Enterprise Java Beans

CUGS

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EJB Intro

- An EJB is a **distributed** server-side non-visual **component**
  - Multiple address spaces
  - Distributed objects
  - Transactional access to remote objects
- EJB is a part of the **J2EE standard**
  - `javax.ejb` package
  - Component specification
  - Programmer implements a set of interfaces from the EJB API
- Implementation by independent vendors
  - Tools and Containers
    - **Proprietory**: IBM (WebSphere), BEA (WebLogic), Sun and Netscape (iPlanet), Oracle, Borland
    - **Open source**: JBoss (www.jboss.org)

EJB Intro cont.

- Separate business logic from middleware services:
  - networking
  - transactions
  - persistence
  - logging
  - resource pooling
- EJB Container / Application server
  - Manages beans
  - Provides middleware services
- Clients: JSPs, Servlets, Java applications, and other EJBs

EJB Yesterday and Today

- 2.0
- 3.0

- The goal of Enterprise JavaBeans (EJB) 3.0 is to simplify development of Java applications and standardize the persistence API for the Java platform.
- EJB 3.0 is a part of the next major revision of the J2EE platform, J2EE 5.0.

2.0 vs. 3.0

- Simplified EJB
  - EJB 3.0 eliminates the need for **home** and **component interfaces** and the requirement for bean classes for **implementing javax.ejb.EnterpriseBean** interfaces. The **EJB** bean class **can be** a pure Java class often referred as **POJO** and the interface can be a simple business interface. The bean class can implement the business interface.

2.0. vs 3.0

- Use of Annotations Instead of Deployment Descriptors
  - Metadata annotation is being used as an alternative to deployment descriptors.
  - Annotations can be used to specify bean types, different attributes such as transaction or security settings, O-R mapping and injection of environment or resource references.
  - Deployment descriptor can be used to override metadata annotations.

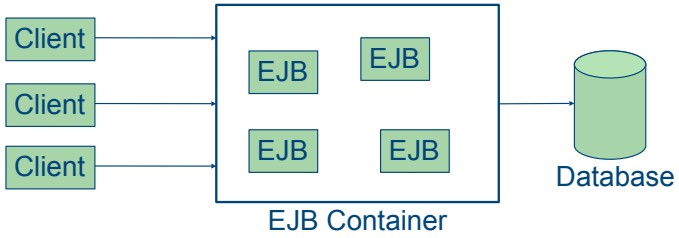
2.0 vs 3.0

- Interceptors
  - An interceptor is a method that intercepts a **business method** invocation.
  - An interceptor method may be defined in a Stateless Session Bean, Stateful Session Bean or an interceptor class may also be used instead of defining the interceptor method in the bean class.

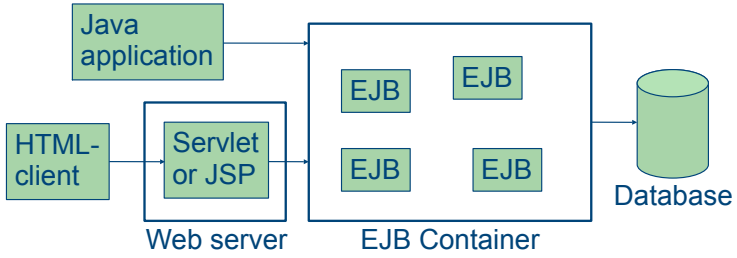
2.0 vs. 3.0

- Simple JNDI lookup of EJB
  - Lookup of EJB has been simplified and clients do not have to create a bean instance by invoking create method on EJB and can directly invoke a method on the EJB.

EJB Architecture



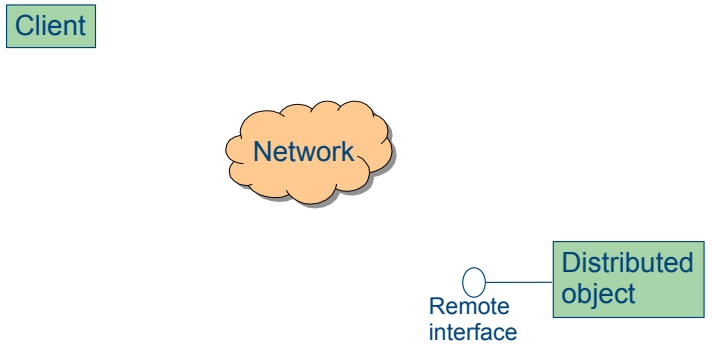
Clients (typical use cases)



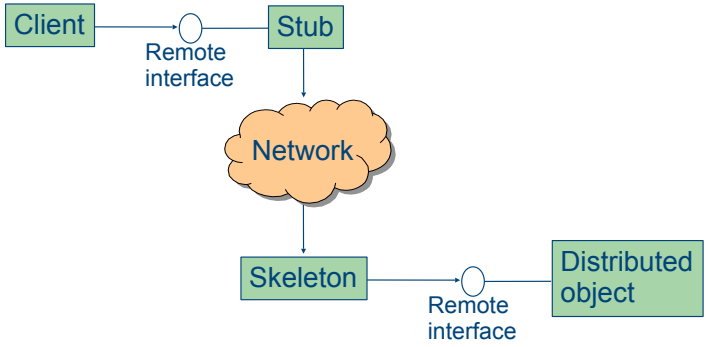
Middleware

- **Explicit middleware** (e.g. CORBA) :
  - Write to API
  - Difficult to write, maintain and support
- **Implicit middleware** (e.g. EJB)
  - Write isolated business logic
  - Declarative middleware service specifications
  - Middleware services generated automatically
  - Tool support

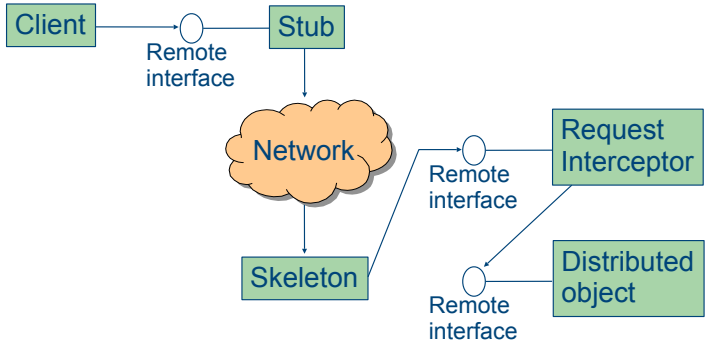
Distributed Objects



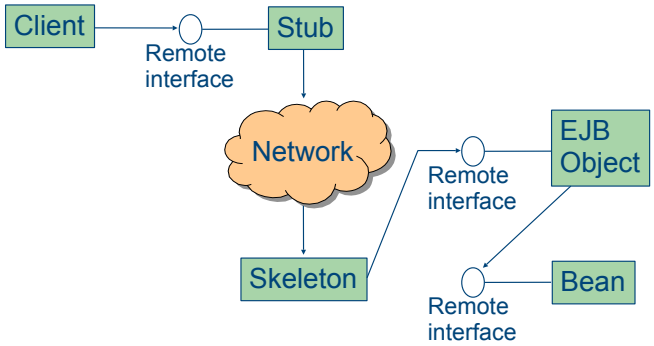
Distributed Objects



Distributed Objects



Distributed Objects using EJBs



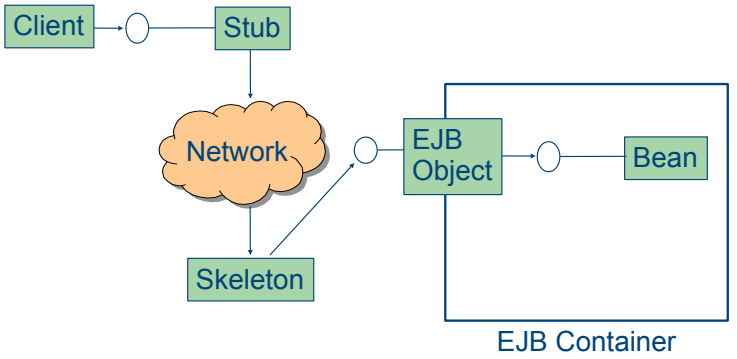
Execution flow

- Client calls a method on the EJB object
- EJB object delegates the call to a bean
- EJB receives the result
- EJB passes the result to the caller

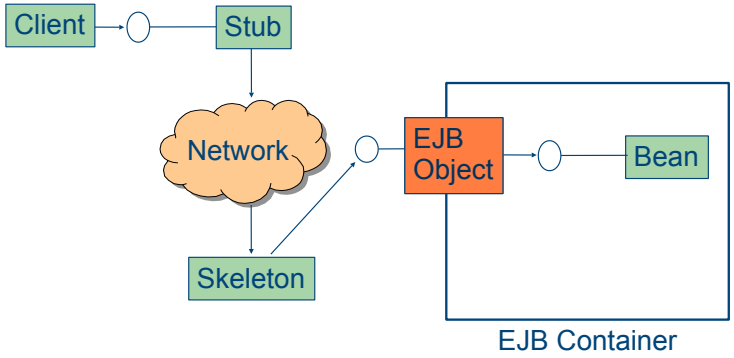
EJB 2.0

- **Home interface**
  - Defines the life cycle methods of the bean
    - Create
    - Destroy
- **Remote interface**
  - Defines the business methods of the bean
- **Bean class**
  - Business logic

Enterprise JavaBeans



EJB Object (Remote Interface)



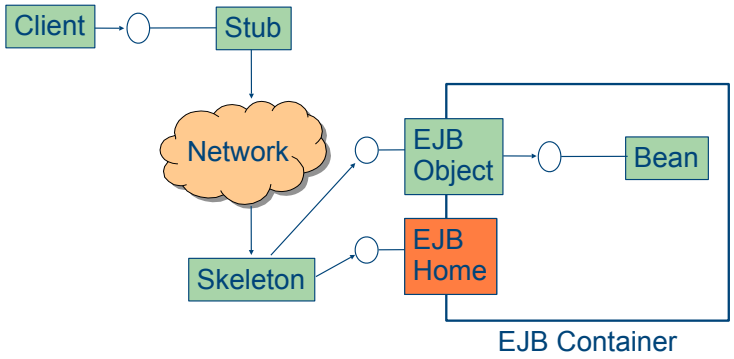
EJB Object (Remote Interface)

- Extends javax.ejb.EJBObject
- Defines business methods clients call
- Acts as a proxy

```
package ejbExample.interfaces

/* This is a remote interface for HelloBean */
public interface Hello extends javax.ejb.EJBObject {
        public String Hello() throws java.rmi.RemoteException;
}
```

EJB Home Object (Home Interface)



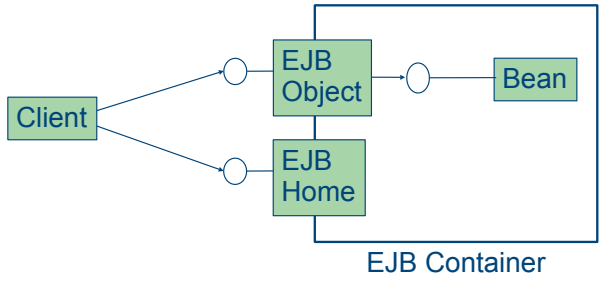
EJB Home Object Characteristics

- Extends javax.ejb.EJBHome
- Acts as a factory to create EJB instances
- Allows clients to create/remove/find EJBs

```
package ejbExample.interfaces

/* HelloBean's home interface */
public interface HelloHome extends javax.ejb.EJBHome {
        Hello create() throws java.rmi.RemoteException,
                                        javax.ejb.CreateException;
}
```


Summary: EJB Architecture



Summary: an EJB consist of

- Enterprise Bean class
- Supporting classes
- EJB Object
- Remote interface
- Home object
- Deployment descriptor (XML)
- Vendor-specific files
- (Local interface)

} EJB-jar file

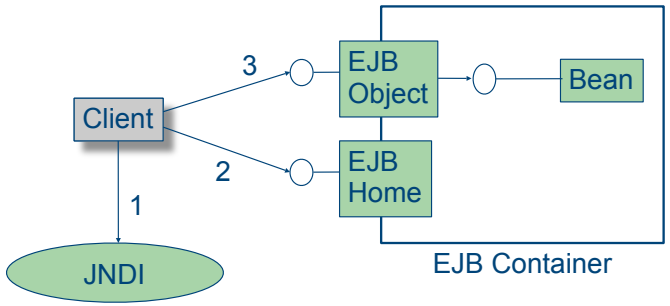
Deployment

- EJB deployment descriptor (XML)
- ejb-jar.xml
- Attributes of the beans specified declaratively
- Deployment descriptor language is a composition language
- EJB-jar file is verified by container
- Container generates stubs and skeletons

How clients find the Home object

- Java Naming and Directory Interface (JNDI)
  - Similar to CORBA naming service
  - Mapping between resource names and physical locations
- No machine address to home object hard coded
  - Address to JNDI server is needed
  - Kept in the initial context
  - Use initial context factory to acquire an initial context (is the JNDI driver)
  - Vendor specific, bound to J2EE server implementation

EJB Architecture




```
Context ctx = new InitialContext();
        HelloWorldHome home = (HelloWorldHome)
                PortableRemoteObject.narrow(ctx.lookup("HelloWorld"),
                                            HelloWorldHome.class);
```


Types of Beans

- Session beans
  - Stateless
  - Stateful
- Entity beans
- Message-Driven beans

So, what does the container do?

- **Generates** stubs and skeletons
- **Creates** EJB **instances** as needed.
- **Persists** entity beans.
- Handles **security** and **transactions**

How can container vendors compete?

- Caching strategies
- Development tool integration
- Database access optimization
- Performance

XDoclet

- Deployment descriptor
- Generate from declarative specification
  - Remote interface
  - home interface
  - local interface
  - local home interface
  - primary key class
- Specification as comments in the Bean class

Demonstration

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Local interfaces

- When beans call beans locally
- Optimization
- Call by value/reference problem

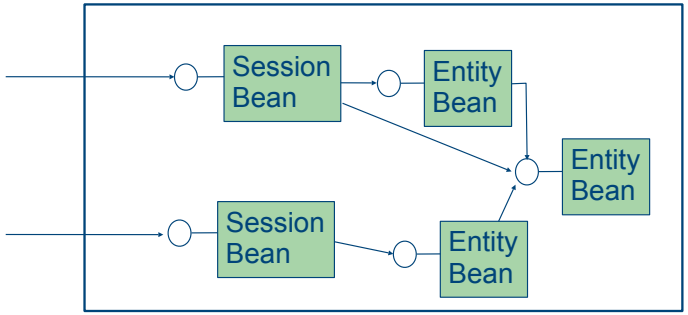
Entity Beans

- Represent business data stored in database
- Database types converted to Java types
- Change of values in the Entity Bean is propagated to the DB

Entity Beans: Persistence

- Bean managed persistence (BMP)
- Container managed persistence (CMP):
  - Object to relational database mapping (common)
  - Object databases (uncommon)
  - Container generates persistence as subclass
  - EJB-QL, query language
- An entity bean is a view into a data source, e.g., a database

Entity Beans: Façade design pattern



Entity Beans: Security

- Authentication - JAAS
- Authorization
- Deployment descriptor
  - Roles
  - Roles and methods
- No instance level based security

Demonstration

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Message-Driven Beans (MDB)

- Don't have home, remote or local interfaces
- Have a single business method:
  - onMessage
- No static type check
- No return values
- No exceptions
- Stateless

Why Message-Driven Beans?

- Performance
- Reliability
- Support for multiple senders and receivers
- “Easy” integration to legacy systems

Final thoughts

- Is it object-oriented?
  - Separation of data and operations (entity beans and session beans)
  - No inheritance between beans in 2.0!
    - 3.0 Standard: beans are POJOs
- Suitable for which tasks?
  - One architecture. Anomalies if trying to do anything else
- Component marketplace?
  - Not today!

Possible problem sources

- Remotability
  - Pramatics: stay away from large distributed systems
- Security
- Persistence
- Caching
- Scalability
- Messaging
- Transactions

Resources

- Szyperski, chapter 14
- Sun EJB tutorial
  - http://java.sun.com/j2ee/learning/tutorial/index.html
- Ed Roman: Mastering EJB
  - http://www.theserverside.com/books/wiley/masteringEJB/index.jsp
- JBoss, Open source EJB Container
  - http://www.jboss.org

What we have to do

- Create a project
- Create an EJB
- Generate the EJB-related files
- Create a servlet and a web application
- Generate the servlet-related files
- Create a J2EE Application
- Package the application (jar, war)
- Configure JBoss servlet container and launch
- Deploy the application

Create a New Project

- File > New > Project > JBoss-IDE > J2EE Projects > J2EE Project
  - Name: CUGS-EJB
  - Create folder *src*
  - Set default output to */EJB-CUGS/bin*

EJB

- File > New > Other > JBoss-IDE > EJB Components > Session Bean
- Set package to *cugs-ejb.ejb* and the class to *MyBean*.
- Make sure *ejbCreate()* is selected
- Click create, note all the method stubs are generated with the default *ejbCreate()* method

EJB Add business method

- Right click on the MyBean class under the MyBean Java file
- *J2EE > Add Business Method*
- Enter getName as the method name and String for the return type
- Add the implementation to the method

```
/**
 * Business method
 * @ejb.interface-method  view-type = "remote"
 */
public String getName(String input_str) {
        // TODO Auto-generated method stub
        return input_str;
```


Generate EJB related files (1)

- Project properties (right click on the project)
- Select the XDoclet configurations
- Enable XDoclet

- EJB Configuration: right-click in the upper area to pop-up a menu and choose *Add*.
  - Type EJB
  - Click Ok

Generate EJB related files (2)

- EJBdoclet Configuration
  - Select EJB configuration
  - Right-click in the lower-left area. Choose *Add* Doclet
  - Choose *ejbdoclet* and click Ok.
    - Lower-right area
      - Set *destDir* to *src*
      - Set *ejbSpec* to 2.0
- This creates an ejbdoclet that will produce files in *src* folder under the EJB 2.0 specification.

Generate EJB related files (3)

- Fileset configuration
  - Right-click *ejbdoclet* and choose *Add*
  - Choose *fileset* and click Ok
  - Lower-right area
    - Set *dir* to *src*
    - Uncheck *excludes*
    - Set *includes* to ***/*Bean.java*
- This will define a fileset that contains the *src* directory and all files under it that end in Bean.java (i.e., including our MyBean.java)

Generate EJB related files (4)

- Deployment Descriptor
  - Add a new *deploymentdescriptor* subtask to the *ejbdoclet*
  - Set the *destDir* to *src/META-INF*
- All of the standard EJB deployment descriptors will now be placed in the *src/META-INF* directory

Generate EJB related files (5)

- Container Configuration (JBoss)
  - Add a new *jboss* subtask to *ejbdoclet*
  - Set *destDir* to *src/META-INF*
  - Set *Version* to 3.0
- All of the JBoss-specific deployment descriptors will now be placed in the src/META-INF directory.

Generate EJB related files (6)

- Package Substitution Configuration
  - Add a new *packageSubstitution* subtask to the *ejbdoclet*
  - Set *packages* property to *ejb*
  - Set *substituteWith* property to *interfaces*
- This will place our generated EJB interfaces in the *cugs-ejb.interfaces* java package.

Generate EJB related files (7)

- Interface Configuration
  - Add a new *remoteInterface* subtask to the *ejbdoclet*
  - Add a new *homeInterface* subtask to the *ejbdoclet*
- These will generate the EJB home and remote interfaces.
- Click OK
- Right-click on the EJB-CUGS and select *Run XDoclet*

The Servlet and the Web-App (1)

- Create a new HTTP Servlet
  - File > New > Other > JBoss-IDE > Web Components > HTTP Servlet
- Set *Package* to *cugs-ejb.web*
- Set class *Name* to *MyServlet*
- Under which stubs..... > *init()*
- Under which service method stubs > *doPost()*

The Servlet and the Web-App (2)

- Add a home member

```
private MyHome home;
```

- Complete the init method

```
public void init(ServletConfig config) throws ServletException {

    try {
     Context context = new InitialContext();
     Object ref = context.lookup("java:/comp/env/ejb/My");
     home = (MyHome) PortableRemoteObject.narrow(ref, MyHome.class);
     } catch (Exception e) {
             throw new ServletException("Lookup of java:/comp/env/
ejb/My failed");
     }
}
```

The Servlet and the Web-App (3)

- Complete the *doPost()* method

```
protected void doPost(HttpServletRequest request, HttpServletResponse response)
                throws ServletException,
                IOException {
                // TODO Auto-generated method stub
                response.setContentType("text/html");
                PrintWriter out = response.getWriter();
                out.println("<html><head><title>");
                out.println("Name Service");
                out.println("</title></head>");
                out.println("<body>");
                out.println("<h1>");
                out.println("Getting the name");
                out.println("</h1>");
                try {
                          My bean = home.create();
                          String result = bean.getName();
                          bean.remove();
                          out.println("<p>");
                          out.print("The name is: ");
                          out.println(result);
                          out.println("</p>");
                } catch (Exception e) {
                          out.println(e.getMessage()); e.printStackTrace(out);
                } finally {
                out.println("</body></html>");
                out.close();
                } }
```


The Servlet and the Web-App (4)

- Insert the missing XDoclet tags in the `class MyServlet`

```
/**
 * Servlet Class
 *
 * @web.servlet                name="MyServlet"
 *                             display-name="My servlet"
 *                             description="Servlet that returns a name"
 * @web.servlet-mapping        url-pattern="/MyServlet"
 * @web.servlet-init-param     name="A parameter"
 *                             value="A value"
 * @web.ejb-ref
 *   name= "ejb/My"
 *   type= "Session"
 *   home= "tddc18.interfaces.MyHome"
 *   remote= "tddc18.interfaces.My"
 *
 * @jboss.ejb-ref-jndi
 *    ref-name= "ejb/My"
 *    jndi-name= "ejb/My"
 */
```


Generate Servlet -related files (1)

- Select Project properties > XDoclet Configuration > Add > Type Web
- Select the *Web configuration*
- Right-click lower-right area and choose *Add Doclet*
- Choose *webdoclet* and click Ok.
- Set *destDir* to *src/WEB-INF*

- Our configuration now contains a *webdoclet* that will produce files in the *src/WEB-INF* folder.

Generate Servlet -related files (2)

- Fileset Configuration
  - Right-click on the *webdoclet* and choose *Add*
  - Choose *fileset* and click *Ok.*
  - Set properties in the lower-rigth area
    - Set *dir* to *src*
    - Uncheck *excludes*
    - Set *includes* to ***/*Servlet.java*

- Our configuration now contains a webdoclet with a fileset that cointains the *src* directory, and all files under it that end in *Servlet.java*

Generate Servlet -related files (3)

- Deployment Descriptor
  - Add a new *deploymentdescriptor* subtask to the *webdoclet*
  - Set *Servletspec* to 2.3.
- All of the standrad Web deployment descriptors will now be placed in the *src/WEB-INF*

Generate Servlet -related files (4)

- JBoss Configuration
  - Add a new *jbosswebxml* subtask to the web-doclet
  - Set *version* to 3.0
- All of the JBoss-specific Web deployment descriptors will now be placed in the *src/WEB-INF* directory
- Click on the XDoclet and save
- Right-click on the Project and select *Run XDoclet*

Generate Servlet -related files (5)

- Create the HTML page
  - Create a *docroot* folder under the *root* of the project
  - Create an *index.html* under the *docroot* folder.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<html>
<head>
    <title>Name Request</title>
</head>
<body>
<h1>Name Request Form</h1>
<form action="MyServlet" method="POST" >
    <table cellspacing="2" cellpadding="2" border="0">
        <tr><td><input type="submit" name="Compute" value="Compute"></td>
        <td><input type="Reset"></td></tr>
        </table>
    </form>
</body>
</html>
```


We have done

- Created a project
- Created an EJB
- Generated the EJB-related files
- Created a servlet and a web application
- Generated the servlet-related files

Remains to be done

- Create a J2EE Application
- Package the application (jar, war)
- Configure JBoss servlet container and launch
- Deploy the application

J2EE Application (1)

- Create the *application.xml*
  - Right-click on the *src/META-INF* and choose *New > Other...*
  - Choose *JBoss-IDE > Descriptors > EAR 1.3 Deployment Descriptor* and click *Next*
- Make sure *application.xml* is the name of the file and click *Finish*

J2EE Application (2)

- Add the following to the *application.xml*

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE application PUBLIC
      "-//Sun Microsystems, Inc.//DTD J2EE Application 1.3//EN"
      "http://java.sun.com/dtd/application_1_3.dtd">
<application>
      <display-name>Get Name Application</display-name>
      <module>
                <ejb>MyEJB.jar</ejb>
      </module>
      <module>
                <web>
                          <web-uri>MyWeb.war</web-uri>
                          <context-root>/My</context-root>
                </web>
      </module>
</application>
```


Packaging (1)

- The EJB JAR. It will contain the EJB classes and interfaces, as well as the *ejb-jar.xml* and *jboss.xml* deployment descriptors
- The EJB Client Jar. It will contain the EJB interfaces.
- The Web Application WAR. It will contain the Servlet class, the EJB client Jar, as well as the *web.xml* deployment descriptors
- The J2EE Application EAR. It will contain the EJB Jar and the Web Application War, as well as the *application.xml* deployment descriptor.

Packaging (2)

- Enable Packaging
  - Right-click project properties
  - Select *Packaging Configurations*
  - *Enable Packaging*

Packaging (3): MyEJB.jar

- Create EJB JAR
  - Right-click in the area to pop-up the menu and choose *Add Archive*. Type *MyEJB.jar*
- We want to add the EJB classes and interfaces.
  - Select the *MyEJB.jar* and right-click in the area to pop-up the menu and select *Add Folder*.
  - A folder chooser dialog appears
    - Click *Project Folder*
    - Select */CUGS-EJB/bin*. Click *Ok*.
  - Set includes to: *cugs-ejb/ejb/*.class,cugs-ejb/interfaces/*.class* and click *Ok*.

Packaging (4): MyEJB.jar

- Add the **standard** EJB deployment descriptor
  - Select the MyEJB.jar
  - Right-click in the area and select *Add File* from the pop-up menu
  - The dialog allows to select which file to include in the package and to set a prefix which will be appended when building the package
    - Click *Project File*
    - Select *CUGS-EJB/src/META-INF/ejb-jar.xml* and click *Ok.*
    - Set the *Prefix* to *META-INF*. The ejb-jar.xml should be located in the META-INF directory.

Packaging (5): MyEJB.jar

- Add the **specific** EJB deployment descriptor (JBoss)
  - Select the MyEJB.jar
  - Right-click in the area and select *Add File* from the pop-up menu
    - Click *Project File*
    - Choose *CUGS-EJB/src/META-INF/jboss.xml*
    - Set *Prefix* to *META-INF*. The jboss.xml should be located in the META-INF directory.
- The package configuration for MyEJB.jar is complete now

Packaging (6): MyEJB-client.jar

- MyEJB-client.jar
  - No need if you run JBoss 4.0 or above

Packaging (7): MyWeb.jar

- Create a WEB WAR
  - Click the *Add* button in the *Packaging Configuration* and type *MyWeb.war*
- Add the web classes
  - Select the *MyWeb.war,* right-click in the area and select *Add Folder* from the pop-up menu.
  - Click *Project Folder* in the folder chooser dialog and select *CUGS-EJB/bin*. Click *Ok.*
  - Set *Includes* to *cugs-ejb/web/*.class* as we only want to include web-related class files.
  - Web classes should be located in the *WEB-INF/ classes* folder according to the container specification. Set the *Prefix* to *WEB-INF/classes*

Packaging (8): MyWeb.jar

- Add the **standard** web deployment descriptor
  - Select the *MyWeb.war,* right-click in the area and select *Add File* from the pop-up menu.
  - Click *Project File* in the folder chooser dialog and select *CUGS-EJB/src/WEB-INF/web.xml*. Click *Ok.*
  - The *web.xml* should be located in the *WEB-INF* folder according to the container specification. Set the *Prefix* to *WEB-INF*

Packaging (9): MyWeb.jar

- Add the **specific** web deployment descriptor (JBoss)
  - Select the *MyWeb.war,* right-click in the area and select *Add File* from the pop-up menu.
  - Click *Project File* in the folder chooser dialog and select *CUGS-EJB/src/WEB-INF/jboss-web.xml*. Click *Ok.*
  - The *web.xml* should be located in the *WEB-INF* folder according to the container specification. Set the *Prefix* to *WEB-INF*

Packaging (10): MyWeb.jar

- Add HTML
  - Select the *MyWeb.war,* right-click in the area and select *Add Folder* from the pop-up menu.
  - Click *Project Folder* in the folder chooser dialog and select *CUGS-EJB/docroot*. Click *Ok.*
- The package configuration for MyWeb.jar is now complete.

Packaging (11): MyApp.ear

- Create an APP EAR
  - Click the *Add* button in the *Packaging Configuration* and type *MyApp.ear.* You have created a packaging configuration that will produce *MyApp.ear.*
- Add the application deployment descriptor
  - Select the *MyApp.ear,* right-click in the area and select *Add File* from the pop-up menu.
  - Click *Project File* in the folder chooser dialog and select *CUGS-EJB/src/WEB-INF/application.xml*. Click *Ok.*
  - The *application.xml* should be located in the *WEB-INF* folder according to the container specification. Set the *Prefix* to *WEB-INF*

Packaging (12): MyApp.ear

- Add the EJB module to the application
  - Select the *MyApp.ear,* right-click in the area and select *Add File* from the pop-up menu.
  - Click *Project File* in the folder chooser dialog
    - The file to be selected is *CUGS-EJB/MyEJB.jar* but it does not exist yet, so set *File* to *CUGS-EJB/MyEJB.jar* manually (type it in)
  - Click *Ok.*

Packaging (13): MyApp.ear

- Add the WEB module to the application
  - Select the *MyApp.ear,* right-click in the area and select *Add File* from the pop-up menu.
  - Click *Project File* in the folder chooser dialog
    - The file to be selected is *CUGS-EJB/MyWeb.jar* but it does not exist yet, so set *File* to *CUGS-EJB/MyWeb.jar* manually (type it in)
  - Click *Ok.*
- The packaging configuration for MyApp.ear is now complete.
- Right-click on the project and > *Run Packaging*

Remains

- JBoss Configuration and launch
- Applicaton deployment

- See JBoss documentation www.jboss.org