

Department of Computer  
and Systems Sciences  
SU / KTH

# ***COMPONENT BASED DEVELOPMENT WITH ENTERPRISE JAVABEANS COMPENDIUM***

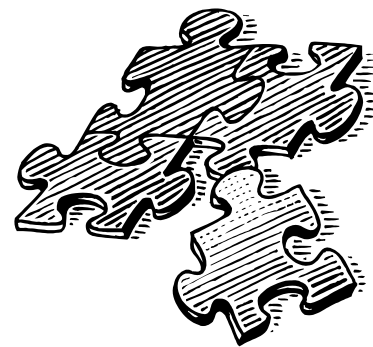
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Model driven development of components

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<http://L238.dsv.su.se:86/courses/IS7/>



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# 1 Introduction

This compendium contains the following:

- An introduction to the JBoss J2EE server and its facilities for deploying and running EJBs
- A short presentation of the database used by some of the EJBs in the exercises
- Step-by-step exercises for creating, deploying, running and testing EJBs
- Assignments

It is recommended that you read through the entire compendium before beginning with the exercises. It is of course necessary to have some basic understanding of Microsoft Windows, Relational Databases (and SQL), Java, Component Based Development (CBD) and the EJB architecture/component model. For the last two the following reading is recommended prior to reading this compendium:

- Lecture notes on CBD and EJB by Martin Henkel
- The J2EE Tutorial by SUN

## 1.1 Homepage

Information about this compendium can be found here:

<http://L238.dsv.su.se:86/courses/IS7>

The following can be found at this address:

- Files - The latest version of the compendium and all the files needed to complete the exercises in the compendium.
- FAQ - Here there is a list of corrections and explanations.
- Links - Internet resources that can be helpful when working with the compendium.

## 1.2 The environment

For completing the exercises in this compendium we will use the following facilities/software:

- Lite version of JBoss that is used to run EJBs
- MSAccess used for the example database
- ODBC driver/manager used for accessing the database from the EJBs
- Java tools (compiler, jar-tool)
- Command prompt (execution of commands, etc.)
- Text editor (of your choice) for editing of batch files, java source code and XML files

Most of this environment does not require any particular configuration. JBoss needs some configuration. How to set up the necessary environment for JBoss is described in chapter 2.

# 2 JBoss and EJB

In this chapter we will set up the necessary environment for deploying and running the EJBs that we will create later. We will also take a look on the specific details of JBoss that are relevant for EJB deployment.

## 2.1 Installing JBoss

The standard version of JBoss is quite large since it includes a lot more than what we need for the exercises in this compendium. Therefore, we have created a lite version that only includes the necessary components (the JBoss Java engine and the EJB container). This version of JBoss is zipped in a file named JBossIS7.zip and can be downloaded from the following locations:

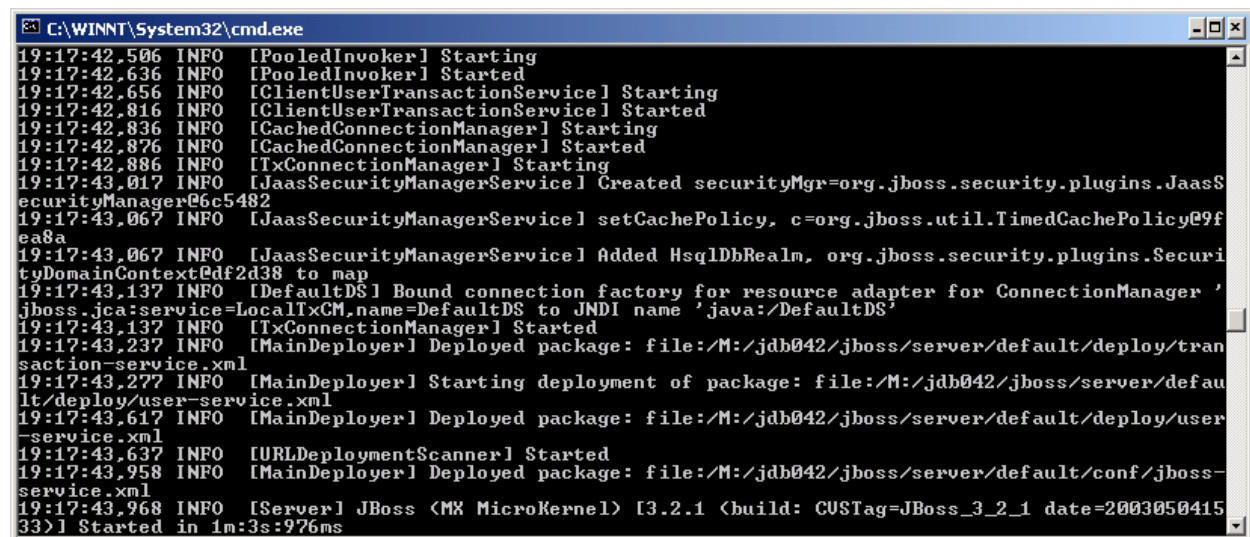
- \\DB-SRV-1\StudKursInfo\IS7 ht2003\CBDwithEJB\JBossIS7.zip
- <http://L238.dsv.su.se:86/courses/IS7/JBossIS7.zip>

By just extracting the contents of the file at your home directory (normally found under M:), you get a working JBoss installation.

## 2.2 Starting JBoss

To start the JBoss server just execute the file `run.bat` that is located in the directory `jboss\bin` (relative to where you extracted the `JBossIS7.zip`). In the rest of this compendium we will assume that JBoss resides at `M:\jdb042\jboss`. In this case `jdb042` represents the current user-name. You will simply have to replace `jdb042` with your user-name to acquire the correct paths.

Starting the JBoss server takes approximately 1 minute. A command prompt window (JBoss's standard output) will during this time show the progress of loading the server and deploying configuration files and other java components (for example the EJB container). When the server has finished loading a message will appear stating that JBoss has started:



```
C:\WINNT\System32\cmd.exe
19:17:42,506 INFO [PooledInvoker] Starting
19:17:42,636 INFO [PooledInvoker] Started
19:17:42,656 INFO [ClientUserTransactionService] Starting
19:17:42,816 INFO [ClientUserTransactionService] Started
19:17:42,836 INFO [CachedConnectionManager] Starting
19:17:42,876 INFO [CachedConnectionManager] Started
19:17:42,886 INFO [TxConnectionManager] Starting
19:17:43,017 INFO [JaasSecurityManagerService] Created securityMgr=org.jboss.security.plugins.JaasSecurityManager@6c5482
19:17:43,067 INFO [JaasSecurityManagerService] setCachePolicy, c=org.jboss.util.TimedCachePolicy@9f
ea8a
19:17:43,067 INFO [JaasSecurityManagerService] Added HsqlDbRealm, org.jboss.security.plugins.SecurityDomainContext@df2d38 to map
19:17:43,137 INFO [DefaultDS] Bound connection factory for resource adapter for ConnectionManager '
jboss.jca:service=LocalTxCM,name=DefaultDS to JNDI name 'java:/DefaultDS'
19:17:43,137 INFO [TxConnectionManager] Started
19:17:43,237 INFO [MainDeployer] Deployed package: file:/M:/jdb042/jboss/server/default/deploy/transaction-service.xml
19:17:43,277 INFO [MainDeployer] Starting deployment of package: file:/M:/jdb042/jboss/server/default/deploy/user-service.xml
19:17:43,617 INFO [MainDeployer] Deployed package: file:/M:/jdb042/jboss/server/default/deploy/user-service.xml
19:17:43,637 INFO [URLDeploymentScanner] Started
19:17:43,958 INFO [MainDeployer] Deployed package: file:/M:/jdb042/jboss/server/default/conf/jboss-service.xml
19:17:43,968 INFO [Server] JBoss (MX MicroKernel) [3.2.1 (build: CUSTag=JBoss_3_2_1 date=200305041533)] Started in 1m:3s:976ms
```

This window is now locked by JBoss. To stop the server press Ctrl-C while the window is active. Closing the window will have a similar effect to pressing Ctrl-C, but Windows may start complaining of the process not responding. It is therefore best to use Ctrl-C to shut down the JBoss server.

JBoss will use this window for any messages during run-time. For example EJB deployment done while the server is running will produce a message in this window. *Also, server error messages appear in this window*, so make sure to keep an eye on the message window.

At this point it is also important to know that the JBoss server listens on port 1099. The server should have confirmed this during start-up with this message:

```
INFO [NamingService] Listening on port 1099
```

This is very useful information that we need when we later build java programs that need to access the JBoss server.

## **2.3 Deploying EJBs**

To deploy an EJB in JBoss we need a jar file containing

1. The EJB bean class
2. The applicable interfaces (home and remote) for the EJB
3. All necessary helper classes, such as data classes and exception classes
4. A deployment descriptor for the EJB

The jar file only needs to be placed in the `jboss\server\default\deploy` directory. The JBoss Server will then deploy it automatically. The reverse is also possible: Removing a deployed jar file from this directory will cause JBoss to undeploy it.

# **3 Database and ODBC**

In the exercises in chapter 4 we will create EJBs. Some of them will provide business logic that requires a database. To illustrate this database functionality we will use a sample database. This chapter describes this database.

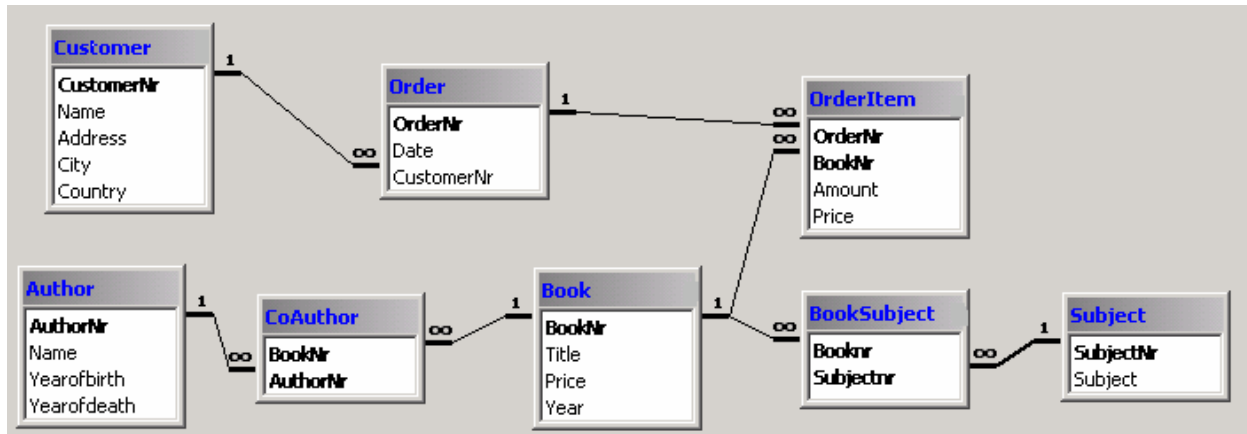
## **3.1 The Book Database**

The database is an MS Access database named `book.mdb`. The database file can be downloaded from

- `\\DB-SRV-1\StudKursInfo\IS7 ht2003\CBDwithEJB\book.mdb`
- `http://L238.dsv.su.se:86/courses/IS7/book.mdb`

Download a copy of the database and place it on your home directory!

The figure bellow shows the tables included in the database and their relationships:



**Figure 1 Book database**

The main entities of the database are the customers and the books. Customers place orders that contain one or more orderitems. Each orderitem represents one book in one or more copies (attribute amount). Each book has a title, a year (of publishing) and a current price. (Since this is the current price the actual price at the time of an order is stored in OrderItem.) Each book has one or more authors and one or more subjects.

The database is populated with enough data for our simple testing purposes. MS Access can be used to browse and edit the database.

## 4 Exercises

In this chapter we will go through the entire process of creating, deploying and running/testing 3 EJBs. The first one (section 4.1) will be a simple "Hello World" EJB, while the next two (section 4.2) will provide some basic database functionality. All the files needed for the exercises in this chapter as well as the result files of the exercises (completed) are available here:

- \\DB-SRV-1\StudKursInfo\IS7 ht2003\CBDwithEJB
- <http://L238.dsv.su.se:86/courses/IS7>

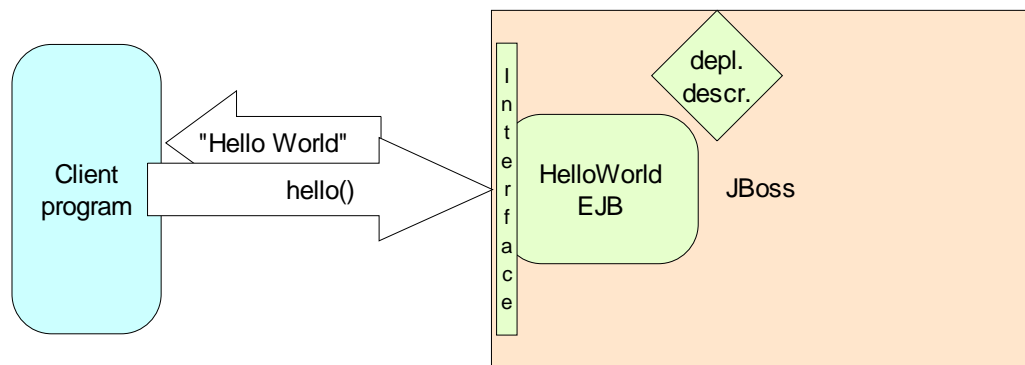
The files used in the exercises in this chapter can be reused as templates for the assignments and the project work!

The exercises that follow contain quite a lot of java code. A good way to work with the step-by-step descriptions of creating the necessary java files is to open this compendium in MS Word and then copy and paste the java code from the compendium into the appropriate java files. Another possibility is, of course, to just download the complete files one by one and place them in the appropriate directories.

The exercises also include compiling, packaging, copying and running files. There are batch files that help with those operations and they are also available for download. These batch files need to be edited so that the correct home directory is defined.

## 4.1 Hello World

In this exercise we will create an EJB component that simply returns a string "Hello World" when its only business method `hello()` is called. Our EJB will be a stateless session bean and will only allow remote access. The following figure outlines the structure of the "full Hello World system":

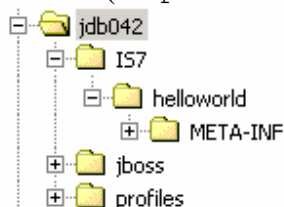


**Figure 2** Hello World system outline

In short here is what we have to do:

- Create a java class `HelloWorldBean` where the method `hello()` will be implemented.
- Create a home interface `HelloWorldHome` with the signatures of the create methods.
- Create a remote interface `HelloWorld` with the signatures of the business methods.
- Create a deployment descriptor file `ejb-jar.xml`.
- Package our EJB in a jar file and deploy it.
- Create a test client for our EJB.
- Run the test client.

Before we begin programming we have to decide a package structure. As the root package we will use `IS7`. Under this we will have a package `helloworld` where all the files for the EJB will be. So we have to create two directories `IS7` and `helloworld`. We can put them under `M:/jdb042`. In the directory `helloworld` we will place the interfaces and the bean class of the EJB and a directory `META-INF` where the deployment descriptor will be placed. We should have the following directory structure (the `profiles` directory should already be available at your home directory!):



#### 4.1.1 Bean class

So let's start with the class HelloWorldBean:

1. Create a file HelloWorldBean.java (in IS7\helloworld) and open it for editing (for example in SciTE or NetObjects ScriptBuilder)!
2. Define the package: `package IS7.helloworld;`
3. Define the class: `public class HelloWorldBean implements javax.ejb.SessionBean {}`
4. The session bean must implement at least one `ejbCreate()` method (A stateless session bean can only contain one `ejbCreate()` method which cannot take any arguments). In our case it's enough with an empty one: `public void ejbCreate() {}`
5. We also need to implement our business method `hello()`:  

```
public String hello()
{
    return "Hello World!";
}
```
6. All session beans must also implement the following methods (that in this case can be left empty):  

```
public void ejbRemove() {}
public void ejbActivate() {}
public void ejbPassivate() {}
public void setSessionContext(javax.ejb.SessionContext ctx) {}
```

The complete content of the HelloWorldBean.java should be the following:

```
package IS7.helloworld;

public class HelloWorldBean implements javax.ejb.SessionBean
{
    public void ejbCreate() {}
    public void ejbRemove() {}
    public void ejbActivate() {}
    public void ejbPassivate() {}
    public void setSessionContext(javax.ejb.SessionContext ctx) {}

    public String hello()
    {
        return "Hello World!";
    }
}
```

7. The session bean HelloWorldBean is now complete and can be compiled! In order to compile it the compiler must know where the necessary EJB framework classes can be found. (They are available in the file M:\jdb042\jboss\server\default\lib\jboss-j2ee.jar.)



In a new command prompt window move to your home directory (cd M:\jdb042 and M:) and compile the session bean with the following command:  
javac IS7\helloworld\\*.java -classpath jboss\server\default\lib\jboss-j2ee.jar

#### 4.1.2 Home interface

Next we have to create a home interface for our session bean:

8. Create a file HelloWorldHome.java (in IS7\helloworld) and open it for editing!
9. Define the package: `package IS7.helloworld;`
10. Define the interface: `public interface HelloWorldHome extends javax.ejb.EJBHome {}`
11. This interface must contain a `create()` method for each `ejbCreate()` method in the class HelloWorldBean. These `create()` methods, unlike the `ejbCreate()` methods, must return an instance of the remote interface HelloWorld (that we have not yet defined) and must also throw a `RemoteException` and a `CreateException`:  
`HelloWorld create() throws java.rmi.RemoteException, javax.ejb.CreateException;`
12. Our home interface is now ready, but we cannot compile it until we have the remote interface.

The complete content of the HelloWorldHome.java should be the following:

```
package IS7.helloworld;

public interface HelloWorldHome extends javax.ejb.EJBHome
{
    HelloWorld create() throws java.rmi.RemoteException,
                          javax.ejb.CreateException;
}
```

#### 4.1.3 Remote interface

Naturally we must now define the remote interface HelloWorld:

13. Create a file HelloWorld.java (in IS7\helloworld) and open it for editing!
14. Define the package: `package IS7.helloworld;`
15. Define the interface: `public interface HelloWorld extends javax.ejb.EJBObject {}`  
This interface must contain the signatures of all business methods defined in the session bean. All the business methods must in this interface throw a `RemoteException`. In our case there is only the method `hello()`:  
`public String hello() throws java.rmi.RemoteException;`
16. Now that both interfaces are ready and in place we can compile them (using the same compiler command as before).

The complete content of the `HelloWorld.java` should be the following:

```
package IS7.helloworld;

public interface HelloWorld extends javax.ejb.EJBObject
{
    public String hello() throws java.rmi.RemoteException;
}
```

#### 4.1.4 Deployment descriptor

The final component of our EJB before we can deploy it is the deployment descriptor. This is a simple xml file that tells the JBoss server the names and locations of the session bean and its interfaces.

17. Create a directory `META-INF` (in `IS7\helloworld`)!

18. Create a file `ejb-jar.xml` (in `IS7\helloworld\META-INF`) and open it for editing!

19. This is an xml document so it has to start with the two standard xml directives. (The EJB deployment descriptor is defined by SUN. The full dtd can be found at <http://java.sun.com/dtd/>):

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar
    PUBLIC "-//Sun Microsystems, Inc.//DTD Enterprise JavaBeans 2.0//EN"
    'http://java.sun.com/dtd/ejb-jar_2_0.dtd'>
```

20. The root element is `<ejb-jar>` and it contains all the necessary elements for defining the components of one or more EJBs. The main two sub-elements are `<enterprise-beans>` and `<assembly-descriptor>`. The first one is where the components and type of the EJBs are specified, while the second one contains security and transaction information for the EJBs and their methods. The elements `<description>` and `<display-name>` can also be used for providing useful information. Here is the content of the `<ejb-jar>` element for the `HelloWorld` EJB:

```
<description>
    Hello World EJB as part of the CBD with EJB compendium for IS7 ht2003
</description>
<display-name>Hello World EJB</display-name>
<enterprise-beans>
    <session>
        <ejb-name>HelloWorld</ejb-name>
        <home>IS7.helloworld.HelloWorldHome</home>
        <remote>IS7.helloworld.HelloWorld</remote>
        <ejb-class>IS7.helloworld.HelloWorldBean</ejb-class>
        <session-type>Stateless</session-type>
        <transaction-type>Container</transaction-type>
    </session>
</enterprise-beans>
<assembly-descriptor>
```

```
<container-transaction>
  <method>
    <ejb-name>HelloWorld</ejb-name>
    <method-name>*</method-name>
  </method>
  <trans-attribute>Required</trans-attribute>
</container-transaction>
</assembly-descriptor>
```

This defines a stateless (<session-type>) session EJB (<session>) with container managed transactions (<transaction-type>). It also defines that all (\*) the methods (<method-name>) must be within transactions (<trans-attribute>).

#### 4.1.5 Packaging and deployment

21. Start the JBoss server if it is not already running! (This will make sure that deployment error messages appear after all start up messages of the server)
22. With the deployment descriptor file ready, we have all necessary files for packaging and deploying the HelloWorld EJB. The only thing we need to do is put all the files in a jar file (packaging) HelloWorldJAR.jar and copy it to the deployment area of JBoss (deployment) (the directory jboss\server\default\deploy). We do the packaging with the following commands:

```
jar cMvf HelloWorldJAR.jar IS7\helloworld\*.class
jar uMvf HelloWorldJAR.jar -C IS7\helloworld META-INF\ejb-jar.xml
```

The first command adds the class files to a new jar file (the first c in the command stands for create). The second command adds the deployment descriptor to the jar file (updates the jar file – u stands for update).

23. The EJB is now packaged and we can deploy it with the following command:  
copy HelloWorldJAR.jar jboss\server\default\deploy

This command simply copies the jar file to JBoss which automatically deploys it. If JBoss was not running, the EJB would be deployed when JBoss started.

24. Check for any deployment error or warnings at the JBoss server window
25. At this point the HelloWorld EJB is available to clients. The only thing missing is a test client. In order to develop our test client we need to know the interfaces (home and remote) of the EJB. Since the developer of the EJB and the developer of the clients accessing it aren't necessarily the same, we have to assume that the developer of the client does not have access to the original IS7.helloworld package. Therefore we can create a jar file with the two interfaces and make it available to the client developers. We can call it HelloWorldInterface.jar and we can create it with the following command:

```
jar cMvf HelloWorldInterface.jar IS7\helloworld\HelloWorld.class
IS7\helloworld\HelloWorldHome.class
```

#### 4.1.6 Test client

Taking now the role of the client developer we only have access to the HelloWorldInterface.jar. We also know that it is deployed on a JBoss server listening on port 1099. In order to access JBoss and the HelloWorld EJB we need to use the following classes:

```
javax.naming.Context  
javax.naming.InitialContext  
javax.rmi.PortableRemoteObject
```

26. We can start developing our test client by defining the package and class name. We will use a package `test` and call the class `HelloWorldTestClient`.

27. Create a directory `test` at your home directory (in our case `M:\jdb042\test`)!

28. Create a new file `HelloWorldTestClient.java` (in the directory `test`) and open it for editing!

29. Define the package: `package test;`

30. Import the necessary classes:

```
import javax.naming.Context;  
import javax.naming.InitialContext;  
import javax.rmi.PortableRemoteObject;  
import IS7.helloworld.*;
```

31. Define the class: `public class HelloWorldTestClient {}`

32. We only need a `main()` method, so we can start by defining it:

```
public static void main(String[] args) { }
```

Inside the `main()` method we will need to first establish a context (a description of how to access the server), then using this context look up the HelloWorld EJB, then request an instance of the session bean on which we can finally call the business method `hello()`. We start by creating a context and setting up its environment (We do all this within a `try` clause since there are possible exceptions). The values below are adjusted for our configuration of JBoss and only for running the client on the same machine as the JBoss server:

```
try  
{  
    Context ctx = new InitialContext();  
    ctx.addToEnvironment(Context.INITIAL_CONTEXT_FACTORY,  
                          "org.jnp.interfaces.NamingContextFactory");  
    ctx.addToEnvironment(Context.PROVIDER_URL, "127.0.0.1:1099");  
    //instead of 127.0.0.1 you can use localhost  
    ctx.addToEnvironment("java.naming.factory.url.pkgs",  
                          "org.jboss.naming:org.jnp.interfaces");  
}
```

33. Still inside the `try` block we have to ask the context to look up the HelloWorld EJB. The context will return an object which we can (in a bit unusual way) cast into an instance of the

HelloWorldHome interface. Using this instance we can call the `create()` method to acquire an instance of the HelloWorld interface:

```
Object obj = ctx.lookup("HelloWorld");
HelloWorldHome home = (HelloWorldHome)
    PortableRemoteObject.narrow(obj, HelloWorldHome.class);
HelloWorld helloWorld = home.create();
```

34. The last thing to do before the end of the `try` block is to call the business method `hello()`. We can for example print the result of the `hello()` method:

```
System.out.println(helloWorld.hello());
```

35. We can now finish the `try` block and add a `catch` block to print any unexpected exception:

```
} //end of try block
catch (Exception ex)
{
    System.err.println("Caught an unexpected exception!");
    ex.printStackTrace();
}
```

The complete content of the `HelloWorldTestClient.java` should be the following:

```
import javax.naming.InitialContext;
import javax.naming.Context;
import javax.rmi.PortableRemoteObject;
import IS7.helloworld.*;

public class HelloWorldTestClient
{
    public static void main(String[] args)
    {
        try
        {
            Context ctx = new InitialContext();
            ctx.addToEnvironment(Context.INITIAL_CONTEXT_FACTORY,
"org.jnp.interfaces.NamingContextFactory");
            ctx.addToEnvironment(Context.PROVIDER_URL,
"127.0.0.1:1099");//instead of 127.0.0.1 you can use localhost
            ctx.addToEnvironment("java.naming.factory.url.pkgs",
"org.jboss.naming:org.jnp.interfaces");

            Object obj = ctx.lookup("HelloWorld");

            HelloWorldHome home = (HelloWorldHome)
PortableRemoteObject.narrow(obj, HelloWorldHome.class);
            HelloWorld helloWorld = home.create();

            System.out.println(helloWorld.hello());
        }
        catch (Exception ex)
        {
            System.err.println("Caught an unexpected exception!");
            ex.printStackTrace();
        }
    }
}
```

36. We are now ready to compile and run our test client. In order to compile the test client we need the classes that we have imported and some classes included in the EJB framework. All the classes are available in the following two jar files:

`HelloWorldInterface.jar`  
`jboss\client\jbossall-client.jar`

We can compile our test client with the following command:

```
javac test\HelloWorldTestClient.java -classpath jboss\client\jbossall-
client.jar;HelloWorldInterface.jar
```

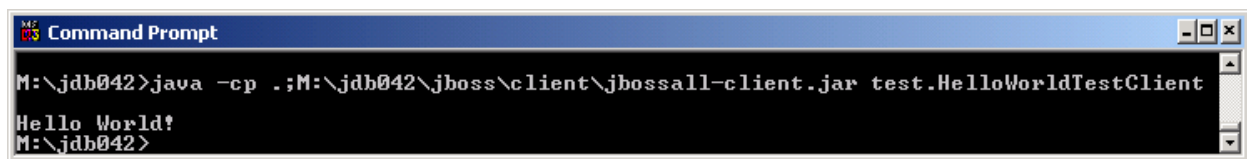
37. To run the test client we only need to have

- the classes necessary for the environment of the context, which are all included in the following jar file: `jboss\client\jbossall-client.jar`
- the jar file with the home and remote interfaces of the EJB. (We used the same jar file when we compiled our test client)

We can run our test client with the following command:

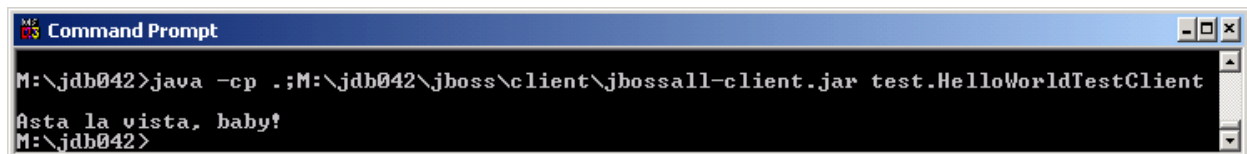
```
java -cp .;jboss\client\jbossall-client.jar;HelloWorldInterface.jar  
test.HelloWorldTestClient
```

Running the test client will cause the message "Hello World!" to be printed:



```
Command Prompt  
M:\jdb042>java -cp .;M:\jdb042\jboss\client\jbossall-client.jar test.HelloWorldTestClient  
Hello World!  
M:\jdb042>
```

Should we change something in the implementation of our HelloWorld EJB, the client would not be affected. We can for example change the message returned by the business method `hello()` to "Asta la vista, baby!" and run the client:



```
Command Prompt  
M:\jdb042>java -cp .;M:\jdb042\jboss\client\jbossall-client.jar test.HelloWorldTestClient  
Asta la vista, baby!  
M:\jdb042>
```

#### 4.1.7 Learning by errors

J2EE servers and EJB development is complex, you are bound to run into some kind of problems sooner or later. Once you master the theoretical foundation of component based development and EJB most problems are easy to solve. An excellent way of learning the fundamentals of EJB is to learn from mistakes. To learn from mistakes, you have to focus not only on solving the problem, but also dig deeper into the cause of the problem.

In this section we will introduce errors into the simple HelloWorld bean, your task is to explain why the errors occurs/why not and when (not as easy as it seems).

##### *Syntax errors*

1. Make sure that the helloworld bean and its test client work as described in previous sections.
2. Introduce a syntax error into the Bean class, for instance just write "hgdgaj" into the code somewhere.
3. Compile the bean (of course, this will give you a compiler error).
4. Run the testclient – It still works!, explain why!

### ***Home interface error***

5. Remove the introduced error, compile the bean to make sure the error is removed.
6. Introduce a error by changing the name of the home interface to `HelloWorldHome2`
7. Answer the following question: When will the introduced error be discovered?
  - a) when the bean is compiled
  - b) when the bean in packaged
  - c) when the bean is deployed
  - d) when running the test clientAlso, explain what in the EJB design that makes you think that your answer will be the right one.
8. Compile, package, deploy and run the bean to find out the right answer. Explain the behavior.

### ***Remote interface error***

9. Remove the introduced error.
10. Introduce a new error by changing the name of the remote interface to `HelloWorld2`.
11. Answer the same question as before, find out the right answer, explain it (why are the answer not the same for this error and the previous one?).

### ***Bean class error***

12. Remove the introduced error.
13. Add a parameter to the method `hello()` in the bean class (for instance `public String hello(String name)`)
14. Answer the same question as before, find out the right answer, explain it.

### ***Deployment descriptor error***

15. Remove the introduced error.
16. Change the `<ejb-name>HelloWorld</ejb-name>` to `<ejb-name>HelloWorld2</ejb-name>` in the deployment descriptor.
17. Answer the same question as before, find out the right answer by compiling, packaging, deploying and testing the bean, explain the answer.

## **4.2 Database EJBs**

Now that we have familiarized ourselves with JBoss and to the basic EJB structure, let's try to do something that benefits from the use of EJBs.

In the sections that follow we will create two EJB components that work against the database described in chapter 3. The first one will retrieve data (about books) from the database and the second one will insert a new customer into the database. In order to transfer the data between the client and the server we will need some data classes (so that we can send a book object instead of just strings and other simple objects). In section 4.2.3 we will define those data classes that we will later use when developing the EJBs and test clients. We will also need to configure our JBoss server to access the database. We will do this in section 4.2.1 and 4.2.2.



It is also necessary to decide the package structure for our EJBs and data classes. We will use the same root package as before (IS7) and under this we will create a new package `bookdb`. In this package we will place our data classes and one sub-package for each EJB. We will place the test client in the package `test` (as before).

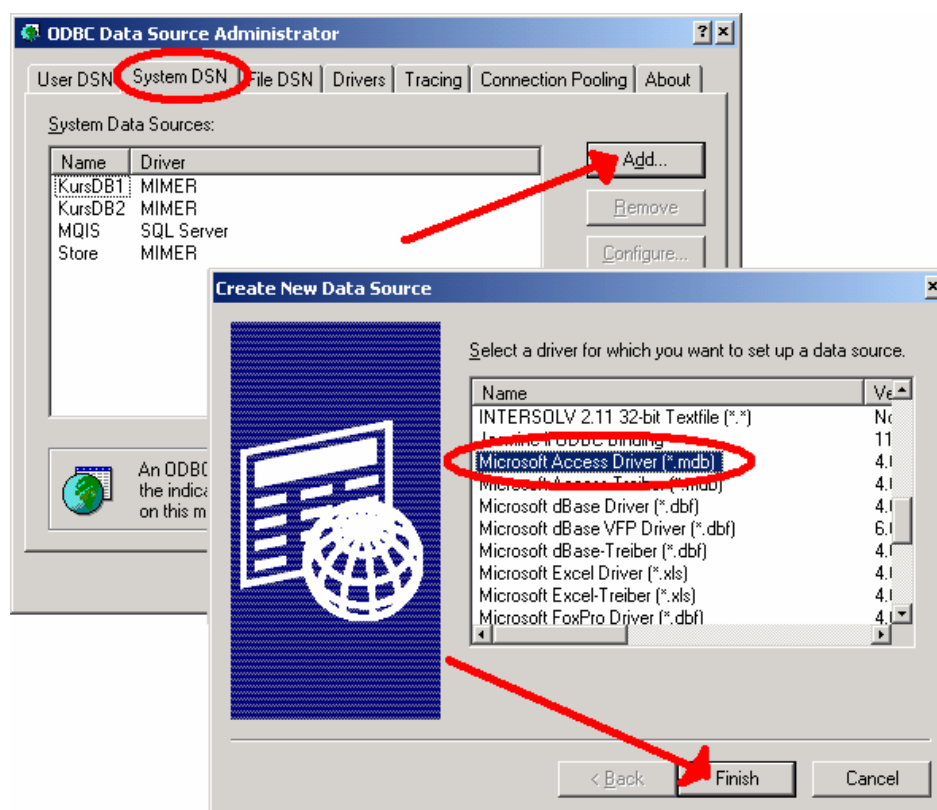
#### 4.2.1 Creating an ODBC Data Source

In order to connect to an MS Access database from a java program we need a driver. Since there is no native java driver for MS Access we will use an ODBC driver. In order to make our database available through an ODBC driver, we have to register it with the ODBC Data Source Administrator that is part of Windows. To invoke the ODBC Data Source Administrator execute the following file (for example through Start→Run...):

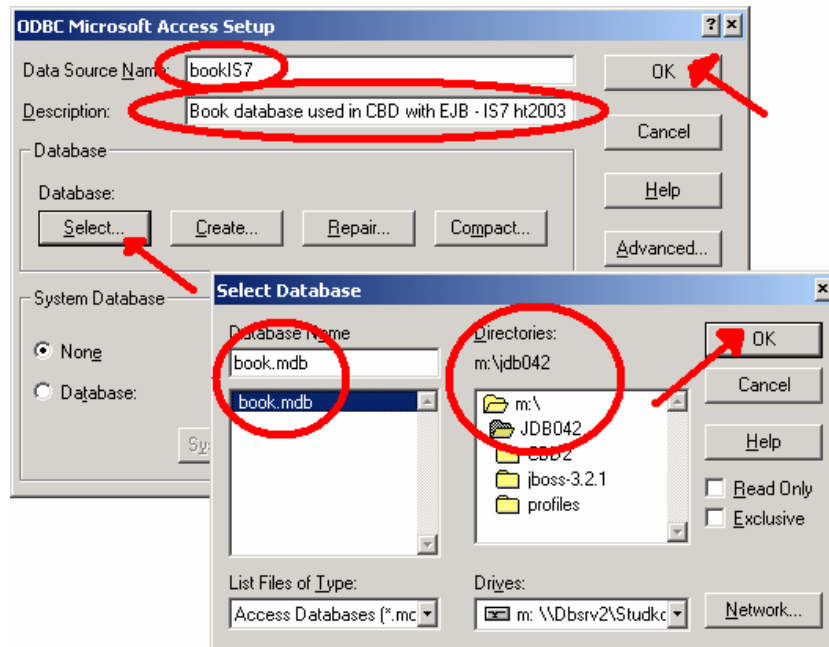
```
C:\WINNT\system32\odbcad32.exe
```

This will bring you to the ODBC Data Source Administrator.

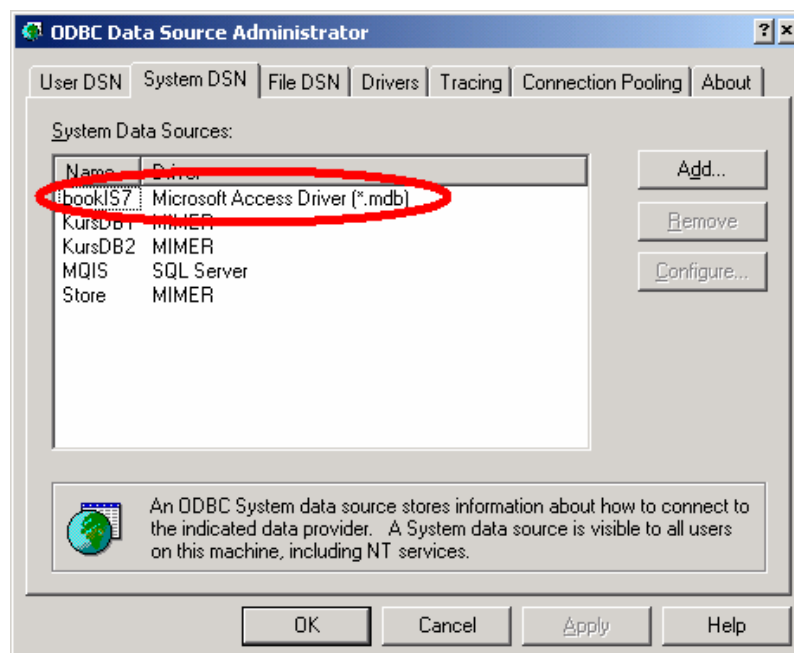
Create an ODBC alias (also known as DSN – Data Source Name) in the System DSN tab:



You can now give a name and a short description to your DSN and also select a database file to associate to this DSN:



The new DSN should now be available under System DSN:



The database is now available through an ODBC driver and it is mapped to the alias bookIS7. In the next section we will configure our JBoss connection pool for this ODBC data source.

### 4.2.2 Configuring JBoss connection pool

In this section we will define the database connection pool properties. These properties are stored in the local jndi dictionary. This is done in an xml file that is then placed in the deploy directory of JBoss! This xml is called `msaccess-ds.xml` and it must have a root element `<datasources>`. This element can contain zero or more `<local-tx-datasource>` elements. We will need one such element for our book database according to the following:

```
<local-tx-datasource>
  <jndi-name>jdbc/BookDB</jndi-name>
  <!-- format of URL is "jdbc:odbc:DSNNAME" -->
  <connection-url>jdbc:odbc:BookIS7</connection-url>
  <driver-class>sun.jdbc.odbc.JdbcOdbcDriver</driver-class>
  <user-name></user-name>
  <password></password>
  <min-pool-size>0</min-pool-size>
  <max-pool-size>5</max-pool-size>
</local-tx-datasource>
```

Download the file `msaccess-ds.xml` and place it in the directory `jboss\server\default\deploy`. The file can be downloaded from here:

- `\\DB-SRV-1\StudKursInfo\IS7 ht2003\CBDwithEJB\msaccess-ds.xml`
- `http://L238.dsv.su.se:86/courses/IS7/msaccess-ds.xml`

It is important to check that the ODBC DSN alias is the same as the DSNNAME (the part after `jdbc:odbc:`) in the `<connection-url>` element. The `jndi-name` is the name we will use in the java code on order to find the database.

### 4.2.3 Data Classes

The database contains eight tables, so we could think that we need eight data classes. Since our EJBs are only going to be using book objects and customer objects it is enough to create data classes for those two types of objects.

Let's start with a data class for book objects called `Book`!

1. Create a new file `Book.java` (or download it) in the directory `IS7\bookdb` and open it for editing!
2. Define the package: `package IS7.bookdb;`
3. Define the class: `public class Book implements java.io.Serializable {}`

***Notice that it must implement the `java.io.Serializable` Interface in order for the instances to be transmittable between the server and the client!***

4. Define a private field for each interesting field/relation in the database:  
`private int booknr;`  
`private String title;`  
`private int price;`

```
private int year;
```

Here we could create, for example, vectors of strings for the subjects or the author names, but let's keep it simple. The four fields above will be enough in this exercise.

5. Define getters and setters for the four fields:

```
public int getBooknr() {return booknr;}
public String getTitle() {return title;}
public int getPrice() {return price;}
public int getYear() {return year;}
public void setBooknr(int value) {booknr = value;}
public void setTitle(String value) {title = value;}
public void setPrice(int value) {price = value;}
public void setYear(int value) {year = value;}
```

6. Define the following constructors:

```
public Book() {}
public Book(int booknr, String title, int price, int year)
{
    this.booknr=booknr;
    this.title=title;
    this.price=price;
    this.year=year;
}
```

7. Book.java is now complete. Compile it with the following command:

```
javac IS7\bookdb\Book.java
```

We can now create the other data class:

8. Create (or download it ready!) a new file Customer.java (in IS7\bookdb) and open it for editing!

9. Define its content according to the following:

```
package IS7.bookdb;

public class Customer implements java.io.Serializable
{
    private int customernr;
    private String name;
    private String address;
    private String city;
    private String country;
    //Here too, we could create a vector for Order objects, but we won't.

    public int getCustomernr() {return customernr;}
    public String getName() {return name;}
    public String getAddress() {return address;}
    public String getCity() {return city;}
    public String getCountry() {return country;}
    public void setCustomernr(int value) {customernr = value;}
    public void setName(String value) {name = value;}
    public void setAddress(String value) {address = value;}
    public void setCity(String value) {city = value;}
    public void setCountry(String value) {country = value;}
```

```
public Customer() {}  
public Customer(int customernr, String name, String address, String city,  
String country)  
{  
    this.customernr=customernr;  
    this.name=name;  
    this.address=address;  
    this.city=city;  
    this.country=country;  
}  
}
```

10. Customer.java is now complete and can be compiled with the following command:

```
javac IS7\bookdb\Customer.java
```

These two classes are now available for use in our EJBs and test clients.

#### 4.2.4 Retrieving Data

In this section we will create an EJB that will provide business methods for retrieving books from the database. Our EJB will return books given one of the following:

- nothing – return all books
- a subject – return all books about this subject
- a booknr – return the book with this booknr

In order to provide this functionality we will need to define 3 business methods (one for each type of request).

We can start by creating the package (directory) where our EJB will be. We will call this package bookmgr and the EJB BookMgr.

##### 4.2.4.1 Bean class

1. Create a directory bookmgr (in IS7\bookdb)!
2. Create a new file BookMgrBean.java (in IS7\bookdb\bookmgr) and open it for editing!
3. Define the package: `package IS7.bookdb.bookmgr;`
4. Define all necessary imports:  
`import IS7.bookdb.Book;`

We will probably have to add more imports here later. We will certainly need to import some classes that are necessary for our business methods.

5. Define the class: `public class BookMgrBean implements javax.ejb.SessionBean {}`
6. Define an empty ejbCreate() method: `public void ejbCreate() {}`
7. Define the rest of the necessary methods:

```
public void ejbRemove() {}  
public void ejbActivate() {}  
public void ejbPassivate() {}  
public void setSessionContext(javax.ejb.SessionContext ctx) {}
```

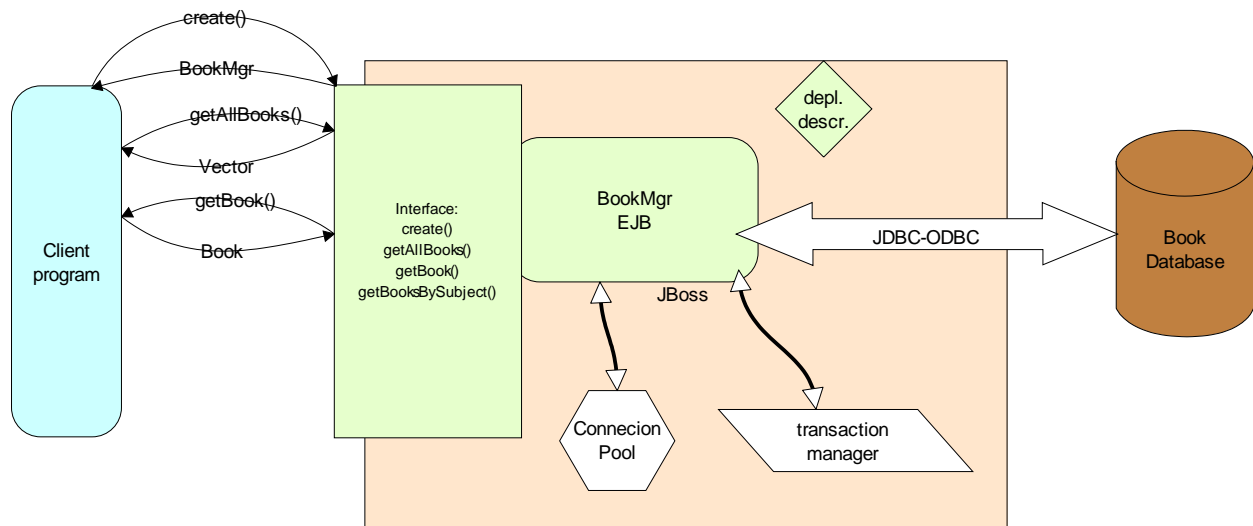
We have now completed the standard parts of the session bean. We must now define our business methods.

8. We can start by defining their signatures:

```
/** Returns a vector of Books containing all the books  
 * @return null when something goes wrong  
 */  
public Vector getAllBooks()  
  
/**Returns a vector of Books containing all the books about this subject  
 * @return null when something goes wrong  
 */  
public Vector getBooksBySubject(String subject)  
  
/**Returns the Book for the given booknr  
 * @return null when something goes wrong  
 */  
public Book getBook(int booknr)
```

9. In order to use the class Vector without qualifying it every time we must add an import for it:  
`import java.util.Vector;`

Before we start coding our business methods, let's take a look at the blueprint of our EJB:



**Figure 3 BookMgr system outline**

As we can see it is our EJB that contacts the database with any requests, but the connection to the database and the transactions associated to our EJB are handled by the JBoss server. That means that the EJB must request a database connection from the JBoss server and not directly from the

database. If we establish a connection directly to the database then any requests send on this connection would not be visible to the transaction manager of the JBoss server.

We also know that all of the business methods need access to the database. In order to avoid writing the same code (for requesting a connection from the connection pool) five times we can create a private method in our session bean that the business methods can use.

We can start by defining this method and then implement the business method that will call it.

10. Define a private method `getConnection()`:

```
private Connection getConnection()
{
    Connection con = null;
    try
    {
        Context jndiCtx = new InitialContext();
        DataSource ds = (javax.sql.DataSource)
            jndiCtx.lookup("java:/jdbc/BookDB");
        con = ds.getConnection();
        return con;
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
        System.err.println("getConnection failed." + ex.getMessage());
    }
    catch (NamingException e)
    {
        e.printStackTrace();
        System.err.println("lookup failed." + e.getMessage());
    }
    return null;
}
```

What we do is request a `Context` so that we can look up our database alias in the local dictionary (managed by the JBoss server) through the Java Naming and Directory Interface (`jndi`). From there we retrieve a `DataSource` which can provide us with the database connection which in turn we return. The method also catches two possible exceptions.

11. In the method defined above we used a number of classes. We must therefore add `import` statements for them:

```
import java.sql.*;
import javax.naming.Context;
import javax.naming.NamingException;
import javax.naming.InitialContext;
import javax.sql.DataSource;
```

We can import the entire `java.sql` package since we are going to use more classes included there in our business methods.

We can now start defining one by one the business methods:

12. Define the implementation of the getAllBooks() method:

```
/** Returns a vector of Books containing all the books
 * @return null when something goes wrong
 */
public Vector getAllBooks()
{
    Vector books = new Vector();
    Connection con = getConnection();
    if (con == null)
        return null;

    String query = "SELECT * FROM Book";
    try
    {
        Statement stmt = con.createStatement();

        ResultSet rs = stmt.executeQuery(query);

        while (rs.next())
        {
            Book newbook = new Book(rs.getInt("booknr"),
            rs.getString("title"), rs.getInt("price"), rs.getInt("year"));
            books.add(newbook);
        }
        stmt.close();
        con.close();
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
        System.err.println("Database error in getAllBooks() " +
        ex.getMessage());
        return null;
    }
    return books;
}
```

13. Similarly we define the other two business methods:

```
/** Returns a vector of Books containing all the books about this subject
 * @return null when something goes wrong
 */
public Vector getBooksBySubject(String subject)
{
    Vector books = new Vector();
    Connection con = getConnection();
    if (con == null)
        return null;

    String query = "SELECT * FROM Book WHERE booknr IN (SELECT booknr FROM
    BookSubject bs, Subject s WHERE s.subjectnr = bs.subjectnr AND s.subject =
    ?)";
    try
    {

```



```
        PreparedStatement stmt = con.prepareStatement(query);

        stmt.setString(1, subject);

        ResultSet rs = stmt.executeQuery();

        while (rs.next())
        {
            Book newbook = new Book(rs.getInt("booknr"),
rs.getString("title"), rs.getInt("price"), rs.getInt("year"));
            books.add(newbook);
        }
        stmt.close();
        con.close();
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
        System.err.println("Database error in getBooksBySubject() " +
ex.getMessage());
        return null;
    }
    return books;
}

/**Returns the Book for the given booknr
 * @return null when something goes wrong
 */
public Book getBook(int booknr)
{
    Connection con = getConnection();
    if (con == null)
        return null;

    String query = "SELECT * FROM Book WHERE booknr = ?";
    try
    {
        PreparedStatement stmt = con.prepareStatement(query);

        stmt.setInt(1, booknr);

        ResultSet rs = stmt.executeQuery();

        Book thebook = null;

        if (rs.next())
        {
            thebook = new Book(rs.getInt("booknr"), rs.getString("title"),
rs.getInt("price"), rs.getInt("year"));
        }
        stmt.close();
        con.close();
        return thebook;
    }
    catch (SQLException ex)
    {

```

```
        ex.printStackTrace();
        System.err.println("Database error in getBook() " + ex.getMessage());
    }
    return null;
}
```

14. Our bean class is now complete and can be compiled with the following command (it must be run from the `M:\jdb042` directory and the `Book` class must have already been compiled):

```
javac          IS7\bookdb\bookmgr\BookMgrBean.java          -classpath
.;M:\jdb042\jboss\server\default\lib\jboss-j2ee.jar
```

We still have a lot to do:

- We must create the home interface
- We must create the remote interface
- We must create the `ejb-jar.xml`

Only then we can package our `BookMgr` EJB in a jar file and deploy it. The first three tasks are not different from the `HelloWorld` EJB. Let's start by fixing the interfaces:

#### **4.2.4.2 Home and remote interface**

15. Create a file `BookMgrHome.java` (in `IS7\bookdb\bookmgr`) and open it for editing!

16. Define the package: `package IS7.bookdb.bookmgr;`

17. Define the interface: `public interface BookMgrHome extends javax.ejb.EJBHome {}`

18. Define the `create()` method:

```
BookMgr create() throws java.rmi.RemoteException, javax.ejb.CreateException;
```

19. Create a file `BookMgr.java` (in `IS7\bookdb\bookmgr`) and open it for editing!

20. Define the package: `package IS7.bookdb.bookmgr;`

21. Define the interface: `public interface BookMgr extends javax.ejb.EJBObject {}`

22. Define the interfaces of the business methods (adding a `throws` clause):

```
/**Returns a vector of Books containing all the books***/
public Vector getAllBooks() throws java.rmi.RemoteException;
```

```
/**Returns a vector of Books containing all the books about this
subject***/
public Vector getBooksBySubject(String subject) throws
java.rmi.RemoteException;
```

```
/**Returns the Book for the given booknr***/
public Book getBook(int booknr) throws java.rmi.RemoteException;
```

23. The signatures of the business methods refer to classes `Vector` and `Book`. These classes must either be qualified or stated in an `import` statement. Add the following import statements:

```
import java.util.Vector;  
import IS7.bookdb.Book;
```

24. Both interfaces are now complete and can be compiled with the following command (also compiles the session bean class):

```
javac IS7\bookdb\bookmgr\*.java -classpath .;jboss\server\default\lib\jboss-j2ee.jar
```

#### **4.2.4.3 Deployment descriptor**

Next we can create the deployment descriptor:

25. Create a directory META-INF under IS7\bookdb\bookmgr!

26. Create a new file ejb-jar.xml (in the new META-INF directory) and open it for editing!

27. Define the contents of the deployment descriptor:

```
<?xml version="1.0" encoding="UTF-8"?>  
<!DOCTYPE ejb-jar  
  PUBLIC "-//Sun Microsystems, Inc.//DTD Enterprise JavaBeans 2.0//EN"  
  'http://java.sun.com/dtd/ejb-jar_2_0.dtd'>  
<ejb-jar>  
  <description>BookMgr EJB as part of the CBD with EJB compendium for IS7  
ht2003</description>  
  <display-name>Book Manager EJB</display-name>  
  <enterprise-beans>  
    <session>  
      <ejb-name>BookMgr</ejb-name>  
      <home>IS7.bookdb.bookmgr.BookMgrHome</home>  
      <remote>IS7.bookdb.bookmgr.BookMgr</remote>  
      <ejb-class>IS7.bookdb.bookmgr.BookMgrBean</ejb-class>  
      <session-type>Stateless</session-type>  
      <transaction-type>Container</transaction-type>  
    </session>  
  </enterprise-beans>  
  <assembly-descriptor>  
    <container-transaction>  
      <method>  
        <ejb-name>BookMgr</ejb-name>  
        <method-name>*</method-name>  
      </method>  
      <trans-attribute>Required</trans-attribute>  
    </container-transaction>  
  </assembly-descriptor>  
</ejb-jar>
```

#### **4.2.4.4 Packaging and deployment**

28. We can now also deploy the BookMgr EJB. We start by packaging everything in a jar file BookMgrJAR.jar with the following commands:

```
jar cMvf BookMgrJAR.jar IS7\bookdb\Book.class IS7\bookdb\bookmgr\*.class  
jar uMvf BookMgrJAR.jar -C IS7\bookdb\bookmgr META-INF\ejb-jar.xml
```

29. We deploy our new jar file with the following command:

```
copy BookMgrJAR.jar jboss\server\default\deploy
```

30. We can also create a jar file `BookMgrInterface.jar` with the classes and interfaces needed by the client developers. This jar file must therefore include the two interfaces and the `Book` class. We can create this file with the following command:

```
jar cMvf BookMgrInterface.jar IS7\bookdb\Book.class  
IS7\bookdb\bookmgr\BookMgrHome.class IS7\bookdb\bookmgr\BookMgr.class
```

We can once again change roles and assume the role of the client developer. We can now design a little test client for the `BookMgr` EJB:

#### 4.2.4.5 Test client

31. Create a new file `BookMgrTestClient.java` in the `M:\jdb042\test` directory! (The class `BookMgrTestClient` will be in the package `test`.)

32. Open the file for editing!

33. Define the package: `package test;`

34. Import the necessary classes:

```
import javax.naming.Context;  
import javax.naming.InitialContext;  
import javax.rmi.PortableRemoteObject;  
import IS7.bookdb.bookmgr.*;  
import IS7.bookdb.Book;  
import java.util.Vector;  
import java.io.BufferedReader;  
import java.io.InputStreamReader;
```

35. Define the class: `public class BookMgrTestClient {}`

36. We only need a `main()` method, so we can start by defining it:

```
public static void main(String[] args) { }
```

37. Inside the `main()` method we will need to first establish a context in order to lookup the `BookMgr` EJB (this is exactly the same we did in the `HelloWorldTestClient`):

```
try  
{  
    Context ctx = new InitialContext();  
    ctx.addToEnvironment(Context.INITIAL_CONTEXT_FACTORY,  
        "org.jnp.interfaces.NamingContextFactory");  
    ctx.addToEnvironment(Context.PROVIDER_URL, "127.0.0.1:1099");  
    //instead of 127.0.0.1 you can use localhost  
    ctx.addToEnvironment("java.naming.factory.url.pkgs",  
        "org.jboss.naming:org.jnp.interfaces");  
  
    Object obj = ctx.lookup("BookMgr");  
    BookMgrHome home = (BookMgrHome)  
        PortableRemoteObject.narrow(obj, BookMgrHome.class);  
    BookMgr bookMgr = home.create();  
}
```

38. The only thing missing now is the call (or calls) to the business methods. We can for example create a little loop that interacts with the user and the calls the appropriate business method of the EJB. We can also create a couple of private function for printing the list of books on the screen. Let's start by completing the `main()` method:

```
        BufferedReader br = new BufferedReader(new
InputStreamReader(System.in));
        String input;
        boolean stay = true;
        while (stay)
        {
            System.out.println("Choose one of the following options:");
            System.out.println("-----");
            System.out.println("1. Show all books!");
            System.out.println("2. Show books about a specific subject!");
            System.out.println("3. Show a specific book (by specifying
booknr)!");
            System.out.println("4. Exit!");
            System.out.println("-----");
            System.out.print("Enter your choice: ");
            input = br.readLine();
            switch ((new Integer(input)).intValue())
            {
                case 1:
                    printBookList(bookMgr.getAllBooks());
                    break;
                case 2:
                    System.out.print("Enter a subject: ");
                    String subject = br.readLine();
                    printBookList(bookMgr.getBooksBySubject(subject));
                    break;
                case 3:
                    System.out.print("Enter a booknr: ");
                    String temp = br.readLine();
                    int booknr = (new Integer(temp)).intValue();
                    printHeader();
                    printBook(bookMgr.getBook(booknr));
                    break;
                case 4:
                    stay=false;
                    break;
            } //end of switch
        } //end of while
    } //end of try block
    catch (Exception ex)
    {
        System.err.println("Caught an unexpected exception!");
        ex.printStackTrace();
    } //end of catch
```

39. We can now create the private methods `printBookList()`, `printBook()` and `printHeader()` (The layout is not very good, but there is no reason why we should make it any better just for a test client):

```
private static void printHeader()
{
    System.out.println("Booknr   Title                               Price   Year");
    System.out.println("-----");
}

private static void printBook(Book book)
{
    if (book != null)
    {
        System.out.print(book.getBooknr()+"\t");
        System.out.print(book.getTitle()+"\t");
        System.out.print(book.getPrice()+"\t");
        System.out.println(book.getYear());
    }
}

private static void printBookList(Vector books)
{
    if (books != null)
    {
        printHeader();
        for (int i=0;i<books.size();i++)
        {
            printBook((Book) books.elementAt(i));
        }
    }
}
```

40. We are now ready to compile and run our test client. We can compile our test client with the following command:

```
javac    test\BookMgrTestClient.java    -classpath    jboss\client\jbossall-
client.jar;BookMgrInterface.jar
```

41. We can run our test client with the following command:

```
java      -cp      .; jboss\client\jbossall-client.jar;BookMgrInterface.jar
test.BookMgrTestClient
```

Here is an example of the test client in action:

```
Command Prompt
Choose one of the following options:
-----
1. Show all books!
2. Show books about a specific subject!
3. Show a specific book (by specifying booknr)!
4. Exit!
-----
Enter your choice: 2
Enter a subject: religion
Booknr  Title                                     Price  Year
-----
2      Turning the Wheel: Essays on Buddhism and Writing    440    2002
6      The Feng Shui Directory 330      2003
Choose one of the following options:
-----
1. Show all books!
2. Show books about a specific subject!
3. Show a specific book (by specifying booknr)!
4. Exit!
-----
Enter your choice: 2
Enter a subject: meditation
Booknr  Title                                     Price  Year
-----
6      The Feng Shui Directory 330      2003
7      Feng Shui in 10 Simple Lessons 160    1998
8      Feng Shui Fusion: Jane Butler-Biggs 250    1993
Choose one of the following options:
-----
1. Show all books!
2. Show books about a specific subject!
3. Show a specific book (by specifying booknr)!
4. Exit!
-----
Enter your choice: 3
Enter a booknr: 11
Booknr  Title                                     Price  Year
-----
11     MySQL Pocket Reference 110      1999
Choose one of the following options:
-----
1. Show all books!
2. Show books about a specific subject!
3. Show a specific book (by specifying booknr)!
4. Exit!
-----
Enter your choice: 4
M:\jdb042>
```

## 4.2.5 Manipulating Data

So far we have worked with only retrieving data from the database. In this section we will make an EJB that updates the database. The EJB will provide the clients with one business method for inserting a new customer into the table `Customer`. The business method will take one argument (a `Customer` object) and insert the values in the database. If something is incorrect with/in the received `Customer` object it will throw an exception `CustomerMgrException`.

This EJB will be called `CustomerMgr` and it will be in the `IS7.bookdb.customermgr` package. We will need the data class `IS7.bookdb.Customer` (that we created earlier) and the exception class `CustomerMgrException` which we will create and place in the package `IS7.bookdb.customermgr`.

Most of the EJB structure is the same as the previous one. The only thing that differs is the business method and its implementation. We also have to create a new exception class. We can start with just that:

1. Create the file `CustomerMgrException.java` in the package `IS7.bookdb.customermgr` and add the following content:

```
package IS7.bookdb.customermgr;

/**/ Exception to be thrown by CustomerMgr ***/
public class CustomerMgrException extends javax.ejb.EJBException {

    public CustomerMgrException () { }

    public CustomerMgrException (String msg) {
        super(msg);
    }
}
```

We inherit `EJBException` (instead of just `Exception`) so that the current transaction will be automatically rolled back if something goes wrong.

The exception class is ready, so continue with the session bean:

#### 4.2.5.1 Bean class

2. Create the session bean file (`CustomerMgrBean.java`) and add the standard session bean content:

```
package IS7.bookdb.customermgr;

public class CustomerMgrBean implements javax.ejb.SessionBean
{
    public void ejbCreate() {}
    public void ejbRemove() {}
    public void ejbActivate() {}
    public void ejbPassivate() {}
    public void setSessionContext(javax.ejb.SessionContext ctx) {}
}
```

3. We can also add a private method for retrieving a database connection (the same private method we had in `BookMgrBean.java`):

```
private Connection getConnection()
{
    Connection con = null;
    try
    {
        Context jndiCtx = new InitialContext();
        DataSource ds = (javax.sql.DataSource)
            jndiCtx.lookup("java:/jdbc/BookDB");
        con = ds.getConnection();
        return con;
    }
    catch (SQLException ex)
    {

```



```
        ex.printStackTrace();
        System.err.println("getConnection failed." + ex.getMessage());
    }
    catch (NamingException e)
    {
        e.printStackTrace();
        System.err.println("lookup failed." + e.getMessage());
    }
    return null;
}
```

4. The only thing missing is the business method that can be defined as follows:

```
public void insertCustomer(Customer customer) throws CustomerMgrException
{
    if (customer == null)
        throw new CustomerMgrException("Insert failed: A customer must be
specified!");
    if (customer.getName() == null)
        throw new CustomerMgrException("Insert failed: A customer must have a
name!");
    Connection con = getConnection();
    if (con == null)
        throw new CustomerMgrException("Insert failed: No connection to
database available!");

    String name = customer.getName();
    String address = "";
    if (customer.getAddress() != null)
        address = customer.getAddress();
    String city = "";
    if (customer.getCity() != null)
        city = customer.getCity();
    String country = "";
    if (customer.getCountry() != null)
        country = customer.getCountry();

    String query = "INSERT INTO Customer (name, address, city, country)
VALUES (?, ?, ?, ?)";
    try
    {
        PreparedStatement stmt = con.prepareStatement(query);

        stmt.setString(1, name);
        stmt.setString(2, address);
        stmt.setString(3, city);
        stmt.setString(4, country);
        stmt.executeUpdate();
        stmt.close();
        con.close();
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
        System.err.println("Database error in getBook() " + ex.getMessage());
    }
}
```

```
        throw new CustomerMgrException("Insert failed: Database said: " +
ex.getMessage());
    }
}
```

5. These methods use some classes that must be defined in import statements:

```
import IS7.bookdb.Customer;
import java.sql.*;
import javax.naming.Context;
import javax.naming.NamingException;
import javax.naming.InitialContext;
import javax.sql.DataSource;
```

#### 4.2.5.2 Home and remote interface

6. We can quickly define the two interfaces:

Remote interface CustomerMgr:

```
package IS7.bookdb.customermgr;
```

```
import IS7.bookdb.Customer;
```

```
public interface CustomerMgr extends javax.ejb.EJBObject
{
    /** Inserts a new customer in the database */
    public void insertCustomer(Customer customer) throws
java.rmi.RemoteException, CustomerMgrException;
}
```

Home interface CustomerMgrHome:

```
package IS7.bookdb.customermgr;
```

```
public interface CustomerMgrHome extends javax.ejb.EJBHome
{
    CustomerMgr create() throws java.rmi.RemoteException,
javax.ejb.CreateException;
}
```

#### 4.2.5.3 Deployment descriptor

7. We can also create a deployment descriptor ejb-jar.xml (in a META-INF directory) With the following content:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar
    PUBLIC "-//Sun Microsystems, Inc.//DTD Enterprise JavaBeans 2.0//EN"
    'http://java.sun.com/dtd/ejb-jar_2_0.dtd'>
<ejb-jar>
    <description>CustomerMgr EJB as part of the CBD with EJB compendium for
IS7 ht2003</description>
    <display-name>Customer Manager EJB</display-name>
    <enterprise-beans>
        <session>
            <ejb-name>CustomerMgr</ejb-name>
            <home>IS7.bookdb.customermgr.CustomerMgrHome</home>
            <remote>IS7.bookdb.customermgr.CustomerMgr</remote>
            <ejb-class>IS7.bookdb.customermgr.CustomerMgrBean</ejb-class>
```

```
        <session-type>Stateless</session-type>
        <transaction-type>Container</transaction-type>
    </session>
</enterprise-beans>
<assembly-descriptor>
    <container-transaction>
        <method>
            <ejb-name>CustomerMgr</ejb-name>
            <method-name>*</method-name>
        </method>
        <trans-attribute>Required</trans-attribute>
    </container-transaction>
</assembly-descriptor>
</ejb-jar>
```

#### 4.2.5.4 Packaging and deployment

8. We can now compile, package and deploy the CustomerMgr EJB with the following commands:

```
javac          IS7\bookdb\customermgr\*.java          -classpath
. ; jboss\server\default\lib\jboss-j2ee.jar
jar            cMvf          CustomerMgrJAR.jar        IS7\bookdb\Customer.class
IS7\bookdb\customermgr\*.class
jar uMvf CustomerMgrJAR.jar -C IS7\bookdb\customermgr META-INF\ejb-jar.xml
copy CustomerMgrJAR.jar jboss\server\default\deploy
```

9. We can also create ajar file for the client developers with the following command:

```
jar            cMvf          CustomerMgrInterface.jar    IS7\bookdb\Customer.class
IS7\bookdb\customermgr\CustomerMgrHome.class
IS7\bookdb\customermgr\CustomerMgr.class
```

#### 4.2.5.5 Test client

10. The EJB is now deployed. We need a test client to test our business method! Here is a simple test client (test.CustomerMgrTestClient):

```
package test;

import javax.naming.Context;
import javax.naming.InitialContext;
import javax.rmi.PortableRemoteObject;
import IS7.bookdb.customermgr.*;
import IS7.bookdb.Customer;
import java.io.BufferedReader;
import java.io.InputStreamReader;

public class CustomerMgrTestClient
{
    public static void main(String[] args)
    {
        try
        {
            Context ctx = new InitialContext();
            ctx.addToEnvironment(Context.INITIAL_CONTEXT_FACTORY,
"org.jnp.interfaces.NamingContextFactory");
            ctx.addToEnvironment(Context.PROVIDER_URL, "127.0.0.1:1099");
```

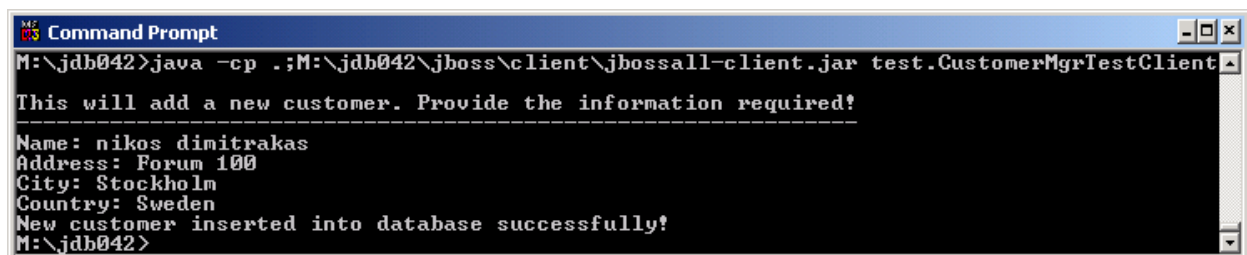
```
        ctx.addToEnvironment("java.naming.factory.url.pkgs",
"org.jboss.naming:org.jnp.interfaces");
        Object obj = ctx.lookup("CustomerMgr");
        CustomerMgrHome home = (CustomerMgrHome)
PortableRemoteObject.narrow(obj, CustomerMgrHome.class);
        CustomerMgr customerMgr = home.create();

        BufferedReader br = new BufferedReader(new
InputStreamReader(System.in));
        System.out.println("This will add a new customer. Provide the
information required!");
        System.out.println("-----");
        System.out.print("Name: ");
        String name = br.readLine();
        System.out.print("Address: ");
        String address = br.readLine();
        System.out.print("City: ");
        String city = br.readLine();
        System.out.print("Country: ");
        String country = br.readLine();
        customerMgr.insertCustomer(new Customer(0, name, address, city,
country));
    } //end of try block
    catch (CustomerMgrException ex)
    {
        System.out.println(ex.getMessage());
    } //end of catch
    catch (Exception ex)
    {
        System.err.println("Caught an unexpected exception : " + ex);
        ex.printStackTrace();
    } //end of catch
    System.out.println("New customer inserted into database
successfully!");
} //end of main
}
```

11. We compile and run our test client with the following commands:

```
javac test\CustomerMgrTestClient.java -classpath .;jboss\client\jbossall-
client.jar;CustomerMgrInterface.jar
java -cp .;jboss\client\jbossall-client.jar;CustomerMgrInterface.jar
test.CustomerMgrTestClient
```

Here is an example of our test client in action:



```
Command Prompt
M:\jdb042>java -cp .;M:\jdb042\jboss\client\jbossall-client.jar test.CustomerMgrTestClient

This will add a new customer. Provide the information required!
-----
Name: nikos dimitrakas
Address: Forum 100
City: Stockholm
Country: Sweden
New customer inserted into database successfully!
M:\jdb042>
```

## 5 Assignments

One of the assignments in this section is compulsory and must be presented for either nikos dimitrakas or Martin Henkel in order to acquire a pass grade for the practical part of the course. You may, of course, complete more than one of the assignments, but only one is required. Choose one of the following four assignments!

Assignments:

1. Create an EJB and a test client for adding and retrieving subjects (two business methods)!
2. Create an EJB and a test client for retrieving authors! Two business methods should be available:
  - Get all authors
  - Get all authors for a particular book (booknr)
3. Create an EJB and a test client for adding authors to the database!
4. Modify the CustomerMgr EJB so that it also provides business methods for the following:
  - Retrieve all the customers that have ordered a particular book (given a book title).
  - Retrieve all the customers that have ordered books for more than a particular total price.Modify also the test client (or write a new test client) to test the new business methods!

It is of course possible to combine many EJBs in one client and provide a more complete functionality for our database.

## 6 When things have gone bad!

Luckily all the files for the exercises in this compendium and the JBoss server are available to download. Should you, by mistake, delete or change files, you can quickly restore the JBoss server and exercise files. Should the JBoss server crash (-has not happened during the development of this compendium-), it is enough to close the command prompt window where it is running. This will force Windows to kill the JBoss process. If it still won't go away, one can always reboot windows!

## 7 Internet Resources

The most important site is <http://java.sun.com/> where there are tutorials and documentation for all java frameworks.

Java: <http://java.sun.com/>

J2EE: <http://java.sun.com/j2ee/>

J2EE Tutorial: <http://java.sun.com/j2ee/tutorial/>

J2EE v1.4 API Documentation: <http://java.sun.com/j2ee/1.4/docs/api/index.html>

Java Basics Tutorial: <http://java.sun.com/docs/books/tutorial/>

JDBC Tutorial: <http://java.sun.com/docs/books/tutorial/jdbc/index.html>

## 8 Epilogue

When all this is done, you should have a fair understanding of the EJB framework. This compendium only covered a part of the EJB framework (session beans), but hopefully this is enough for illustrating the advantages of component based development and the Enterprise JavaBeans framework.

I hope you have enjoyed this compendium.

The Author

*nikos dimitrakas*