitate system and data maintenance. It also offers features to prevent system and data failure as compared to SQL Server. MySQL and PostgreSQL are open source databases with comparable features and designed primarily for small scale applications. We will use MySQL database. Some of the reasons to choose MySQL are discussed at `http://www.mysql.com/why-mysql/topreasons.html`.

We will configure a datasource with the MySQL database for use in the EJB 3.x application for object/relational mapping. Use the following steps to configure a datasource:

1. First, we need to create a module for MySQL database. For the MySQL module, create a module.xml file in the `%JBOSS_HOME%/modules/mysql/main` directory; the `mysql/main` subdirectory is also to be created. The module.xml file is listed in the following code snippet:

    ```
    <module xmlns="urn:jboss:module:1.1" name="mysql" slot="main">
      <resources>
        <resource-root path="mysql-connector-java-5.1.33-bin.jar"/>
      </resources>
      <dependencies>
        <module name="javax.api"/>
      </dependencies>
    </module>
    ```

2. Copy the `mysql-connector-java-5.1.33-bin.jar` (MySQL JDBC JAR) file from `C:\Program Files (x86)\MySQL\Connector.J 5.1` to the `%JBOSS_HOME%/modules/mysql/main` directory. The MySQL `mysql-connector-java` JAR file version specified in `module.xml` must be the same as the version of the JAR file copied to the `/modules/mysql/main` directory.

3. Add a `<datasource/>` definition for the MySQL database to

   the

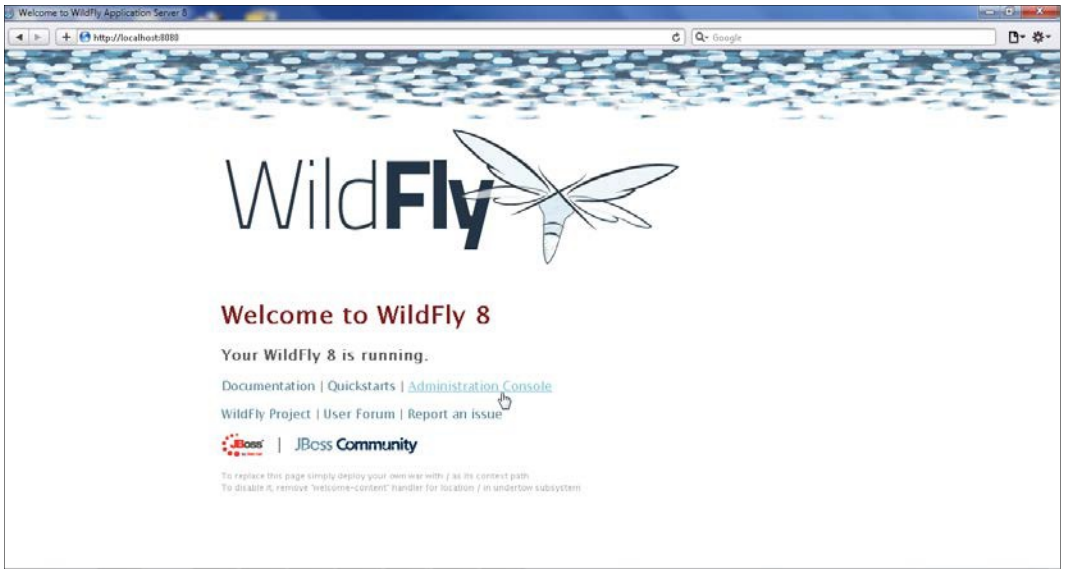
   `<datasources/>` element and a `<driver/>` definition to the `<drivers/>` element in the `%JBOSS_HOME%/standalone/configuration/standalone.xml` file within the `<subsystem xmlns="urn:jboss:domain:datasources:2.0"> </subsystem>` element. The `<password/>` tag in the

   `<datasource/>` configuration tag is the password configured when the MySQL database is installed. The datasource class for the MySQL driver is a `XA` datasource, which is used for distributed transactions:

```
<subsystem xmlns="urn:jboss:domain:datasources:2.0">
  <datasources>
    <datasource jndi-name="java:jboss/datasources/MySQLDS" pool-
name="MySQLDS" enabled="true" use-java-context="true">
      <connection-url>jdbc:mysql://localhost:3306/test</
connection-url>
      <driver>mysql</driver>
      <pool>
        <min-pool-size>10</min-pool-size>
        <max-pool-size>20</max-pool-size>
        <prefill>true</prefill>
      </pool>
      <security>
        <user-name>root</user-name>
        <password>mysql</password>
      </security>
    </datasource>
    <drivers>
      <driver name="mysql" module="mysql">
        <driver-class>com.mysql.jdbc.Driver</driver-class>
        <xa-datasource-class>com.mysql.jdbc.jdbc2.optional.
MysqlXADataSource</xa-datasource-class>
      </driver>
    </drivers>
  </datasources>
</subsystem>
```

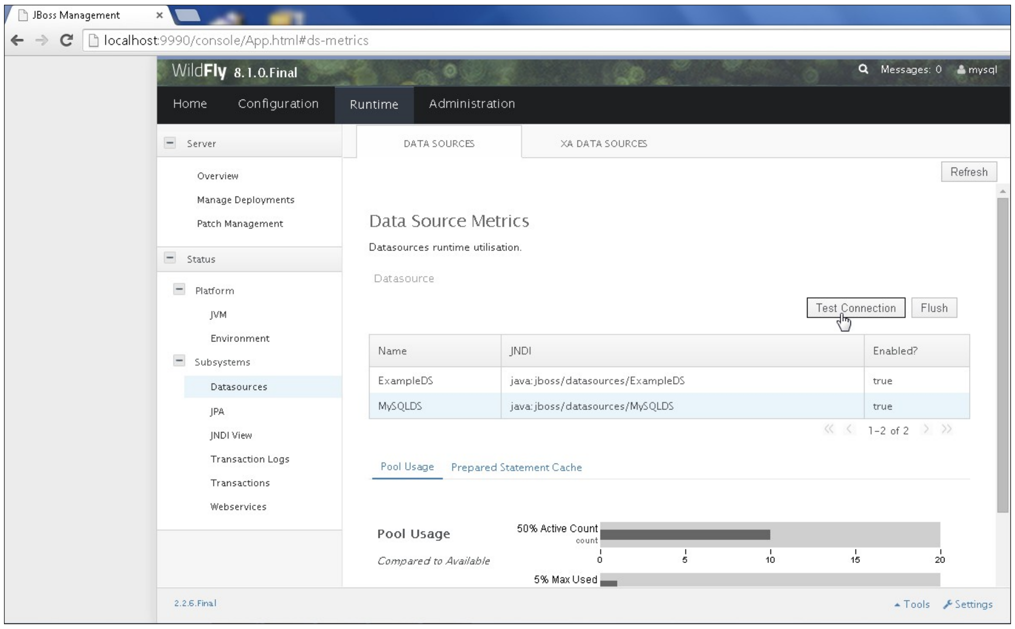
4. If the server is running after modifying the standalone.xml configuration file, restart WildFly 8.x server. The MySQL datasource gets deployed. To start or restart the WildFly server, double-click on the `C:\wildfly-8.1.0.Final\bin\standalone` batch file.

5. Log in to the WildFly 8 Administration Console with the URL: `http://localhost:8080`. Click on **Administration Console**, as shown in the following screenshot:


Welcome to WildFly Application Server 8
http://localhost:8080
WildFly
Welcome to WildFly 8
Your WildFly 8 is running.
Documentation | Quickstarts | Administration Console
WildFly Project | User Forum | Report an issue
JBoss | JBoss Community

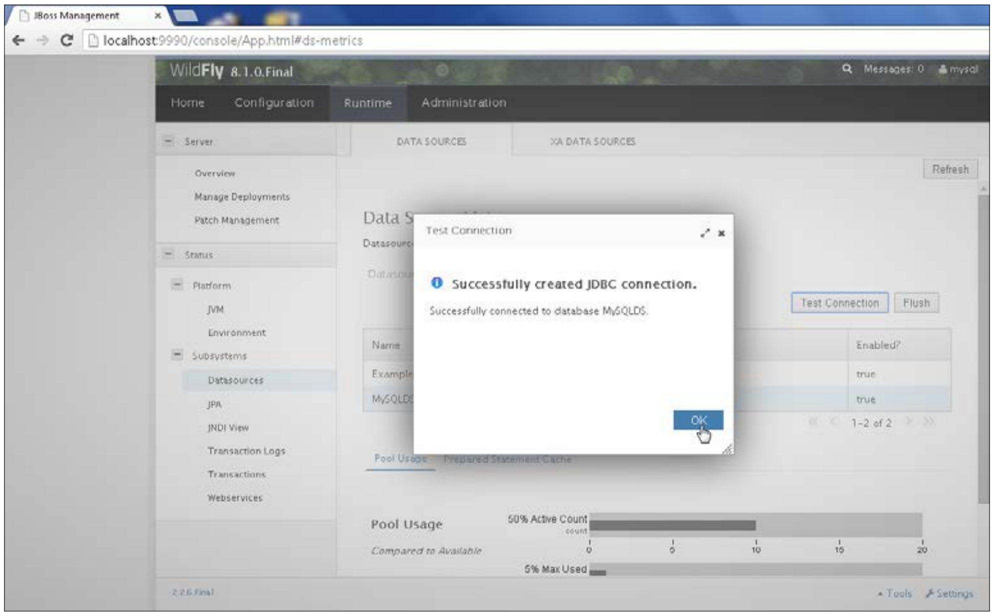
To replace this page simply deploy your own war with / as its context path.
To disable it, remove "welcome-content" handler for location / in undertow subsystem

6. In the login dialog box, specify the username and password for the user added with the add-user.bat script.
7. Select the **Runtime** tab in Administration Console. The MySQL datasource is listed as deployed in **Datasources Subsystems**, as shown in the following screenshot. Click on **Test Connection** to test the connection:



Name	JNDI	Enabled?
ExampleDS	java:jboss/datasources/ExampleDS	true
MySQLDS	java:jboss/datasources/MySQLDS	true

8. If a connection with the MySQL database is established, a **Successfully created JDBC connection** message will get displayed:



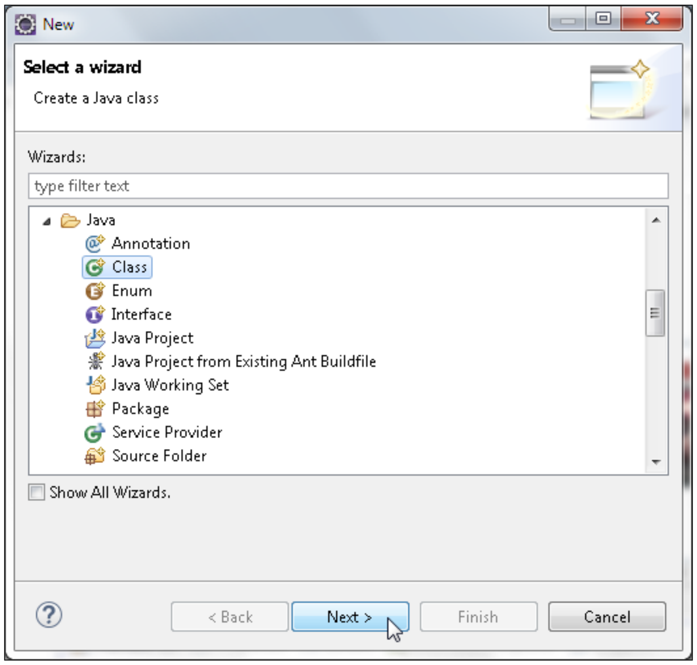
Successfully created JDBC connection.

Successfully connected to database MySQLDS.

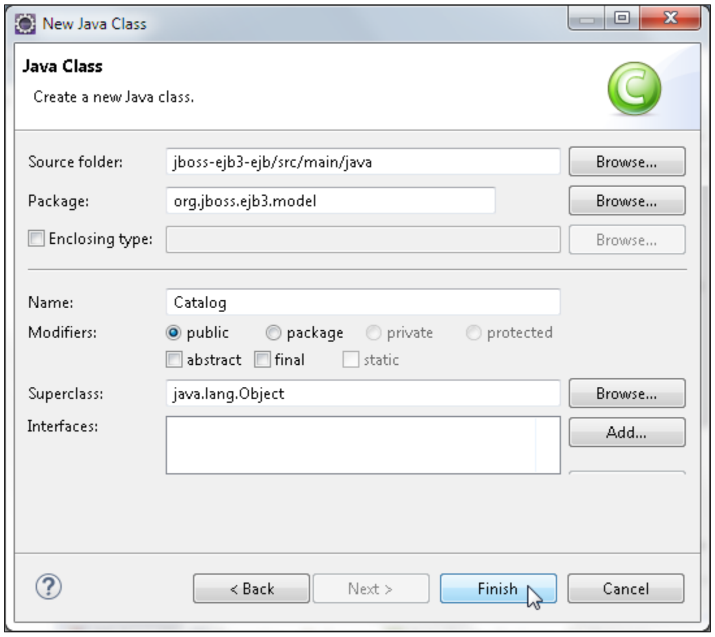
In the next section, we will create entities for the EJB 3.x application.

Creating entities

In EJB 3.x, an entity is a **POJO** (**Plain Old Java Object**) persistent domain objecta represents a database table row. As an entity is a Java class, create a Java class in the `jboss-ejb3-ejb` subproject of the jboss-ejb3 project. Select **File** | **New**. In the **New** window, select **Java** | **Class** and click on **Next**:



Select/specify `jboss-ejb3/jboss-ejb3-ejb/src/main/java` as the Java **Source folder**, `org.jboss.ejb3.model` as the **Package**, and `Catalog` as the class **Name**. Click on **Finish**:



New Java Class

Java Class

Create a new Java class.

Source folder: jboss-ejb3-ejb/src/main/java

Package: org.jboss.ejb3.model

Enclosing type:

Name: Catalog

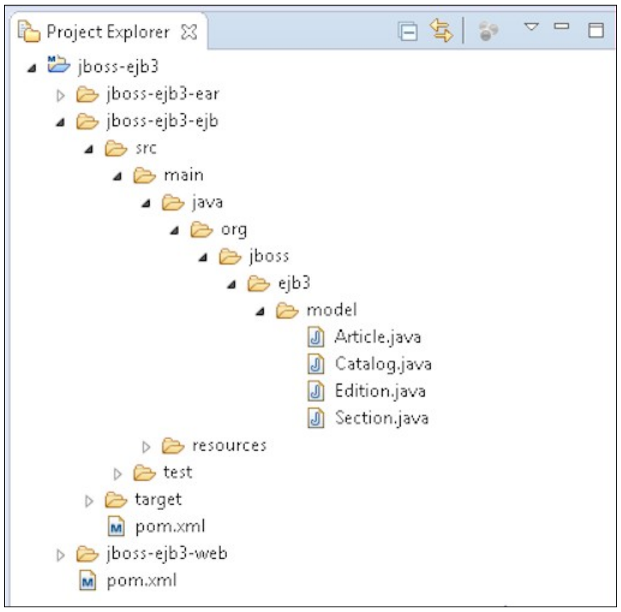
Modifiers: [✓ public] package private protected

abstract final static

Superclass: java.lang.Object

Interfaces:

Similarly, add Java classes for the `Edition.java`, `Section.java`, and `Article.java` entities, as shown in the following **Project Explorer**:

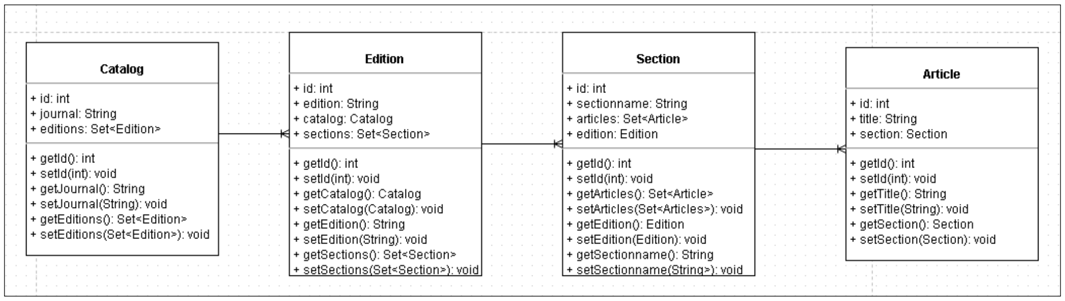


```
Project Explorer
jboss-ejb3
  jboss-ejb3-ear
  jboss-ejb3-ejb
    src
      main
        java
          org
            jboss
              ejb3
                model
                  Article.java
                  Catalog.java
                  Edition.java
                  Section.java
        resources
      test
    target
    pom.xml
  jboss-ejb3-web
  pom.xml
```

Next, we develop the EJB 3.x entities. A JPA persistence provider is required for the EJB entities, and we will use the Hibernate persistence provider. The Hibernate persistence provider has some peculiarities that need to be mentioned, as follows:

- If an entity has more than one non-lazy association of the following types,
- Hibernate fails to fetch the entity:
  - The `java.util.List`, `java.util.Collection` properties annotated with `@org.hibernate.annotations.CollectionOfElements`
  - The `@OneToMany` or `@ManyToMany` associations not annotated with `@org.hibernate.annotations.IndexColumn`
  - Associations marked as mappedBy must not define database mappings (such as @JoinTable or @JoinColumn)

We will develop the Catalog, Edition, Section, and Article class with one-to-many relationship between the Catalog and Edition class, the Edition and Section class, and the Section and Article class, as shown in the following UML class diagram:



Annotate the Catalog entity class with the @Entity annotation and the @Table annotation. If the @Table annotation is not used, then the entity name is used as the table name by default. In the @Table annotation, specify the table name as CATALOG and uniqueConstraints, using the @UniqueConstraint annotation for the `id` column. Specify the named queries as findCatalogAll, which selects all Catalog and findCatalogByJournal entities. This selects a Catalog entity by Journal, using the @NamedQueries and @NamedQuery annotations:

```
@Entity
@Table(name = "CATALOG", uniqueConstraints = @
UniqueConstraint(columnNames = "ID"))
@NamedQueries({
  @NamedQuery(name="findCatalogAll", query="SELECT c FROM Catalog c"),
  @NamedQuery(name="findCatalogByJournal",
    query="SELECT c FROM Catalog c WHERE c.journal = :journal")
})
public class Catalog implements Serializable {
}
```

Specify the `no-argument` constructor, which is required in an entity class. The Catalog entity class implements the Serializable interface to serialize a cache-enabled entity to a cache when persisted to a database. To associate a version number with a serializable class for a serialization runtime, specify a serialVersionUID variable. Declare `String` variables for id and journal bean properties and for a collection of Set<Edition> type, as the Catalog entity has a bi-directional one-to-many associationto Edition. The collection is chosen as Set for the reason mentioned earlier. Hibernate does not support more than one EAGER association of the java.util.List type. Add `get/set` methods for the bean properties. The @Id annotation specifies the identifier property. The @Column annotation specifies the column name associated with the property. The nullable element is set to false as the primary key cannot be `null`.

If we were using the Oracle database, we would have specified the primary key generator to be of the `sequence` type, using the `@SequenceGenerator` annotation. The generation strategy is specified with the `@GeneratedValue` annotation. For the Oracle database, the generation strategy would be `strategy=GenerationType.SEQUENCE`, but as MySQL database supports auto increment of primary key column values by generating a sequence, we have set the generation strategy to `GenerationType.AUTO`.

Specify the bi-directional one-to-many association to `Edition` using the `@OneToMany` annotation. The `mappedBy` element is specified on the non-owning side of the relationship, which is the `Catalog` entity. The `cascade` element is set to `ALL`. Cascading is used to cascade database table operations to associated tables. The `fetch` element is set to `EAGER`. With `EAGER` fetching the associated entity, collection is immediately fetched when an entity is retrieved:

```
    // bi-directional many-to-one association to Edition
    @OneToMany(mappedBy = "catalog", targetEntity=org.jboss.ejb3.model.
    Edition.class, cascade = { CascadeType.ALL }, fetch = FetchType.EAGER)
      public Set<Edition> getEditions() {
        return this.editions;
      }
    }
```

As mentioned earlier, associations marked with `mappedBy` must not specify `@JoinTable` or `@JoinColumn`. The get and set methods for the `Edition` collection are also specified. The `Catalog.java` entity class is available in the code download sundar github.

Next, develop the entity class for the `EDITION` database table: `Edition.java`. Specify the `@Entity`, `@Table`, `@Id`, `@Column`, and `@GeneratedValue` annotations, as discussed for the `Catalog` entity. Specify the `findEditionAll` and `findEditionByEdition` named queries to find Edition collections. Specify the bean properties and associated get/set methods for `id` and `edition`. Also, specify the one-to-many association to the `Section` entity using a collection of the `Set` type. The bi-directional many-to-one association to the `Catalog` relationship is specified using the `@ManyToOne` annotation, and with cascade of type `PERSIST`, `MERGE`, and `REFRESH`. The `Edition` entity is the owning side of the relationship. Using the `@JoinTable` annotation, a join table is included on the owning side to initiate cascade operations. The join columns are specified using the `@JoinColumn` annotation. The `Edition.java` entity class is available in the code download for the chapter.

Develop the entity class for the `SECTION` table: `Section.java`. Specify the `findSectionAll` and `findSectionBySectionName` named queries to find `Section` entities. Specify the `id` and `sectionname` bean properties. Specify the bi-directional many-to-one association to `Edition` using the `@ManyToOne` annotation and the bi-directional one-to-many association to `Article` using `@OneToMany`. The `@JoinTable` and `@JoinColumn` are specified only for the `@ManyToOne` association for which `Section` is the owning side. The `Section.java` entity class is available in the code Sundar github

Specify the entity class for the `ARTICLE` table: `Article.java`. The `Article` entity is mapped to the `ARTICLE` database table using the `@TABLE` annotation. Add the `findArticleAll` and `findArticleByTitle` named queries to find `Article` entities.Specify `id` and `sectionname` bean properties and the associated `get/set` methods. The `Article` entity is the owning side of the bi-directional many-to-one association to `Section`. Therefore, the `@JoinTable` and `@JoinColumn` are specified. The `Article.java` class is available in the code downloaded for the chapter.

Creating a JPA persistence configuration file

The `META-INF/persistence.xml` configuration file in the `ejb/src/main/resources` folder in the `jboss-ejb3-ejb` subproject was created when we created the Java EE project. The `persistence.xml` specifies a persistence provider to be used to map object/relational entities to the database. Specify that, the persistence unit is using the `persistence-unit` element. Set the `transaction-type` to `JTA` (the default value). Specify the persistence provider as the Hibernate persistence provider: `org.hibernate.ejb.HibernatePersistence`. Set the `jta-data-source` element value to the `java:jboss/datasources/MySQLDS` data source, which we created earlier. Specify the entity classes using the `class` element. The DDL generation strategy is set to `create-drop` using the `hibernate.hbm2ddl.auto` property,

which automatically validates or exports the DDL schema to the database, when the `SessionFactory` class is created. With the `create-drop` strategy, the required tables are created and dropped when the `SessionFactory` is closed. The `hibernate.show_sql` property is set to `false`. Setting it to `true` implies that all SQL statements be the output, which is an alternative method to debug. The `hibernate.dialect` property is set to `org.hibernate.dialect.MySQLDialect` for MySQL Database. Other Hibernate properties (`http://docs.jboss.org/hibernate/orm/3.3/reference/en/html/session-configuration.html`) can also be specified as required. The persistence.xml configuration file is listed in the following code:

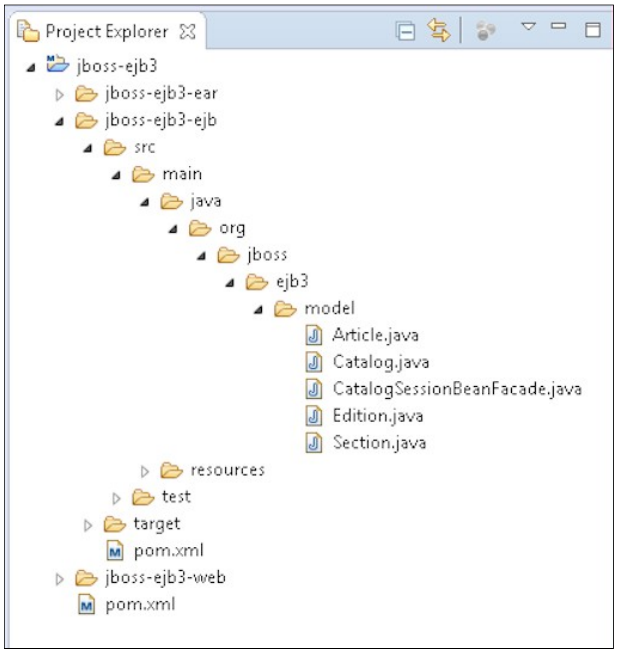
```
<?xml version="1.0" encoding="UTF-8"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="2.0"
xsi:schemaLocation="         http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd">
  <persistence-unit name="em" transaction-type="JTA">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <!-- If you are running in a production environment, add a managed
data source, the example data source is just for development and
testing! -->
    <jta-data-source>java:jboss/datasources/MySQLDS</jta-data-source>
    <class>org.jboss.ejb3.model.Article</class>
    <class>org.jboss.ejb3.model.Catalog</class>
    <class>org.jboss.ejb3.model.Edition</class>
    <class>org.jboss.ejb3.model.Section</class>
    <properties>
      <!-- Properties for Hibernate -->
      <property name="hibernate.hbm2ddl.auto" value="create-drop" />
      <property name="hibernate.show_sql" value="false" />
```

```
        <property name="hibernate.dialect" value="org.hibernate.dialect.
MySQLDialect" />
      </properties>
    </persistence-unit>
</persistence>
```

The JPA specification does not mandate a persistence provider to create tables with the `hibernate.hbm2ddl.auto` property set to `create-drop` or `create`. Hibernate persistence provider supports creating tables. In addition to the entity tables, some additional tables (such as the join tables and the sequence table) are created by the Hibernate persistence provider.

Creating a session bean facade

One of the best practices of developing entities for separation of concerns and maintainable code and as a result better performance is to wrap the entities in a session bean facade. With a Session Facade, fewer remote method calls are required, and an outer transaction context is created with which each get method invocation does not start a new transaction. Session Facade is one of the core Java EE design patterns (`http://www.oracle.com/technetwork/java/sessionfacade-141285.html`). Create a `CatalogSessionBeanFacade` session bean class in the `org.jboss.ejb3.model` package, as shown in the following screenshot. The Session Facade class can also be created in a different package (such as `org.jboss.ejb3.view`):



The session bean class is annotated with the `@Stateless` annotation:

```
@Stateless
public class CatalogSessionBeanFacade {}
```

In the bean session, we use an `EntityManager` to create, remove, find, and query persistence entity instances. Inject a `EntityManager` using the `@PersistenceContext` annotation. Specify the `unitName` as the `unitName` configured in `persistence.xml`. Next, specify the `getAllEditions`, `getAllSections`, `getAllArticles`, `getAllCatalogs` get methods to fetch the collection of entities. The `get` methods get all entities' collections with the named queries specified in the entities. The `createNamedQuery` method of `EntityManager` is used to create a `Query` object from a named query. Specify the `TransactionAttribute` annotation's `TransactionAttributeType` enumeration to `REQUIRES_NEW`, which has the

advantage that if a transaction is rolled back due to an error in a different transaction context from which the session bean is invoked, it does not affect the session bean. To demonstrate the use of the entities, create the test data with the `createTestData`

convenience method in the session bean. Alternatively, a unit test or an extension class can also be used. Create a `Catalog` entity and set the journal using the `setJournal` method. We do not set the id for the `Catalog` entity as we use the `GenerationType.AUTO` generation strategy for the `ID` column. Persist the entity using the `persist` method of the `EntityManager` object. However, the `persist` method does not persist the entity to the database. It only makes the entity instance managed and adds it to the persistence context. The `EntityManager.flush()` method is not required to be invoked to synchronize the entity with the database as `EntityManager` is configured with `FlushModeType` as `AUTO` (the other setting being `COMMIT`) and a flush will be done automatically when the
EntityManager.persist()
is invoked:

```
Catalog catalog1 = new Catalog();
catalog1.setJournal("Oracle Magazine");
em.persist(catalog1);
```

Similarly, create and persist an `Edition` entity object. Add the `Catalog` object:

`catalog1` using the `setCatalog` method of the `Edition` entity class:

```
Edition edition = new Edition();
edition.setEdition("January/February 2009");
edition.setCatalog(catalog1);
em.persist(edition);
```

Likewise add the `Section` and `Article` entity instances. Add another `Catalog` object, but without any associated `Edition`, `Section`, or `Article` entities:

```
Catalog catalog2 = new Catalog();
catalog2.setJournal("Linux Magazine");
em.persist(catalog2);
```

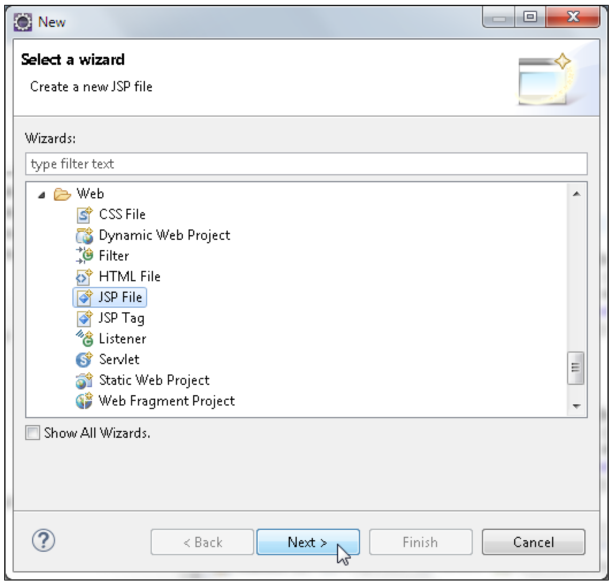
Next, we will delete data with the `deleteSomeData` method, wherein we first createa `Query` object using the named query `findCatalogByJournal`. Specify the journalto delete with the `setParameter` method of the Query object. Get the `List` result with the `getResultList` method of the `Query` object. Iterate the `List` result and remove the `Catalog` objects with the `remove` method of the `EntityManager` object. The `remove` method only removes the `Catalog` object from the persistence context:

```
public void deleteSomeData() {
  // remove a catalog
  Query q = em.createNamedQuery("findCatalogByJournal");
  //q.setParameter("journal", "Linux Magazine");
  q.setParameter("journal", "Oracle Magazine");
  List<Catalog> catalogs = q.getResultList();
  for (Catalog catalog : catalogs) {
    em.remove(catalog);
  }
}
```

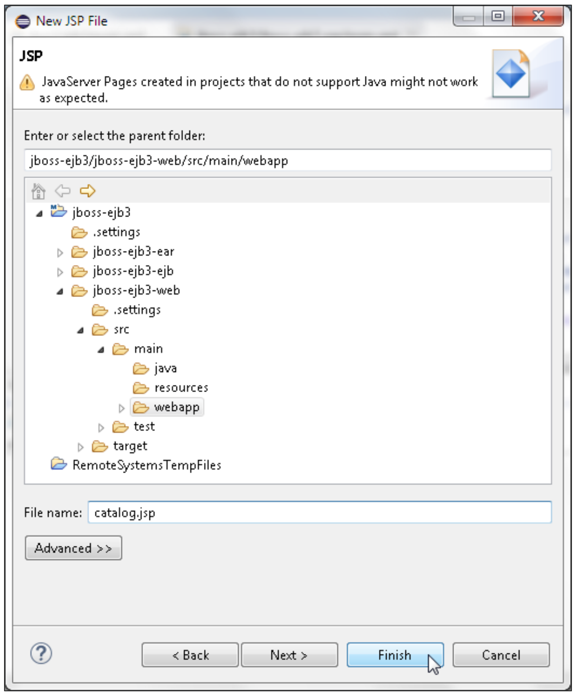
The `CatalogSessionBeanFacade` session bean class is available in the code downloaded for the chapter.

Creating a JSP client

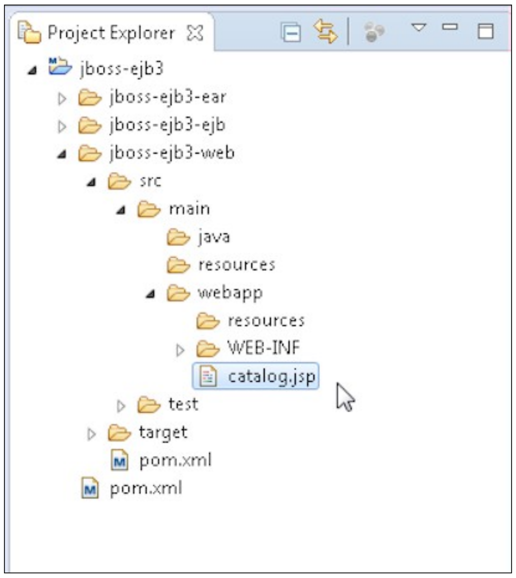
Next, we will create a JSP client to test the EJB entities. We will look up the session bean using a local JNDI name. Subsequently, we will invoke the testData method of the session bean to test database persistence using these entities. First create a JSP file. Select **File** | **New** | **Other**, and in the **New** wizard, select **Web** | **JSP File** and click on **Next**, as in the following screenshot:



In the **New JSP File** wizard, select the **jboss-ejb3/web/src/main/webapp** folder in the **jboss-ejb3-web** subproject. Specify **catalog.jsp** as as **File name** and click on **Next**. Then click on **Finish**:



The `catalog.jsp` file gets added to the **jboss-ejb3-web** subproject:



We need to retrieve the `CatalogSessionBeanFacade` component from the JSP client. WildFly 8 provides the local **JNDI** (**Java Naming and Directory Interface**) namespace: Java, and the following JNDI contexts:

JNDI Context	Description
`java:comp`	This is the namespace that is scoped to the current component, the EJB.
`java:module`	This namespace is scoped to the current module.
`java:app`	This namespace is scoped to the current application.
`java:global`	This namespace is scoped to the application server.

When the `jboss-ejb3` application is deployed, the JNDI bindings in the namespaces (discussed in the preceding table) are created as indicated by the server message:

```
JNDI bindings for session bean named CatalogSessionBeanFacade in
deployment unit subdeployment "jboss-ejb3-ejb.jar" of deployment
"jboss-ejb3-ear.ear" are as follows:
  java:global/jboss-ejb3-ear/jboss-ejb3-ejb/
CatalogSessionBeanFacade!org.jboss.ejb3.model.CatalogSessionBeanFacade
  java:app/jboss-ejb3-ejb/CatalogSessionBeanFacade!org.jboss.ejb3.
model.CatalogSessionBeanFacade
  java:module/CatalogSessionBeanFacade!org.jboss.ejb3.model.
    CatalogSession
```

```
BeanFacade
  java:global/jboss-ejb3-ear/jboss-ejb3-
  ejb/CatalogSessionBeanFacade java:app/jboss-ejb3-
  ejb/CatalogSessionBeanFacade java:module/CatalogSessionBeanFacade
```

Next we will retrieve the session bean façade: `CatalogSessionBeanFacade` using the standard Java SE JNDI API, which does not require any additional configuration, using the local JNDI lookup in the `java:app` namespace. For the local JNDI lookup, we need to create an `InitialContext` object:

```
Context context = new InitialContext();
```

Using the local JNDI name lookup in the `java:app` namespace ,retrieve the

`CatalogSessionBeanFacade` component:

```
CatalogSessionBeanFacade bean = (CatalogSessionBeanFacade) context
.lookup("java:app/jboss-ejb3-ejb/CatalogSessionBeanFacade!org.jboss.
ejb3.model.CatalogSessionBeanFacade");
```

Invoke the `createTestData` method and retrieve the `List Catalog` entities. Iterate over the `Catalog` entities and output the catalog ID as the journal name:

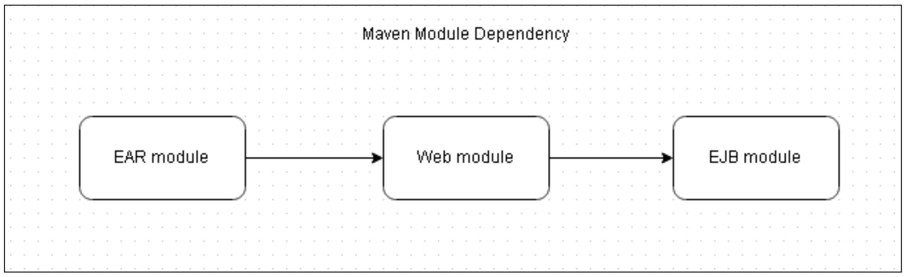
```
bean.createTestData();
List<Catalog> catalogs = beanRemote.getAllCatalogs();
out.println("<br/>" + "List of Catalogs" + "<br/>");
for (Catalog catalog : catalogs) {
  out.println("Catalog Id:");
  out.println("<br/>" + catalog.getId() + "<br/>");
  out.println("Catalog Journal:");
  out.println(catalog.getJournal() + "<br/>");
}
```

Similarly, obtain the `Entity`, `Section`, and `Article` entities and output the entity property values. The `catalog.jsp` file is available in the code downloaded for the chapter.

Configuring the jboss-ejb3-ejb subproject

We will generate an EAR file using the Maven project: `jboss-ejb3`, which includes the `jboss-ejb3-ejb`, `jboss-ejb-web` and `jboss-ejb3-ear` subproject/artifacts. We will use the Maven build tool to compile, package, and deploy the EAR application. The `jboss-ejb3-ear` module to be deployed to WildFly has two submodules: `jboss-ejb3-web` and `jboss-ejb3-ejb`.

The `jboss-ejb3-ear`, `jboss-ejb3-web` and `jboss-ejb3-ejb` modules may be referred to as `ear`, `web`, and `ejb` modules respectively. The `ear` module has dependency on the `web` module, and the `web` module has dependency on the `ejb` module, as shown in the following diagram:



The `ejb`, `web`, and `ear` modules can be built and installed individually using subproject-specific `pom.xml`, or these can be built together using the `pom.xml` file in the `jboss-ejb3` project. If built individually, the `ejb` module has to be built and installed before the `web` module, as the `web` module has a dependency on the `ejb` module. The `ear` module is to be built after the `web` and `ejb` modules have been built and installed. We will build and install the top level project using the `pom.xml` file in the `jboss-ejb3` project, which has dependency specified on the `jboss-ejb3-web` and `jboss-ejb3-ejb` artifacts. The `pom.xml` file for the `jboss-ejb3-ejb` subproject specifies packaging as `ejb`. The WildFly 8.x provides most of the APIs required for an EJB 3.x application. The provided APIs are specified with `scope` set to `provided` in `pom.xml`. Dependencies for the EJB 3.1 API and the JPA 2.0 API are pre-specified. Add the following dependency for the **Hibernate Annotations API**:

```
<dependency>
  <groupId>org.jboss.spec.javax.ejb</groupId>
  <artifactId>jboss-ejb-api_3.1_spec</artifactId>
  <version>1.0.0.Final</version>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>org.hibernate.javax.persistence</groupId>
  <artifactId>hibernate-jpa-2.0-api</artifactId>
  <version>1.0.0.Final</version>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>org.hibernate</groupId>
  <artifactId>hibernate-annotations</artifactId>
  <version>3.5.6-Final</version>
</dependency>
```

The Hibernate Validator API dependency is also preconfigured in `pom.xml`. The build is preconfigured with the Maven EJB plugin, which is required to package the subproject into an EJB module. The EJB version in the Maven EJB plugin is 3.1:

```
<build>
  <finalName>${project.artifactId}</finalName>
  <plugins>
    <plugin>
      <artifactId>maven-ejb-plugin</artifactId>
      <version>${version.ejb.plugin}</version>
      <configuration>
        <!-- Tell Maven we are using EJB 3.1 -->
        <ejbVersion>3.1</ejbVersion>
      </configuration>
    </plugin>
  </plugins>
</build>
```

The Maven `POM.xml` file for the EJB subproject is available in the code downloaded for the chapter.

Configuring the jboss-ejb3-web subproject

Most of the required configuration for the `jboss-ejb3-web` subproject is pre-specified. The packaging for the `jboss-ejb3-web` artifacts is set to `war`:

```
<artifactId>jboss-ejb3-web</artifactId>
<packaging>war</packaging>
<name>jboss-ejb3 Web module</name>
```

The `pom.xml` file for the subproject pre-specifies most of the required dependencies. It also specifies dependency on the `jboss-ejb3-ejb` artifact:

```
<dependency>
  <groupId>org.jboss.ejb3</groupId>
  <artifactId>jboss-ejb3-ejb</artifactId>
  <type>ejb</type>
  <version>1.0.0</version>
  <scope>provided</scope>
</dependency>
```

The EJB 3.1 API, the JPA 2.0 API, the JSF 2.1 API, and the JAX-RS 1.1 API are provided by the WildFly 8.x server, as indicated by the `provided` scope in the `dependency` declarations. Add the dependency on the `hibernate-annotations` artifact. The build is preconfigured with the Maven `WAR` plugin, which is required to package the subproject into an `WAR` file:

```
<?xml version="1.0" encoding="UTF-8"?>
<build>
  <finalName>${project.artifactId}</finalName>
  <plugins>
    <plugin>
      <artifactId>maven-war-plugin</artifactId>
      <version>${version.war.plugin}</version>
      <configuration>
        <!-- Java EE 6 doesn't require web.xml, Maven needs to catch
up! -->
        <failOnMissingWebXml>false</failOnMissingWebXml>
      </configuration>
    </plugin>
  </plugins>
</build>
```

The `pom.xml` file for the `jboss-ejb3-web` subproject is available in the codedownloaded for the chapter.

Configuring the jboss-ejb3-ear subproject

In `pom.xml` for the `jboss-ejb3-ear` subproject, the packaging for the

`jboss-ejb3-ear` artifact is specified as `ear`:

```
<artifactId>jboss-ejb3-ear</artifactId>
<packaging>ear</packaging>
```

The `pom.xml` file specifies dependency on the ejb and web modules:

```
<dependencies>
  <!-- Depend on the ejb module and war so that we can package them
-->
  <dependency>
  <groupId>org.jboss.ejb3</groupId>
```

```
      <artifactId>jboss-ejb3-web</artifactId>
      <version>1.0.0</version>
      <type>war</type>
    </dependency>
      <dependency>
      <groupId>org.jboss.ejb3</groupId>
      <artifactId>jboss-ejb3-web</artifactId>
      <version>1.0.0</version>
      <type>war</type>
    </dependency>
    </dependencies>
```

The `build` tag in the `pom.xml` file specifies the configuration for the `maven-ear-plugin` plugin with output directory as the `deployments` directory in the WildFly 8.x standalone server. The `EAR` file generated from the Maven project is deployed

to the directory specified in the `<outputDirectory/>` element. Specify the `<outputDirectory/>` element as the `C:\wildfly-8.1.0.Final\standalone\deployments` directory. The `outputDirectory` might need to be modified based on the installation directory of WildFly 8.1. The `EAR`, `WAR`, and `JAR` modules in thedeployments directory get deployed to the WildFly automatically, if the server
is running:

```
    <plugin>
      <groupId>org.apache.maven.plugins</groupId>
      <artifactId>maven-ear-plugin</artifactId>
      <version>2.8</version>
      <configuration>
        <!-- Tell Maven we are using Java EE 6 -->
        <version>6</version>
        <!-- Use Java EE ear libraries as needed. Java EE ear libraries
    are in easy way to package any libraries needed in the ear, and
    automatically have any modules (EJB-JARs and WARs) use them -->
        <defaultLibBundleDir>lib</defaultLibBundleDir>
        <fileNameMapping>no-version</fileNameMapping>
        <outputDirectory>C:\wildfly-8.1.0.Final\standalone\deployments</
    outputDirectory>
      </configuration>
    </plugin>
```

Deploying the EAR module

In this section, we will build and deploy the application EAR module to the WildFly 8.x server. The `pom.xml` for the `jboss-ejb3` Maven project specifies three modules: `jboss-ejb3-ejb`, `jboss-ejb3-web`, and `jboss-ejb3-ear`:

```
<modules>
  <module>jboss-ejb3-ejb</module>
  <module>jboss-ejb3-web</module>
  <module>jboss-ejb3-ear</module>
</modules>
```

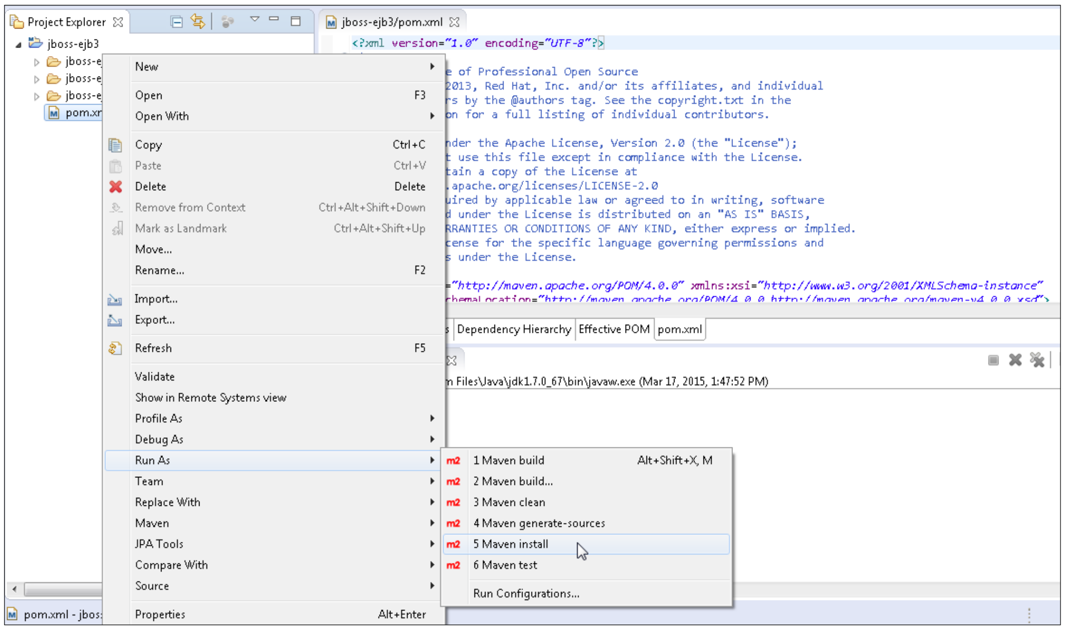
Specify the JBoss AS version as `8.1.0.Final`:

```
<version.jboss.as>8.1.0.Final</version.jboss.as>
```

The `pom.xml` for the `jboss-ejb3` project specifies dependency on the `jboss-ejb3-web` and `jboss-ejb3-ejb` artifacts:

```
<dependency>
  <groupId>org.jboss.ejb3</groupId>
  <artifactId>jboss-ejb3-ejb</artifactId>
  <version>${project.version}</version>
  <type>ejb</type>
</dependency>
<dependency>
  <groupId>org.jboss.ejb3</groupId>
  <artifactId>jboss-ejb3-web</artifactId>
  <version>${project.version}</version>
  <type>war</type>
  <scope>compile</scope>
</dependency>
```

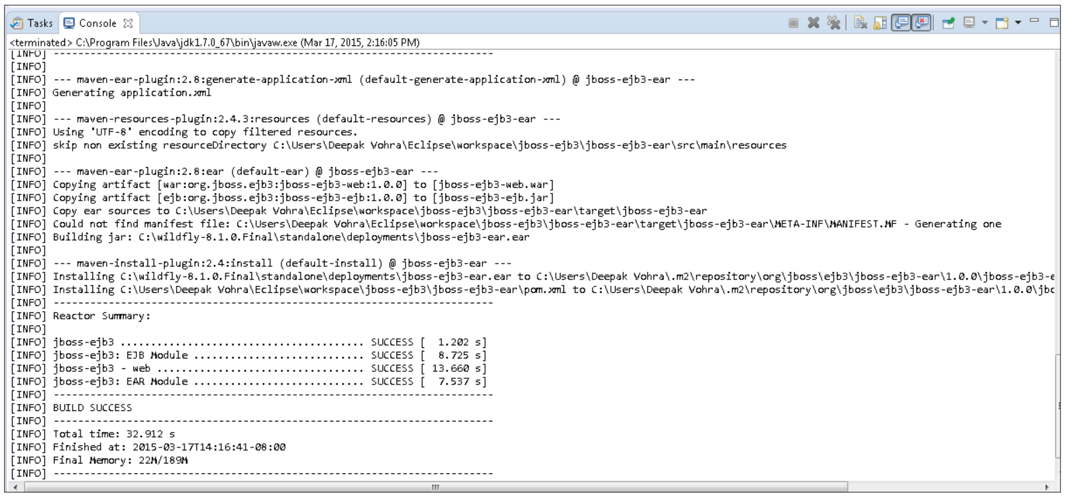
Next, we will build and deploy the EAR module to WildFly 8.x while the server is running. Right-click on `pom.xml` for the `jboss-ejb3` Maven project and select **Run As** | **Maven install**, as shown in the following screenshot:



```
<?xml version="1.0" encoding="UTF-8"?>
e of Professional Open Source
2013, Red Hat, Inc. and/or its affiliates, and individual
rs by the @authors tag. See the copyright.txt in the
on for a full listing of individual contributors.

nder the Apache License, Version 2.0 (the "License");
t use this file except in compliance with the License.
tain a copy of the License at
.apache.org/licenses/LICENSE-2.0
uired by applicable law or agreed to in writing, software
d under the License is distributed on an "AS IS" BASIS,
RRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
cense for the specific language governing permissions and
s under the License.

="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
```

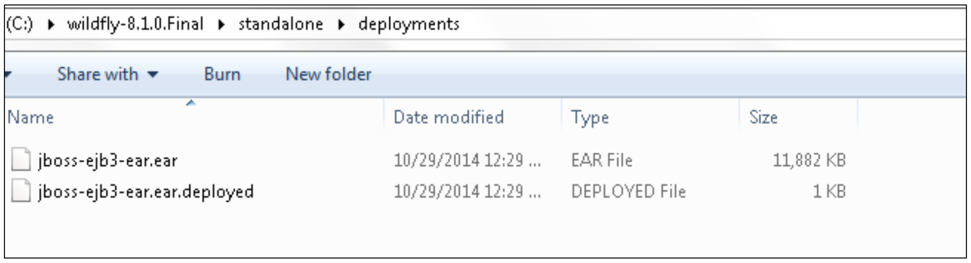
```
n Files\Java\jdk1.7.0_67\bin\javaw.exe (Mar 17, 2015, 1:47:52 PM)
```

As the output from the `pom.xml` indicates all the three modules: `ejb`, `web`, and `ear` get built. The `ear` module gets copied to the `deployments` directory in WildFly 8.x:



```
<terminated> C:\Program Files\Java\jdk1.7.0_67\bin\javaw.exe (Mar 17, 2015, 2:16:05 PM)
[INFO] ------------------------------------------------------------------------
[INFO]
[INFO] --- maven-ear-plugin:2.8:generate-application-xml (default-generate-application-xml) @ jboss-ejb3-ear ---
[INFO] Generating application.xml
[INFO]
[INFO] --- maven-resources-plugin:2.4.3:resources (default-resources) @ jboss-ejb3-ear ---
[INFO] Using 'UTF-8' encoding to copy filtered resources.
[INFO] skip non existing resourceDirectory C:\Users\Deepak Vohra\Eclipse\workspace\jboss-ejb3\jboss-ejb3-ear\src\main\resources
[INFO]
[INFO] --- maven-ear-plugin:2.8:ear (default-ear) @ jboss-ejb3-ear ---
[INFO] Copying artifact [war:org.jboss.ejb3:jboss-ejb3-web:1.0.0] to [jboss-ejb3-web.war]
[INFO] Copying artifact [ejb:org.jboss.ejb3:jboss-ejb3-ejb:1.0.0] to [jboss-ejb3-ejb.jar]
[INFO] Copy ear sources to C:\Users\Deepak Vohra\Eclipse\workspace\jboss-ejb3\jboss-ejb3-ear\target\jboss-ejb3-ear
[INFO] Could not find manifest file: C:\Users\Deepak Vohra\Eclipse\workspace\jboss-ejb3\jboss-ejb3-ear\target\jboss-ejb3-ear\META-INF\MANIFEST.MF - Generating one
[INFO] Building jar: C:\wildfly-8.1.0.Final\standalone\deployments\jboss-ejb3-ear.ear
[INFO]
[INFO] --- maven-install-plugin:2.4:install (default-install) @ jboss-ejb3-ear ---
[INFO] Installing C:\wildfly-8.1.0.Final\standalone\deployments\jboss-ejb3-ear.ear to C:\Users\Deepak Vohra\.m2\repository\org\jboss\ejb3\jboss-ejb3-ear\1.0.0\jboss-ejb3-e
[INFO] Installing C:\Users\Deepak Vohra\Eclipse\workspace\jboss-ejb3\jboss-ejb3-ear\pom.xml to C:\Users\Deepak Vohra\.m2\repository\org\jboss\ejb3\jboss-ejb3-ear\1.0.0\jbc
[INFO] ------------------------------------------------------------------------
[INFO] Reactor Summary:
[INFO]
[INFO] jboss-ejb3 ........................................ SUCCESS [  1.202 s]
[INFO] jboss-ejb3: EJB Module ............................ SUCCESS [  8.725 s]
[INFO] jboss-ejb3 - web .................................. SUCCESS [ 13.660 s]
[INFO] jboss-ejb3: EAR Module ............................ SUCCESS [  7.537 s]
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time: 32.912 s
[INFO] Finished at: 2015-03-17T14:16:41-08:00
[INFO] Final Memory: 22M/189M
[INFO] ------------------------------------------------------------------------
```

Start the WildFly 8.x server if not already started. The `jboss-ejb3.ear` file gets deployed to the WildFly 8.x server and the `jboss-ejb3-web` context gets registered. The `jboss-ejb3.ear.deployed` file gets generated in the `deployments` directory, as shown in the following screenshot:

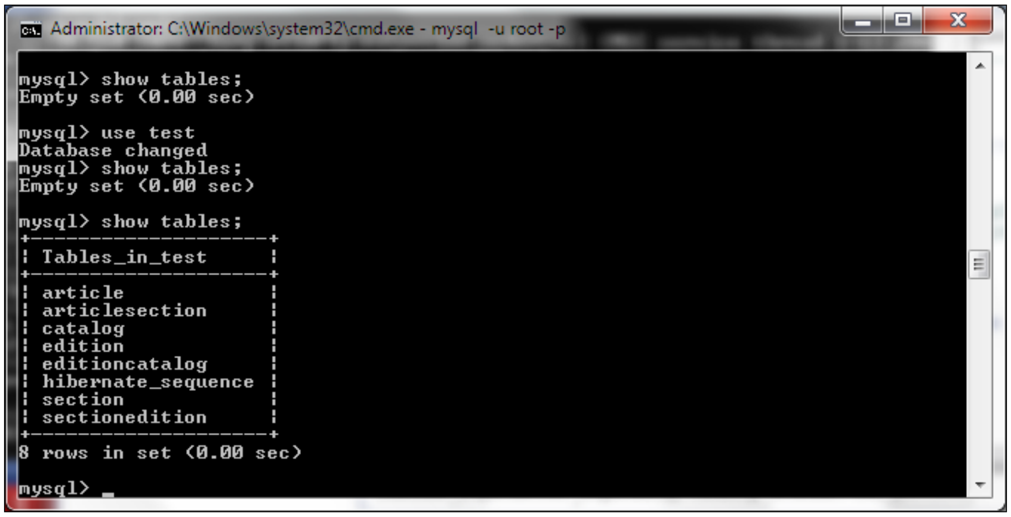


Name	Date modified	Type	Size
jboss-ejb3-ear.ear	10/29/2014 12:29 ...	EAR File	11,882 KB
jboss-ejb3-ear.ear.deployed	10/29/2014 12:29 ...	DEPLOYED File	1 KB

The `EntityManager em` persistence unit gets registered and the JNDI bindings for the `CatalogSessionBeanFacade` session bean gets generated:

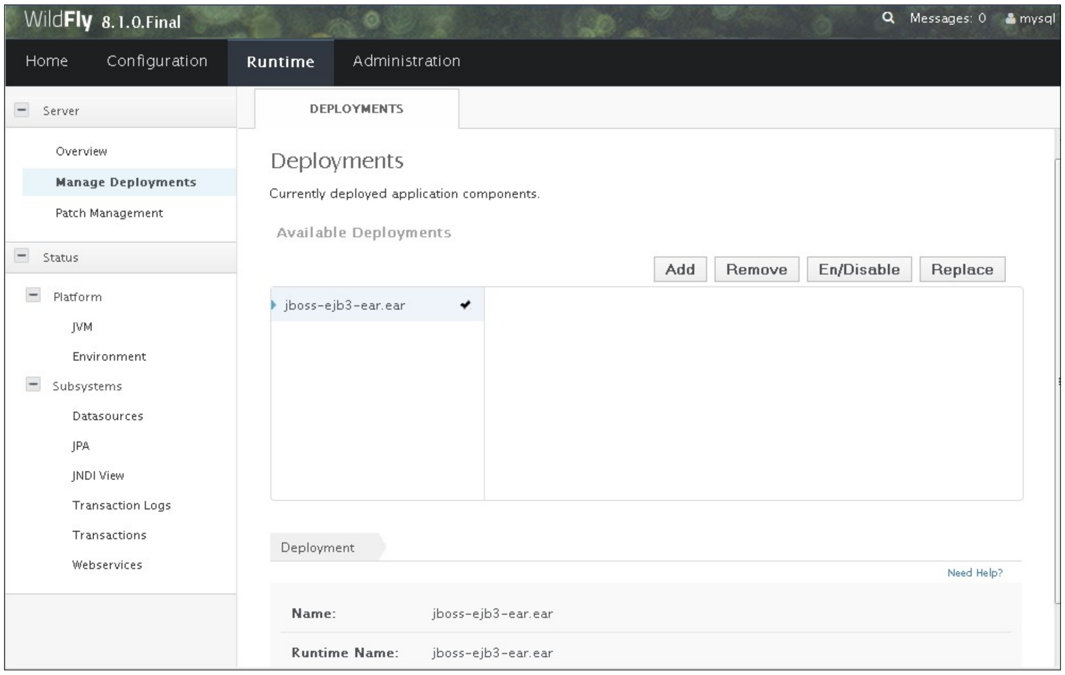
```
Starting Persistence Unit (phase 1 of 2) Service 'jboss-ejb3-ear.ear/
jboss-e
jb3-ejb.jar#em'
12:30:32,047 INFO  [org.hibernate.jpa.internal.util.LogHelper]
(ServerService Th
read Pool -- 50) HHH000204: Processing PersistenceUnitInfo [
  name: em
...]
```

The MySQL database tables for the entities get created, as shown in the following screenshot:


Administrator: C:\Windows\system32\cmd.exe - mysql -u root -p

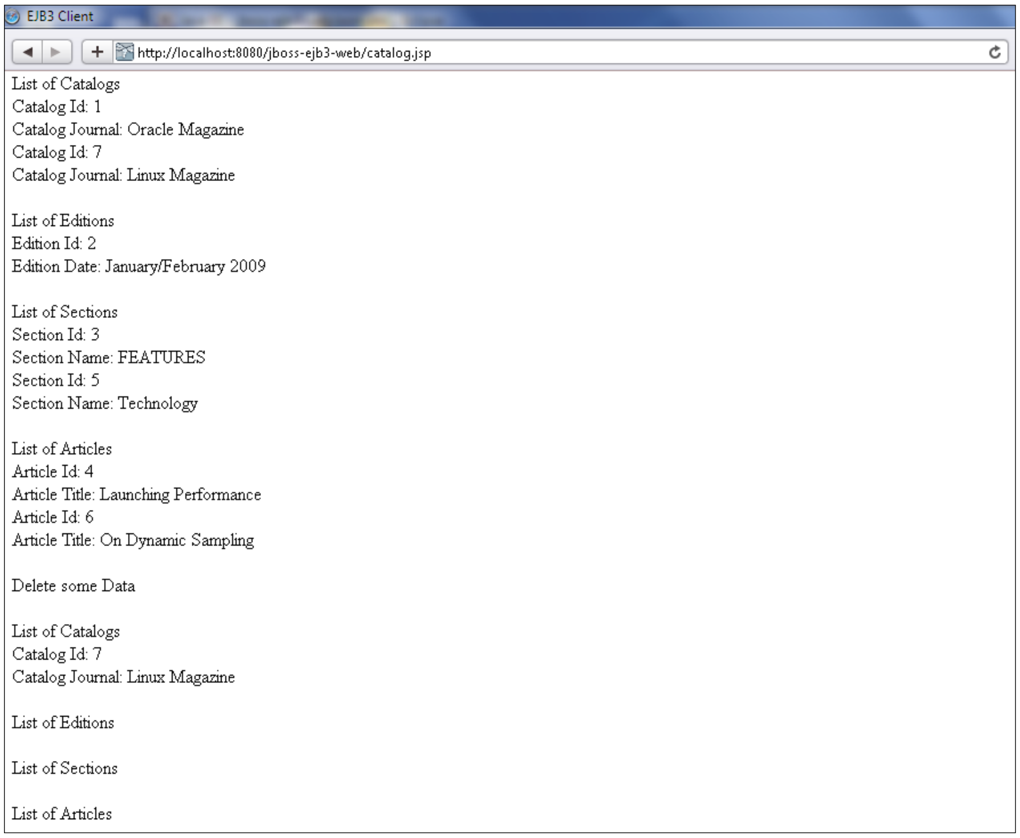
```
mysql> show tables;
Empty set (0.00 sec)

mysql> use test
Database changed
mysql> show tables;
Empty set (0.00 sec)

mysql> show tables;
+--------------------+
| Tables_in_test     |
+--------------------+
| article            |
| articlesection     |
| catalog            |
| edition            |
| editioncatalog     |
| hibernate_sequence |
| section            |
| sectionedition     |
+--------------------+
8 rows in set (0.00 sec)

mysql> _
```

To log in to the WildFly 8 administration console, open `http://localhost:8080` in any web browser. Click on the **Administration Console** link. Specify **User Name** and **Password** and click on **Log In**. Select the **Runtime** tab. The `jboss-ejb3.ear` application is listed as deployed in the **Deployments** | **Manage Deployments** section:



Running the JSP client

Next, open `http://localhost:8080/jboss-ejb3-web/catalog.jsp` and run the JSP client. The **List of Catalogs** gets displayed. The `deleteSomeData` method deletes `Catalog` for `Oracle Magazine`. As the `Linux Magazine` catalog does not have any data, the empty list gets displayed, as shown in the following screenshot:



```
List of Catalogs
Catalog Id: 1
Catalog Journal: Oracle Magazine
Catalog Id: 7
Catalog Journal: Linux Magazine

List of Editions
Edition Id: 2
Edition Date: January/February 2009

List of Sections
Section Id: 3
Section Name: FEATURES
Section Id: 5
Section Name: Technology

List of Articles
Article Id: 4
Article Title: Launching Performance
Article Id: 6
Article Title: On Dynamic Sampling

Delete some Data

List of Catalogs
Catalog Id: 7
Catalog Journal: Linux Magazine

List of Editions

List of Sections

List of Articles
```

Configuring a Java EE 7 Maven project

The default JBoss Java EE EAR project created is a Java EE 6 project. If a Java EE 7 project is required to avail of the EJB 3.2, Servlet 3.1, JSF 2.2, and Hibernate JPA

2.1 APIs, the `pom.xml` for the `ejb` module and the `web` module subprojects should 2.2 include the **BOM** (**Bill of Materials**) for Java EE 7 and the Nexus repository:

```
<repositories>
  <repository>
    <id>JBoss Repository</id>
```

```
      <url>https://repository.jboss.org/nexus/content/groups/public/
</url>
  </repository>
</repositories>
<dependencyManagement>
  <dependencies>
      <dependency>
        <groupId>org.jboss.spec</groupId>
        <artifactId>jboss-javaee-7.0</artifactId>
        <version>1.0.0.Final</version>
        <type>pom</type>
        <scope>import</scope>
      </dependency>
  </dependencies>
</dependencyManagement>
```

In addition the `pom.xml` for the `ejb` module and `web` module subprojects should specify the dependencies for the EJB 3.2, JSF 2.2, Servlet 3.1, and Hibernate JPA 2.1 specifications, as required, instead of the dependencies for the EJB 3.1, JSF 2.1, Servlet 3.0, and Hibernate JPA 2.0:

```
<dependency>
  <groupId>org.jboss.spec.javax.ejb</groupId>
  <artifactId>jboss-ejb-api_3.2_spec</artifactId>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>org.hibernate.javax.persistence</groupId>
  <artifactId>hibernate-jpa-2.1-api</artifactId>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>org.jboss.spec.javax.servlet</groupId>
  <artifactId>jboss-servlet-api_3.1_spec</artifactId>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>org.jboss.spec.javax.faces</groupId>
  <artifactId>jboss-jsf-api_2.2_spec</artifactId>
  <scope>provided</scope>
</dependency>
```

Summary

In this chapter, we used the JBoss Tools plugin 4.2 in Eclipse Luna to generate a Java EE project for an EJB 3.x application in Eclipse IDE for Java EE Developers. We created entities to create a `Catalog` and used the Hibernate persistence provider to map the entities to the MySQL 5.6 database. Subsequently, we created a session bean façade for the entities. In the session bean, we created a catalog using the `EntityManager` API. We also created a JSP client to invoke the session bean facade using the local JNDI lookup and subsequently invoke the session bean methods to display database data. We used Maven to build the `EJB`, `Web`, and `EAR` modules and deploy the `EAR` module to WildFly 8.1. We ran the JSP client in a browser to fetch and display the data from the MySQL database. In the next chapter, we will discuss another database persistence technology: **Hibernate**.

2

Developing Object/Relational Mapping with Hibernate 4

Hibernate is an object/relational mapping Java framework with which POJO domain objects can be mapped to a relational database. Though Hibernate has evolved beyond just being a object/relational framework, we will discuss only its object/relational mapping aspect. Hibernate's advantage over traditional **Java Database Connectivity** (**JDBC**) is that it provides the mapping of Java objects to relational database tables and the mapping of Java data types to SQL data types without a developer to provide the mapping, which implies having to make fewer API calls and the elimination of SQL statements. Hibernate provides loose coupling with

the database with vendor-specific mapping using dialect configuration. Hibernate implements features such as caching, query tuning, and connection pooling, which have to be implemented by a developer in JDBC.

- Creating a Java EE web project
- Creating a Hibernate XML Mapping file
- Creating a properties file
- Creating a Hibernate configuration file
- Creating JSPs for CRUD
- Creating the JavaBean class
- Exporting schema
- Creating table data

- Retrieving table data
- Updating a table row

- Deleting a table row
- Installing the Maven project
- Running schema export
- Creating table rows
- Retrieving table data
- Updating table
- Deleting the table row

Setting up the environment

We need to install the following software (the same as in *Module1, Getting Started with EJB 3.x*):

- **WildFly 8.1.0.Final**: Download `wildfly-8.1.0.Final.zip` from `http://wildfly.org/downloads/`.
- **MySQL 5.6 Database-Community Edition**: Download this edition from
- http://dev.mysql.com/downloads/mysql/. When installing MySQL,
- also install **Connector/J**.
- **Eclipse IDE for Java EE Developers**: Download Eclipse Luna from `https://www.eclipse.org/downloads/packages/release/Luna/SR1`.
- **JBoss Tools (Luna) 4.2.0.Final (or the latest version)**: Install this as a pluginto
- Eclipse from the Eclipse Marketplace (`http://tools.jboss.org/`
- `downloads/installation.html`).
-
- **Apache Maven**: Download version 3.05 or higher from `http://maven.`
- `apache.org/download.cgi`.
-
- **Java 7**: Download Java 7 from `http://www.oracle.com/technetwork/`
- `java/javase/downloads/index.html?ssSourceSiteId=ocomcn`.

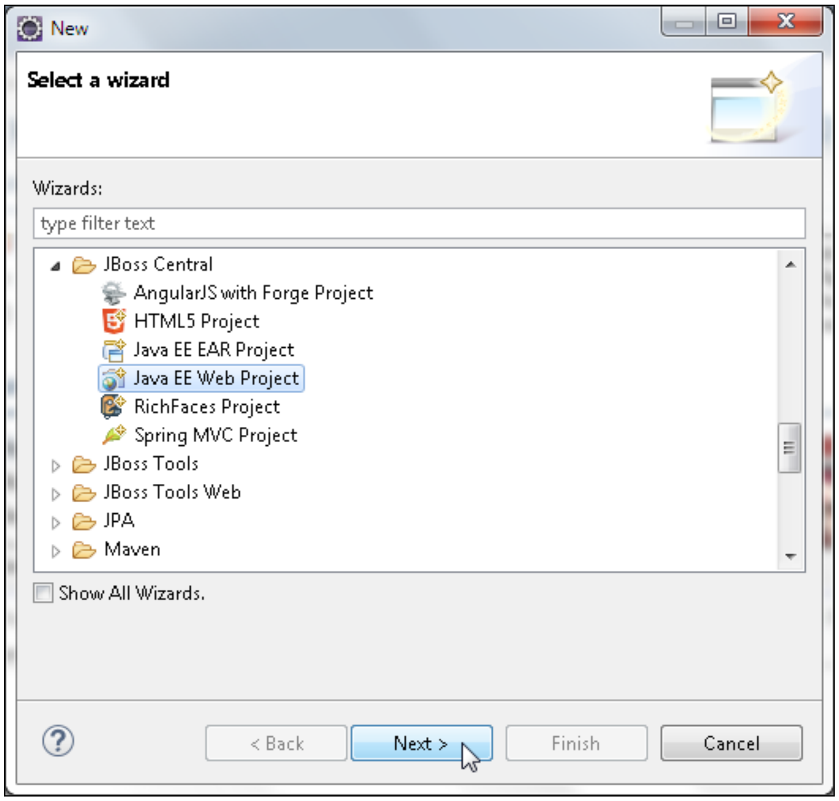
Set the same environment variables as in *Module1, Getting Started with EJB 3.x*: `JAVA_HOME`, `JBOSS_HOME`, `MAVEN_HOME`, and `MYSQL_HOME`. Add `%JAVA_HOME%/bin`, `%MAVEN_HOME%/bin`, `%JBOSS_HOME%/bin`, and `%MYSQL_HOME%/bin` to the `PATH` environment variable.

Create a WildFly 8.1.0 runtime as discussed in *Module1, Getting Started with EJB 3.x*.

Creating a Java EE web project

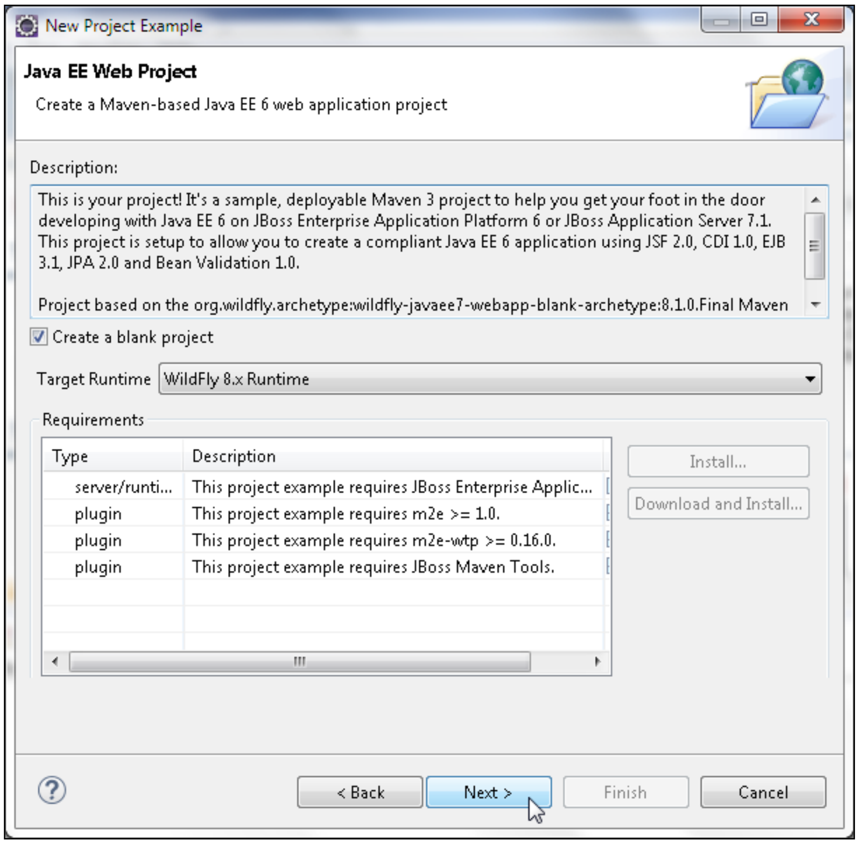
In this section, we will create **Java EE Web Project** in Eclipse IDE. Perform the following steps to accomplish this task:

1. Select **File** | **New** | **Other**. In the **New** window, select **JBoss Central** | **Java EE Web Project** and click on **Next**, as shown in the following screenshot:



The **Java EE Web Project** wizard gets started. A test is run for the requirements, which includes a JBoss server runtime, the JBoss Tools runtime, and the **m2e** and **m2eclipes-wtp** plugins.

2. Select the **Create a blank project** checkbox and **Target Runtime WildFly 8.x Runtime** and click on **Next**, as shown in the following screenshot. Even though Java EE Web Project indicates the Java EE version as Java EE 6, a Java EE 7 web project is actually created.



Java EE Web Project

Create a Maven-based Java EE 6 web application project

Description:

This is your project! It's a sample, deployable Maven 3 project to help you get your foot in the door developing with Java EE 6 on JBoss Enterprise Application Platform 6 or JBoss Application Server 7.1. This project is setup to allow you to create a compliant Java EE 6 application using JSF 2.0, CDI 1.0, EJB 3.1, JPA 2.0 and Bean Validation 1.0.

Project based on the org.wildfly.archetype:wildfly-javaee7-webapp-blank-archetype:8.1.0.Final Maven

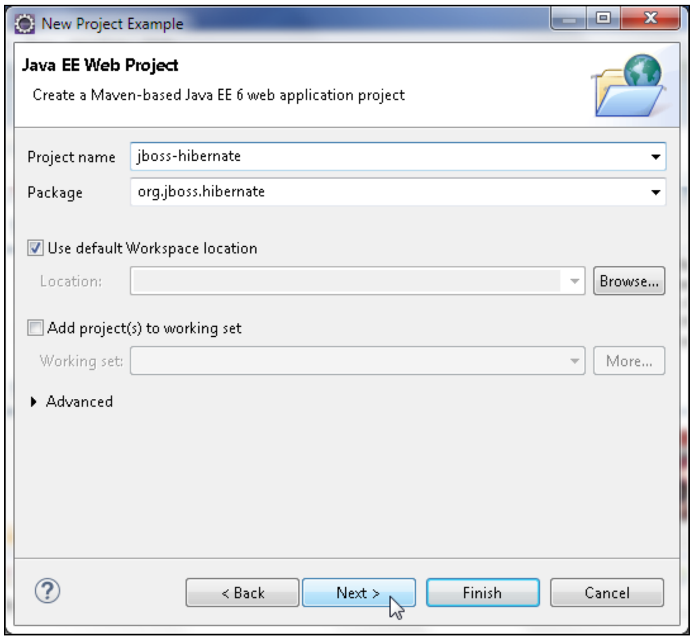
[✓] Create a blank project

Target Runtime: WildFly 8.x Runtime

Requirements

Type	Description
server/runti...	This project example requires JBoss Enterprise Applic...
plugin	This project example requires m2e >= 1.0.
plugin	This project example requires m2e-wtp >= 0.16.0.
plugin	This project example requires JBoss Maven Tools.

3. Specify **Project Name** (`jboss-hibernate`) and **Package** (`org.jboss.hibernate`), and click on **Next**, as shown in the following screenshot:


New Project Example

Java EE Web Project

Create a Maven-based Java EE 6 web application project

Project name: jboss-hibernate

Package: org.jboss.hibernate

[✓] Use default Workspace location

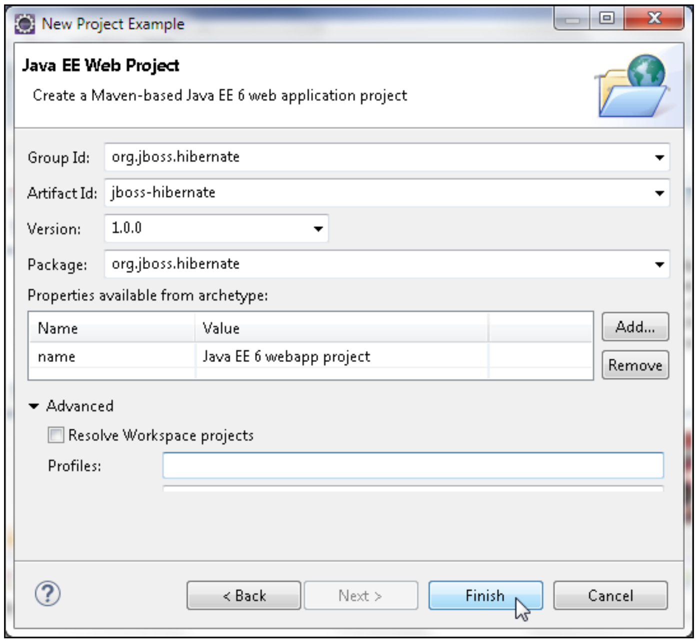
Location:

[ ] Add project(s) to working set

Working set:

Advanced

4. Specify **Group Id** (`org.jboss.hibernate`), **Artifact Id** (`jboss-hibernate`), **Version** (`1.0.0`), and **Package** (`org.jboss.hibernate`), as shown in the following screenshot. Click on the **Finish** button.


New Project Example

Java EE Web Project

Create a Maven-based Java EE 6 web application project

Group Id: org.jboss.hibernate

Artifact Id: jboss-hibernate

Version: 1.0.0

Package: org.jboss.hibernate

Properties available from archetype:

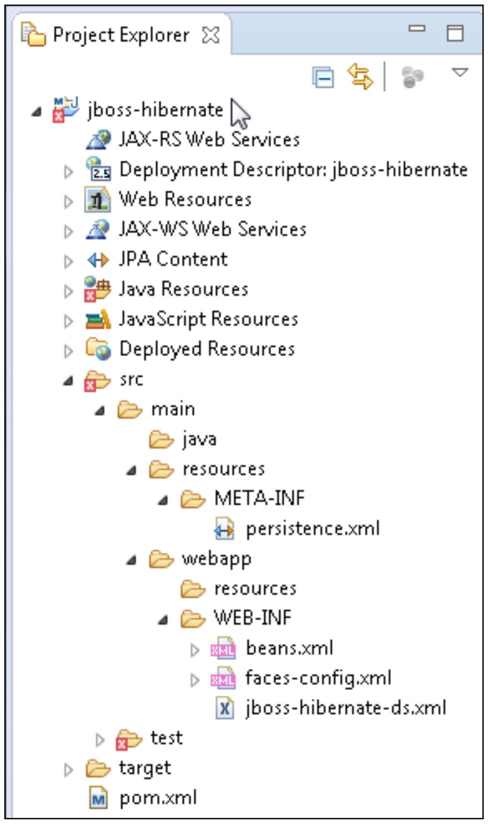
Name	Value
name	Java EE 6 webapp project

Advanced

[ ] Resolve Workspace projects

Profiles:

5. The `jboss-hibernate` project gets created in Eclipse and gets added to **Project Explorer**, as shown in the following screenshot:

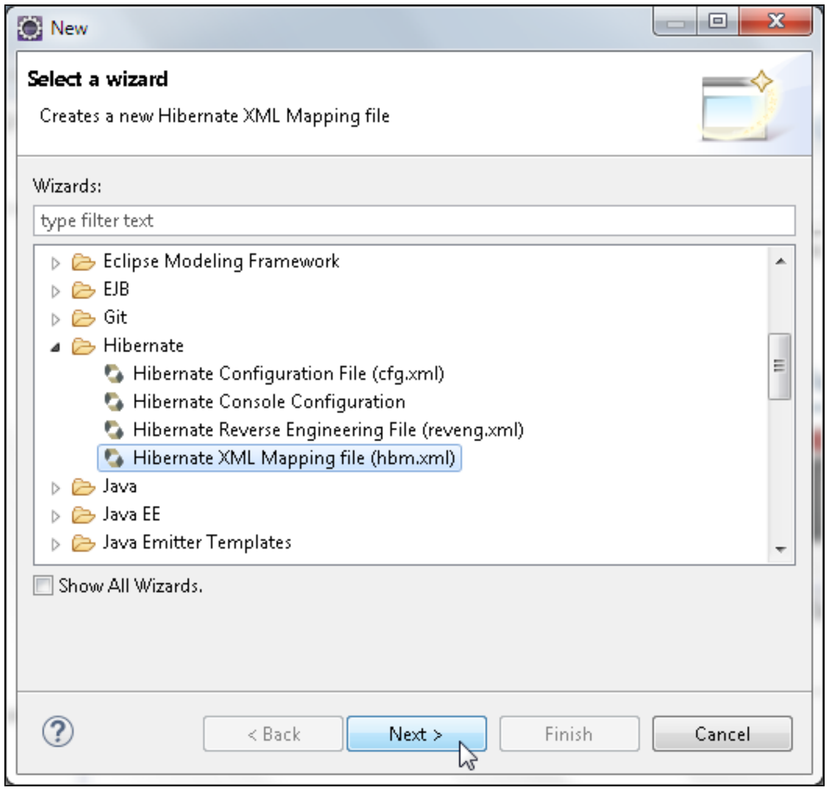


Creating a Hibernate XML Mapping file

Hibernate provides transparent mapping between a persistence class and a relational database using an XML mapping file. The actual storing and loading of objects of the persistence class is based on the mapping metadata. Perform the following steps to accomplish this:

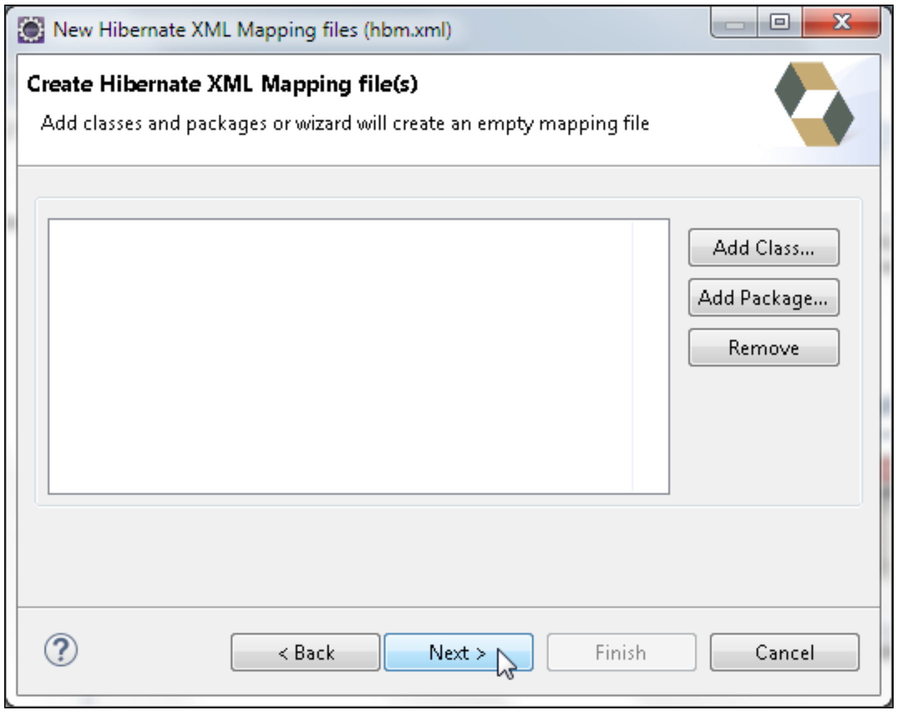
1. To create a Hibernate XML Mapping file, select **File** | **New** | **Other**.

2. In the **New** window, select **Hibernate | Hibernate XML Mapping File (hbm.xml)** and click on **Next**, as shown in the following screenshot:


New
Select a wizard
Creates a new Hibernate XML Mapping file
Wizards:
type filter text
Eclipse Modeling Framework
EJB
Git
Hibernate
Hibernate Configuration File (cfg.xml)
Hibernate Console Configuration
Hibernate Reverse Engineering File (reveng.xml)
Hibernate XML Mapping file (hbm.xml)
Java
Java EE
Java Emitter Templates
Show All Wizards.
< Back
Next >
Finish
Cancel

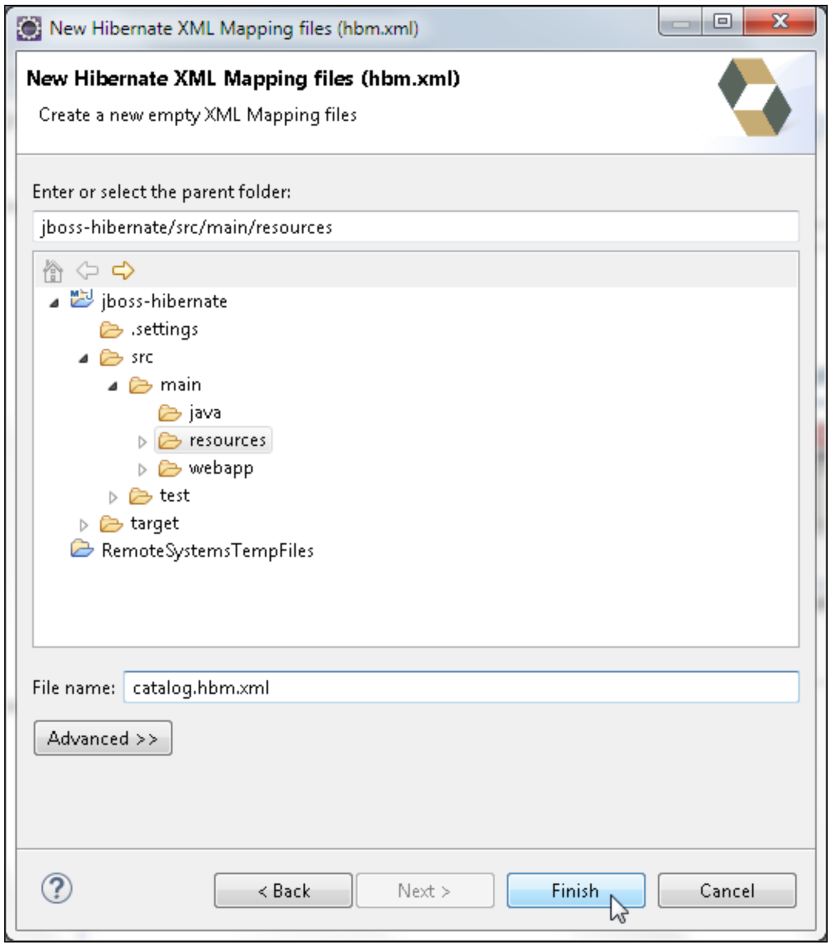
The **New Hibernate XML Mapping files** wizard gets started. As we have not yet defined any persistence classes to map, we will first create an empty XML mapping file.

3. In **Create Hibernate XML Mapping file(s)**, click on **Next**, as shown in the following screenshot:


New Hibernate XML Mapping files (hbm.xml)
Create Hibernate XML Mapping file(s)
Add classes and packages or wizard will create an empty mapping file
Add Class...
Add Package...
Remove
< Back
Next >
Finish
Cancel

The resources in the `src/main/resources` directory are in the classpath of a Hibernate application.

4. Select the `jboss-hibernate` | `src` | `main` | `resources` folder and specify **File name** as `catalog.hbm.xml`, as shown in the following screenshot. Click on **Finish**.


New Hibernate XML Mapping files (hbm.xml)
New Hibernate XML Mapping files (hbm.xml)
Create a new empty XML Mapping files
jboss-hibernate
.settings
src
main
java
resources
webapp
test
target
RemoteSystemsTempFiles
Advanced >>
< Back
Next >
Finish
Cancel

Enter or select the parent folder: jboss-hibernate/src/main/resources

File name: catalog.hbm.xml

The `catalog.hbm.xml` mapping file gets added to the `resources` directory. The root element of the mapping file is `hibernate-mapping`. The persistence classes are configured using the `<class/>` element. Add a `<class/>` element to the `org.jboss.hibernate.model.Catalog` class specified with the `name` attribute in the `<class/>` element. We have yet to create the persistence class, which would not be required if we were just exporting a schema to a relational database but is required to store or load any POJO objects. Specify a table that the class is to be mapped to with the `table` attribute of the `<class/>` element. With the specified mapping, an instance of the `Catalog` class is mapped to a row in the `CATALOG` database table. A mapped persistence class is required to specify the primary key column of the table it is mapped to. The primary key column is mapped to an identifier property in the persistence class. The primary key column and the identifier property are specified using the `<id/>` element. The column attribute specifies the primary key column; the name attribute specifies the identifier property in the persistence class being mapped; and the type attribute specifies the Hibernate type. The `<generator/>` subelement of the `<id/>` element specifies the primary key generation strategy. Some built-in generation strategies are available and different relational databases support different ID generation strategies.

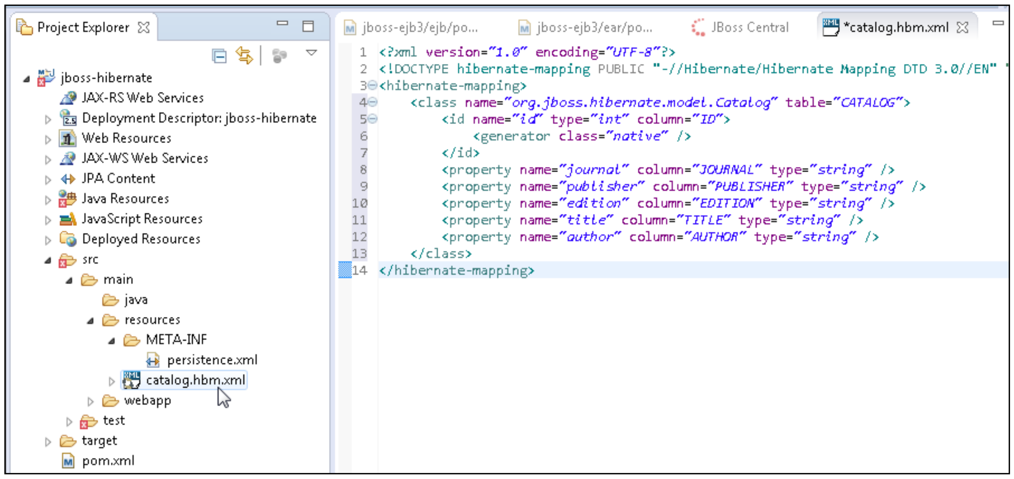
As we are using the MySQL database, which supports identity columns using `AUTO_INCREMENT`, we can use the generation strategy as `identity` or `native`. An identity column is a table column of the `INTEGER` type, with `AUTO_INCREMENT` and `PRIMARY KEY` or `UNIQUE KEY` specified, such as `id INTEGER AUTO_INCREMENT PRIMARY KEY` or `id INTEGER AUTO_INCREMENT UNIQUE KEY`.

Add JavaBean properties using the `<property/>` element. The JavaBean properties in the persistence class are mapped to the columns of the database table. The `name` attribute of the `<property/>` element specifies the property name and is the only required attribute. The `column` attribute specifies the database table column name; the default column name is the property name. The `type` attribute specifies the Hibernate type. If the `type` attribute is not specified, Hibernate finds the type, which might not be exactly the same as the actual type specified in the JavaBean class. To distinguish between similar Hibernate types, it is recommended that you specify the type in the `property` element. Add the `<property/>` elements `journal`, `publisher`, `edition`, `title`, and `author` of the type `string` and mapped to the columns `JOURNAL`, `PUBLISHER`, `EDITION`, `TITLE`, and `AUTHOR` respectively. The `catalog.hbm.xml` mapping file is listed in the following code:

```
<?xml version="1.0"?><!DOCTYPE hibernate-mapping PUBLIC"-//Hibernate/
Hibernate Mapping DTD 3.0//EN"
"http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">
<hibernate-mapping>
```

```
    <class name="org.jboss.hibernate.model.Catalog" table="CATALOG">
      <id name="id" type="int" column="ID">
        <generator class="native" />
      </id>
      <property name="journal" column="JOURNAL" type="string" />
      <property name="publisher" column="PUBLISHER" type="string" />
      <property name="edition" column="EDITION" type="string" />
      <property name="title" column="TITLE" type="string" />
      <property name="author" column="AUTHOR" type="string" />
    </class>
  </hibernate-mapping>
```

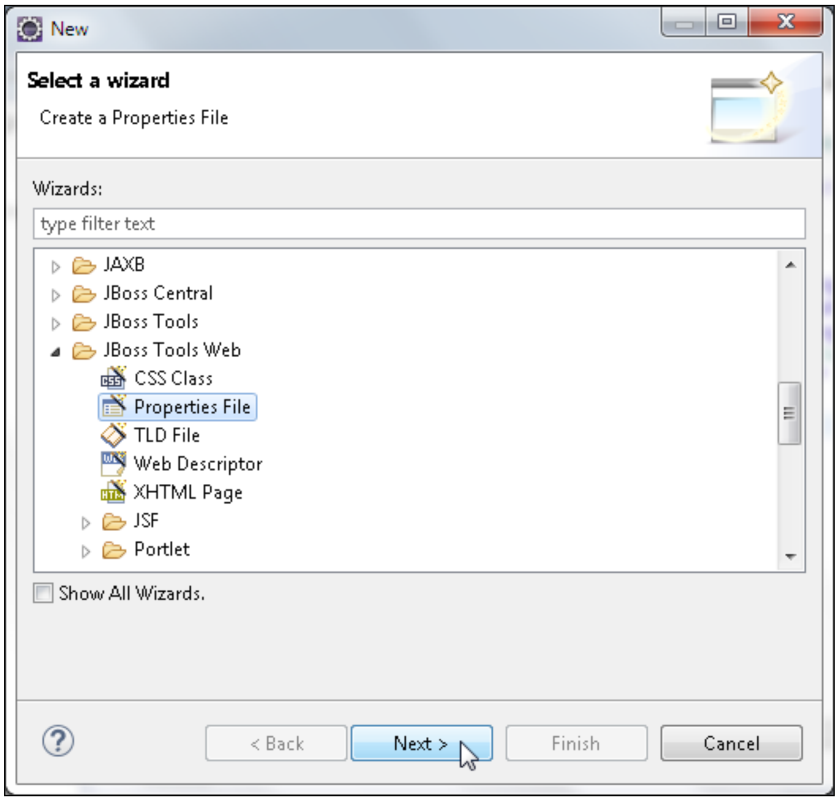
The mapping file is shown in the `jboss-hibernate` project, as shown in the following screenshot:



```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE hibernate-mapping PUBLIC "-//Hibernate/Hibernate Mapping DTD 3.0//EN" "
<hibernate-mapping>
    <class name="org.jboss.hibernate.model.Catalog" table="CATALOG">
        <id name="id" type="int" column="ID">
            <generator class="native" />
        </id>
        <property name="journal" column="JOURNAL" type="string" />
        <property name="publisher" column="PUBLISHER" type="string" />
        <property name="edition" column="EDITION" type="string" />
        <property name="title" column="TITLE" type="string" />
        <property name="author" column="AUTHOR" type="string" />
    </class>
</hibernate-mapping>
```

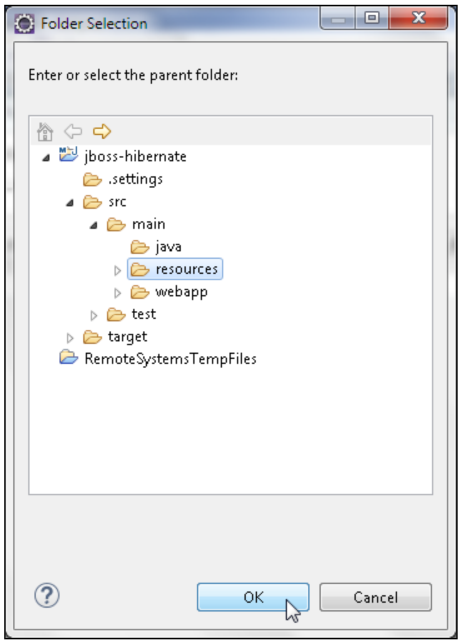
Creating a properties file

1. The Hibernate XML Mapping file defines the mapping of the persistence or class or classes with the relational database. The connection parameters used to connect to the database can be configured in a properties file or an XML configuration file, or both. To create a properties file, select **File** | **New** | **Other**. In the **New** wizard, select **JBoss Tools Web** | **Properties File** and click on **Next**, as shown in the following screenshot:

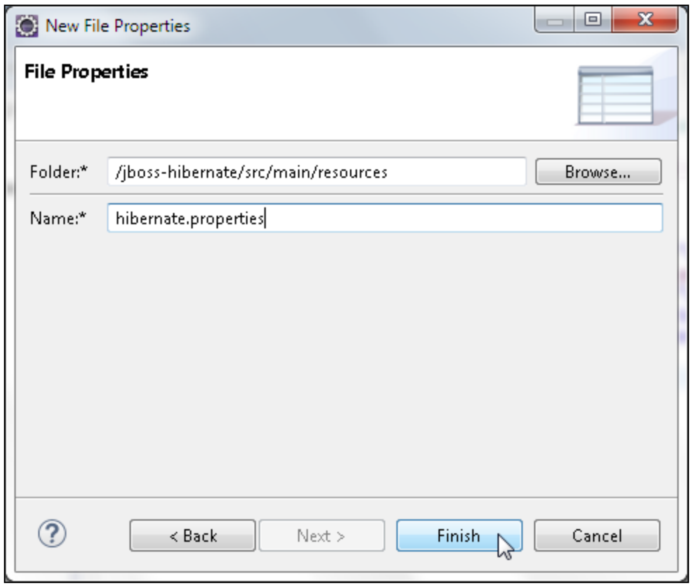


The **New File Properties** wizard gets started.

2. Click on **Browser** for the **Folder** field to select a folder. In **Folder Selection**, select the `jboss-hibernate` | `src` | `main` | `resources` folder and click on **OK**, as shown in the following screenshot:



3. Specify **Name*** as `hibernate.properties` and click on **Finish**, as shown in the following screenshot:

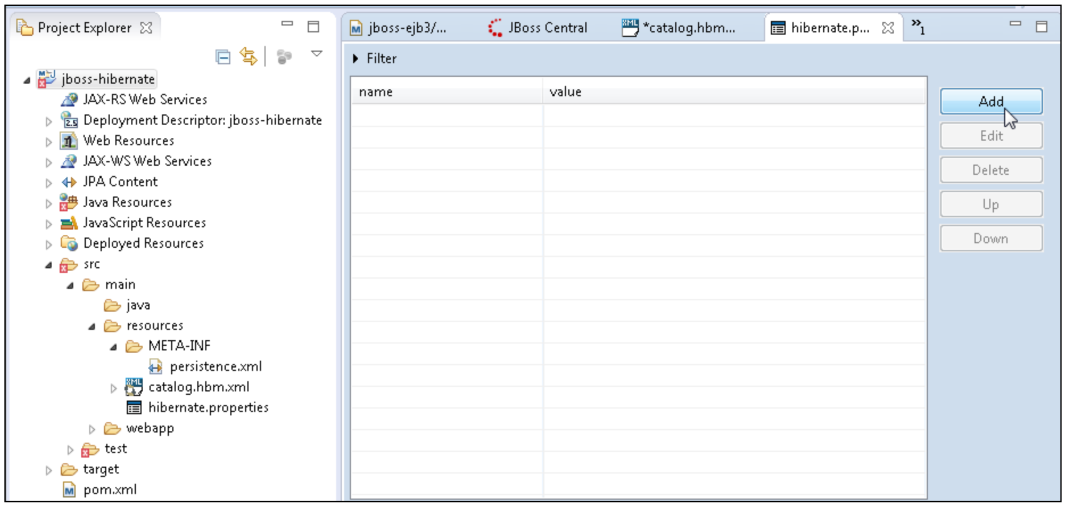


Folder:* /jboss-hibernate/src/main/resources

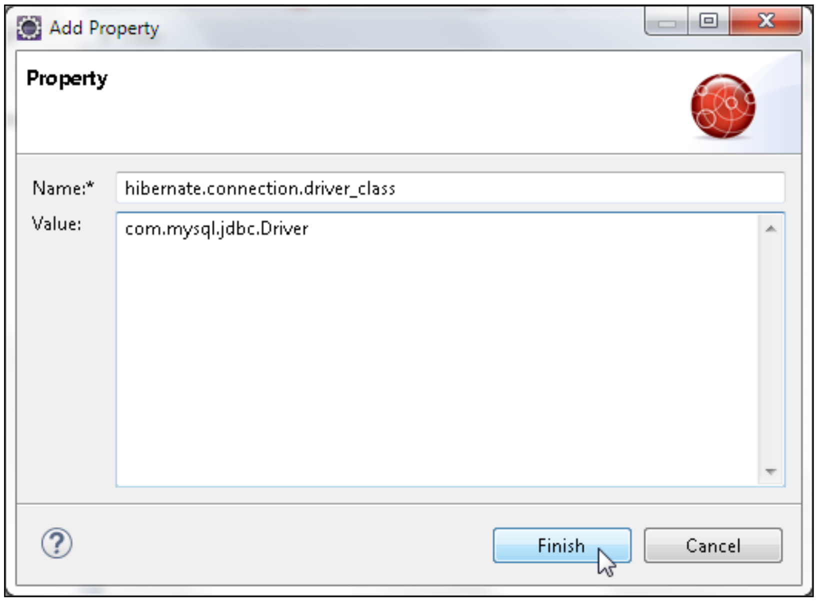
Name:* hibernate.properties

The `hibernate.properties` file gets added to the `resources` folder.

4. In the `hibernate.properties` table, click on the **Add** button to add a property, as shown in the following screenshot:

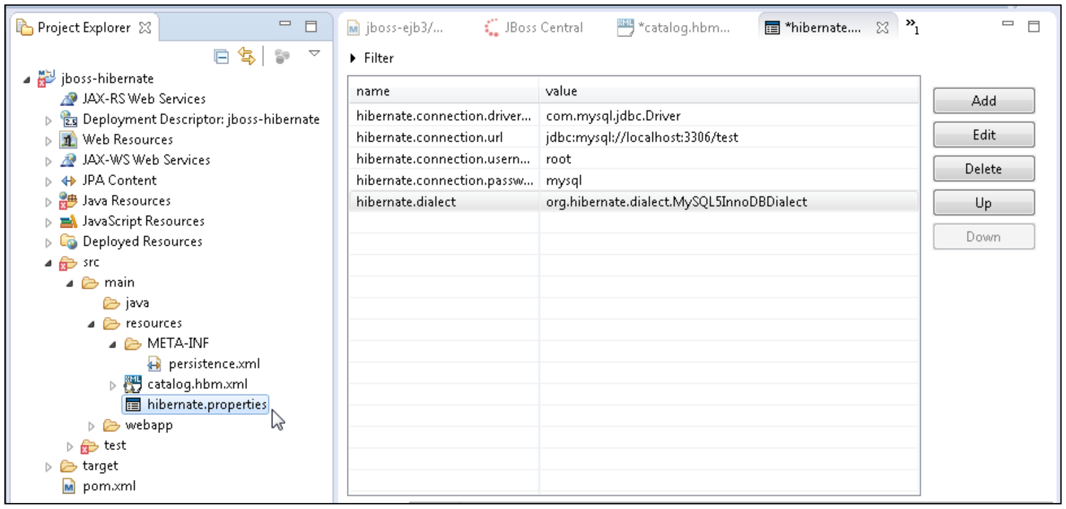


5. Add the `hibernate.connection.driver_class` property with **Value** as `com.mysql.jdbc.Driver` and click on **Finish**, as shown in the following screenshot:



Name:* hibernate.connection.driver_class
Value: com.mysql.jdbc.Driver

6. Similarly, add other properties as shown in the `hibernate.properties` table. The `hibernate.connection.url` property specifies the connection URL, and the `hibernate.dialect` property specifies the database dialect tobe used as `MySQL5InnoDBDialect`, as shown in the following screenshot:



name	value
hibernate.connection.driver...	com.mysql.jdbc.Driver
hibernate.connection.url	jdbc:mysql://localhost:3306/test
hibernate.connection.usern...	root
hibernate.connection.passw...	mysql
hibernate.dialect	org.hibernate.dialect.MySQL5InnoDBDialect

The `hibernate.properties` file is listed in the following code. The `username` and `password` attributes can be different than the ones listed:

```
hibernate.connection.driver_class=com.mysql.jdbc.Driver
hibernate.connection.url=jdbc:mysql://localhost:3306/test
hibernate.connection.username=root
hibernate.connection.password=mysql16
hibernate.dialect=org.hibernate.dialect.MySQL5InnoDBDialect
```

Creating a Hibernate configuration file

The Hibernate configuration can be specified in the **Hibernate Configuration File (cfg.xml)**, which has more configuration parameters than the properties file.

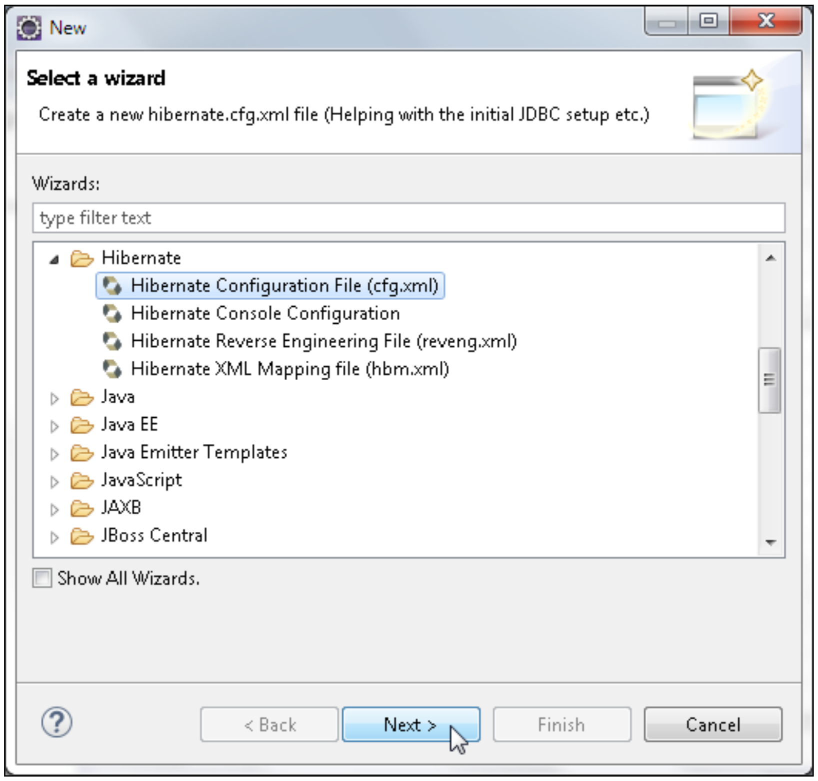
Either the properties file or the configuration file can be used to specify the configuration, or both can be used. If both are provided, the configuration file overrides the properties file for the configuration parameters specified in both.

The Hibernate XML configuration file has the following advantages over the properties file:

- The Hibernate configuration file is more convenient when tuning the Hibernate cache. The Hibernate configuration file has the provision to configure the Hibernate XML Mapping files.
- For exporting a schema to a database using the `SchemaExport` tool, just the properties file would suffice, but for object/relational mapping of a persistence class, the Hibernate XML configuration file is a better option.

The following are the steps to create a Hibernate configuration file:

1. Select **File** | **New** | **Other**. In **New**, select **Hibernate** | **Hibernate Configuration File (cfg.xml)** and click on **Next**, as shown in the following screenshot:



New

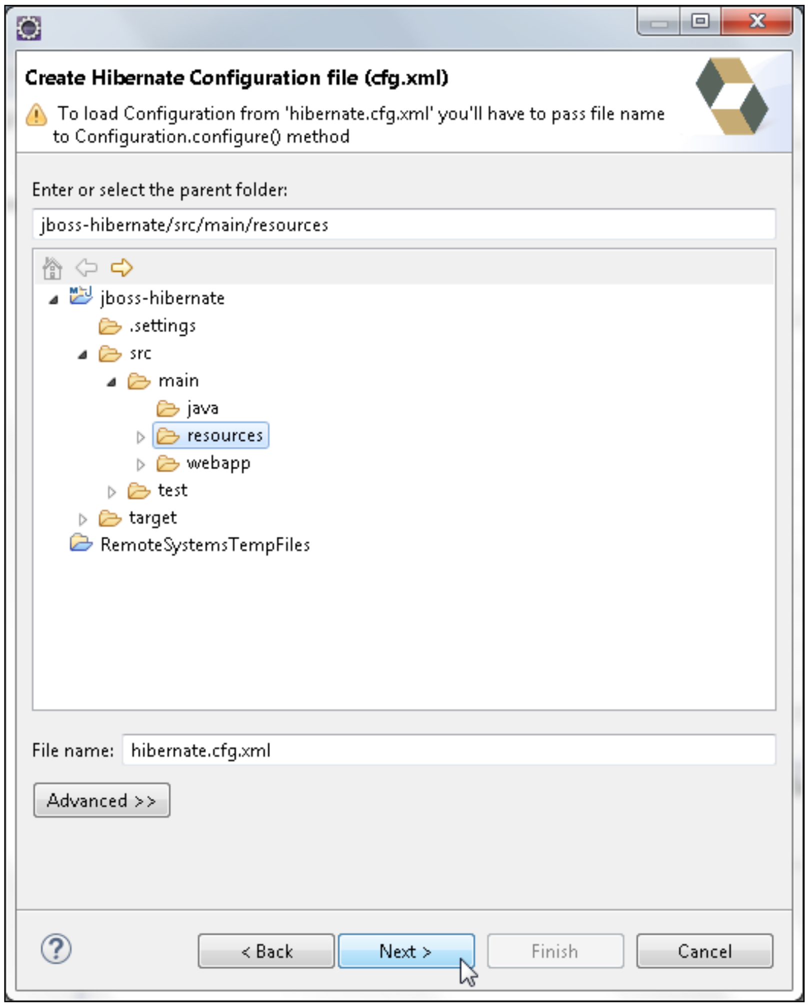
Select a wizard

Create a new hibernate.cfg.xml file (Helping with the initial JDBC setup etc.)

Wizards:
type filter text
Hibernate
Hibernate Configuration File (cfg.xml)
Hibernate Console Configuration
Hibernate Reverse Engineering File (reveng.xml)
Hibernate XML Mapping file (hbm.xml)
Java
Java EE
Java Emitter Templates
JavaScript
JAXB
JBoss Central
Show All Wizards.
< Back
Next >
Finish
Cancel

The **Create Hibernate Configuration file** wizard gets started.

2. Select the `jboss-hibernate` | `src` | `main` | `resources` folder, specify **File name** as `hibernate.cfg.xml`, and click on `Next`, as shown in the following screenshot:


Create Hibernate Configuration file (cfg.xml)

To load Configuration from 'hibernate.cfg.xml' you'll have to pass file name to Configuration.configure() method

Enter or select the parent folder:

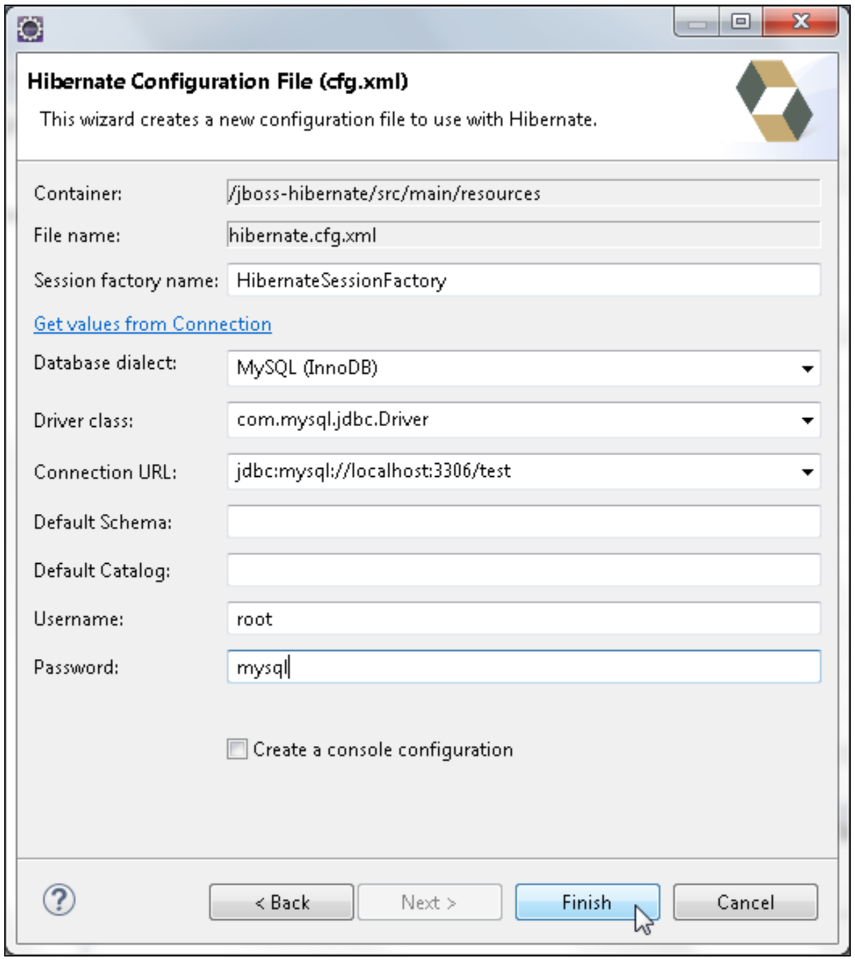
jboss-hibernate/src/main/resources

```
jboss-hibernate
    .settings
    src
        main
            java
            resources
            webapp
        test
    target
RemoteSystemsTempFiles
```

File name: hibernate.cfg.xml

3. In the **Hibernate Configuration File** wizard, specify **Session factory name** (`HibernateSessionFactory`). A session factory is a factory that is used to generate client sessions to Hibernate. A session factory stores the metadata for the object/relational mapping.
4. Select **Database dialect** as `MySQL 5 (InnoDB)`. Select **Driver class** as `com.mysql.jdbc.Driver`.
5. Specify **Connection URL** as `jdbc:mysql://localhost:3306/test`.

6. Specify the **Username** and **Password** and click on **Finish**, as shown in the following screenshot:



Hibernate Configuration File (cfg.xml)

This wizard creates a new configuration file to use with Hibernate.

Container: /jboss-hibernate/src/main/resources

File name: hibernate.cfg.xml

Session factory name: HibernateSessionFactory

Get values from Connection

Database dialect: MySQL (InnoDB)

Driver class: com.mysql.jdbc.Driver

Connection URL: jdbc:mysql://localhost:3306/test

Default Schema:

Default Catalog:

Username: root

Password: mysql

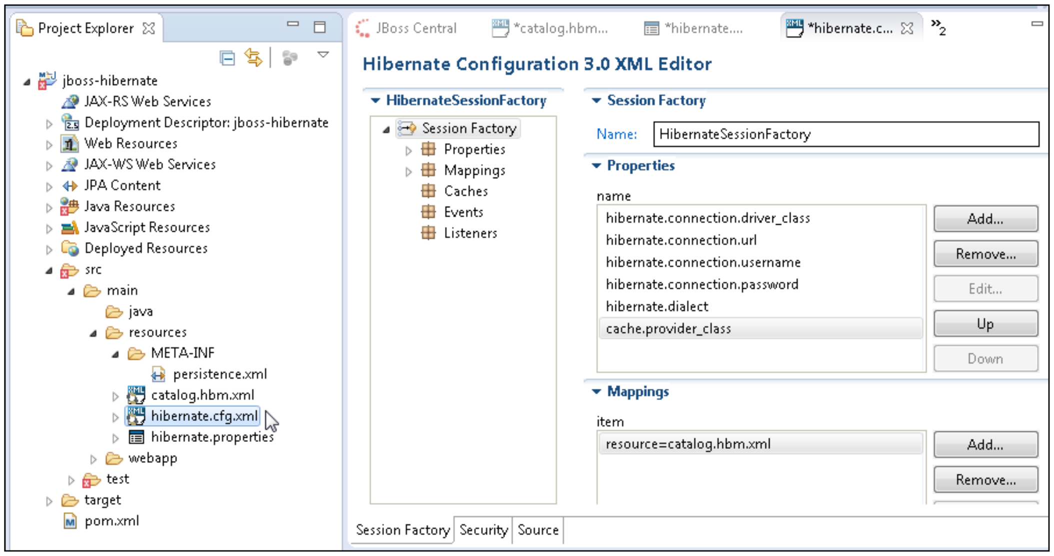
☐ Create a console configuration

Hibernate provides transaction-level caching of persistence data in a session by default. Hibernate has the provision for a query-level cache, which is turned off by default, to frequently run queries. Hibernate also has the provision for a second-level cache on the `SessionFactory` level or on the cluster level. The second-level cache is configured in the `hibernate.cfg.xml` file using the `hibernate.cache.provider_class` property. Classes that specify `<cache/>` mapping have the second-level cache enabled by default. The second-level cache can be turned off by setting the `cache.provider_class` property to `org.hibernate.cache.NoCacheProvider`. Specify the Hibernate XML Mapping file using the `<mapping/>` element with the `resource` attribute set to `catalog.hbm.xml`.

The `hibernate.cfg.xml` file is listed in the following code:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE hibernate-configuration PUBLIC"-//Hibernate/Hibernate
Configuration DTD 3.0//EN"
"http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
  <session-factory name="HibernateSessionFactory">
    <property name="hibernate.connection.driver_class">com.mysql.jdbc.
Driver</property>
    <property name="hibernate.connection.url">jdbc:mysql://
localhost:3306/test</property>
    <property name="hibernate.connection.username">root</property>
    <property name="hibernate.connection.password">mysql16</property>
    <property name="hibernate.dialect">org.hibernate.dialect.
MySQL5InnoDBDialect</property>
    <property name="cache.provider_class">org.hibernate.cache.
NoCacheProvider</property>
    <mapping resource="catalog.hbm.xml" />
  </session-factory>
</hibernate-configuration>
```

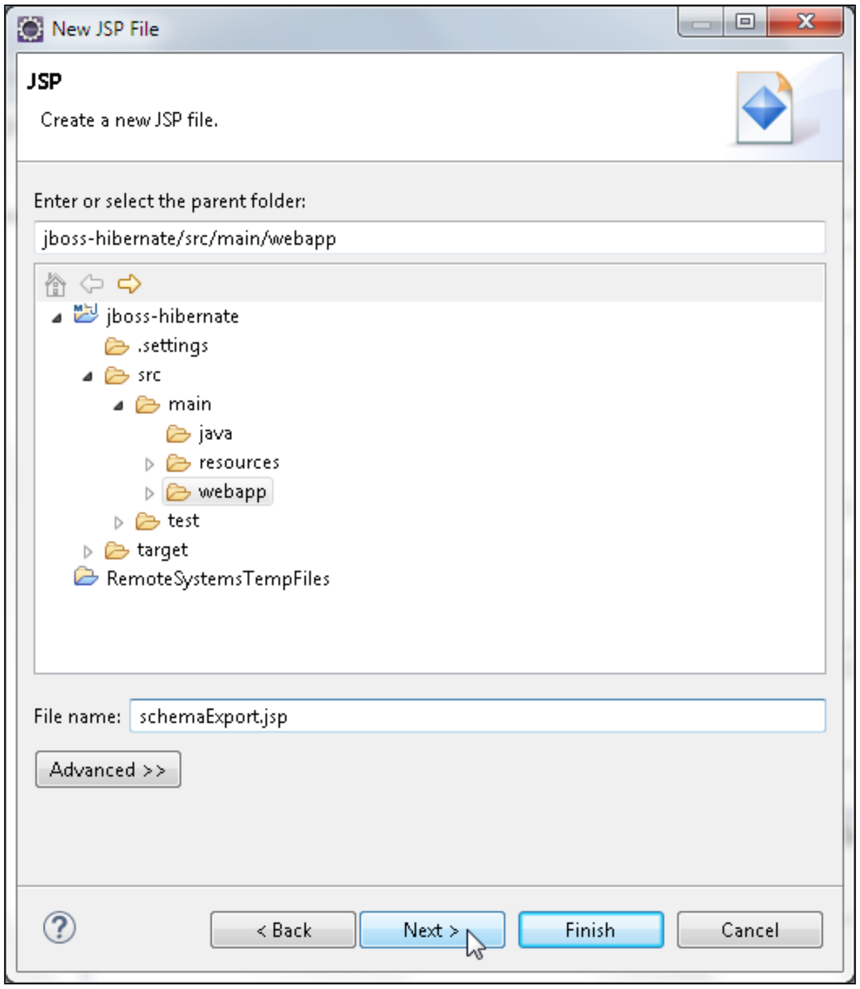
The `hibernate.cfg.xml` file is shown in the `jboss-hibernate` project folder,as follows:



Creating JSPs for CRUD

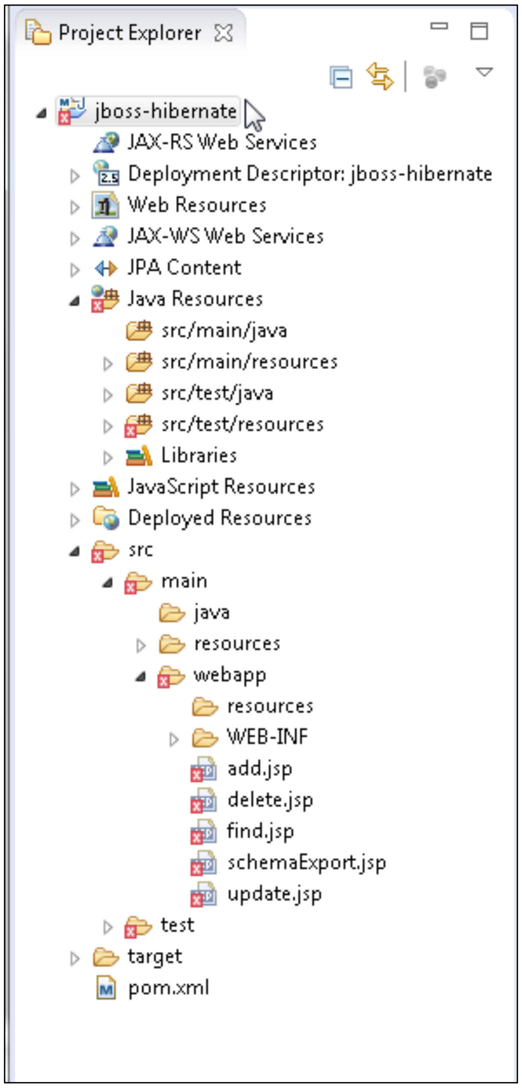
We have created the required configuration files for Hibernate. Next, we will create the JSPs to persist, load, update, and delete POJO domain objects, which are also referred to as **create, read, update, delete** (**CRUD**). Perform the following steps to accomplish this:

1. Select **File** | **New** | **Other**, and in **New**, select **Web** | **JSP** File and click on **Next**.
2. In **New JSP File**, select the `webapp` folder and specify **File name** as `schemaExport.jsp`. Click on **Next**, as shown in the following screenshot:



3. Select the **New JSP file (html)** template, which is also the default, and click on **Finish**. The `schemaExport.jsp` file gets added to the `webapp` folder.
4. Similarly, use `add.jsp` (to add table data), `find.jsp` (to find table data), `update.jsp` (to update a table row), and `delete.jsp` (to delete a table row).

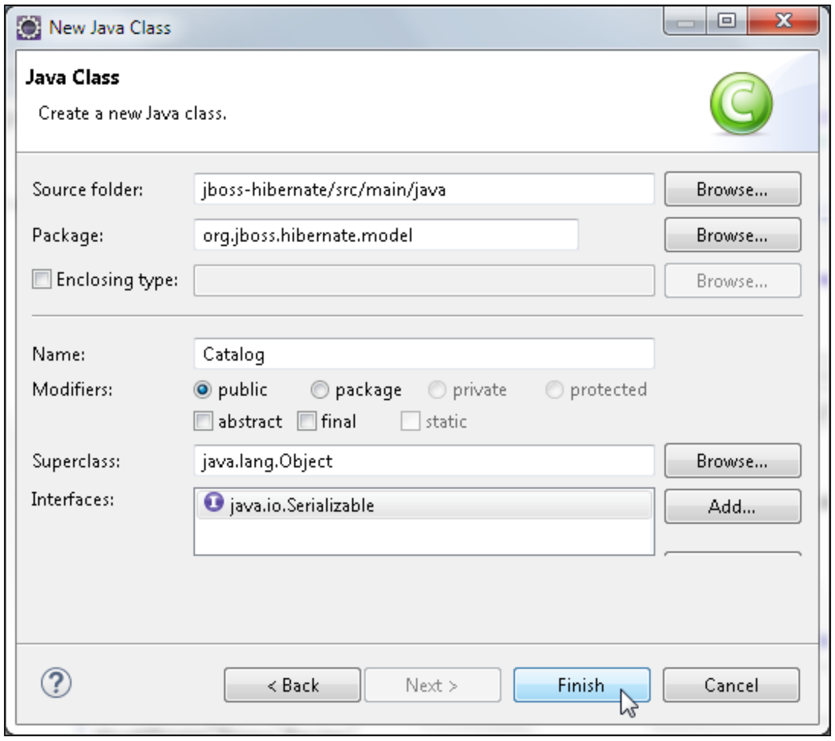
The directory structure of the `jboss-hibernate` project is shown in the following screenshot. The JSP files might indicate an error, which will get fixed as the application is developed and the Maven dependencies are added.



Creating the JavaBean class

In this section, we create the JavaBean class to be persisted to the database. To accomplish this, perform the following steps:

1. Select **File** | **New** | **Other**, and in the **New** wizard, select **Class** and click on **Next**.
2. In the **New Java Class** wizard, specify **Source folder** as `jboss-hibernate/src/main/java` and specify **Package** as `org.jboss.hibernate.model`. Specify **Name** as `Catalog` and in **Interfaces**, add `java.io.Serializable`. Click on **Finish**, as shown in the following screenshot:


New Java Class

Java Class

Create a new Java class.

Source folder: jboss-hibernate/src/main/java

Package: org.jboss.hibernate.model

Enclosing type:

Name: Catalog

Modifiers: [✓ public] package private protected

abstract final static

Superclass: java.lang.Object

Interfaces: java.io.Serializable

The `org.jboss.hibernate.model.Catalog` class is added to the `jboss-hibernate` project. In the `Catalog` class, declare the `id` property of the type `Integer`. The

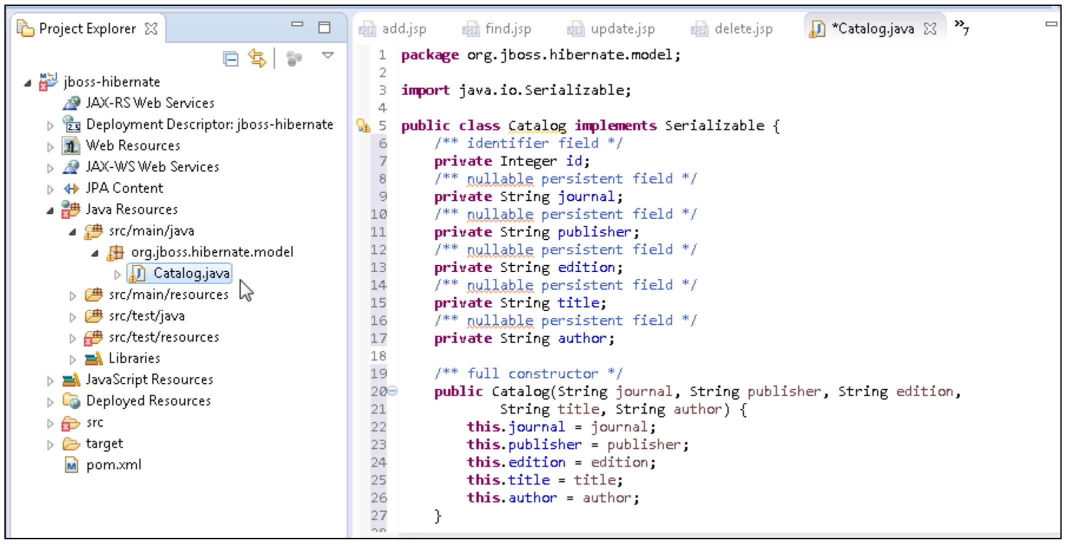
`id` property is mapped to the `ID` column in the `CATALOG` table as specified in the `catalog.hbm.xml` file. Add the `journal`, `publisher`, `edition`, `title`, and `author` properties of the `String` type. Add the no-argument constructor and a constructor with all properties as parameters. Add getter/setter methods for the properties.

The `Catalog` persistence class is listed in the following code:

```
package org.jboss.hibernate.model;
import java.io.Serializable;

public class Catalog implements Serializable {
  /** identifier field */
  private Integer id;
  /** nullable persistent field */
  private String journal;
  /** nullable persistent field */
  private String publisher;
  /** nullable persistent field */
  private String edition;
  /** nullable persistent field */
  private String title;
  /** nullable persistent field */
  private String author;

  /** full constructor */
  public Catalog(String journal, String publisher, String edition,
  String title, String author) {
    this.journal = journal;
    this.publisher = publisher;
    this.edition = edition;
    this.title = title;
    this.author = author;
  }

  /** default constructor */
  public Catalog() {
  }

  public Integer getId() {
    return this.id;
  }

  public void setId(Integer id) {
    this.id = id;
  }

  public String getJournal() {
    return this.journal;
  }
```

```
    public void setJournal(String journal) {
      this.journal = journal;
    }

    public String getPublisher() {
      return this.publisher;
    }

    public void setPublisher(String publisher) {
      this.publisher = publisher;
    }

    public String getEdition() {
      return this.edition;
    }

    public void setEdition(String edition) {
      this.edition = edition;
    }

    public String getTitle() {
      return this.title;
    }

    public void setTitle(String title) {
      this.title = title;
    }

    public String getAuthor() {
      return this.author;
    }

    public void setAuthor(String author) {
      this.author = author;
    }
  }
```

The `org.jboss.hibernate.model.Catalog` class is shown in the `jboss-hibernate` project in the following screenshot:



```java
package org.jboss.hibernate.model;

import java.io.Serializable;

public class Catalog implements Serializable {
    /** identifier field */
    private Integer id;
    /** nullable persistent field */
    private String journal;
    /** nullable persistent field */
    private String publisher;
    /** nullable persistent field */
    private String edition;
    /** nullable persistent field */
    private String title;
    /** nullable persistent field */
    private String author;

    /** full constructor */
    public Catalog(String journal, String publisher, String edition,
            String title, String author) {
        this.journal = journal;
        this.publisher = publisher;
        this.edition = edition;
        this.title = title;
        this.author = author;
    }
```

Exporting schema

In this section, we export the schema in `schemaExport.jsp JSP`. We will

run `schemaExport.jsp` in a later section. Import the `org.hibernate.cfg.Configuration` and `org.hibernate.tool.hbm2ddl.SchemaExport` Hibernate classes. An `org.hibernate.cfg.Configuration` object is an initialization-time-only object to configure properties and mapping files. Create an instance of the `Configuration` class with the no-argument constructor and configure the

`hibernate.cfg.xml` Hibernate XML configuration file using the `configure` methodin the manner shown in the following code:

```
Configuration cfg=new Configuration();
cfg.configure("hibernate.cfg.xml");
```

The `org.hibernate.tool.hbm2ddl.SchemaExport` class is a command-line tool

to export a table schema to a database and can also be invoked from an application. Create an instance of `SchemaExport` using the constructor that takes a `Configuration` object as an argument. Specify the `Configuration` object we created using the `hibernate.cfg.xml` file. The following is the line of code to accomplish this:

```
   SchemaExport schemaExport =new  SchemaExport(cfg);
```

Set the output file for the **DDL** script used to create the database table. Use the following line of code to accomplish this:

```
schemaExport.setOutputFile("hbd2ddl.sql");
```

The output file gets generated in the `bin` directory of the WildFly installation. Export the schema to the database using the `create(boolean script,boolean export)` method. The `script` parameter specifies whether the DDL script used to create the database table is to be output to the console. The `export` parameter specifies whether the schema is to be exported. The `create` method can be run with export set to `false` to test the DDL script. Here's the code that encapsulates the discussion in this paragraph:

```
schemaExport.create(true, true);
```

Optionally, add an `out` statement to output a message that the schema has been exported. The `schemaExport.jsp` file is listed in the following code:

```
<%@ page language="java" contentType="text/html; charset=ISO-8859-1"
pageEncoding="ISO-8859-1"%>
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<%@ page import="org.hibernate.*,org.hibernate.cfg.Configuration,org.
hibernate.tool.hbm2ddl.SchemaExport"%>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/xml;
charset=windows-1252" />
    <title>Export Schema</title>
  </head>
  <body>
    <%
      Configuration cfg=new Configuration();
      cfg.configure("hibernate.cfg.xml");
      SchemaExport schemaExport =new  SchemaExport(cfg);
      schemaExport.setOutputFile("hbd2ddl.sql");
      schemaExport.create(true, true);
      out.println("Schema Exported");
  %>
    </body>
</html>
```

Creating table data

Having exported the schema to the database, in `add.jsp`, persist the `Catalog` POJO domain model to the database. We will run `schemaExport.jsp` and the other JSPs in a later section after discussing the JSPs:

1. Import the classes in the `org.jboss.hibernate.model` and `org.hibernate` packages and the `org.hibernate.cfg.Configuration` class. Create an instance of the `Configuration` object and configure the `hibernate.cfg.xml` file as in the `schemaExport.jsp`.
2. Create instances of the `Catalog` class using either the no-argument constructor with the setter methods for the properties or the argument constructor that takes all properties in the manner shown in the following code:
   ```
   Catalog catalog = new Catalog();
   catalog.setId(1);
   catalog.setJournal("Oracle Magazine");
   catalog.setPublisher("Oracle Publishing");
   catalog.setEdition("Jan-Feb 2004");
   catalog.setTitle("Understanding Optimization");
   catalog.setAuthor("Kimberly Floss");
   ```
3. Create `SessionFactory` from the `Configuration` object using the `buildSessionFactory()` method. `SessionFactory` has all the metadata from the mapping and properties files in `Configuration`. The `Configuration` object is not used after `SessionFactory` has been created. Create a `Session` object from the `SessionFactory` object using the `openSession()` method. The `openSession` method implements JDBC transparently. JDBC connections are obtained from `ConnectionProvider` internally by Hibernate. We made the `Catalog` persistent class serializable because a `Session` object is serializable only if the persistent class is serializable. A `Session` object is a client interface to Hibernate. The actual persistence to the database is made using a `Transaction` object. Refer to the following line of code, which puts into action the discussion in this paragraph:
   ```
   Session sess = sessionFactory.openSession();
   ```
4. Begin a client session using the `beginTransaction()` method that returns a `Transaction` object. A `Transaction` object represents a global transaction. Refer to the following line of code that summarizes the discussion in this step:
   ```
   Transaction tx = sess.beginTransaction();
   ```

5. The `beginTransaction()` method starts a new underlying transaction only if required; otherwise it uses an existing transaction. Make the `Catalog` instances associate with the `Session` object using the `save()` method, as follows:

   ```
   sess.save(catalog);
   sess.save(catalog2);
   ```

6. The `save()` method does not store the `Catalog` instances to the database but only adds the POJOs to `Session`. To store the `Catalog` instances, invoke the `commit()` method of the `Transaction` object in the manner shown in the following code:

   ```
   tx.commit();
   ```

7. Optionally output a message to indicate that the data has been added to the database. The `add.jsp` file is listed in the following code:

   ```
   <%@ page language="java" contentType="text/html;
   charset=ISO-8859-1" pageEncoding="ISO-8859-1"%><!DOCTYPE HTML
   PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
   "http://www.w3.org/TR/html4/loose.dtd">
   <%@ page import="org.jboss.hibernate.model.*,org.hibernate.*,java.
   util.List,org.hibernate.cfg.Configuration"%>
   <html>
     <head>
       <meta http-equiv="Content-Type" content="text/xml;
   charset=windows-1252" />
       <title>Export Schema</title>
     </head>
     <body>
       <%
         Configuration cfg = new Configuration();
         cfg.configure("hibernate.cfg.xml");
         Catalog catalog = new Catalog();
         catalog.setId(1);
         catalog.setJournal("Oracle Magazine");
         catalog.setPublisher("Oracle Publishing");
         catalog.setEdition("Jan-Feb 2004");
         catalog.setTitle("Understanding Optimization");
         catalog.setAuthor("Kimberly Floss");

         Catalog catalog2 = new Catalog();
         catalog2.setId(2);
         catalog2.setJournal("Oracle Magazine");
         catalog2.setPublisher("Oracle Publishing");
         catalog2.setEdition("March-April 2005");
   ```

```
            catalog2.setTitle("Starting with Oracle ADF");
            catalog2.setAuthor("Steve Muench");
            SessionFactory sessionFactory = cfg.buildSessionFactory();
            Session sess = sessionFactory.openSession();
            Transaction tx = sess.beginTransaction();
            sess.save(catalog);
            sess.save(catalog2);
            tx.commit();
            out.println("Added");
          %>
        </body>
      </html>
```

Retrieving table data

In this section, we query the database to find all instances of a persistent object. Hibernate provides HQL, a query language, which has syntax similar to SQL but is object oriented. A reference to all HQL commands is available at `https://docs.jboss.org/hibernate/orm/3.3/reference/en/html/queryhql.html`. The query is made on the persistent object, which is the `Catalog` class instance, and not on the `CATALOG` database table. To query the database to find all instances of the persistent object, perform the following steps:

1. Create a `String` HQL query to get all instances of the `Catalog` class:
   ```
   String hqlQuery = "from Catalog";
   ```
2. Create and configure a `Configuration` object, create a `SessionFactory` object, and obtain a `Session` object as discussed for `add.jsp`
3. Create a `Query` object from the string HQL query using the `createQuery(String)` method of the `Session` object, as follows:
   ```
   Query query = sess.createQuery(hqlQuery);
   ```
4. A `Query` object is an object-oriented representation of a Hibernate query. Obtain the result of the Hibernate query using the `list()` method, which returns `List`. The SQL used to query the database is implemented internally by Hibernate. A `Transaction` object is not required for a Hibernate query. A `Transaction` object is required only to add, update, or delete a table row.
5. Iterate over `List` to output the query result. The `find.jsp` file is listed in the following code:
   ```
   <%@ page language="java" contentType="text/html;
   charset=ISO-8859-1" pageEncoding="ISO-8859-1"%><!DOCTYPE HTML
   PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
   ```

```
"http://www.w3.org/TR/html4/loose.dtd">
<%@ page import="org.jboss.hibernate.model.*,org.hibernate.*,java.
util.List,org.hibernate.cfg.Configuration"%>
<html>
  <head>
    <meta name="generator" content="HTML Tidy for Linux/x86 (vers
25 March 2009), see www.w3.org" />
    <meta http-equiv="Content-Type" content="text/xml; charset=us-
ascii" />
    <title>
      Export Schema
    </title>
  </head>
  <body>
    <%
      String hqlQuery = "from Catalog";
      Configuration cfg = new Configuration();
      cfg.configure("hibernate.cfg.xml");
      SessionFactory sessionFactory = cfg.buildSessionFactory();
      Session sess = sessionFactory.openSession();
      Query query = sess.createQuery(hqlQuery);
      List list = query.list();
      for (int i = 0; i < list.size(); i++) {
        Catalog catalog = (Catalog) list.get(i);
        out.println("<br>");
        out.println("CatalogId " + catalog.getId() + " Journal: "+
catalog.getJournal());
        out.println("<br>");
        out.println("CatalogId " + catalog.getId() + " Publisher:
" + catalog.getPublisher());
        out.println("<br>");
        out.println("CatalogId " + catalog.getId() + " Edition: "+
catalog.getEdition());
        out.println("<br>");
        out.println("CatalogId " + catalog.getId() + " Title "+
catalog.getTitle());
        out.println("<br>");
         out.println("CatalogId " + catalog.getId() + " Author: "+
catalog.getAuthor());
      }
      sess.close();
    %>
  </body>
</html>
```

Updating a table row

In this section, we will update a table row. Perform the following steps to accomplish this:

1. Create an HQL query `String` and create a `Query` object to generate `List` as discussed for `find.jsp`.
2. Obtain the first item in `List` and modify the `publisher` value with the `setPublisher()` method, as follows:

```
Catalog catalog = (Catalog) list.get(0);
catalog.setPublisher("Oracle Magazine");
```

3. Create a `Transaction` object, which represents a transaction with the database, with the `beginTransaction()` method. Save or update the persistent state of the `Catalog` object in `Session` with the `saveOrUpdate` method. Invoke the `commit()` method of the `Transaction` object to save the `Catalog` instance in the database.
4. Optionally, output a message to indicate that the update was completed:

```
Transaction tx = sess.beginTransaction();
sess.saveOrUpdate(catalog);
tx.commit();
```

The `update.jsp` is listed in the following code:

```
<%@ page language="java" contentType="text/html;
charset=ISO-8859-1"       pageEncoding="ISO-8859-1"%><!DOCTYPE
HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<%@ page import="org.jboss.hibernate.model.*,org.hibernate.*,java.
util.List,org.hibernate.cfg.Configuration"%>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/xml;
charset=windows-1252" />
    <title>Export Schema</title>
  </head>
  <body>
    <%
      String hqlQuery = "from Catalog";
      Configuration cfg = new Configuration();
```

```
            cfg.configure("hibernate.cfg.xml");
            SessionFactory sessionFactory = cfg.buildSessionFactory();
            Session sess = sessionFactory.openSession();
            Query query = sess.createQuery(hqlQuery);
            List list = query.list();
            Catalog catalog = (Catalog) list.get(0);
            catalog.setPublisher("Oracle Magazine");
            Transaction tx = sess.beginTransaction();
            sess.saveOrUpdate(catalog);
            tx.commit();
            out.println("Updated");
          %>
        </body>
      </html>
```

Deleting a table row

In this section, we will delete a table row from the `CATALOG` table. Perform the following steps to accomplish this:

1. Create a HQL query `String` for the `Catalog` instance to delete the table row using the following line of code:
   ```
   String hqlQuery = "from Catalog as catalog WHERE catalog.
   edition='March-April 2005'";
   ```
2. As in `find.jsp` and `update.jsp`, get `List` for `Catalog` instances. As only one `Catalog` instance has `edition` set to `March-April 2005`, we only need to get the first `Catalog` instance from `List`. To do so, use the following code:
   ```
   Catalog catalog = (Catalog) list.get(0);
   ```
3. Create a `Transaction` object with `beginTransaction()`.
4. Delete the `Catalog` instance from the `Session` with the `delete` method, which doesn't delete the `Catalog` instance from the database. Invoke the `commit()` method of the `Transaction` object to save the `Session` state in the database, which deletes the corresponding table row from the `CATALOG` table.

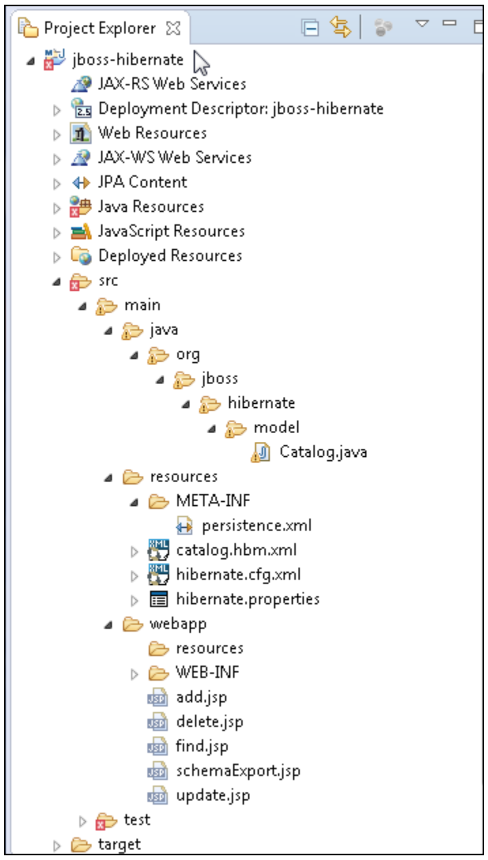
5. Optionally, using the following code, output a message to indicate deletion:

```
sess.delete(catalog);
tx.commit();
```

The `delete.jsp` file is listed in the following code:

```
<%@ page language="java" contentType="text/html;
charset=ISO-8859-1" pageEncoding="ISO-8859-1"%><!DOCTYPE HTML
PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<%@ page import="org.jboss.hibernate.model.*,org.hibernate.*,java.
util.List,org.hibernate.cfg.Configuration"%>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/xml;
charset=windows-1252" />
    <title>Export Schema</title>
  </head>
  <body>
    <%
     String hqlQuery = "from Catalog as catalog WHERE catalog.
edition='March-April 2005'";
      Configuration cfg = new Configuration();
     cfg.configure("hibernate.cfg.xml");
     SessionFactory sessionFactory = cfg.buildSessionFactory();
     Session sess = sessionFactory.openSession();
     Query query = sess.createQuery(hqlQuery);
     List list = query.list();
     Catalog catalog = (Catalog) list.get(0);
     Transaction tx = sess.beginTransaction();
     sess.delete(catalog);
     tx.commit();
      out.println("Deleted");
    %>
    </body>
</html>
```

The directory structure of the Maven project is shown in the following screenshot:



```
Project Explorer
jboss-hibernate
  JAX-RS Web Services
  Deployment Descriptor: jboss-hibernate
  Web Resources
  JAX-WS Web Services
  JPA Content
  Java Resources
  JavaScript Resources
  Deployed Resources
  src
    main
      java
        org
          jboss
            hibernate
              model
                Catalog.java
      resources
        META-INF
          persistence.xml
        catalog.hbm.xml
        hibernate.cfg.xml
        hibernate.properties
      webapp
        resources
        WEB-INF
        add.jsp
        delete.jsp
        find.jsp
        schemaExport.jsp
        update.jsp
    test
  target
```

Installing the Maven project

In this section, we will compile and package the Hibernate web application using the Maven build tool. Some APIs, such as the Common Annotations API, Hibernate validator API, and CDI API, are provided by WildFly 8. We need to add the MySQL JDBC connector dependency to `pom.xml` inside the `<dependencies/>` element. To acomplish this, use the following code:

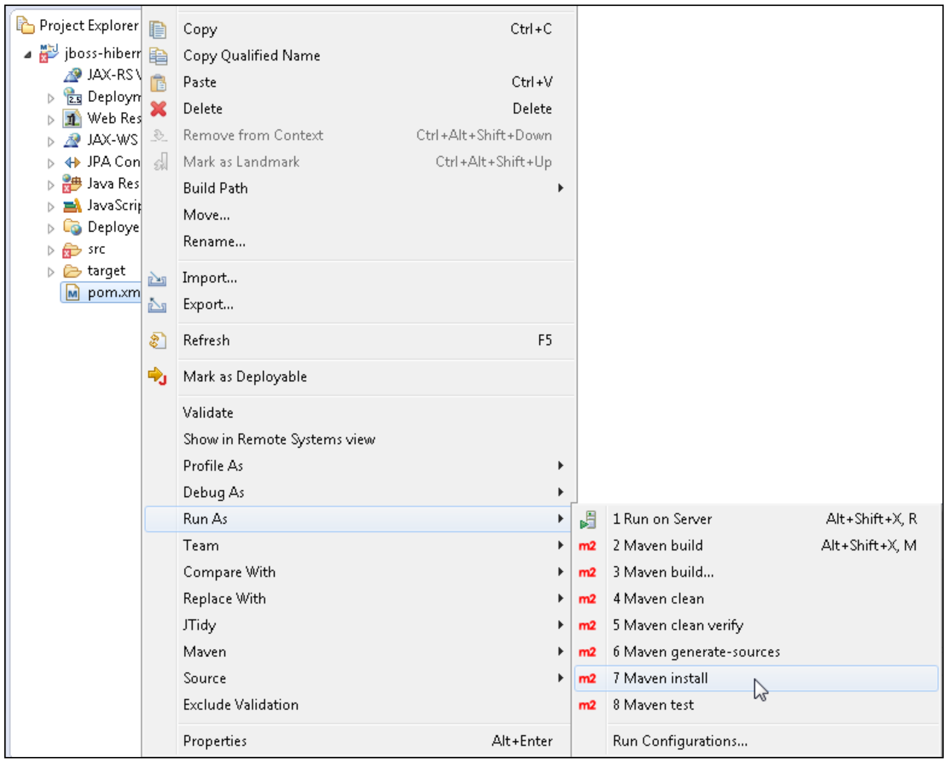
```
<dependency>
  <groupId>mysql</groupId>
  <artifactId>mysql-connector-java</artifactId>
  <version>5.1.28</version>
</dependency>
```

Hibernate provides Hibernate-related artifacts in the group ID `org.hibernate`. Include the Hibernate artifacts listed in the following table:

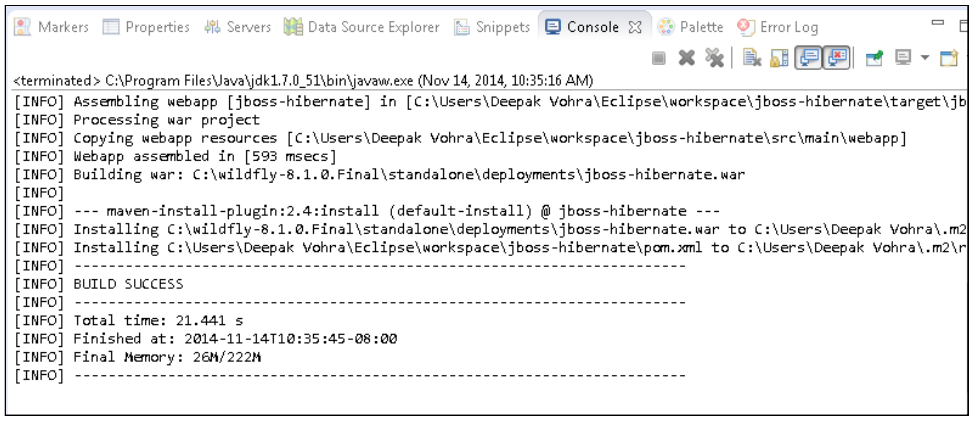
Artifact	**Description**
`hibernate-core`	This is the main artifact for the Hibernate API.
`hibernate-annotations`	This is for the annotations metadata.
`hibernate-commons-annotations`	This pertains to the EJB 3 style annotations for Hibernate.
`hibernate-ehcache`	This provides the cache for second-level cache.
`hibernate-c3p0`	This is the C3P0 connection-pooling library.
`antlr`	This is the parser generator.
`hibernate-cglib-repack`	This is the CGLIB code generation library and also signifies ASM dependencies.
`hibernate-tools`	This provides tools to generate various Hibernate source artifacts, such as mapping files and Java entities.
`hibernate-envers`	This is used for auditing and versioning of persistent classes.
`hibernate-jpamodelgen`	This is an annotation processor to generate JPA 2 static meta-model classes. The Catalog entity in *Module1, Getting Started with EJB 3.x*, is an example of a JPA 2 meta-model class.

The Maven compiler plugin is used to compile the project sources, and the Maven WAR plugin collects all the dependencies, classes, and resources and generates a WAR archive. In the configuration for `maven-war-plugin`, specify the directory to output the `WAR` file with the `outputDirectory` element as `C:\JBossAS8\wildfly-8.0.0.CR1\standalone\deployments`. The `EAR`, `WAR`, and `JAR` files in the `deployments` directory get deployed to the WildFly application server. The `pom.xml` file for the `jboss-hibernate` project is available in the code download for this chapter.

Next, we install the Maven project. Right-click on `pom.xml` and select **Run As** | **Maven install**, as shown in the following screenshot:



The Maven project is compiled and the `jboss-hibernate.war` archive gets generated and output to the `deployments` directory of WildFly 8, as shown in the following screenshot:

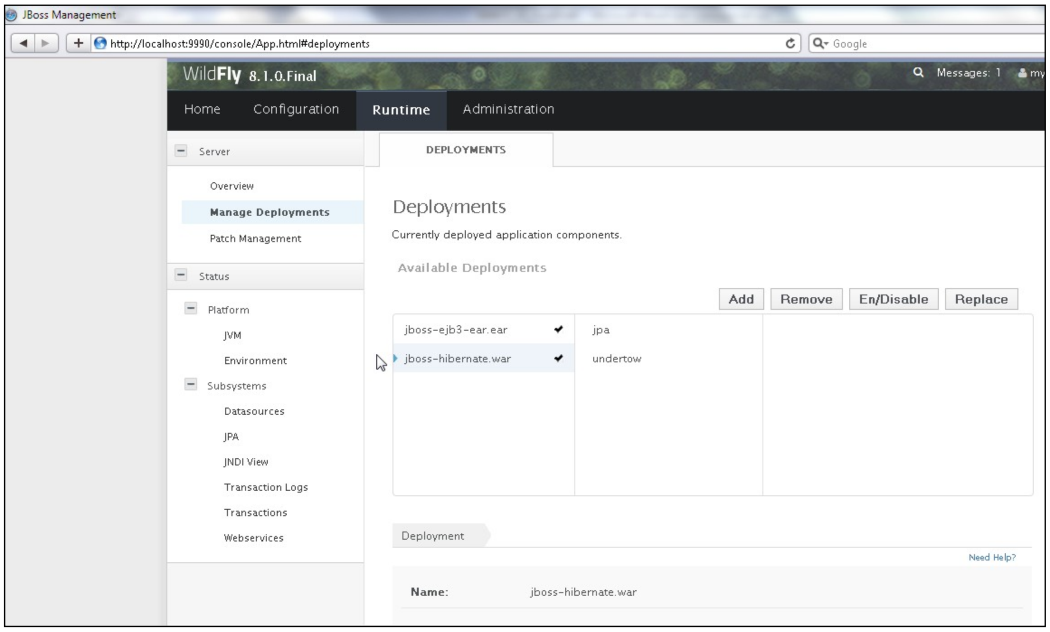


```
<terminated> C:\Program Files\Java\jdk1.7.0_51\bin\javaw.exe (Nov 14, 2014, 10:35:16 AM)
[INFO] Assembling webapp [jboss-hibernate] in [C:\Users\Deepak Vohra\Eclipse\workspace\jboss-hibernate\target\jb
[INFO] Processing war project
[INFO] Copying webapp resources [C:\Users\Deepak Vohra\Eclipse\workspace\jboss-hibernate\src\main\webapp]
[INFO] Webapp assembled in [593 msecs]
[INFO] Building war: C:\wildfly-8.1.0.Final\standalone\deployments\jboss-hibernate.war
[INFO]
[INFO] --- maven-install-plugin:2.4:install (default-install) @ jboss-hibernate ---
[INFO] Installing C:\wildfly-8.1.0.Final\standalone\deployments\jboss-hibernate.war to C:\Users\Deepak Vohra\.m2
[INFO] Installing C:\Users\Deepak Vohra\Eclipse\workspace\jboss-hibernate\pom.xml to C:\Users\Deepak Vohra\.m2\r
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time: 21.441 s
[INFO] Finished at: 2014-11-14T10:35:45-08:00
[INFO] Final Memory: 26M/222M
[INFO] ------------------------------------------------------------------------
```

Start the WildFly 8 server. The `jboss-hibernate.war` file gets deployed

to

the server and the MySQL data source also gets deployed. The persistence unit gets started. The `jboss-hibernate.war` is shown deployed in the WildFly **Administration Console** in the following screenshot:



Deployments

Currently deployed application components.

Available Deployments

jboss-ejb3-ear.ear ✓	jpa
jboss-hibernate.war ✓	undertow

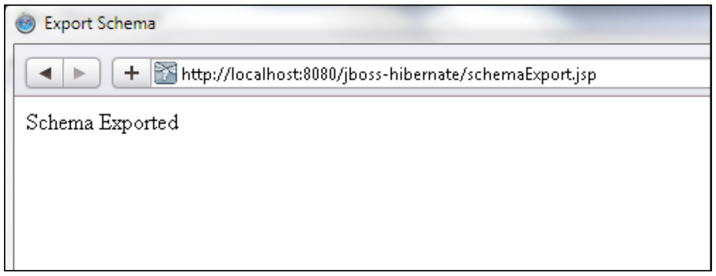
Deployment

Name: jboss-hibernate.war

Running a schema export

In this section, we will run `schemaExport.jsp` on the WildFly application server to export the schema to the MySQL database. To accomplish this, perform the following steps:

1. Invoke the URL `http://localhost:8080/jboss-hibernate/schemaExport.jsp` in a browser, as shown in the following screenshot. The schema gets exported to the MySQL database.

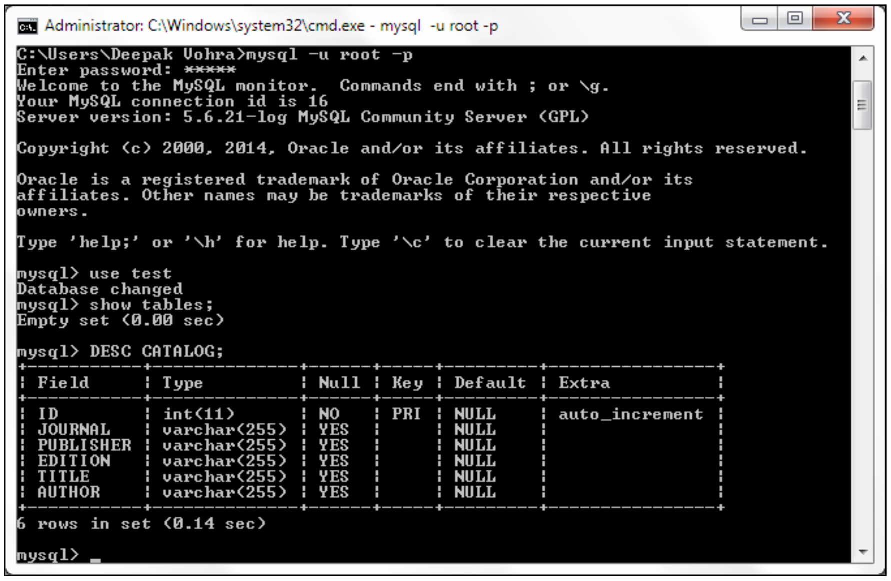


```
Schema Exported
```

2. The output from `schemaExport.jsp` on the server is shown in the following code:

```
10:57:23,589 INFO  [org.hibernate.cfg.Configuration] (default
task-8) HHH000041:
 Configured SessionFactory: HibernateSessionFactory
10:57:23,590 INFO  [org.hibernate.dialect.Dialect] (default task-
8) HHH000400: U
sing dialect: org.hibernate.dialect.MySQL5InnoDBDialect
10:57:23,592 INFO  [org.hibernate.tool.hbm2ddl.SchemaExport]
(default task-8) HH
H000227: Running hbm2ddl schema export
10:57:23,761 WARN  [org.hibernate.engine.jdbc.connections.
internal.DriverManager
ConnectionProviderImpl] (default task-8) HHH000402: Using
Hibernate built-in con
nection pool (not for production use!)
10:57:23,841 INFO  [org.hibernate.engine.jdbc.connections.
internal.DriverManager
ConnectionProviderImpl] (default task-8) HHH000401: using driver
[com.mysql.jdbc
.Driver] at URL [jdbc:mysql://localhost:3306/test]
10:57:23,842 INFO  [org.hibernate.engine.jdbc.connections.
internal.DriverManager
ConnectionProviderImpl] (default task-8) HHH000046: Connection
properties: {user
=root, password=****}
10:57:23,843 INFO  [org.hibernate.engine.jdbc.connections.
internal.DriverManager
ConnectionProviderImpl] (default task-8) HHH000006: Autocommit
mode: false
10:57:23,843 INFO  [org.hibernate.engine.jdbc.connections.
internal.DriverManager
ConnectionProviderImpl] (default task-8) HHH000115: Hibernate
connection pool si
ze: 20 (min=1)
10:57:24,035 INFO  [stdout] (default task-8)
10:57:24,036 INFO  [stdout] (default task-8)     drop table if
exists CATALOG
10:57:24,038 INFO  [stdout] (default task-8)
10:57:24,038 INFO  [stdout] (default task-8)     create table
CATALOG (
10:57:24,038 INFO  [stdout] (default task-8)         ID integer
not null auto_in
crement,
10:57:24,039 INFO  [stdout] (default task-8)         JOURNAL
varchar(255),
10:57:24,039 INFO  [stdout] (default task-8)         PUBLISHER
varchar(255),
10:57:24,039 INFO  [stdout] (default task-8)         EDITION
varchar(255),
10:57:24,039 INFO  [stdout] (default task-8)         TITLE
varchar(255),
10:57:24,039 INFO  [stdout] (default task-8)         AUTHOR
varchar(255),
10:57:24,040 INFO  [stdout] (default task-8)         primary key
(ID)
10:57:24,040 INFO  [stdout] (default task-8)     ) ENGINE=InnoDB
10:57:27,224 INFO  [org.hibernate.engine.jdbc.connections.
internal.DriverManagerConnectionProviderImpl] (default task-8) HHH000030: Cleaning up
connection pool
[jdbc:mysql://localhost:3306/test]
10:57:27,225 INFO  [org.hibernate.tool.hbm2ddl.SchemaExport]
(default task-8) HHH000230: Schema export complete
```

3. Run the `DESC CATALOG` command in the MySQL command line for the structure of the `CATALOG` table, as shown in the following screenshot:



```
C:\Users\Deepak Vohra>mysql -u root -p
Enter password: *****
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 16
Server version: 5.6.21-log MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> use test
Database changed
mysql> show tables;
Empty set (0.00 sec)

mysql> DESC CATALOG;
+-----------+--------------+------+-----+---------+----------------+
| Field     | Type         | Null | Key | Default | Extra          |
+-----------+--------------+------+-----+---------+----------------+
| ID        | int(11)      | NO   | PRI | NULL    | auto_increment |
| JOURNAL   | varchar(255) | YES  |     | NULL    |                |
| PUBLISHER | varchar(255) | YES  |     | NULL    |                |
| EDITION   | varchar(255) | YES  |     | NULL    |                |
| TITLE     | varchar(255) | YES  |     | NULL    |                |
| AUTHOR    | varchar(255) | YES  |     | NULL    |                |
+-----------+--------------+------+-----+---------+----------------+
6 rows in set (0.14 sec)

mysql> _
```
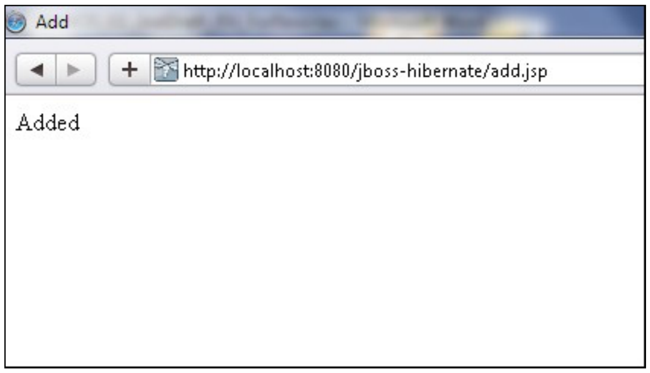
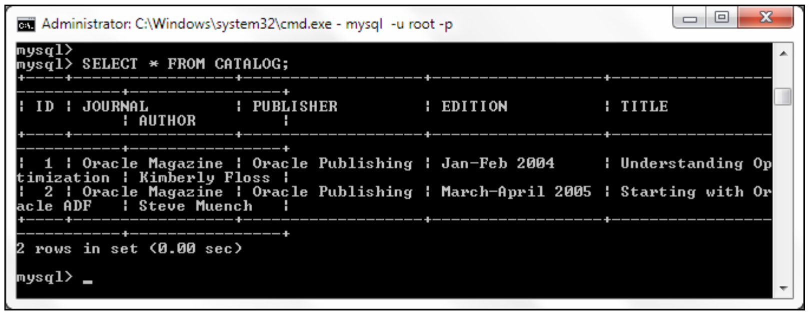

Creating table rows

In this section, we will add the table data to the `CATALOG` table. Invoke the URL `http://localhost:8080/jboss-hibernate/add.jsp`, as shown in the following screenshot. The table data gets added.



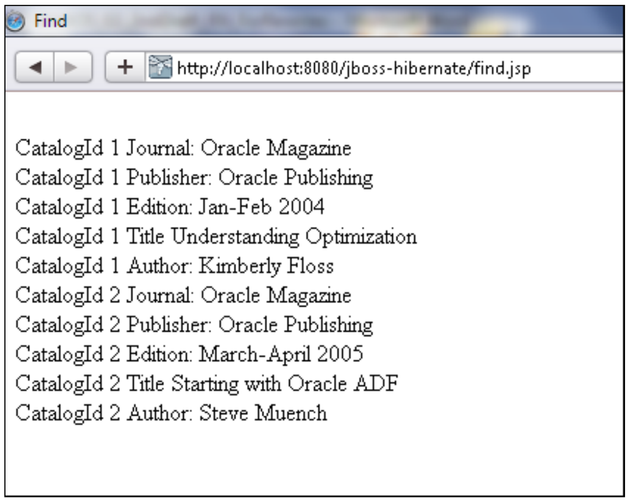
Data gets added to the `CATALOG` table. A `SELECT` query in the MySQL command line lists the `CATALOG` table in the manner shown in the following screenshot:


Administrator: C:\Windows\system32\cmd.exe - mysql -u root -p

```
mysql>
mysql> SELECT * FROM CATALOG;
+----+-----------------+-------------------+------------------+-----------------
-----------+----------------+
| ID | JOURNAL         | PUBLISHER         | EDITION          | TITLE
           | AUTHOR         |
+----+-----------------+-------------------+------------------+-----------------
-----------+----------------+
|  1 | Oracle Magazine | Oracle Publishing | Jan-Feb 2004     | Understanding Op
timization | Kimberly Floss |
|  2 | Oracle Magazine | Oracle Publishing | March-April 2005 | Starting with Or
acle ADF   | Steve Muench   |
+----+-----------------+-------------------+------------------+-----------------
-----------+----------------+
2 rows in set (0.00 sec)

mysql> _
```

Retrieving table data

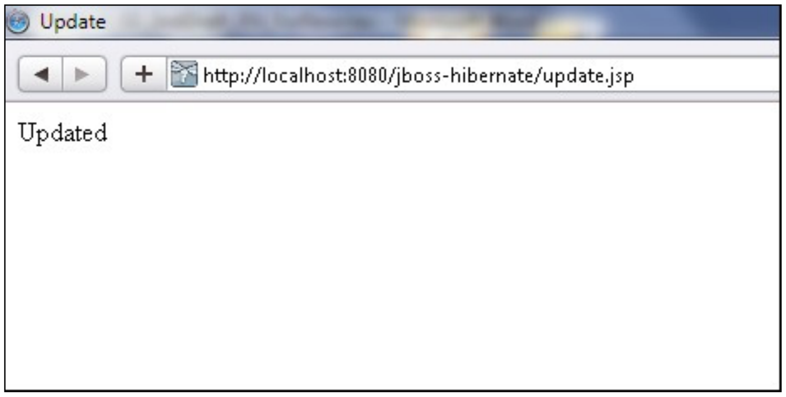
In this section, we will run `find.jsp` to get and display the `CATALOG` table data. Invoke the URL `http://localhost:8080/jboss-hibernate/find.jsp`, as shown in the following screenshot. The `CATALOG` table data gets output in the browser.



```
CatalogId 1 Journal: Oracle Magazine
CatalogId 1 Publisher: Oracle Publishing
CatalogId 1 Edition: Jan-Feb 2004
CatalogId 1 Title Understanding Optimization
CatalogId 1 Author: Kimberly Floss
CatalogId 2 Journal: Oracle Magazine
CatalogId 2 Publisher: Oracle Publishing
CatalogId 2 Edition: March-April 2005
CatalogId 2 Title Starting with Oracle ADF
CatalogId 2 Author: Steve Muench
```

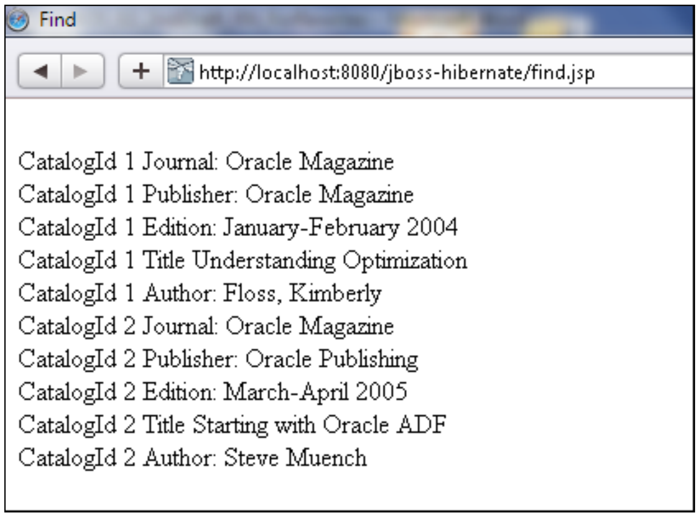
Updating the table

In this section, we will update the `CATALOG` table. Invoke the URL `http://localhost:8080/jboss-hibernate/update.jsp`, as shown in the following screenshot. The `CATALOG` table gets updated.



```
Updated
```

Run `find.jsp` to get and display the updated `CATALOG` table data. Invoke the URL `http://localhost:8080/jboss-hibernate/find.jsp`, as shown in the following screenshot:

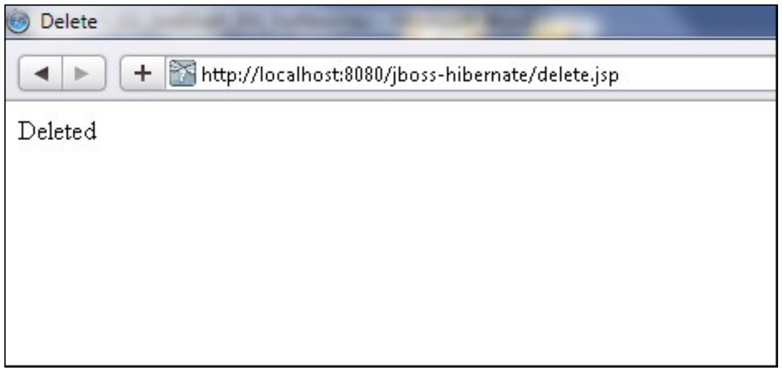


```
CatalogId 1 Journal: Oracle Magazine
CatalogId 1 Publisher: Oracle Magazine
CatalogId 1 Edition: January-February 2004
CatalogId 1 Title Understanding Optimization
CatalogId 1 Author: Floss, Kimberly
CatalogId 2 Journal: Oracle Magazine
CatalogId 2 Publisher: Oracle Publishing
CatalogId 2 Edition: March-April 2005
CatalogId 2 Title Starting with Oracle ADF
CatalogId 2 Author: Steve Muench
```

Deleting the table row

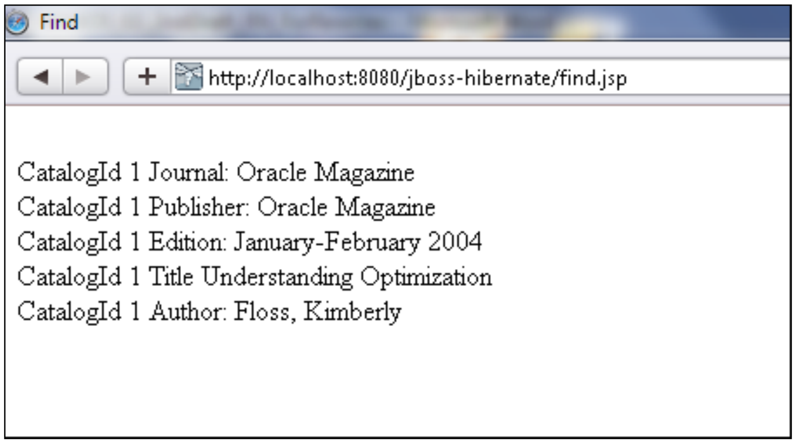
In this section, we will delete a table row with the `delete.jsp` file. To accomplish this, perform the following steps:

1. Invoke the URL `http://localhost:8080/jboss-hibernate/delete.jsp`, as shown in the following screenshot. A table row gets deleted from `CATALOG`.



```
Deleted
```

2. Run `find.jsp` again to list the updated `CATALOG` table with a row deleted. The output in the browser is shown in the following screenshot:



```
CatalogId 1 Journal: Oracle Magazine
CatalogId 1 Publisher: Oracle Magazine
CatalogId 1 Edition: January-February 2004
CatalogId 1 Title Understanding Optimization
CatalogId 1 Author: Floss, Kimberly
```

Summary

In this chapter, we created a CRUD application with the Hibernate API.
We configured Hibernate using `hibernate.cfg.xml`. We mapped the persistence class`Catalog` to a MySQL database table with mapping specified in `catalog.hbm.xml`.We compiled and packaged the Hibernate web application with the Maven build tool. We ran the web application on the WildFly 8 server to export a schema to the MySQL database and created, retrieved, updated, and deleted table data. We used hardcoded `set`, `get`, `update`, and `delete` operations, but a more dynamic CRUD application can be created with user interfaces.
.