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WebSphere J2EE Application Development for the IBM eserver iSeries Server

Build and deploy J2EE compliant applications for WebSphere 4.0

Use Application Developer to build iSeries servlets, JSPs, and EJBs

Learn how to interface to legacy applications

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Luis Aused
Cliff Liang
Biswanath Panigrahi
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International Technical Support Organization

WebSphere J2EE Application Development for the IBM @server iSeries Server

May 2002

SG24-6559-00

Take Note! Before using this information and the product it supports, be sure to read the general information in “Notices” on page ix.

First Edition (May 2002)

This edition applies to Version 4, Release 0, of WebSphere Application Server Advanced Edition for iSeries, Program Number 5733-WA4, and Version 4, Release 0, of WebSphere Application Server Advanced Single Server Edition for iSeries, Program Number 5733-WS4, for use with the OS/400 V5R1.

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Preface

WebSphere Application Server 4.0 delivers the Java 2 Enterprise Edition (J2EE) implementation. It is the IBM strategic Web application server and a key IBM @server iSeries product for enabling e-business applications. The iSeries server and WebSphere Application Server are a perfect match for hosting e-business applications.

You can build J2EE applications using WebSphere Studio Application Developer – a new IBM application development environment. This is a follow-on product for VisualAge for Java and WebSphere Studio. It combines the best of these products into one integrated development environment.

This IBM Redbook shows customers, business partners, and ISVs how to build and deploy iSeries J2EE applications and how to use them to access iSeries resources. It also shows you how to use your iSeries server as a Java server. It is written for anyone who wants to use Java servlets, JavaServer Pages, and Enterprise JavaBeans on the iSeries server.

This redbook provides many practical programming examples with detailed explanations of how they work. The examples were developed using VisualAge for Java Enterprise Edition 4.0 and WebSphere Studio Application Developer 4.02. They were tested using WebSphere Application Server 4.0.2 Advanced Edition and Advanced Edition Single Server. To effectively use this book, you should be familiar with the Java programming language and object-oriented application development.

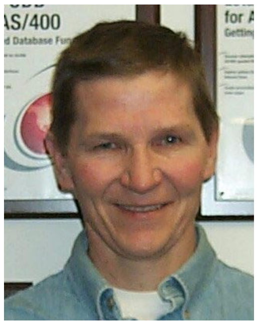
Throughout this redbook, we show and discuss code snippets from example programs. The example code is available for download. To understand this code better, download the files, as explained in Appendix A, and use them as a reference.

You can learn how to install, configure, and administer WebSphere 4.0 in an iSeries environment by referring to the complementary redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815.

Note: This Redbook reflects the IBM @server iSeries server name. Throughout this Redbook, we use the shortened version “iSeries” to refer to both AS/400e and iSeries servers.

The team that wrote this redbook

This redbook was produced by a team of specialists from around the world working at the International Technical Support Organization Rochester Center.



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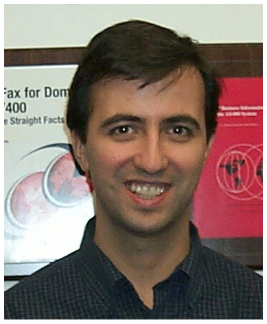

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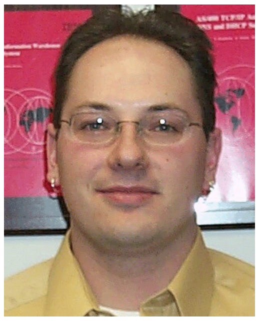

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Thanks to the following people for their invaluable contributions to this project:

Jim Beck
Mike Burke
Larry Hall
Dan Hiebert
Kevin Paterson
George Silber
Art Smet
Frances Stewart
Mike Turk
Lisa Wellman
IBM Rochester Laboratory

Special notice

This publication is intended to help anyone who wants to use IBM WebSphere Application Server Version 4.0 Advanced Edition or WebSphere Application Server Version 4.0 Advanced Single Server Edition in the iSeries environment. The information in this publication is not intended as the specification of any programming interfaces that are provided by the IBM WebSphere Application Server Advanced Edition product. See the PUBLICATIONS section of the IBM Programming Announcement for the IBM WebSphere Application Server Standard Edition product for more information about what publications are considered to be product documentation.

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1

Introduction to J2EE

Java 2 Platform, Enterprise Edition (J2EE) defines a standard that applies to all aspects of architecting and developing multi-tier server-based applications. It defines a standard architecture composed of an application model, a platform for hosting applications, a compatibility test suite (CTS), and a reference implementation.

The primary concern of J2EE is the platform specification. It describes the runtime environment for a J2EE application. This environment includes application components, containers, resource manager drivers, and databases. The elements of this environment communicate with a set of standard services that are also specified.

J2EE makes all Java enterprise APIs and functionality available and accessible in an integrated manner. This integration helps to simplify complex problems in the development, deployment, and management of multi-tier server-centric enterprise solutions. WebSphere Application Server Version 4.0 is fully J2EE 1.2 compliant.

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1.1 Java 2 Enterprise Edition (J2EE)

The Java 2 platform is a Sun specification for enterprise application development. Sun licenses the technology of J2EE to other companies, also known as the Web Technology Providers, such as IBM. Figure 1-1 shows the three editions that make up the Java 2 platform.

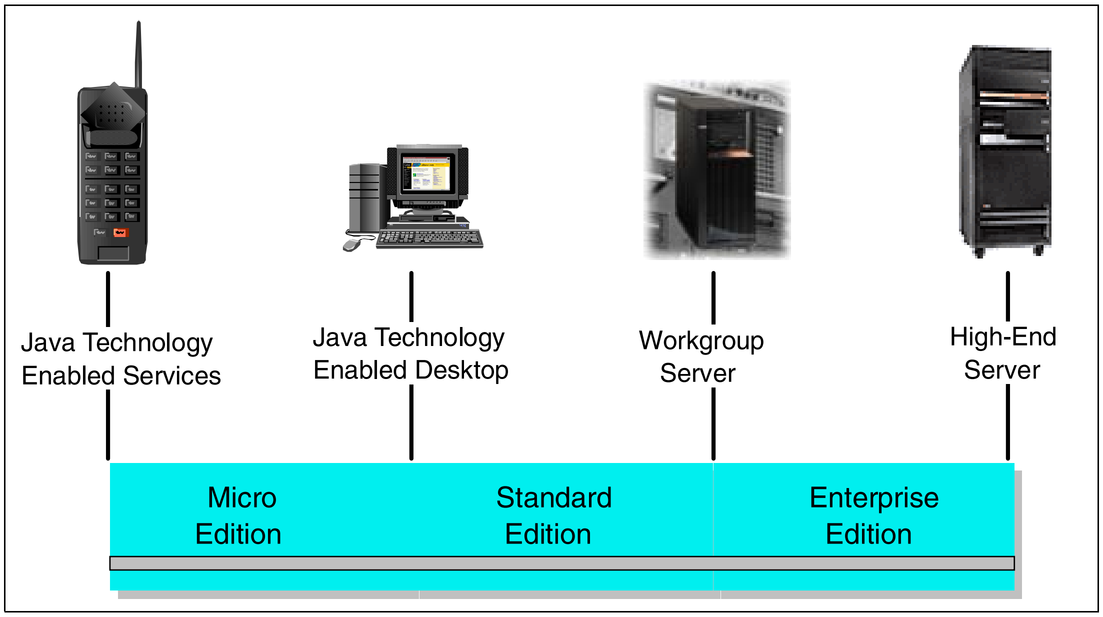


Figure 1-1 Java 2 platform editions

Each of the platforms are explained here:

- **Java 2 Platform, Micro Edition (J2ME)**

  A highly optimized Java runtime environment targeting a wide range of consumer products, including pagers, cellular phones, screen phones, digital set-top boxes, and car navigation systems.

- **Java 2 Platform, Standard Edition (J2SE)**

  The essential Java 2 SDK, tools, runtimes, and APIs for developers writing, deploying, and running applets and applications in the Java programming language. It includes earlier Java Development Kit versions JDK 1.1 and JRE 1.1.

- **Java 2 Platform, Enterprise Edition (J2EE)**

  Combines a number of technologies in one architecture with a comprehensive Application Programming Model and compatibility test suite for building enterprise-class server-side applications.

  Java 2 Enterprise Edition is a set of related specifications, a single standard for implementing and deploying enterprise applications. J2EE is an extension of the Java 2 Platform, Standard Edition. J2EE makes all Java enterprise APIs and functionality available and accessible in an integrated manner. Companies can use J2EE as a reference to identify product capabilities before they invest in a technology provider vendor. As shown in Figure 1-2, the standard includes:

  – An Application Programming Model for enterprise application developers and architects.

  – A platform to run the applications.

  – A compatibility test suite to verify that a platform complies with the standard.

- A reference implementation to show the capabilities of J2EE and provide an operational definition.
- Containers that are run-time environments that provide components with specific services. For example, Web containers provide run-time support to clients by processing requests by invoking JavaServer Page (JSP) files and servlets and returning results from the components to the client. Similarly, Enterprise JavaBean (EJB) containers provide automated support for transaction and state management of enterprise bean components, as well as lookup and security services.

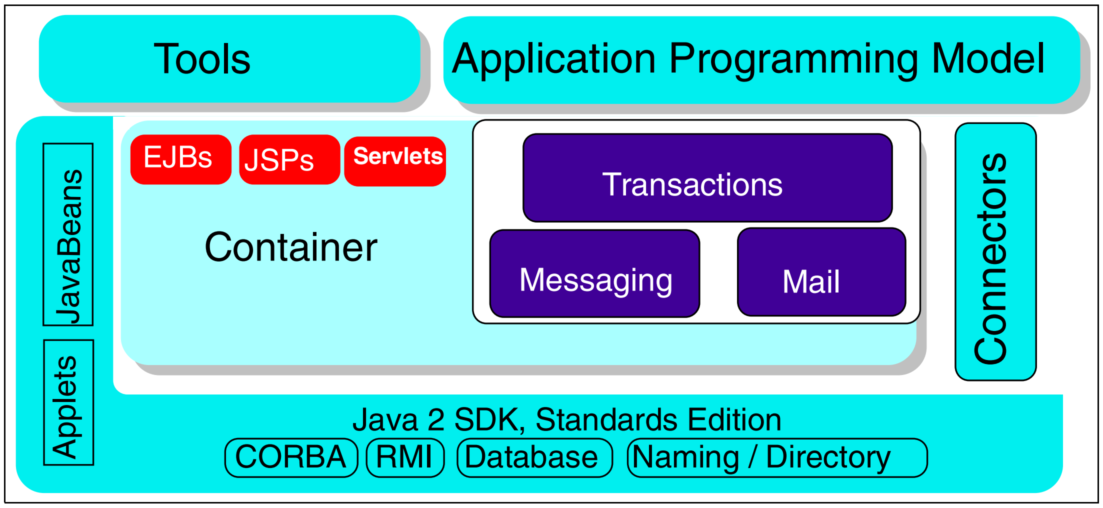


Figure 1-2 J2EE architecture

The J2EE specification is a consensus and collaboration from numerous major enterprise software vendors. The current J2EE specification level is 1.3. Since this redbook covers WebSphere Application Server 4.0, which supports J2EE 1.2, we focus on the WebSphere Application Server 4.0 supported J2EE 1.2 level. WebSphere 4.0 supports some of the J2EE 1.3 specification.

Benefits of J2EE

J2EE defines a simple standard that applies to all aspects of architecting and developing large scale applications. J2EE naturally encourages the adoption of a multiple tier architecture and a strict separation between business logic and the presentation layer.

In addition, the architectural approach suggested by the J2EE standards lends itself to the implementation of highly scalable infrastructures. An example is WebSphere Application Server 4.0, where the application workload can be transparently distributed across a number of concurrent processes or even across a number of parallel systems. J2EE also provides the technology to facilitate the integration of existing applications with newly developed J2EE applications.

The specifications are generic enough to allow an end user to choose among a wide array of middleware, tools, hardware, operating systems, and application designs. J2EE has created a whole new market for application servers, development tools, connectors, and components.

Multi-tier application environments

The J2EE specification supports a distributed application model. Applications can be spread across multiple platforms or tiers. Typically, we divide J2EE applications into three tiers. The J2EE application parts as shown in Figure 1-3 are presented in the J2EE components.

- The first tier contains the presentation logic. Typically this is a done by a servlet or JavaServer Page.The middle tier contains the business logic. Typically this is controlled by servlets or Enterprise JavaBeans.
- The third tier contains the database and legacy applications.
- Clients typically interface to the application through a Web browser, a Java application, or a pervasive computing device.

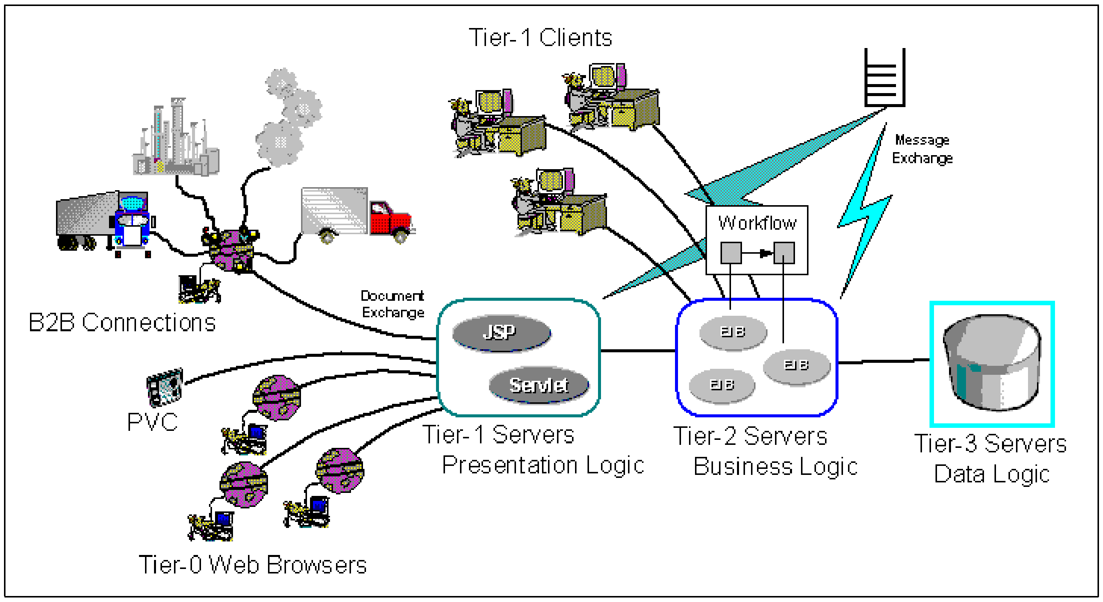


Figure 1-3 Multi-tier application environments

1.1.1 J2EE platform technologies

From a pure technological standpoint, you can recognize three areas (shown in Figure 1-4) within the J2EE specifications.

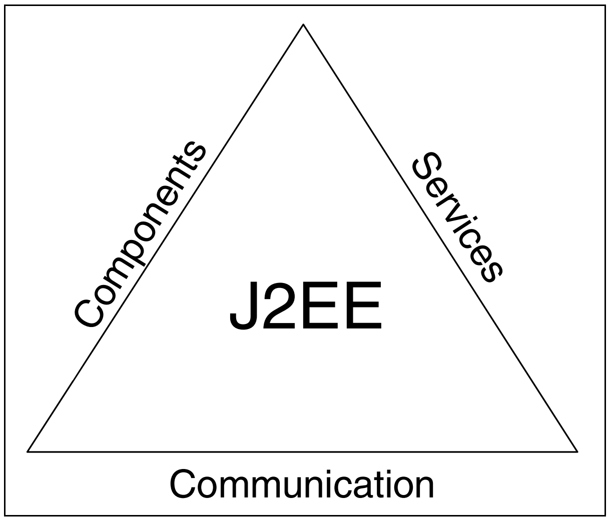


Figure 1-4 J2EE Platform technologies

Components

Components are provided by the application developers and include servlets, JavaServer Pages, and Enterprise JavaBeans. These components live inside J2EE containers that are provided by the middleware vendors, such as IBM with the WebSphere Application Server. A J2EE container needs to provide support for a number of services and communications. See 1.3, “J2EE components” on page 7, for details.

Services

The services are functions that are accessible to the components via a standard set of APIs. For example, a component has to access a relational database by using the Java Database Connectivity (JDBC) APIs, while it can use the Java Naming Directory Interface (JNDI) APIs to access the naming services. These APIs need to be supported by the container. Each level of the J2EE specification calls for supporting a specific level of each set of APIs. For example, the current level of J2EE supported by WebSphere 4.0 is 1.2. This implies support for JDBC level 2.0. See 1.4, “J2EE services” on page 9.

Communication

The essence of J2EE is the definition of a distributed, object-oriented infrastructure. Components need to communicate with each other in this distributed world. Therefore, the containers need to provide the appropriate communication mechanisms to make this happen. Examples of communications included in the J2EE standards are RMI/IIOP for remote method calls, JavaMail for programmatic access to e-mail, and Java Messaging Service (JMS) for accessing messaging technologies. Refer to 1.5, “J2EE communication” on page 13, for more details.

1.1.2 J2EE 1.2 required standard extension APIs

J2EE application components run in runtime environments provided by the containers that are part of the J2EE platform. The J2EE platform supports four separate types of containers (Figure 1-5), one for each J2EE application component type. The containers include application client containers, applet containers, Web containers for servlets and JSPs, and Enterprise JavaBean containers.

The J2EE platform also includes a number of Java standard extensions. Table 1-1 indicates which standard extensions are required to be available in each type of container. It also shows the required version of the standard extension.

Table 1-1 J2EE 1.2 required standard APIs

API	Applet	Application client	Web	EJB
JDBC 2.0	N	Y	Y	Y
JTA 1.0	N	Y	Y	Y
JNDI 1.2	N	N	Y	Y
Servlet 2.2	N	Y	Y	N
JSP 1.1	N	N	Y	N
EJB 1.1	N	Y (1)	Y (2)	Y
RMI/IIOP 1.0	N	Y	Y	Y
JMS 1.0	N	Y	Y	Y
JavaMail 1.1	N	N	Y	Y
JAF 1.0	N	N	Y	Y

(1) - Application clients can only use the enterprise bean client APIs.
(2) - Servlets and JSP pages can only use the enterprise bean client APIs.

1.1.3 J2EE package levels in WebSphere

Table 1-2 shows the details of servlet, JSP, and EJB changes included in the J2EE component level of WebSphere.

Table 1-2 J2EE component API levels in WebSphere

API	WAS 3.5.2+	WAS 4.0
Servlet	2.1, 2.2	2.2
JSP	0.91, 1.0, 1.1	1.1
EJB	1.0	1.1

Table 1-3 show the details of JDBC, JTA/JTS, JNDI, JAF, XML4J, and XSL changes included in J2EE Services level of WebSphere.

Table 1-3 J2EE service API levels in WebSphere

API	WAS 3.5.2+	WAS 4.0
JDBC	1.0, 2.0	2.0
JTA/JTS	1.0, 1.0.1, 1.1	1.1
JNDI	1.2	1.2.1
JAF	N/A	1.0
XML4J	2.0.15	3.1.1
XSL	1.0.1	2.0

Table 1-4 shows the details of RMI/IIOP, JMS, and Java Mail changes included in the J2EE communication level of WebSphere.

Table 1-4 J2EE communication API levels in WebSphere

API	WAS 3.5.2+	WAS 4.0
RMI/IIOP	1.0	1.0
JMS	1.0.1	1.0.1
Java Mail	N/A	1.1

Note: WebSphere Application Server 4.0 also includes some J2EE 1.3 features such and J2C and JMS Transaction (JMS/XA).

WebSphere 4.0 JDK level

WebSphere 4.0 implements JDK level 1.3, while WebSphere 3.5 used JDK 1.2.2. One of its major benefits is improved performance. The IBM Java Runtime Environment (JRE) 1.3 provides up to a 22 percent improvement over the JRE 1.2.2. Improvements in the JVM, JIT compiler, garbage collection, and threads management account for the performance improvements.

1.2 J2EE containers

Containers provide the runtime support for the application components. A *container* provides a total view of the underlying J2EE APIs to the application components. Interposing a container between the application components and the J2EE services allows the container to inject services defined by the components' deployment descriptors, such as declarative transaction management, security checks, resource pooling, and state management.

Each component runs inside a container that is provided by the J2EE platform provider. A typical J2EE product provides a container for each application component type: application client container, applet container, Web component container, and enterprise bean container as shown in Figure 1-5. The services that are offered depend on the type of container.

1.3 J2EE components

Components are provided by application developers and include applets, servlets, JavaServer Pages, and Enterprise JavaBeans. These components live inside J2EE containers. A J2EE container needs to provide support for a number of services and communications. Figure 1-5 shows the J2EE component object model.

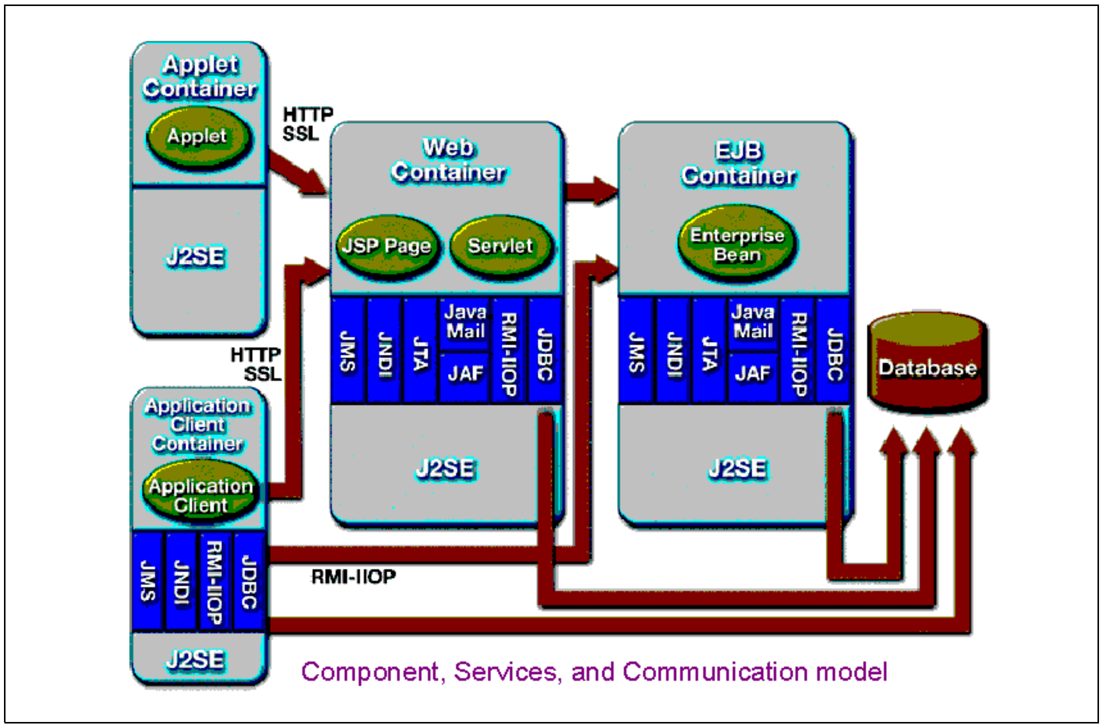


Figure 1-5 J2EE components

1.3.1 Client-side components

Application clients and applets are components that run on the client.

Application clients

Client-side components are Java programs that are typically graphical user interface (GUI) programs that run on a desktop computer. Application clients offer a user similar experience to that of native applications and have access to all of the facilities of the J2EE middle tier.

Client-side components run inside a J2EE compliant *client container*. A client container provides security, communication and other required J2EE services. Application clients can interact with:

- EJBs through RMI/IIOP
- Web components through HTTP/HTTPS

The deployment of client side components is platform specific, since details are unspecified by the J2EE specifications.

Applets

Applets are GUI components that typically run in a Web browser. They can run in a variety of other applications or devices that support the applet programming model. Applets can be used to provide user interfaces for J2EE applications.

Applets were Java's first attempt to solve some of the problems created by the common gateway interface (CGI) programming model. They created an entirely new set of challenges including network bandwidth requirements, poor performance, security, and lack of function. They are not widely accepted. Servlets provide an alternative to applets.

1.3.2 Server-side components: Servlets

Servlets are Java classes that allow application logic to be embedded in the HTTP request-response process.The J2EE 1.2 specification requires support for the servlet 2.2 API, as described in Table 1-1 on page 5. For more details about servlets, see 2.2, “Introduction to servlets” on page 23.

1.3.3 JavaServer Pages: Separating presentation logic

JSPs enable server-side scripting using Java. Server-side scripting is not an alternative to client-side scripting. Client-side scripting, JavaScript or Java applets, is important for performing input validity tests and other computation eliminating interaction with the server.

Although it is certainly possible to create a servlet that "does everything" (controller, model, and view logic), this is highly undesirable from both an initial coding and a maintenance perspective. JSPs provide a clean way to separate the View parts (presentation logic) from the rest of the Web application:

- This means that Java programmers can focus on building highly valuable, reusable component frameworks in the object space, and don’t have to deal with HTML.
- Web developers can focus on building a catchy, attractive Web site, and don't have to deal with the discipline of programming. Even better, they can own the JSPs, eliminating the problem of programmers and Web designers tromping on each others' work.
- The JSP specification allows an <HTML> oriented syntax, with clear <BEAN> tags to help the Web designer understand how to inject dynamic content from the Java components running in the object space.

JSPs are responsible for generating the output HTML going back to the Web client. They bridge the gap between Java and HTML, because the source JSP code is *parsed* and converted to pure a Java servlet, and then loaded and run just like any other servlet under the control of WebSphere. The only responsibility of this JSP/servlet is to generate output HTML, fulfilling the role of the View part of the application. For more information about JSPs, see 2.6, “JSP support in WebSphere Version 4.0” on page 52.

The J2EE 1.2 specification requires support for JSP 1.1, as described in Table 1-1 on page 5.

1.3.4 Server-side components: EJBs

The Enterprise JavaBean standard is a server-side Java-based component architecture for building multi-tier, distributed object applications. Components are pre-developed application code used to assemble applications.

EJBs have the same programming model as the client-side JavaBeans programming model, which makes it easy for Java programmers to use EJBs to build applications. By building reusable business objects as EJBs, programmers can focus on pure business logic and let the open standards based (EJB specification) EJB server manage the way the EJBs are mapped back to persistent data stores.

The J2EE 1.2 specification requires support for EJB 1.1, as described in Table 1-1 on page 5. For more information about Enterprise JavaBeans, see Chapter 6, “Introduction to Enterprise JavaBeans” on page 215.

1.4 J2EE services

The services are functions that are accessible to the components through a standard set of APIs. For example, a component has to access a relational database by using the JDBC APIs, while it can use the JNDI APIs to access the naming services. These APIs need to be supported by the container. Each level of the J2EE specification calls for supporting a specific level of each set of APIs. For example, the current level of J2EE supported by WebSphere 4.0 is 1.2, which requires support for JDBC level 2.0.

1.4.1 Java Naming Directory Interface

JNDI is an integral part of J2EE to lookup J2EE objects and resources. JNDI APIs provide naming and directory functionality to Java programs, allowing components to store and retrieve named Java objects. Naming services provide name-to-object mappings.

JNDI is independent of any specific directory access protocol, allowing easy deployment of new directory services and manipulation of Java instances by name.

Containers provide two levels of naming schemes:

- **Global:** The actual JNDI namespace.
- **Local:** Read-only, accessible to components. Local names are *bound* to their global counterparts at deployment.

The J2EE 1.2 specification requires support for the JNDI 1.2 specification, as described in Table 1-1 on page 5. WebSphere 4.0 provides an integrated JNDI 1.2 compliant name service.

Using JNDI

To access its naming context, a component creates a javax.naming.InitialContext object.

WebSphere 4.0 provides a new naming service named *com.ibm.websphere.naming.WsnInitialContextFactory*. WebSphere 3.5.2+ uses *com.ibm.ejs.ns.jndi.CNInitialContextFactory*. It is deprecated in WebSphere 4.0.

System-provided objects, such as `UserTransaction` objects, are stored in *java:comp/env* in the JNDI name space. User-defined objects are stored in subcontexts of java:comp/env. Here are a couple of examples:

- `java:comp/env/ejb`
- `java:comp/env/jdbc`

1.4.2 Java Database Connectivity

JDBC provides database-independent connectivity to a variety of data stores. The J2EE 1.2 specification requires:

- **JDBC 2.0 Core APIs**: Basic database services
- **JDBC 2.0 Extension APIs**: Advanced functionality
  - Connection Pooling
  - Transactional capabilities

The JDBC 2.0 Core and Extension APIs are supported in WebSphere 3.5 and above. Functionality is provided by a combination of WebSphere Application Server and a compliant JDBC driver.

1.4.3 Security

J2EE access control involves *authentication* to verify the user's identity:

- **Basic authentication:** The Web server authenticates a principal using the user name and password obtained from the Web client.
- **Digest authentication:** User name and a password are transmitted in an encrypted form.
- **Form-based authentication:** The Web container can provide an application-specific form for logging in.
- **Certificate authentication:** The client uses a public key certificate to establish its identity and maintain its own security context.

J2EE access control also involves *authorization* to determine if the user has permission to access the requested resource:

- Authorization is based on *roles*, which contain users or groups of users.
- Permissions are mapped by the deployer.

The security runtime consists of three core components, as shown in Figure 1-6.

A security plug-in is attached to a Web server. The plug-in performs initial security checks when users request Web resources, such as HTML files or servlets, from Web browsers over HTTP. The security plug-in challenges the Web client to authenticate, and contacts the EJS Web Collaborator to check the client's authentication information and check authorization.

An EJS Web collaborator is attached to every application server that contains a Web container. For every method call to a servlet, the EJS Web collaborator contacts the security application to perform the authorization check.

An EJS security collaborator is attached to every application server that contains an Enterprise JavaBean container. For every method call to an enterprise bean, the security collaborator contacts the security application to perform the authorization check and enforce the delegation policy.

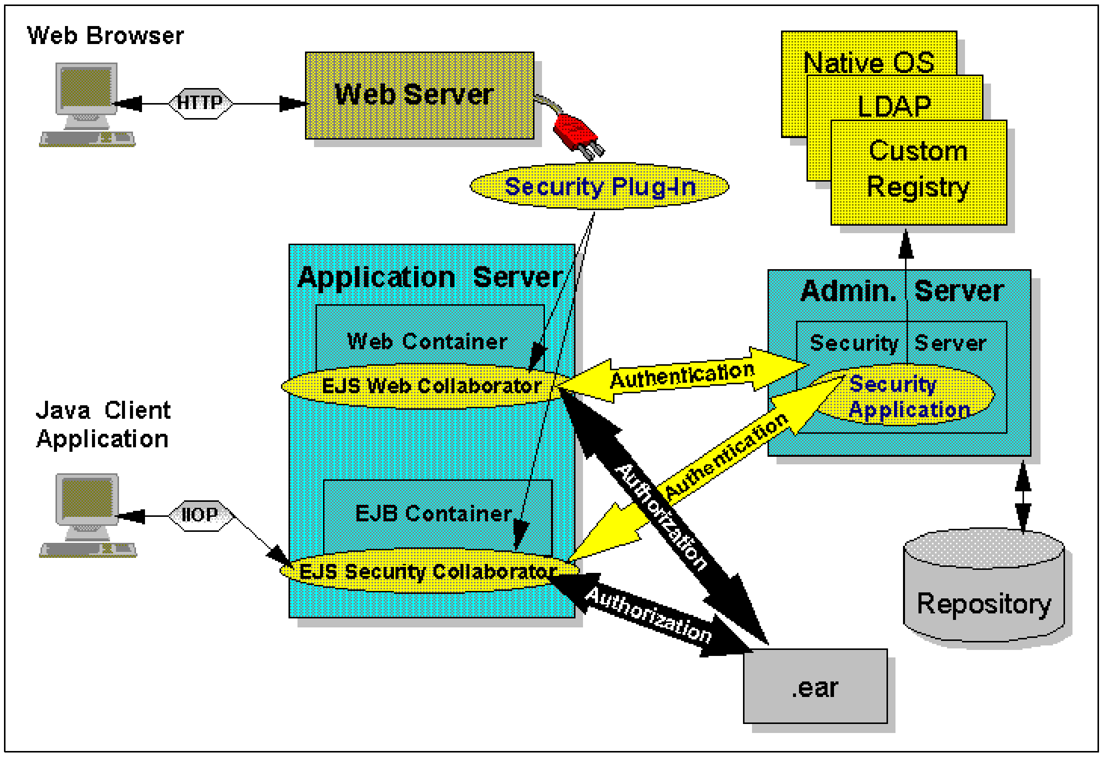


Figure 1-6 Security architecture

For more information on J2EE security in the iSeries environment, see Chapter 6 in the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815.

1.4.4 Transactions (JTA and JTS)

The Java Transaction API (JTA) allows applications to access transactions in a manner that is independent of specific implementations. JTA specifies standard Java interfaces between a transaction manager and the parties involved in a distributed transaction system:

- The transactional application
- The J2EE server
- The manager that controls access to the shared resources affected by the transactions

The J2EE 1.2 specification requires support for JTA 1.0, as described in Table 1-1 on page 5.

Java Transaction Service (JTS) specifies the implementation of a transaction manager that supports JTA and implements the Java mapping of the Object Management Group Object Transaction Service 1.1 specification. A JTS transaction manager provides the services and management functions required to support transaction demarcation, transactional resource management, synchronization, and propagation of information that is specific to a particular transaction instance.

JTA is the API, and JTS is the implementation. JTA is oriented at application developers, and JTS is oriented at middleware providers.

There are two ways to start a transaction:

- **Programmatic:** In the Java code, using the `javax.transaction.UserTransaction` interface.
- **Declarative:** Using EJB Container Managed Transaction.

Container-managed transactions

The EJB container is responsible for managing transaction boundaries, dictated by the transaction attribute modes specified for the EJB method as defined in the EJB deployment descriptor. Two transactional specifiers, the transaction attribute and the isolation attribute, are set in the deployment descriptor. The values chosen for these specifiers give the container the information it needs to generate the support code.

The transaction attributes are:

- **Required:** Use client transaction context, if present; otherwise create a new one.
- **Required New:** Always create a new transaction.
- **Not supported:** Don't propagate the client transaction, if present.
- **Supported:** Use the client transaction, if present.
- **Mandatory:** Use the client transaction, if present; otherwise, throw a `TransactionRequiredException` exception.
- **Never:** If client has transaction, throw an exception (new in EJB 1.1)

Concurrent transaction isolation is dictated by the isolation level. The isolation level is no longer in the EJB 1.1 specification. However, WebSphere Application Server 4.0 continues to support the isolation level as an IBM extension. The isolation levels that are supported are Read, Repeatable-Read, Read-Committed, and Serializable.

Two JDBC drivers are available for the iSeries server that support JTA 1.0:

- IBM Toolbox for Java JDBC driver: *com.ibm.as400.access.AS400JDBCConnectionPoolDataSource*
- IBM Developer Kit for Java (native JDBC driver): *com.ibm.db2.jdbc.app.DB2StdXADataSource*

When running on the iSeries server, such as under WebSphere Application Server, use the native driver. It performs better. The toolbox JDBC driver should be used to access iSeries database tables from remote systems.

1.4.5 JavaBean Activation Framework (JAF)

JAF is a MIME type support used by *JavaMail* to handle data in e-mail messages. It's not intended for typical application use. However, advanced e-mail interactions may require using it. Refer to 1.5.3, "JavaMail" on page 14.

The J2EE 1.2 specification requires support for JAF 1.0, as described in Table 1-1 on page 5.

1.5 J2EE communication

The essence of J2EE is the definition of a distributed, object-oriented infrastructure. Components need to communicate with each other in this distributed world. Therefore, the containers need to provide the appropriate communication mechanisms to make this happen. An example of the communications included in the J2EE standards are RMI/IIOP for remote method calls, JavaMail for programmatic access to e-mail, and JMS for accessing messaging technologies.

1.5.1 Remote method invocation (RMI/IIOP)

Remote method invocation (RMI) turns local method calls into remote method calls. From an application view, it just makes a method call. The infrastructure handles calling the remote method and receiving the response. EJB clients use remote method invocation over Internet Inter-ORB Protocol (RMI/IIOP) to communicate with other EJBs.

RMI support provides the `rmic` compiler, which generates:

- Client and server stubs that work with any Object Request Broker (ORB).
- An IDL file compatible with the RMI interface. To create a C++ server object, an Application Component Provider uses an IDL compiler to produce the server stub and skeleton for the server object.
- A CORBA API and ORB.

An Application Component Provider defines the interface of a remote object in Interface Definition Language (IDL). Then it uses an IDL compiler to generate client and server stubs that connect object implementations to an ORB, a library that enables CORBA objects to locate and communicate with one another. ORBs communicate with each other using the Internet Inter-ORB Protocol (IIOP).

The J2EE 1.2 specification supports RMI/IIOP level 1.0, as described in Table 1-1 on page 5.

1.5.2 Java Messaging Service

Java Messaging Service is a reliable interface for asynchronously sending and receiving messages. Messaging communication is:

- **Peer to peer:** Any client can send/receive messages to or from another client.
- **Loosely coupled:** The sender and receiver do not have to be available at the same time to communicate.
- **Asynchronous:** A JMS provider can deliver messages to a client as they arrive; a client does not have to request messages in order to receive them.
- **Reliable:** The JMS API can ensure that a message is delivered once and only once. Lower levels of reliability are available for applications that can afford to miss messages or receive duplicate messages.
- **Point-to-point messaging**: A client sends a message to the message queue of another client. Each message has one receiver.
- **Publish-subscribe messaging:** Clients subscribe to a well-known node called a *topic*. All subscribers receive a message sent to the topic. The topic adjusts as publishers and subscribers activate and deactivate.

The J2EE 1.2 specification requires support for JMS 1.0, as described in Table 1-1 on page 5. JMS 1.0 requires JMS transactions interacting with a single JMS resource provider only (one-phase commit). J2EE 1.3 requires support for distributed JMS Transaction (JMS/XA) two-phase commit. WebSphere Application Server Version 4.0 Advanced Edition supports JMS/XA. JMS/XA is not available in WebSphere Application Server Version 4.0 Advanced Single Server Edition. JMS/XA requires MQSeries.

1.5.3 JavaMail

JavaMail provides APIs for reading, composing, and sending e-mail. The APIs model a mail system, allowing Web components to interact with an e-mail system.

APIs require service providers to implement specific protocols:

- Send Mail: SMTP
- Receive/Store Mail: POP3, IMAP
- JAF to handle non-plain text mail content (MIME, URL, file attachments)

The J2EE 1.2 specification requires support for JavaMail 1.1, as described in Table 1-1 on page 5.

1.6 J2EE packaging and deployment

J2EE components are grouped in modules. End each module has its own deployment descriptor. Applications can include one or more modules, as shown in Figure 1-7 and as explained here:

- EJB modules group related EJBs in a single module and are packaged in Java Archive (JAR) files. The EJB JAR file contains all the EJBs and a deployment descriptor.
- Web modules group servlet class files, JSPs, HTML files, and images. They are packaged in Web Application Archive (WAR) files. The WAR file contains the Web components and a deployment descriptor.
- Application client modules are also packaged in Java Archive (JAR) files. The application client JAR contains all the Java classes of the application client and a deployment descriptor.

A J2EE application is packaged in an Enterprise Archive (EAR) file. The application has a deployment descriptor that allows configuration to a specific container's environment when deployed, as shown in Figure 1-7.

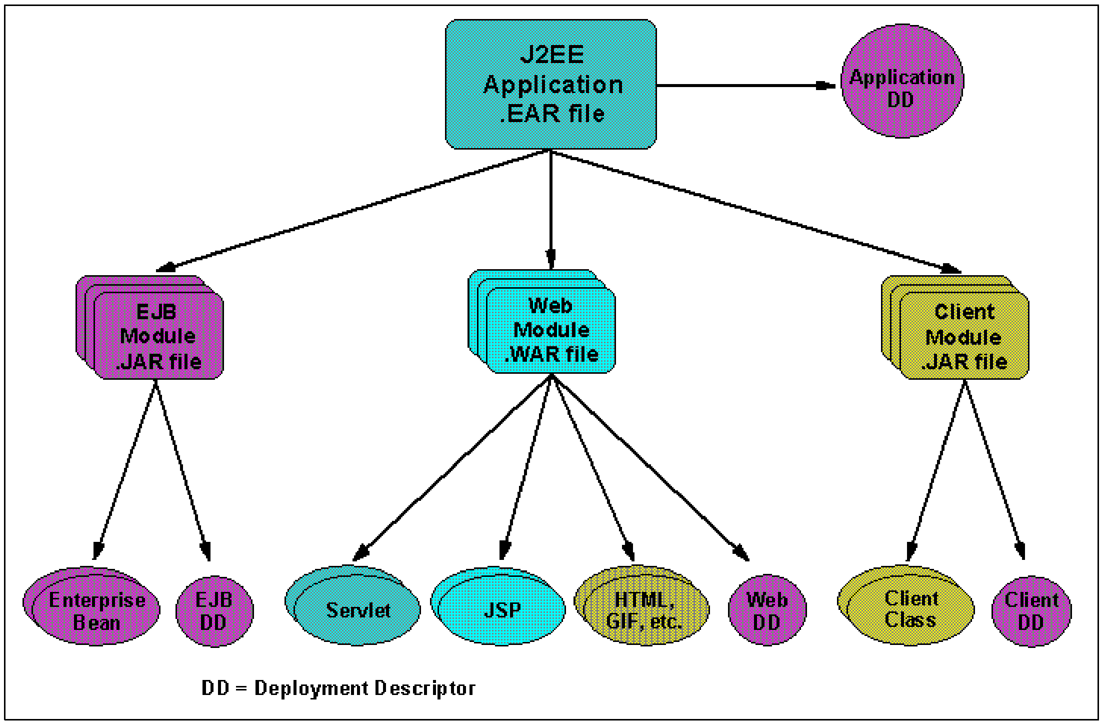


Figure 1-7 J2EE packaging

For more information about deploying J2EE applications, see Chapter 3, “WebSphere V4.0 assembly and deployment tools” on page 75.

1.6.1 J2EE deployment descriptor

Deployment descriptors are used to communicate the needs of application components to the deployer. The deployment descriptor is a contract between the application component provider or assembler and the deployer. The application component provider or assembler is required to specify the application component's external resource requirements, security requirements, environment parameters, and so on in the component's deployment descriptor. The J2EE product provider is required to provide a deployment tool that interprets the J2EE deployment descriptors and allows the deployer to map the application component's requirements to the capabilities of a specific J2EE product and environment.

A modules’s deployment descriptor, an XML-based file, dictates interaction with the container. The deployment descriptor describes the components of the module and the environment that the container is to provide for the components. Each module and ear file has a deployment descriptor.

When using the IBM WebSphere Software Platform foundation and tools, such as WebSphere Application Assembly Tool (AAT) or WebSphere Studio Application Developer, the deployment descriptor can be automatically created and verified by the WebSphere deployment tools.

The deployment descriptor can also be manually created or edited. However, this is *not* recommended because it is tedious and error prone.

EJB deployment descriptor

The deployment descriptor file associated with EJB components is named *ejb-jar.xml*. There is only one deployment descriptor for all the EJBs in the JAR file. Previously, in the EJB 1.0 specification, each enterprise bean had its own deployment descriptor.

The EJB deployment descriptor defines the following information for each EJB:

- Home interface, remote interface and bean name
- For session beans, the session type
- For entity beans, the persistence type

  For container-managed persistence (CMP), the primary key and container managed fields
- Transaction type
- Environment entries
- EJB references

The EJB deployment descriptor defines the following common assembly information:

- The security roles used in the EJB, the mapping of roles to methods
- For container managed transactions, the mapping of EJB methods to transaction attributes

WAR deployment descriptor

The deployment descriptor file associated with Web application components (WAR) is named *web.xml*. It defines the following information.

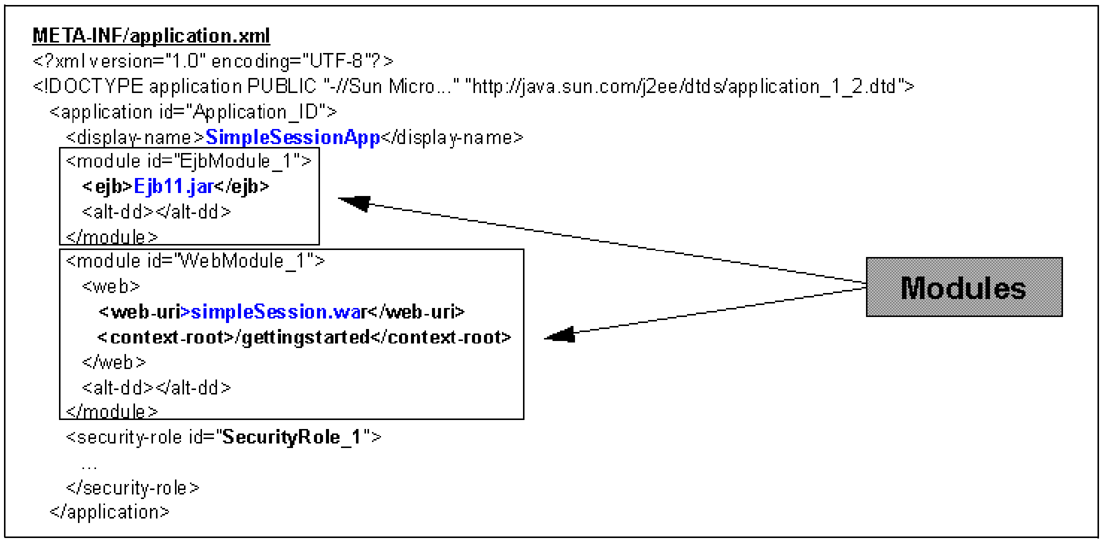
- Servlets, JSP, static resources: Servlet URL pattern, class/file, attributes
- Security constraints: For each URL pattern, the assigned security roles for methods
- Login configuration
- EJB and resource references
- Security roles for this Web module

EAR deployment descriptor

The deployment descriptor file associated with an enterprise application (EAR) modules is named *application.xml*. It defines the following information:

- All the modules packages in the EAR file: EJB, WAR, Application Client
- Defined security roles

Figure 1-8 shows an EAR deployment descriptor example that defines modules for EJB and Web components.



```
META-INF/application.xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE application PUBLIC "-//Sun Micro..." "http://java.sun.com/j2ee/dtds/application_1_2.dtd">
  <application id="Application_ID">
    <display-name>SimpleSessionApp</display-name>
    <module id="EjbModule_1">
      <ejb>Ejb11.jar</ejb>
      <alt-dd></alt-dd>
    </module>
    <module id="WebModule_1">
      <web>
        <web-uri>simpleSession.war</web-uri>
        <context-root>/gettingstarted</context-root>
      </web>
      <alt-dd></alt-dd>
    </module>
    <security-role id="SecurityRole_1">
      ...
    </security-role>
  </application>
```

Figure 1-8 Enterprise application (EAR) deployment descriptor example

1.7 J2EE platform roles

It is important to understand the J2EE roles because it helps to better understand the WebSphere tooling and how it addresses the separation of roles. Figure 1-9 and the following list describe the J2EE roles with a distinct focus on products, applications, and runtime:

- **Product provider:** The company that designs and makes available for purchase the J2EE platform, APIs, and other features defined in the J2EE specification. Product providers are typically operating system, database system, application server, or Web server vendors who implement the J2EE platform. IBM is a J2EE product provider with WebSphere 4.0.
- **Tools provider:** The person or company who makes development, assembly, and packaging tools used by component providers, assemblers, and deployers. IBM is a Tool Provider with VisualAge for Java and WebSphere Studio Application Developer.
- **Component provider:** The company or person who creates Web components, enterprise beans, applets, or application clients for use in J2EE applications.
- **Application assembler:** The company or person who gets application component JAR files from component providers and assembles them into a J2EE application EAR files. The assembler or deployer can edit the deployment descriptor directly or use tools that correctly add and edit XML tags. A software developer performs the following tasks to deliver an EAR file containing the J2EE application:
  - Assembles EJB JAR and Web components (WAR) files created in the previous phases into a J2EE application (EAR) file.
  - Specifies the deployment descriptor for the J2EE application.
  - Verifies that the contents of the EAR file are well formed and comply with the J2EE specification.
- **Deployer:** Deploys or installs the J2EE application (.ear) into the J2EE server platform.
- **System administrator:** Administers the computing and networking infrastructure where J2EE applications run, and oversees the runtime environment.

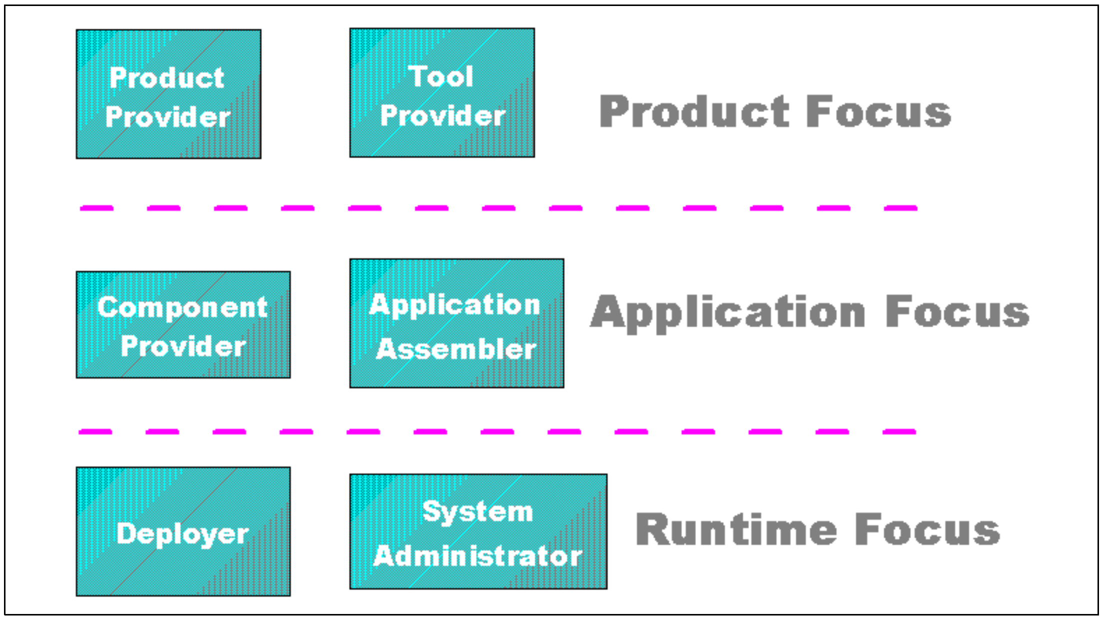


Figure 1-9 J2EE platform roles

Figure 1-10 describes the J2EE packaging and deployment tasks associated with the J2EE roles:

- **Application component provider:** Specifies component deployment descriptors and packages components into modules.
- **Application assembler:** Resolves dependencies between deployment descriptor elements in different modules and assembles modules into larger deployment units.
- **Deployer:** Customizes deployment descriptor elements for the environment and installs deployment units into servers.

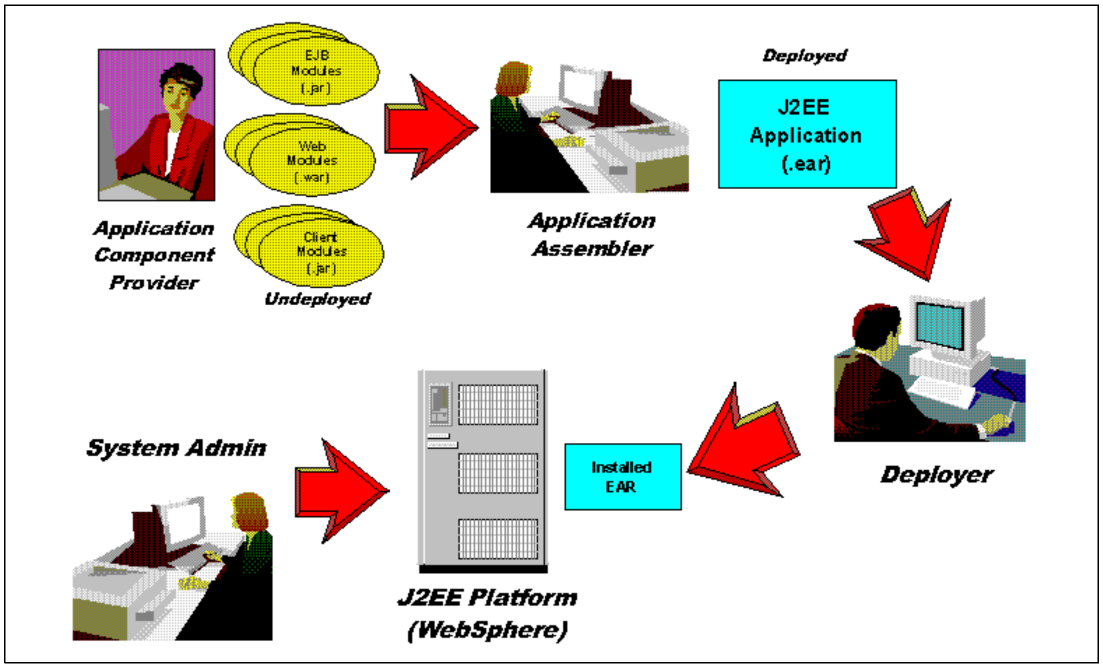


Figure 1-10 J2EE packaging and deployment tasks

1.8 J2EE additional resources

You can find additional J2EE information, such as the J2EE Specification, J2EE Blueprints, J2EE Reference Implementation, Java PetStore application, and articles and discussions on J2EE at: `http://java.sun.com/j2ee`

2

Servlet and JSP development using VisualAge for Java

Servlets are server side Java programs that run inside request/response-oriented servers, such as WebSphere Application Server, and extend them in some manner. For example, a servlet may be responsible for taking data in an HTML order entry form and applying the business logic used to update a company's order database. Servlets are to servers as applets are to browsers.

JavaServer Pages (JSP) extend the servlet architecture. They provide an easy way to separate business logic from the presentation of information. They allow you to access server-side components from Web pages while separating the presentation of dynamic content from the generation of that content. You do not need to know the Java programming language to use JavaServer Pages. JSPs give you the ability to access the feature set of Java in an easy-to-use tagging framework that generates dynamic content for the Web.

This chapter covers iSeries servlet and JSP application development for the WebSphere Application Server V4.0 environment using VisualAge for Java. The servlet and JSP support are the same for WebSphere Application Server Version 4.0 Advanced Single Server Edition and WebSphere Application Server Version 4.0 Advanced Edition.

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2.1 Servlet support in WebSphere Advanced Edition 4.0

Like version 3.5, the WebSphere Application Server 4.0 environment exists independently of the HTTP server using its resources. WebSphere Application Server 4.0 also provides an embedded HTTP server. This internal HTTP server can be used for testing purposes but should not be used in a production environment (Figure 2-1.)

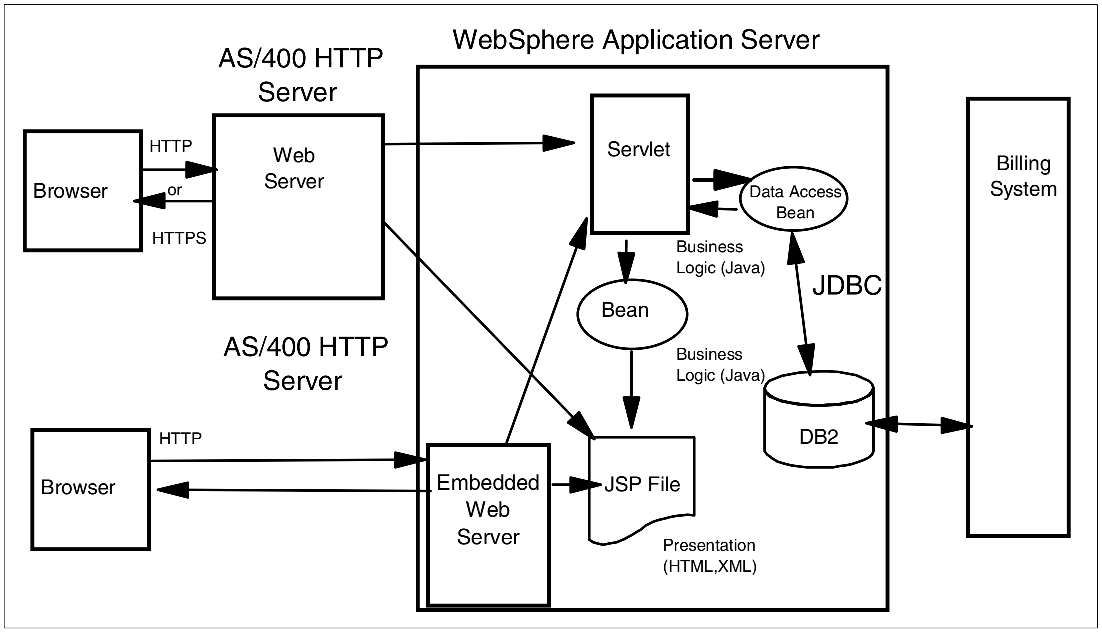


Figure 2-1 WebSphere V4.0: Typical servlet scenarios

As you look at Figure 2-1, notice how WebSphere Application Server works. For both WebSphere Application Server Version 4.0 Advanced Single Server Edition and WebSphere Application Server Version 4.0 Advanced Edition, if you are using an external HTTP server, there is an additional step in the process. This step is the Web server interface to the application server. In this case, the HTTP server and Java application server run as separate jobs in separate subsystems. If you use the internal HTTP server, there is only the application server running in its subsystem.

WebSphere Application Server V4.0 implements the Java Servlet 2.2 and JavaServer Pages 1.1 specification. The JavaServer Web Development Kit (JSWDK) is the reference implementation for the JavaServer Pages technology and the Java servlet API. The JSWDK is available at no charge from the Sun Microsystems Web site. For a complete definition of the Sun Java servlet and JSP API specification, refer to the Sun online documentation at the following Web sites:

- `http://java.sun.com/products/servlet/2.2/`
- `http://java.sun.com/products/jsp`

2.1.1 IBM development environments for WebSphere applications

There are a number of IBM application development environments that can be used for developing WebSphere applications. Two of the most popular ones for an iSeries environment are:

- **VisualAge for Java Enterprise Edition 4.0**: Provides a servlet and Enterprise JavaBean development environment

- **WebSphere Studio Version V4.0**: Provides a combined development environment for servlets and JSPs

In writing this chapter, we used VisualAge for Java Enterprise Edition 4.0 as our development environment. We required the ability to easily integrate servlets with both the IBM Toolbox for Java classes and Enterprise JavaBeans. While IBM WebSphere Studio is a simpler tool to use to achieve servlet/JSP generation, it would have required us to manually modify the generated servlets and import them into VisualAge for Java for integration into our ultimate integrated JSP, servlet, and EJB environment.

We also used a new IBM development tool – WebSphere Studio Application Developer V4.0 (Application Developer). It integrates the functionalities of both VisualAge for Java and WebSphere Studio and provides an advanced development environment for J2EE application development. It improves your productivity by providing an easy way to package J2EE compliant applications. We use Application Developer to build Web applications in Chapter 5, “Building Java servlets and JSPs with WebSphere Studio Application Developer” on page 175.

2.2 Introduction to servlets

Before you develop servlet applications, you need some background information about the basic concepts behind servlets. Figure 2-2 shows an overview of the servlet architecture and how servlets communicate with a browser. Communication between a browser and a servlet application follows this sequence:

1. The client (browser) sends a request to the HTTP server.
2. The HTTP server forwards the request to the servlet.
3. The servlet receives the request and generates a response by accessing resources and passes the response back to the HTTP server. The response usually contains HTML or other data that can be processed by the client.
4. The HTTP server sends the response to the calling client (browser).
5. The browser renders the data.

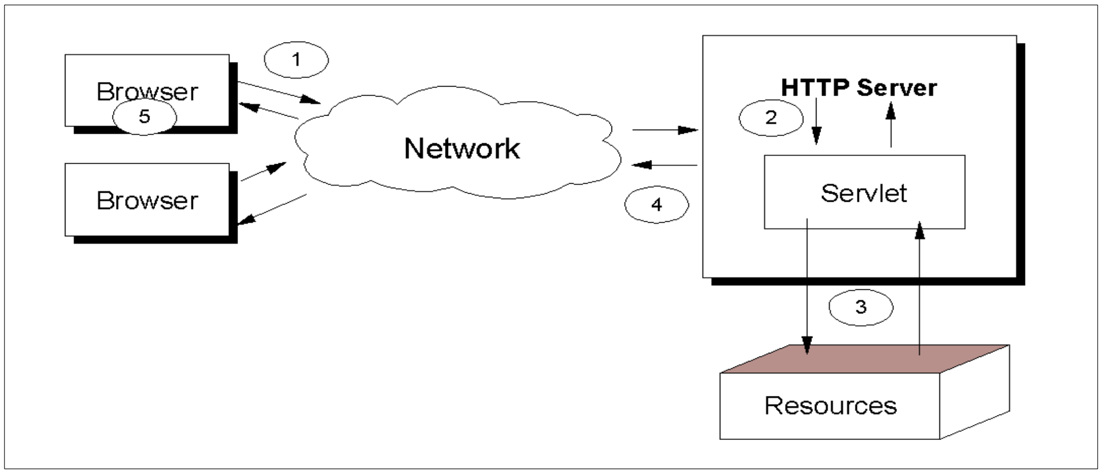


Figure 2-2 Servlet architecture

Servlets are modules that run inside request/response-oriented servers, such as the IBM WebSphere Application Server for iSeries. The servlets extend the servers in some manner. For example, a servlet may be responsible for taking data from an HTML order form and applying the company’s business logic to update a company's order database.

Servlets can provide services for HTTP servers or extensions to HTTP servers. They can perform functions that are equivalent to CGI programs, server-side includes, and server-side APIs (NSAPI and ISAPI). Servlets can also be used as a powerful substitution for CGI scripts. Although servlets can provide services outside of the HTTP environment, the HTTP servlet is of most interest.

Servlet support is provided in two packages:

- **javax.servlet.***: Provides support for generic, protocol-independent servlets
- **javax.servlet.http.***: Provides support for HTTP-specific functionality

The classes and interfaces are organized as shown in Figure 2-3.

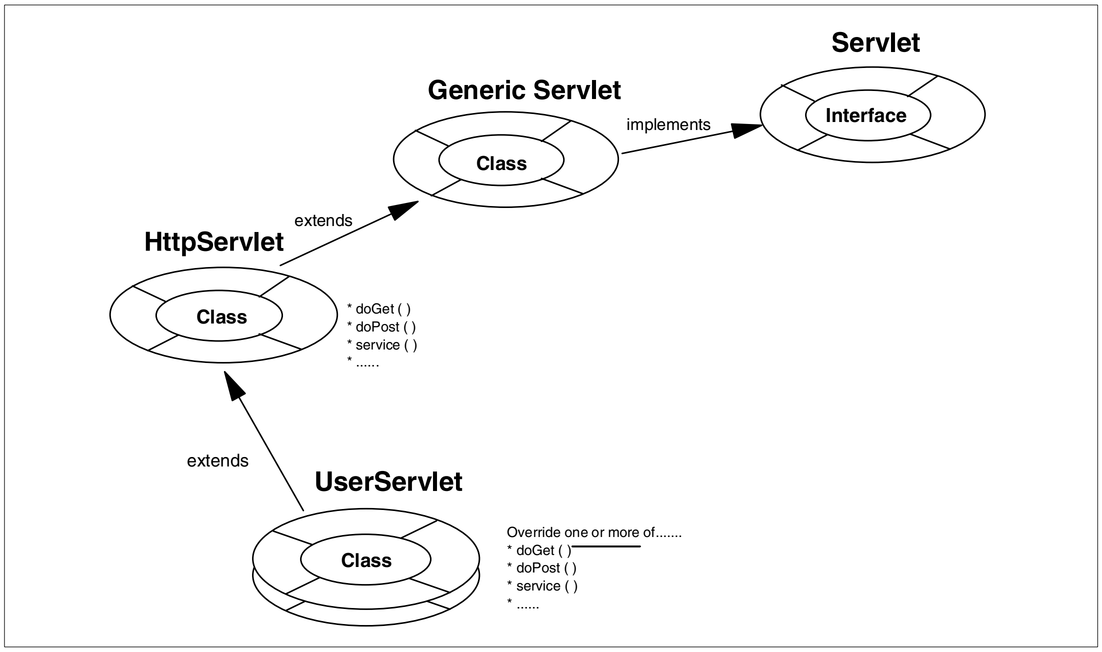


Figure 2-3 Servlet hierarchy

Servlets are a standard extension to Java, which means that servlets are part of the Java language, but they are not part of the core Java API. Therefore, while they may work with any Java Virtual Machine, servlet classes may not be bundled with all Java Virtual Machines.

You can obtain the two packages that are required to develop servlets, javax.servlet and javax.servlet.http, at the Javasoft Web site at: `http://www.javasoft.com`

With VisualAge for Java, these packages are available in the Sun JSDK class libraries project.

Servlets are usually used in the HTTP environment. For this reason, the HttpServlet class is extended, which, in turn, extends the GenericServlet class. To respond to a client request, the HttpServlet must be extended and override one or more of the following methods:

- **doGet()**: To support HTTP GET requests
- **doPost()**: To support HTTP POST requests
- **doDelete()**: To support HTTP DELETE requests
- **doPut()**: To support HTTP PUT requests

Usually, a servlet only overrides the `doGet()` and `doPost()` methods.

2.2.1 Simple servlet example

When accessed from a Web browser, the servlet in Example 2-1 generates the HTML page shown in Example 2-2.

Example 2-1 MyHelloWorldServlet

```
package nservlets;

import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class MyHelloWorldServlet extends javax.servlet.http.HttpServlet {

public void doGet(HttpServletRequest req, HttpServletResponse res)
   throws ServletException, IOException {
   res.setContentType("text/html");
   PrintWriter out = res.getWriter();
   out.println("<html>");
   out.println("<head><title>My Hello World</title></head>");
   out.println("<body>");
   out.println("<P><CENTER><B><FONT SIZE=+3 COLOR=\"RED\">Hello World </FONT></B></P>");
   out.println("</body></html>");
   out.close();
}
}
```

Example 2-2 Hello World HTML source

```
<html>
<head><title>Hello World</title></head>
<body>
<P><CENTER><B><FONT SIZE=+3 COLOR=RED>Hello World</FONT></B></P>
</body></html>
```

The code starts with three import statements. The *java.io* package is a standard package in the core Java platform. However, the two other packages, *javax.servlet* and *javax.servlet.http*, are particular to the servlet API. The javax.servlet package provides the general classes and interfaces for servlets. The javax.servlet.http package provides HTTP-specific classes and interfaces for servlets.

This servlet extends the javax.servlet.http.HttpServlet and overrides the `doGet()` method. By extending the abstract HttpServlet class of the javax.servlet.http package, the servlet gains access to specialized methods for handling the HTTP protocol. Since HttpServlet is an abstract class, classes that extend the HttpServlet class must override at least one method of the HttpServlet class. MyHelloWorldServlet overrides the `doGet()` method.

When the server receives a GET request for the servlet, the server calls the `service()` method of the servlet, passing it two objects as parameters:

- HttpServletRequest (the request object)
- HttpServletResponse (the response object)

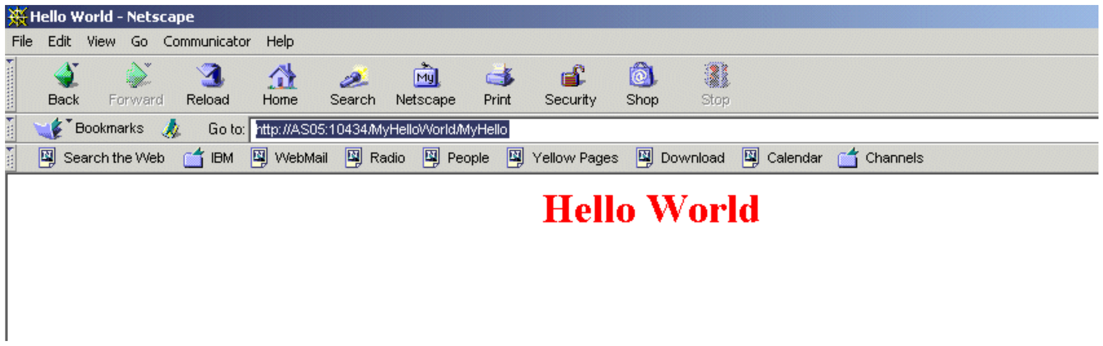
The `service()` method of the servlet routes the GET request to the `doGet()` method of the servlet. The servlet communicates with the server and ultimately with the client through these request and response objects.

The HttpServletRequest object represents the request of the client. This object supplies the servlet with methods to retrieve HTTP protocol specified header information, the parameters for this request, information about the client, and so forth.

The HttpServletResponse object represents the servlet response to the client. The servlet invokes the methods of the response object to send the response that it has prepared back to the client. The servlet can also use these methods to set HTTP response headers.

The servlet then calls the `getWriter()` method of the response object to get a print writer for writing formatted text responses. It uses the returned PrintWriter object to generate the HTML text.

When the servlet is called from the browser, you see the servlet output as shown in Figure 2-4.


Hello World - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Shop Stop
Bookmarks Go to:
Search the Web IBM WebMail Radio People Yellow Pages Download Calendar Channels

http://AS05:10434/MyHelloWorld/MyHello

Hello World

Figure 2-4 MyHelloWorldServlet running on the iSeries server

2.3 Setting up VisualAge for Java to develop and test servlets

VisualAge for Java offers an Integrated Development Environment (IDE). It provides some very useful capabilities for developing and testing servlets and JavaServer Pages.

VisualAge for Java Enterprise Edition 4.0 provides a test version of the WebSphere Application Server. It is called the *WebSphere Test Environment* (WTE). It includes an application server that is integrated right into the integrated development environment. It includes a servlet engine, a persistent name server, a JSP execution monitor, and a DataSource configuration wizard.

2.3.1 Loading the required features

To work with VisualAge for Java, you must first load the necessary features from the repository into the VisualAge for Java work space. To perform a feature installation, follow these steps:

1. Select **File-> Quick Start-> Features-> Add Features**.
2. Select the following features:
   – IBM WebSphere Test Environment
   – IBM Enterprise Toolkit for AS/400
3. Click **OK** to load the features into the workspace.

2.3.2 Using the WebSphere Test Environment

To use the WebSphere Test Environment in VisualAge for Java 4.0, complete the following steps:

1. Install VisualAge for Java Enterprise Edition, Version 4.0. Then, install VisualAge for Java Enterprise Edition's latest patches. During the Feature Install installation process, you are prompted to indicate the *document root* on your system (the document root is where your Web resources, including HTML files and JSP files, are stored). Because there is minimal error checking, make sure that the document root directory exists and is valid.

   Note: If you want to change the document root later, you can change it in the doc.properties file. This file is located in the \ide\project_resources\IBM WebSphere Test Environment\properties\server\servlet\httpservice\ subdirectory.

2. After the installation process is completed, restart VisualAge for Java. The features are automatically imported into the repository.
3. Launch the WebSphere Application Server Test Environment. To do this, in the VisualAge for Java Workbench, select **Workspace-> Tools-> WebSphere Test Environment** (Figure 2-5).

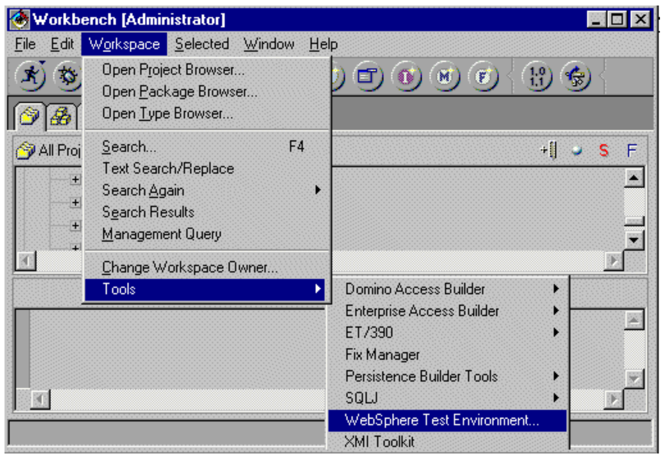


Figure 2-5 Starting the WebSphere Test Environment

4. The WebSphere Test Environment starts. Since this is the first time that it is started, it will take more time than normal to start. Be patient.
5. Once the WTE starts, as shown in Figure 2-6, you can click **Start Servlet Engine** to start the servlet engine.

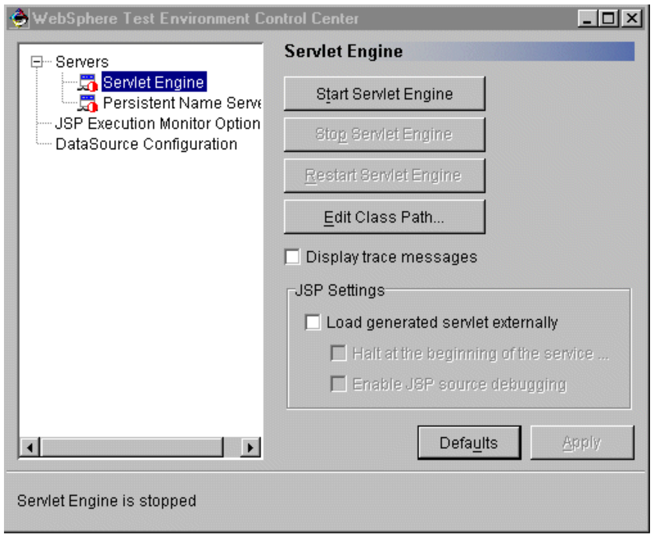


Figure 2-6 Starting Servlet Engine

You can now test servlets inside VisualAge for Java. You can use the VisualAge for Java debugger to monitor and debug the servlet Java code interactively.

2.3.3 Testing the servlet under VisualAge for Java Enterprise Edition 4.0

Once the WebSphere Test Environment starts and the servlet engine is active, you can run the servlet in a Web browser. The servlet, JSP files, and HTML files from the designated document root can be served. To run the MyHelloWorldServlet, enter either of the following URLs:

```
http://127.0.0.1:8080/servlet/nservlets.MyHelloWorldServlet
http://localhost:8080/servlet/nservlets.MyHelloWorldServlet
```

The MyHelloWorld servlet page appears as shown in Figure 2-7.

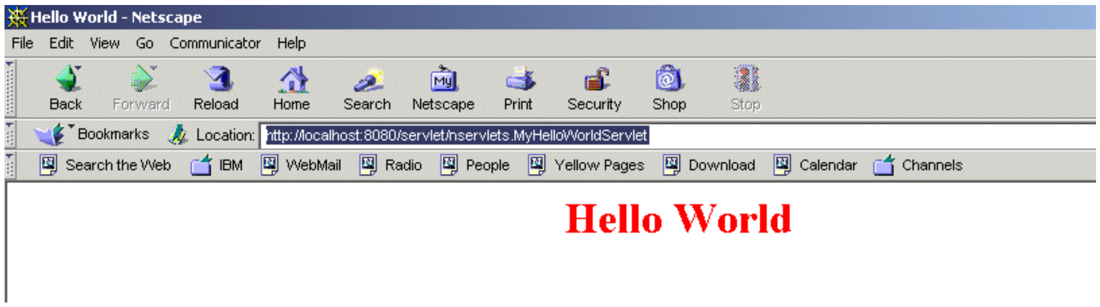

Hello World - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Shop Stop
Bookmarks Location: http://localhost:8080/servlet/nservlets.MyHelloWorldServlet
Search the Web IBM WebMail Radio People Yellow Pages Download Calendar Channels
Hello World

Figure 2-7 The MyHelloWorldServlet class

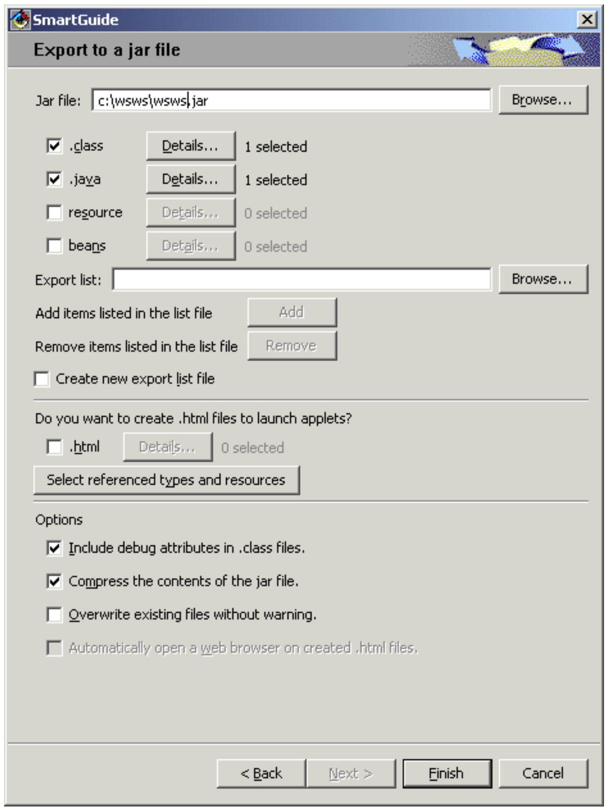
2.3.4 Exporting class files to a JAR file

In WebSphere Application Server V3.5, you can export the class files to the iSeries Integrated File System (IFS) directly and deploy them into the WebSphere Application Server environment. In WebSphere Application Server V4.0, however, this is not supported. You use the WebSphere Application Assembly Tool (AAT) to create a J2EE Web application that can be installed on WebSphere Application Server 4.0. For the Java classes in VisualAge for Java, we first export the files to a JAR file and then we can use it as the source for AAT. See Chapter 3, “WebSphere V4.0 assembly and deployment tools” on page 75, for more information about using AAT.

Here is how to export Java classes into a JAR file:

1. Select the **MyHelloWorldServlet** class file in the VisualAge for Java workbench.
2. Right-click and select **Export**.
3. In the Export SmartGuide, select the **Jar File** radio button.
4. On the next page, enter the JAR file name and directory (here we store it in c:\wsws\wsws.jar), as shown in Figure 2-8.
5. Click **Finish**. The JAR file is stored on the local drive.

In Chapter 3, “WebSphere V4.0 assembly and deployment tools” on page 75, we use AAT to assemble it into a J2EE Web application.


SmartGuide

Export to a jar file

Jar file: c:\wsws\wsws.jar

[✓] .class — 1 selected

[✓] .java — 1 selected

[ ] resource — 0 selected

[ ] beans — 0 selected

Export list:

Add items listed in the list file

Remove items listed in the list file

[ ] Create new export list file

Do you want to create .html files to launch applets?

[ ] .html — 0 selected

Options

[✓] Include debug attributes in .class files.

[✓] Compress the contents of the jar file.

[ ] Overwrite existing files without warning.

[ ] Automatically open a web browser on created .html files.

Figure 2-8 Exporting Java classes into a JAR file

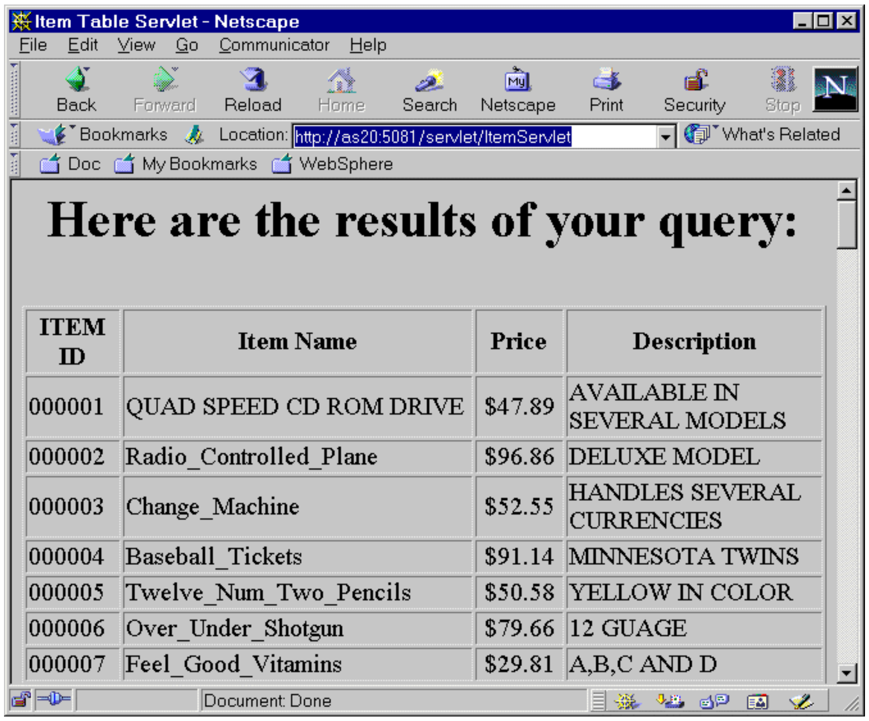
2.4 Using JDBC to access an iSeries database

This example builds a servlet that uses JDBC to access a database table on the iSeries server. The table that we access is named *ITEM*. It has the columns shown in Table 2-1. It is found in a library named *APILIB*.

Table 2-1 Item file description

Column name	Column description	Length	Decimals	Type
IID	Item ID	6	0	Character
INAME	Item Name	24	0	Character
IPRICE	Price	5	2	Packed
IDATA	Item Information	50	0	Character

Figure 2-9 shows the output of the servlet. Please note that, by calling the servlet in this manner, the HTTP request that the servlet receives is the default GET request.


Item Table Servlet - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Netscape Print Security Stop
Bookmarks Location: http://as20:5081/servlet/ItemServlet What's Related
Doc My Bookmarks WebSphere
Document: Done

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	QUAD SPEED CD ROM DRIVE	$47.89	AVAILABLE IN SEVERAL MODELS
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D

Figure 2-9 The results of running ItemServlet

2.4.1 The architecture of the sample application

This section shows you the benefit of a proper application architecture. That is, you can use the same functionality for applets, servlets, and applications with only minor changes. To demonstrate this, we structure the example application as shown in Figure 2-10.

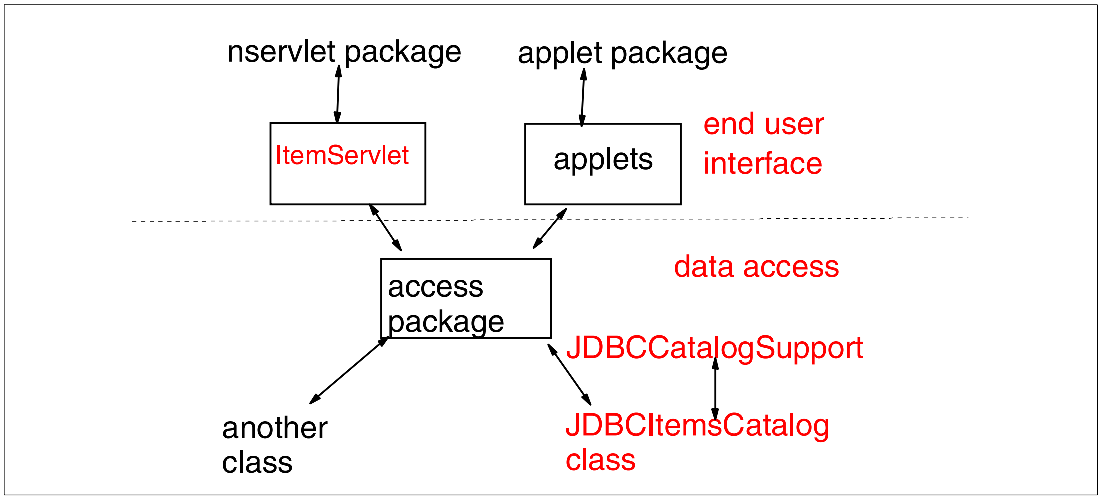


Figure 2-10 Application architecture

The application consists of multiple packages:

- **access:** This package contains the JDBCItemCatalog class that is responsible for database access. The database access is implemented using JDBC. The class contains one method to connect to the database, `connectToDB()`, and two methods, `getRecord()` and `getAllV()`, to retrieve data from the databases.
- **nservlets**: This package contains classes that provide the end-user interface. The servlet examples implement the HttpServlet abstract class. The ItemServlet class in this package manages all the user interface-oriented work, such as getting and interpreting the user requests that are received in the form of HTTP requests and generating the response in the form of HTML. To obtain the items information that is included in the generated HTML, the ItemServlet class forwards the database access work to the JDBCItemCatalog class.

2.4.2 JDBCCatalogSupport class

The JDBCCatalogSupport class is the super class for the JDBC-based access classes. It adds a few methods that are shared among several JDBC-based access classes.

JDBCCatalogSupport.getRows() method

Only one `JDBCCatalogSupport` method is relevant for the JDBCItemCatalog class. The `getRows()` method is shown in Example 2-3.

Example 2-3 JDBCCatalogSupport.getRows() method

```
public java.util.Vector getRows(java.sql.ResultSet aResultSet) {
   java.util.Vector aDataVector = new Vector();

   try {

      while (aResultSet.next()) {
         String[] data = new String[4];
         data[0] = aResultSet.getString(1); // Item ID
         data[1] = aResultSet.getString(2); // Item Name
         data[2] = aResultSet.getBigDecimal(3, 2).toString(); // price
         data[3] = aResultSet.getString(4); // Item Information
         // add the data element (String[]) to the vector
         aDataVector.addElement(data);
      }
   } catch (SQLException ex) {...}
   return aDataVector;
}
```

To make our code more generic in nature, we use vectors to pass information. The `getRows()` method accepts an SQL ResultSet object and returns a vector. It loops through the ResultSet object. Each row of the ResultSet object is converted into an array of strings. The array of strings is added to the vector.

2.4.3 JDBCItemCatalog class

The JDBCItemCatalog class extends JDBCCatalogSupport and defines three private variables as shown in Example 2-4:

- **dbConnection**: A java.sql.Connection object that represents a session with a specific database. Within the context of a Connection object, SQL statements are executed and results are returned.
- **psAllRecord**: A java.sql.PreparedStatement object that represents a precompiled SQL statement that is stored in the PreparedStatement object. This object can then be used to efficiently run this statement multiple times. We use this PreparedStatement object to retrieve all the Item database rows.
- **psSingleRecord**: A java.sql.PreparedStatement object used to retrieve one row from the Item database.

Example 2-4 JDBCItemCatalog class

```
package access;

import java.util.*;
import java.sql.*;

public class JDBCItemsCatalog  extends JDBCCatalogSupport{

   private java.sql.Connection dbConnection;
   private java.sql.PreparedStatement psAllRecord;
   private java.sql.PreparedStatement psSingleRecord;
   .
   .
   .
}
```

JDBCItemCatalog.connectToDB() method

The `connectToDB()` method (Example 2-5) handles the connection to the iSeries server.

Example 2-5 JDBCItemCatalog.connectToDB() method

```
public String connectToDB(String url, String userid, String password,String driver) {
   // Create a properties object for JDBC connection
   Properties jdbcProperties = new Properties();

   // Set the properties for the JDBC connection
   jdbcProperties.put("user", userid);
   jdbcProperties.put("password", password);
   jdbcProperties.put("naming", "sql");
   jdbcProperties.put("errors", "full");
   jdbcProperties.put("date format", "iso");
   jdbcProperties.put("extended dynamic", "true");
   jdbcProperties.put("package", "ServTest");

   try {
      try {
      Driver dr = (Driver)Class.forName(driver).newInstance();
   } catch (Exception ex) {... return "cannot register JDBC driver";}

      dbConnection = DriverManager.getConnection(url, jdbcProperties); //toolbox

      psAllRecord = dbConnection.prepareStatement("select * from item");
      psSingleRecord = dbConnection.prepareStatement(
           "SELECT * FROM ITEM WHERE IID = ?");

   } catch (SQLException ex) {... return "connection failed sql exception";}
   return "connection successful";
}
```

The `connectToDB()` method accepts the four parameters shown in Table 2-2 and returns a String containing a short information message to indicate a successful connection or an error message.

Table 2-2 The parameters of the JDBC driver

Parameter	Description	JDBC driver	Example
url	A database URL in the form `jdbc:subprotocol:subname`	Toolbox	`jdbc:as400://as05/APILIB`
		Native	`jdbc:db2://as05/APILIB`
userid	A valid user ID		
password	A valid password		
driver	The name of the class that implements the JDBC driver to use	Toolbox	`com.ibm.as400.access.AS400JDBCDriver`
		Native	`com.ibm.db2.jdbc.app.DB2Driver`

To make it easier to manage the properties of the JDBC connection, we use a java.util.Properties object and set the different JDBC connection properties, such as SQL naming convention, date format, and so on.

Before a JDBC connection can be made, you need to load the JDBC driver and register it with the driver manager. These two operations can be done in one statement:

```
Class.forName(driver);
```

The JDBC documentation states, “When a Driver class is loaded, it should create an instance of itself and register it with the DriverManager.”

The next step is to use the driver manager to get a JDBC connection. We use the `prepareStatement()` method of the connection object to create two SQL-prepared statements. One SQL statement (psALLRecord) is used to retrieve all the rows from the ITEM table, and the second (psSingleRecord) is used to retrieve one row from the ITEM table. To choose the specific row dynamically, while gaining the performance benefits of compiled SQL statements, we use a parameter marker in the SQL statement.

JDBCItemCatalog.getAllV() method

The `getAllV()` method executes the SQL query previously prepared in the psAllRecord preparedStatement object and uses the `getRows()` method inherited from the JDBCCatalogSupport class (Example 2-6) to convert the returned result set into a vector.

Example 2-6 JDBCItemCatalog.getAllV() method

```
public java.util.Vector getAllV() {
   java.util.Vector aDataVector = new Vector();
   java.sql.ResultSet aResultSet = null;
   try {
      aResultSet = psAllRecord.executeQuery();
      aDataVector = getRows(aResultSet);
   } catch (SQLException ex) {
      ex.printStackTrace();
   }
   return aDataVector;
}
```

JDBCItemCatalog.getRecord() method

The `getRecord()` method sets the part number value for the parameter marker using the `setString()` method of the psSingleRecord preparedStatement object. Then, it executes the SQL query and uses the `getRows()` method, shown in Example 2-7, to convert the returned result set into a vector.

Example 2-7 JDBCItemCatalog.getRecord() method

```
public java.util.Vector getRecord(String partNo) {

   java.util.Vector aDataVector = new Vector();
   java.sql.ResultSet aResultSet = null;
   try {
      psSingleRecord.setString(1, partNo);
      aResultSet = psSingleRecord.executeQuery();
      aDataVector = getRows(aResultSet);
   } catch (SQLException ex) {
      ex.printStackTrace();
   }
   return aDataVector;
}
```

2.4.4 Testing the application in the scrapbook

Before we implement the servlet, we want to make sure the data access bean works properly. There is a function in VisualAge for Java called the *scrapbook*, which can be used to test the class without a user interface.

We open the scrapbook from the Workbench window menu and enter the code shown in Example 2-8.

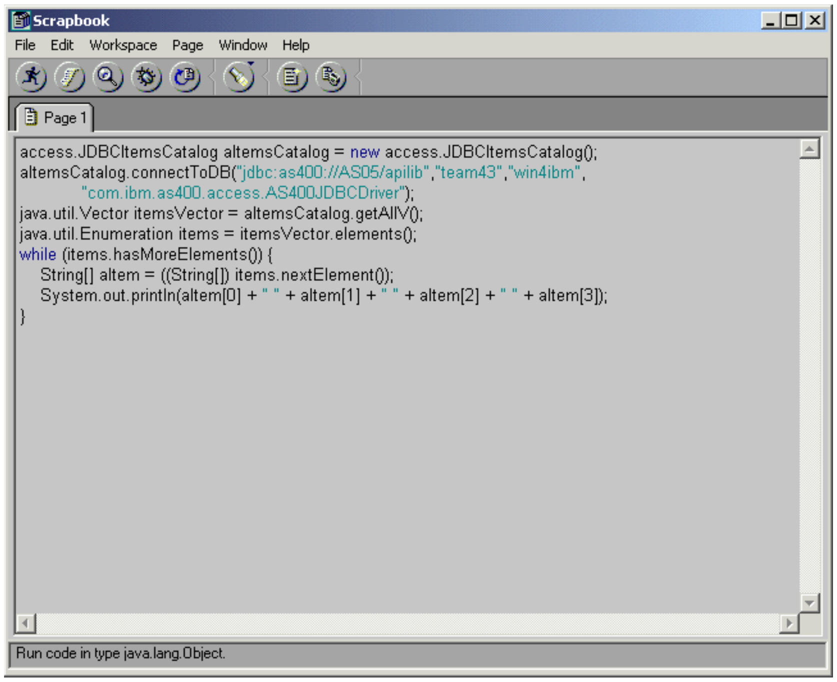
Example 2-8 Code in scrapbook

```
access.JDBCItemsCatalog aItemsCatalog = new access.JDBCItemsCatalog();
aItemsCatalog.connectToDB("jdbc:as400://system/teamxx","user","password",
            "com.ibm.as400.access.AS400JDBCDriver");
java.util.Vector itemsVector = aItemsCatalog.getAllV();
java.util.Enumeration items = itemsVector.elements();
while (items.hasMoreElements()) {
    String[] aItem = ((String[]) items.nextElement());
    System.out.println(aItem[0] + " " + aItem[1] + " " + aItem[2] + " " + aItem[3]);
}
```

Let's go through the code. First, it creates a new instance of the JDBCItemsCatalog class named aItemsCatalog. Then it executes the `connectToDB` method of the JDBCItemsCatalog class. Once connected, it executes the `getAllV` method of the JDBCItemsCatalog class to retrieve all the rows from the Items Table and return them in a vector named itemsVector. Then it uses the Enumeration `nextElement` method to read each row from an Enumeration and store the information in a String array named aItem and print them on the console.

As shown in Figure 2-11, to execute this code, we need to enter the valid values for:

- URL
- User
- Password
- JDBC driver

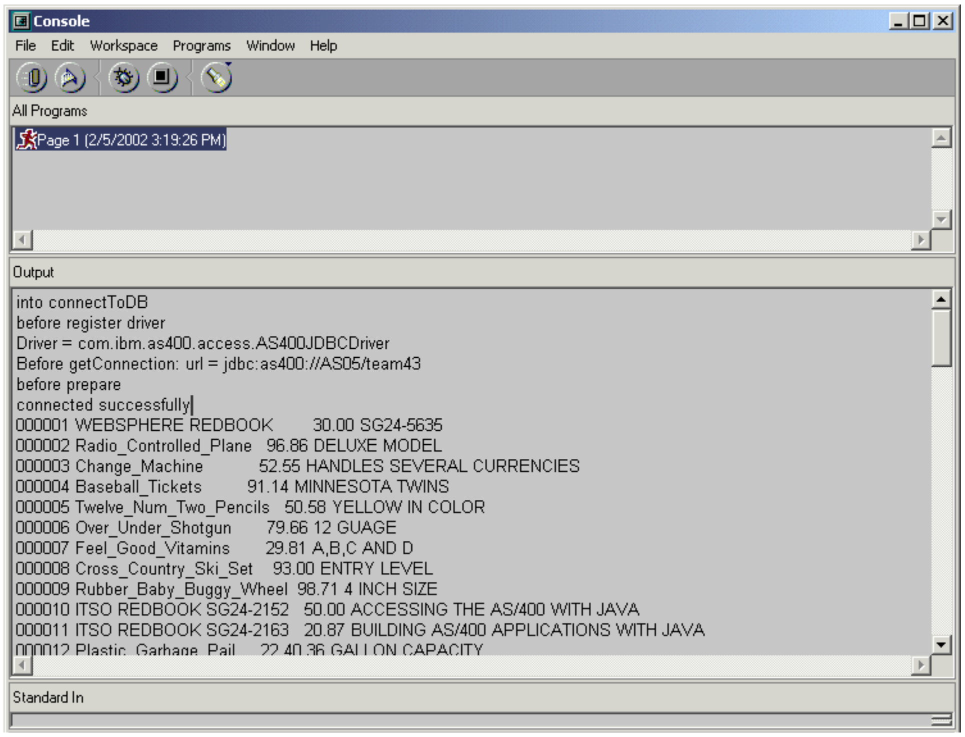

Scrapbook
File Edit Workspace Page Window Help
Page 1
Run code in type java.lang.Object.

```
access.JDBCItemsCatalog aItemsCatalog = new access.JDBCItemsCatalog();
aItemsCatalog.connectToDB("jdbc:as400://AS05/apilib","team43","win4ibm",
        "com.ibm.as400.access.AS400JDBCDriver");
java.util.Vector itemsVector = aItemsCatalog.getAllV();
java.util.Enumeration items = itemsVector.elements();
while (items.hasMoreElements()) {
   String[] aItem = ((String[]) items.nextElement());
   System.out.println(aItem[0] + " " + aItem[1] + " " + aItem[2] + " " + aItem[3]);
}
```

Figure 2-11 Scrapbook in VisualAge for Java

We open the Console window of VisualAge for Java (from Window menu) to see the output messages.

We select all the text and press either Ctrl-E to run the code or use the pop-up menu and select the Run option. As shown in Figure 2-12, you see the rows retrieved from the database and displayed on the console, which means the data access bean works.


Console
File Edit Workspace Programs Window Help
All Programs
Page 1 (2/5/2002 3:19:26 PM)
Output
Standard In

```
into connectToDB
before register driver
Driver = com.ibm.as400.access.AS400JDBCDriver
Before getConnection: url = jdbc:as400://AS05/team43
before prepare
connected successfully
000001 WEBSPHERE REDBOOK        30.00 SG24-5635
000002 Radio_Controlled_Plane   96.86 DELUXE MODEL
000003 Change_Machine           52.55 HANDLES SEVERAL CURRENCIES
000004 Baseball_Tickets         91.14 MINNESOTA TWINS
000005 Twelve_Num_Two_Pencils   50.58 YELLOW IN COLOR
000006 Over_Under_Shotgun       79.66 12 GUAGE
000007 Feel_Good_Vitamins       29.81 A,B,C AND D
000008 Cross_Country_Ski_Set    93.00 ENTRY LEVEL
000009 Rubber_Baby_Buggy_Wheel  98.71 4 INCH SIZE
000010 ITSO REDBOOK SG24-2152   50.00 ACCESSING THE AS/400 WITH JAVA
000011 ITSO REDBOOK SG24-2163   20.87 BUILDING AS/400 APPLICATIONS WITH JAVA
000012 Plastic_Garbage_Pail     22.40 36 GALLON CAPACITY
```

Figure 2-12 Console results for the scrapbook test

2.4.5 ItemServlet class

The ItemServlet class shown in Example 2-9 is the servlet implementation. It imports the generic servlet support package, javax.servlet, and the HTTP servlet support package, javax.servlet.http. This class extends the SuperServlet support class.

The SuperServlet class is a support class that we provide in the nservlets package. We use it to help control the logging of messages and to read information from an external properties file. It provides these methods:

- **getServerRoot()**: Returns the base URL of the server upon which this servlet is running, making it easy to dynamically build URLs.
- **flexLog()**: Writes a log entry either to the servlet log or to the system log as defined in the class initialization.
- **getMainPropertiesFile()**: Returns a Properties object loaded from the config.properties file.
- **outputHeader()**: Writes the HTML Header to the specified PrintWriter.

The ItemServlet class keeps a reference to the JDBCItemsCatalog class that does all the database-related work.

Example 2-9 ItemServlet class

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
import java.util.*;

public class ItemServlet extends SuperServlet {
   private access.JDBCItemsCatalog aJDBCItemsCatalog;
}
```

ItemServlet.init() method

The `init()` method is called automatically only once during the servlet life cycle by WebSphere Application Server when it loads the servlet. It is guaranteed to finish before any service requests are accepted. After successful initialization, WebSphere does not call the `init()` method again, unless it reloads the servlet after it has unloaded and destroyed it.

The `init()` method shown in Example 2-10 starts by calling `super.init (config)` and passing it a ServletConfig object. This call is very important because the `init` method should save the ServletConfig object so that it can be returned by the `getServletConfig` method. Calling the `super.init()` method saves a reference to the config object for future use.

Example 2-10 ItemServlet.init() method

```
public void init(ServletConfig config) throws ServletException {
   super.init(config);
   aJDBCItemsCatalog = new access.JDBCItemsCatalog();
   String url = getInitParameter("url");
   String userid = getInitParameter("user");
   String password = getInitParameter("password");
   String driver = getInitParameter("driver");
if ((url == null) || (userid == null) || (driver == null) || (password == null)) {

       throw new ServletException("Could not retrieve all the Initial Parameters, cannot
                continue");
   }
   String returnValue = aJDBCItemsCatalog.connectToDB(url, userid, password, driver);
   log("ItemServlet: return from connect = " + returnValue);
   return;
}
```

To connect to the database, we perform these steps:

1. Load the initial parameters for the database URL, user ID, password, and JDBC driver.
2. Connect to the database using the `JDBCItemsCatalog.connectToDB()` method.

The `javax.servlet.GenericServlet.getInitParameter()` method returns a string containing the value of the named initialization parameter. Or it may return null if the requested parameter does not exist.

After the `init()` method returns successfully, the ItemServlet servlet is loaded, the database connection is set, and the two SQL-prepared statements are prepared. The servlet service method is now ready to accept requests from the `doPost()` method.

ItemServlet.doPost() method

The `doPost()` method shown in Example 2-11 is called by the servlet `service()` method to service HTTP POST requests. This method performs the following steps:

1. Sets the response MIME type to text/html.
2. Gets the response PrintWriter to write the HTML output.
3. Gets the value of the request partno input parameter.

The value can be *ALL to indicate that you want to get all the items from the table or a specific item number. If the parameter is null, it defaults to *ALL.

4. Writes the HTML header.

   This work is done by the `outputHeader()` method from the SuperServlet class.

5. Retrieves the data from the database by handing the work to the proper `JDBCItemsCatalog` method.

   If the partno parameter is *ALL, the `getAllV()` method is called. Otherwise, the `getRecord()` method is called. In both cases, a vector of String arrays is returned. Each String array describes one item and includes item ID, name, price, and description.

6. Writes the HTML body by calling the `outputItemInformation()` method.

Example 2-11 ItemServlet.doPost method

```
public void doPost(HttpServletRequest request, HttpServletResponse response) throws
IOException {
   // set the MIME type to text/html
   response.setContentType("text/html");
   // create the output stream
   PrintWriter out = response.getWriter();
   try {
      // get the value from the input field named partno (see HTML file)
      // and check if value is valid

      //Only get the first parameter
      String parameter = null;
      if ((request.getParameter("partno")) == null)
         parameter = "*ALL";
      else
         parameter = request.getParameter("partno");
      Vector parts = null;
      flexLog("ItemServlet: parameter passed in from HTML is: " + parameter);
      // write the HTML header to the output stream
      outputHeader(out, getServletInfo());
      // retrieve all data from the database
      if (parameter.toUpperCase().equals("*ALL")) {
         parts = aJDBCItemsCatalog.getAllV();
      } else
         parts = aJDBCItemsCatalog.getRecord(parameter);

      // write the HTML table to the output stream
      outputItemInformation(out, parts);
      out.close();
      return;
   } catch (Throwable e) {
      printError(out, e);
   }
} // end of doPost()
```

ItemServlet.doGet method

The `doGet()` method, shown in Example 2-12, forwards the HTTP GET requests to the `doPost` method. Since GET is the default HTTP request, invoking the servlet from a URL, such as `http://sysname:port/webapp/OrderEntry/ItemServlet`, causes the `doGet()` method to be called. The `doGet()` method then calls the `doPost()` method. In this case, the partno parameter is null and defaults to *ALL, which eventually creates an HTML page with information about all the items in the Item file.

Example 2-12 ItemServlet.doGet() method

```
public void doGet(HttpServletRequest request,
HttpServletResponse response) throws IOException {
   doPost(request,response);
   return;
}
```

ItemServlet.outputItemInformation() method

The method presented in Example 2-13 generates HTML pages that contain a four-column-wide table and populates this table with information from the parts Vector parameter.

Example 2-13 ItemServlet.outputItemInformation() method

```
private void outputItemInformation(PrintWriter out, Vector partsVector) throws IOException
{
   flexLog("ItemServlet: outputItemInformation()...");
   Enumeration parts = partsVector.elements();
   out.println("<TABLE BORDER>");
   out.println("<P><CENTER><B><FONT SIZE=+3>Here are the results of your
      query:</FONT></B></P>");
   out.println("<TR>");
   out.print("<TH>ITEM ID</TH><TH>Item Name</TH><TH>Price</TH><TH>Description</TH>");
   out.println("</TR>");
   while (parts.hasMoreElements()) {
      String[] aPart = ((String[]) parts.nextElement());
      out.print("<TD>" + aPart[0] + "</TD>");
      out.print("<TD>" + aPart[1] + "</TD>");
      out.print("<TD><CENTER>$" + aPart[2] + "</CENTER></TD>");
      out.print("<TD>" + aPart[3] + "</TD>");
      //out.print("<TD><CENTER>" + aPart[4] + "</CENTER></TD>");
      out.println("</TR>");
   }; // end while
   out.println("</TABLE>");
   out.println("</FONT></BODY></HTML>");
   flexLog("ItemServlet: outputItemInformation() executed.");
} // end outputPartsInformation()
```

2.4.6 Running the ItemServlet inside VisualAge for Java

Once we finish the code, we can test the ItemServlet inside VisualAge for Java. The ItemServlet is different than the MyHelloWorld servlet because it uses initial parameters to set runtime values.

VisualAge for Java uses an XML file named *default_app.webapp* to control running servlets in the WebSphere Test Environment. We need to update it to reflect our system parameters. It is found in the <VAJ install root>\ide\project_resources\IBM WebSphere Test Environment\hosts\default_host\default_app\servlets directory.

1. Locate the default_app.webapp file, and open it with a text-based editor (like Notepad).
2. Add the XML tags for the ItemServlet.

See Example 2-14.

Example 2-14 Adding a servlet to the default_app.webapp file

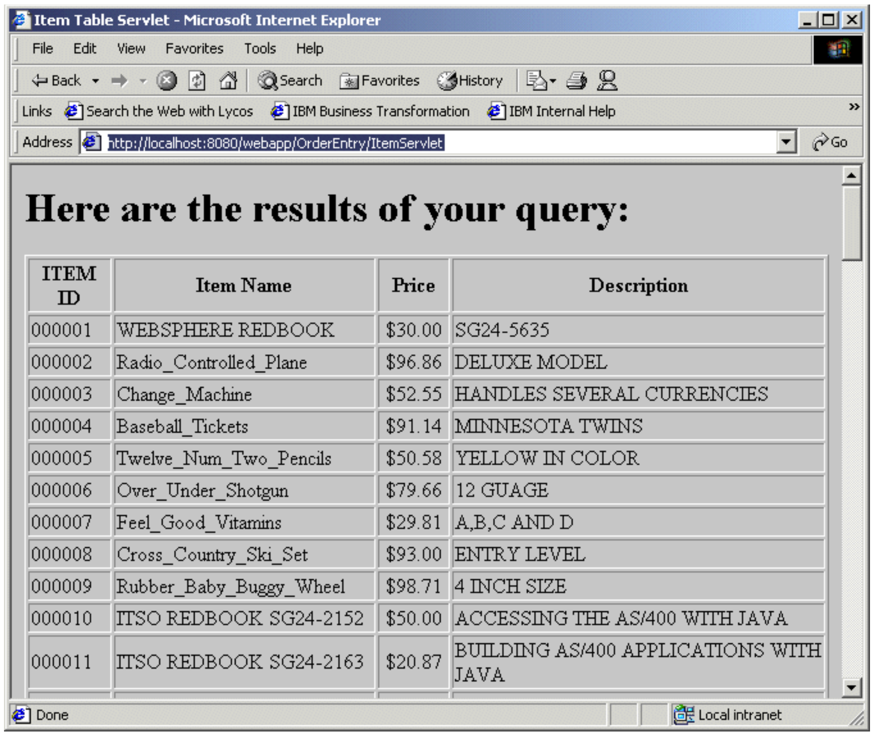
```
<servlet>
      <name>ItemServlet</name>
      <description>Item Servlet</description>
      <code>nservlets.ItemServlet</code>
      <servlet-path>/webapp/OrderEntry/ItemServlet</servlet-path>
      <init-parameter>
         <name>url</name>
         <value>jdbc:as400://AS05/apilib</value>
      </init-parameter>
      <init-parameter>
         <name>driver</name>
         <value>com.ibm.as400.access.AS400JDBCDriver</value>
      </init-parameter>
      <init-parameter>
         <name>user</name>
         <value>team43</value>
      </init-parameter>
      <init-parameter>
         <name>password</name>
         <value>win4ibm</value>
      </init-parameter>
      <autostart>true</autostart>
   </servlet>
```

We make sure the parameters like iSeries server name, userid, and password are correct. We save the changes and stop the WebSphere Test Servlet Engine in the WebSphere Test Environment Control Center. Once it is stopped, select **Servlet Engine-> Edit Class Path**. Ensure that **IBM Enterprise Toolkit for AS/400** and **WebSphere Workshop** (the project that includes the access and nservlets packages) are selected. Restart the Servlet Engine.

Open a browser to access the servlet from the following URL:

```
http://localhost:8080/webapp/OrderEntry/ItemServlet
```

The result is shown in Figure 2-13.


Item Table Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/webapp/OrderEntry/ItemServlet
Go
Done
Local intranet

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D
000008	Cross_Country_Ski_Set	$93.00	ENTRY LEVEL
000009	Rubber_Baby_Buggy_Wheel	$98.71	4 INCH SIZE
000010	ITSO REDBOOK SG24-2152	$50.00	ACCESSING THE AS/400 WITH JAVA
000011	ITSO REDBOOK SG24-2163	$20.87	BUILDING AS/400 APPLICATIONS WITH JAVA

Figure 2-13 Servlet output

2.4.7 Exporting the servlet from VisualAge for Java

Similar to MyHelloWorldServlet, before we deploy to WebSphere Application Server V4.0, we need to export the code into a JAR file. The JAR file can be used by the Application Assembly Tool to build a Web application. In the VisualAge for Java Workbench, select the access and nservlets packages (use the Ctrl key to select both) and export them. The steps are similar with the steps in 2.3.4, “Exporting class files to a JAR file” on page 28. We export to a JAR file named wswsitem.jar. In Chapter 3, “WebSphere V4.0 assembly and deployment tools” on page 75, we use AAT to create a Web application that we install in WebSphere Application Server 4.0.

2.5 Database connection pools

It is essential to understand and feel comfortable using database connection pools when creating servlets that run under WebSphere Application Server Version 4.0 Advanced Edition or WebSphere Application Server Version 4.0 Advanced Single Server Edition.

WebSphere Application Server 4.0 uses the JDBC 2.0 core and optional packages (formerly JDBC 2.0 standard extension) style and APIs for database connection pooling. Both iSeries JDBC drivers, the native and IBM Toolbox for Java drivers, are JDBC 2.0 compliant.

2.5.1 DataSource version

Here is a simple example that shows how to use DataSource objects. As shown in Example 2-15, the class is named *DataBaseConnectivity*.

Example 2-15 DataSource example: Imports and variable definitions

```
package WebSphereV3;

import java.sql.*;
import java.util.*;
import javax.sql.*;
import com.ibm.ejs.dbm.jdbcext.*;
import javax.naming.*;

public class DataBaseConnectivity
{
  // Hard code datasource connectivity information. The information
  // could be brought in at runtime (from an external property file
  // identified) or passed into a method .

  // Use to communicate with connection manager.

  static String userId = "Jeff";
  static String userPassword = "Jeff";
  static String v3DataSourceName = "jdbc/MyDataSource";
  private Context v3Ctx = null;
  private DataSource v3DS = null;
  private Connection dataConn = null;
```

Example 2-15 shows the import statements for the DataSource support. These are explained in Table 2-3.

Table 2-3 DataSource packages

Import statement	Description
javax.sql	This package provides the JDBC DB2 optional package support for JNDI and distributed transaction support.
com.ibm.ejs.dbm.jdbcext	This package provides WebSphere connection pooling support. This package is deprecated in WebSphere 4.0, but is still used in VisualAge for Java.

Notice the two objects required to support the new JDBC 2.0 style lookup for the DataSource support:

- **Context**: Used to access the Java servers JNDI naming service.
- **DataSource**: Used to define the data source.

For simplification, we set the properties using variables.

Example 2-16 shows the default constructor method.

Example 2-16 DataSource example: Retrieving a JDBC connection from the DataSource

```
public DataBaseConnectivity()
{
  try
  {
    Hashtable parms = new Hashtable();
    parms.put(Context.INITIAL_CONTEXT_FACTORY,
           "com.ibm.ejs.ns.jndi.CNInitialContextFactory");
    v3Ctx = new InitialContext(parms);
    v3DS = (DataSource)v3Ctx.lookup(v3DataSourceName);
    dataConn= v3DS.getConnection(userId, userPassword);
  }
  catch (Exception e)
  {
    System.out.println("DataBaseConnectivity Exception occurred: (Build connection) " +
            e.getMessage());
    e.printStackTrace(System.out);
  }
}
```

Note the following points as shown in Example 2-16:

- We use JNDI to access the DataSource (or any other object) from the naming space. We create a Hashtable object to hold the necessary parameters to access the naming space.
- We specify com.ibm.ejs.ns.jndi.CNInitialContextFactory as the Context factory object we want to use. VisualAge for Java 4.0 does not support the new WebSphere 4.0 Context Factory (com.ibm.websphere.naming.WsnInitialContextFactory), so we need to use this Context factory to test inside VisualAge for Java. WebSphere Studio Application Developer V4.0 supports the new WebSphere 4.0 Context factory.

  WebSphere Application Server 4.0 supports both context factories, although CNInitialContextFactory is deprecated.
- We get a Context object for the EJS JNDI interface.
- Using the Context object, we do a JNDI lookup for the logical name of the DataSource.
- The Context lookup returns a Java object, which we cast to a DataSource object. All DataSource names exist in the “jdbc” subcontext of the root.

As shown in Example 2-17, we use the `getConnection()` method to get the JDBC connection.

Example 2-17 DataSource example getConnection method

```
public Connection getConnection() throws Exception, SQLException
{
  try
  {
    if (!dataConn.isClosed())
    {
      // Get valid new data connection, if this one has been closed.
      dataConn = v3DS.getConnection(userId, userPassword);
      System.out.println("getConnection: Data Connection rebuilt");
      return dataConn;
    }
    else
    {
      return dataConn;
    }
  }
  catch (SQLException sqle)
  {
    System.out.println("getConnection: SQL Exception caught " + sqle.getMessage());
    sqle.printStackTrace();
    throw sqle;
  }
  catch (Exception e)
  {
    System.out.println("getConnection: Exception caught " + e.getMessage());
```

```
      e.printStackTrace();
      throw e;
    }
}
```

When the JDBC connection is requested, we ensure that we still have the exclusive use of the connection and that it has not been reclaimed by the DataSource or closed by the caller. If the connection has been closed, we attempt to request a new connection. The WebSphere Application Server Version 4.0 DataSource objects have associated time-outs that you can change if you have long running servlets.

JDBCCatalogSupport class

Next, we change the JDBC example discussed in 2.4, “Using JDBC to access an iSeries database” on page 29, to use DataSource connection pooling support. We start by adding DataSource support into the JDBCCatalogSupport class and its sub-class JDBCPoolCatalog as illustrated in Figure 2-14.

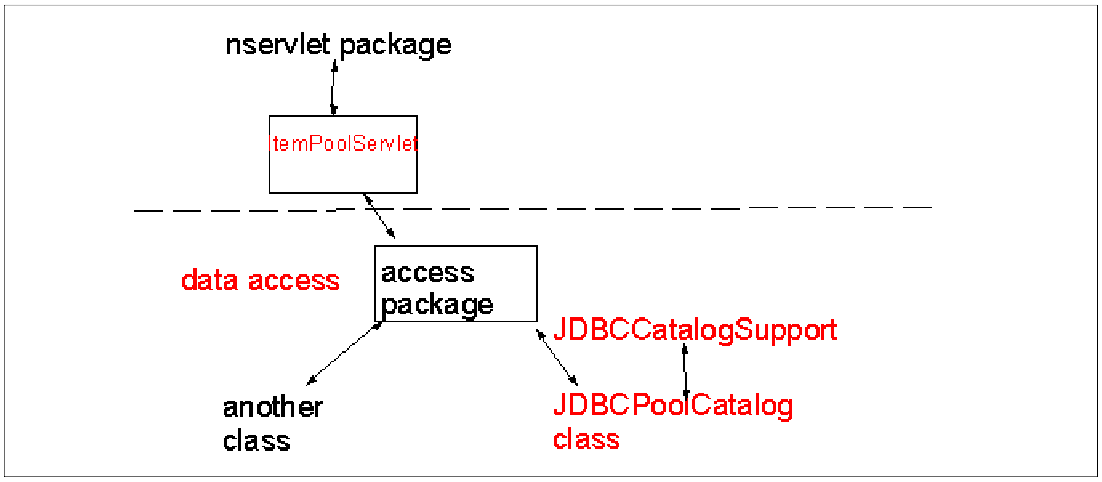


Figure 2-14 Connection pool example

The JDBCCatalogSupport class is the super class for the JDBC-based access classes. It has a few methods that are shared among several JDBC-based access classes.

We start with import statements required for the DataSource support as shown in Example 2-18.

Example 2-18 Import statements

```
package access;

import java.util.*;
import java.sql.*;
import javax.sql.*;
import com.ibm.ejs.dbm.jdbcext.*;
import javax.naming.*;
```

Since we now work directly with JDBC connections, we enhance the `freeConnection` and `getConnection` methods to take advantage of this. As shown in Example 2-19, the `freeConnection` method now simply closes the JDBC connection and the underlying DataSource connection pooling mechanism reclaims the connection.

Example 2-19 The freeConnection method

```
public void freeConnection(Connection dataConn)
{
    try
    {
        if (!dataConn.isClosed())
        {
            dataConn.close();
        }
    }
    catch (SQLException e)
    {
        System.out.println("release connection: " + e.getMessage());
    }
    return;
```

As shown in Example 2-20, within the `getConnection` method, we now return a JDBC connection object. Notice that the parameter list now consists of the DataSource object and a user ID and password only.

Example 2-20 The getConnection method

```
public Connection getConnection(DataSource v3DS, String userId, String userPassword)
{
    Connection dataConn = null;
    try
    {
        System.out.println("JDBCPoolCatalog: retrieving connection");
        dataConn = v3DS.getConnection(userId, userPassword);
    }
    catch (SQLException e)
    {
        System.out.println(e.getMessage());
    }
    return dataConn;
}
```

Only one `JDBCCatalogSupport` method is relevant for the JDBCPoolCatalog class. The `getRows()` method is shown in Example 2-21.

Example 2-21 JDBCCatalogSupport.getRows() method

```
/**
 * getAll method comment.
 */
public java.util.Vector getRows(java.sql.ResultSet aResultSet) {
   java.util.Vector aDataVector = new Vector();
   try {
      //System.out.println("JDBCCatalogCatalog: getRows");
      while (aResultSet.next()) {
         String[] data = new String[4];
         data[0] = aResultSet.getString(1); // Item ID
         data[1] = aResultSet.getString(2); // Item Name
         data[2] = aResultSet.getBigDecimal(3).toString(); // price
         data[3] = aResultSet.getString(4); // Item Information
         // add the data element (String[]) to the vector
         aDataVector.addElement(data);
      }
   } catch (SQLException ex) {
      ex.printStackTrace();
   }
   return aDataVector;
}
```

The `getRows()` method accepts an SQL ResultSet object and returns a vector. It loops through the ResultSet object. Each row of the ResultSet object is converted into an array of strings. The array of strings is added to the vector.

JDBCPoolCatalog class

Next, we look at the JDBCPoolCatalog class. We start with import statements to match those required for the DataSource support as shown in Example 2-22.

Example 2-22 The JDBCPoolCatalog class

```
package access;

import java.util.*;
import java.sql.*;
import javax.sql.*;
import com.ibm.ejs.dbm.jdbcext.*;
import javax.naming.*;

public class JDBCPoolCatalog extends JDBCCatalogSupport
{
    private String connUserId = null;
    private String connUserPassword = null;
    private Context v3Ctx = null;
    private DataSource v3DS = null;
```

We use the `connectToDB()` method, shown in Example 2-23, to get the JDBC connection. We pass in the DataSource name, the user ID, and password.

Example 2-23 The connectToDB method

```
public String connectToDB(String dataSourceName, String userid, String password)
{
    try
    {
        connUserId = userid;
        connUserPassword = password;
        Hashtable parms = new Hashtable();
        parms.put(Context.INITIAL_CONTEXT_FACTORY,
            "com.ibm.ejs.ns.jndi.CNInitialContextFactory");
        v3Ctx = new InitialContext(parms);
        v3DS = (DataSource) v3Ctx.lookup(dataSourceName);
    }
    catch (Exception e)
    {
        System.out.println("JDBCPoolCatalog: (ConnectToDB) " + e.getMessage());
        e.printStackTrace(System.out);
        return "connection unsuccessful";
    }
    System.out.println("connected successfully");
    return "connection successful";
}
```

In reference to Example 2-23, note these points:

- We use JNDI to get access to the DataSource (or any other object) from the naming space. We create a Hashtable object to hold the necessary parameters to access the naming space.
- We specify com.ibm.ejs.ns.jndi.CNInitialContextFactory as the Context factory object we want to use.
- We get a Context object for the EJS JNDI interface.
- Using the Context object, we run a JNDI lookup for the logical name of the DataSource.
- The Context lookup returns a Java object, which we cast to a DataSource object. All Datasource names exist in the "jdbc" subcontext of the root.

In the `getAllV()` method shown in Example 2-24, we call the `getConnection()` method to get the JDBC connection.

Example 2-24 The getAllV method

```
public java.util.Vector getAllV()
{
    java.util.Vector aDataVector = new Vector();
    java.sql.ResultSet aResultSet = null;
    Connection dataConn = null;
    try
    {
        dataConn = getConnection(v3DS, connUserId, connUserPassword);
    }
    catch (Exception e)
    {
        System.out.println("Exception caught: " + e.getMessage());
        e.printStackTrace();
        //      throw e;
    }
    PreparedStatement psAllRecord = null;
    try
    {
        psAllRecord = dataConn.prepareStatement("select * from ITEM");
        aResultSet = psAllRecord.executeQuery();
        aDataVector = getRows(aResultSet);
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
    }
    finally
    {
        try
        {
            if (null != psAllRecord)
            {
                psAllRecord.close();
            }
            freeConnection(dataConn);
        }
        catch (Exception e)
        {
            e.printStackTrace();
        }
    }
    return aDataVector;
}
```

Example 2-25 shows the `getRecord` method.

Example 2-25 The getRecord method

```
public java.util.Vector getRecord(String partNo)
{
    java.util.Vector aDataVector = new Vector();
    java.sql.ResultSet aResultSet = null;
    Connection dataConn = getConnection(v3DS, connUserId, connUserPassword);
    PreparedStatement psSingleRecord = null;
    try
    {
        psSingleRecord = dataConn.prepareStatement("SELECT * FROM ITEM WHERE IID = ?");
        psSingleRecord.setString(1, partNo);
        aResultSet = psSingleRecord.executeQuery();
        aDataVector = getRows(aResultSet);
    }
    catch (SQLException ex)
    {
        ex.printStackTrace();
    }
    finally
    {
        try
        {
            if (null != psSingleRecord)
            {
                psSingleRecord.close();
            }
            freeConnection(dataConn);
        }
        catch (Exception e)
        {
            e.printStackTrace();
        }
    }
    return aDataVector;
}
```

Finally, we show the servlets that use the JDBCPoolCatalog class. Example 2-26 shows the `init()` method for the ItemPoolServlet.

Example 2-26 The init method

```
/public void init(ServletConfig config) throws ServletException
{
    super.init(config, SuperServlet.SYSTEM);
    aJDBCItemCatalog = new access.JDBCPoolCatalog();


    // Get JDBC properties
    String datasource = getInitParameter("datasource");
    String userid = getInitParameter("user");
    String password = getInitParameter("password");
    flexLog("DatSource: " + datasource);
    flexLog("UserID: " + userid);
    flexLog("Password: " + password);
    String returnValue = aJDBCItemCatalog.connectToDB(datasource, userid, password);
    flexLog("ItemPoolServlet: return from connect = " + returnValue);
    return;
}
```

We set the servlet initialization parameters to retrieve the name of the DataSource object and pass this, along with the user ID and password, into the database connection method.

2.5.2 Running the ItemPoolServlet inside VisualAge for Java

Running this servlet inside VisualAge for Java is similar to the ItemServlet discussed earlier. We need to set up the initial parameters for data source, user, and password. But before that, we configure the data source in the VisualAge for Java WebSphere Test Environment.

We start the WebSphere Test Environment if it is not already started. Click the **Persistent Name Server** and start it. Once it is started, select **DataSource Configuration** to add a new data source, as shown in Figure 2-15.

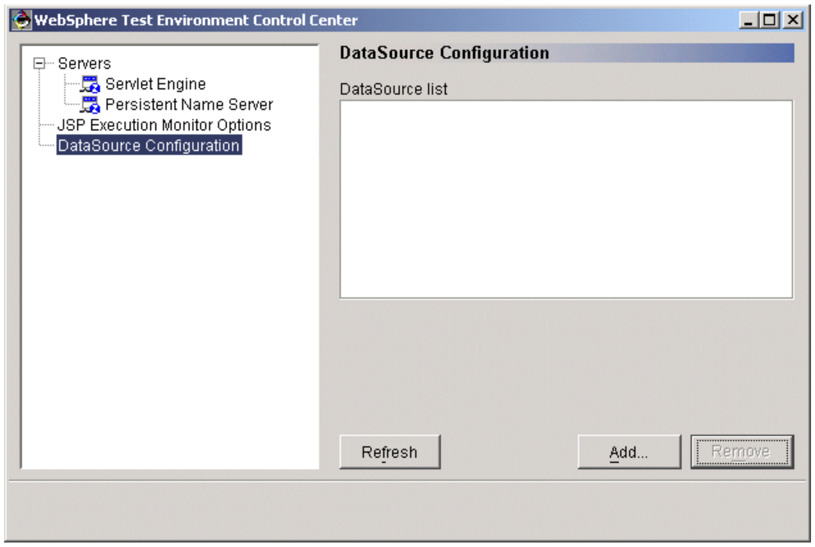
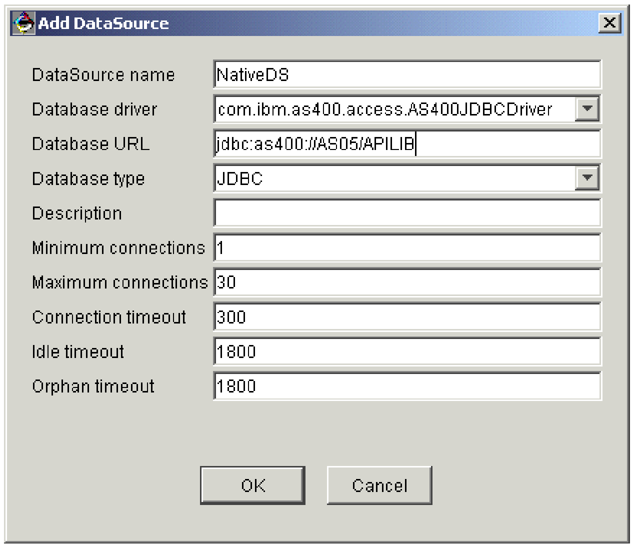


Figure 2-15 DataSource configuration

On the following page (shown in Figure 2-16), we create the DataSource named NativeDS and specify the following parameters:

- DataSource name: `NativeDS`
- Database Driver: `com.ibm.as400.access.AS400JDBCDriver`
- Database URL: `jdbc:as400://`*`sysname`*`/`*`teamxx`*

  We replace *sysname* with the name of the iSeries server, and replace *teamxx* with the correct library name.



DataSource name	NativeDS
Database driver	com.ibm.as400.access.AS400JDBCDriver
Database URL	jdbc:as400://AS05/APILIB
Database type	JDBC
Description	
Minimum connections	1
Maximum connections	30
Connection timeout	300
Idle timeout	1800
Orphan timeout	1800

Figure 2-16 Add DataSource window

The new DataSource appears in the WebSphere Test Environment Control Center as shown in Figure 2-17.

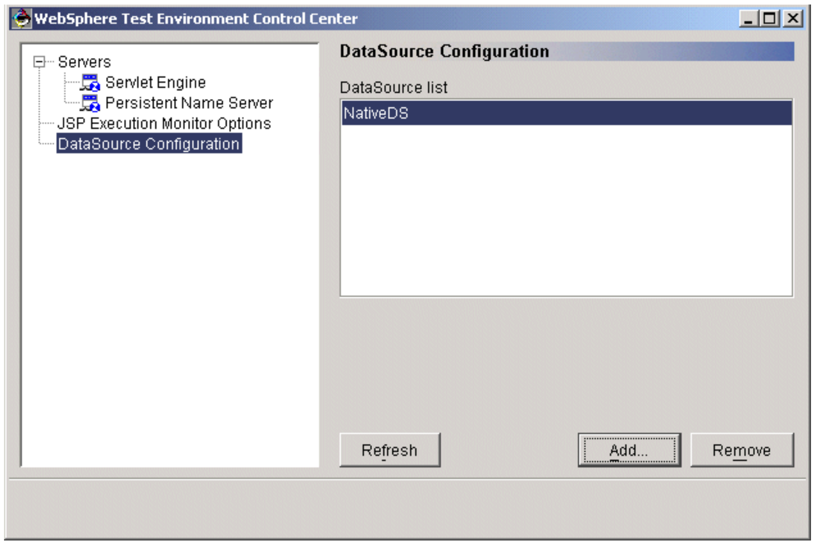


Figure 2-17 DataSource Configuration

Similar to the process in 2.4.6, “Running the ItemServlet inside VisualAge for Java” on page 39, we need to update the default_app.webapp file to reflect the correct DataSource name, user ID and password with a text editor (like Notepad). This is shown in Example 2-27.

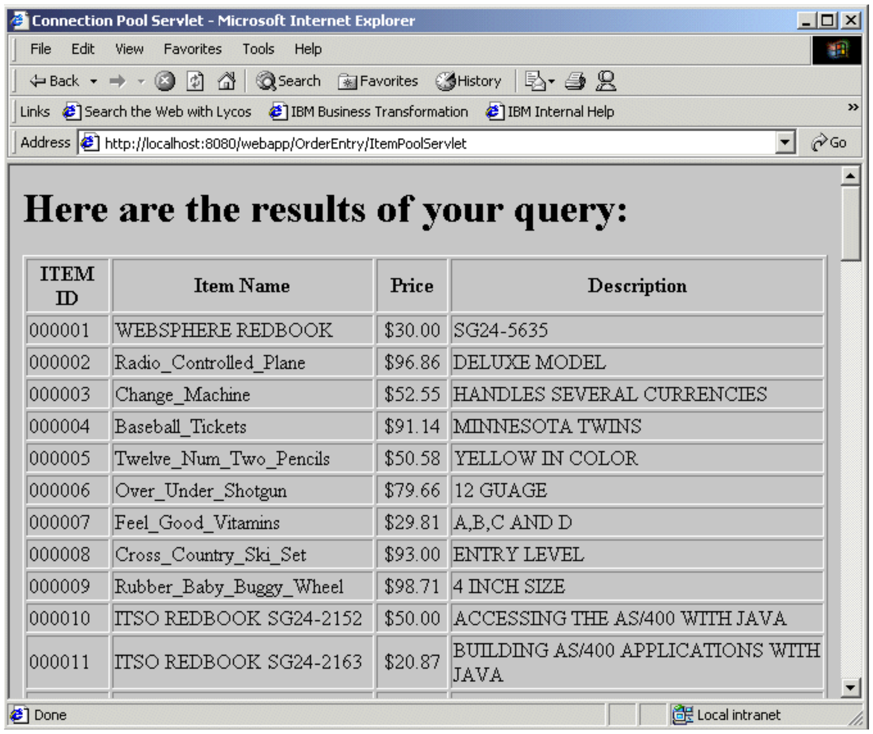
Example 2-27   The default_app.webapp file

```
<servlet>
      <name>ItemPoolServlet</name>
      <description>ItemPoolServlet</description>
      <code>nservlets.ItemPoolServlet</code>
      <servlet-path>/webapp/OrderEntry/ItemPoolServlet</servlet-path>
      <init-parameter>
         <name>datasource</name>
         <value>jdbc/NativeDS</value>
      </init-parameter>
      <init-parameter>
         <name>user</name>
         <value>Team43</value>
      </init-parameter>
      <init-parameter>
         <name>password</name>
         <value>win4ibm</value>
      </init-parameter>
      <autostart>false</autostart>
   </servlet>
```

Once we save the file, we return to the VisualAge for Java WebSphere Test Environment and stop and restart the servlet engine. Now we can access the servlet via the following URL:

```
http://localhost:8080/webapp/OrderEntry/ItemPoolServlet
```

You see the results of the query as shown in Figure 2-18.


Connection Pool Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/webapp/OrderEntry/ItemPoolServlet
Go
Done
Local intranet

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D
000008	Cross_Country_Ski_Set	$93.00	ENTRY LEVEL
000009	Rubber_Baby_Buggy_Wheel	$98.71	4 INCH SIZE
000010	ITSO REDBOOK SG24-2152	$50.00	ACCESSING THE AS/400 WITH JAVA
000011	ITSO REDBOOK SG24-2163	$20.87	BUILDING AS/400 APPLICATIONS WITH JAVA

Figure 2-18   ItemPoolServlet

2.5.3 Exporting the ItemPoolServlet servlet from VisualAge for Java

Similar to ItemServlet, before we deploy our new servlet to WebSphere Application Server V4.0, we have to export it into a JAR file that can be used by the Application Assembly Tool to build a Web application. In the VisualAge for Java Workbench, select the access and nservlets packages and export them to a JAR file. See 2.3.4, "Exporting class files to a JAR file" on page 28. We export to a file named wswspool.jar.

2.6 JSP support in WebSphere Version 4.0

WebSphere Application Server 4.0 (both Advanced Single Server Edition and Advanced Edition) implements the Sun Microsystems JavaServer Pages Specification 1.1 and removes the support for the JSP 0.91 and 1.0 specifications. For JSP files written to the 0.91 specification, you must migrate them to the JSP 1.1 specification. There are functional differences between the tags in the JSP 1.0 and JSP 1.1 specification. You do not need to migrate pages written to the JSP 1.0 specification to the newer JSP 1.1 specification to deploy them in WebSphere Application Server V4.0.

For a complete definition of the Sun JSP specification, refer to the Sun online documentation at: `http://java.sun.com/products/jsp/download.html`

2.6.1 JSP life cycle

The JSP life cycle is similar to the standard servlet life cycle. JSPs are compiled into servlets by a JSP engine and are then run by the standard servlet engine on the server platform. For those working with JSPs for the first time, it can be difficult to visualize just what is happening, when, and where. To help you understand this better, refer to the *activity diagram* in Figure 2-19, which explains the typical JSP life cycle.

Note: The diagram is by no means exhaustive. You should refer to the WebSphere documentation and JSP specification for further details.

Activity diagrams: The activity diagram format is a simplified Unified Modeling Language (UML) activity diagram. The vertical columns are called *swim lanes* and denote one strand of application processing. This process can be a single object, a Java thread, or even a user.

Concurrent (or nearly concurrent) processes are shown side by side in swim lanes. Horizontal bars, or synchronization bars, are used to show points where application flow diverges into separate lanes or converges back again. In this example, a good illustration of this is in lane 3, where the JSP is compiled if it is not already compiled.

In this case, the swim lanes segregate actions that are performed by a particular section of the application architecture. Timing is top to bottom and includes some degree of parallelism. For a good, quick introduction to UML notation, see *UML Distilled: A Brief Guide to the Standard Object Modeling Language* by Martin Fowler.

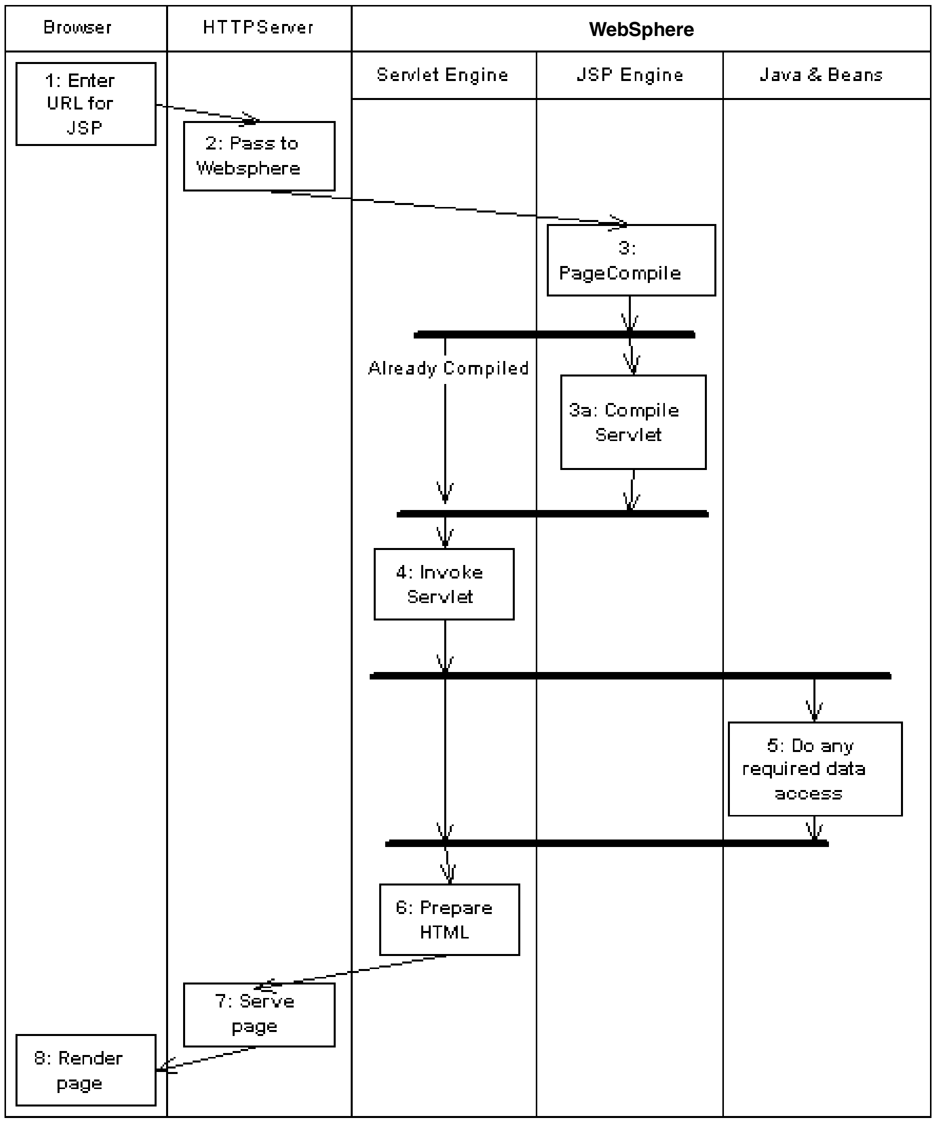


Figure 2-19 Activity diagram showing the JSP life cycle

The steps shown in the activity diagram in Figure 2-19 are explained here in greater detail:

1. At the client side browser, the user enters a URL that references a JSP file. The JSP file goes to the Web server (in this example, it is HTTP server for iSeries, but it could be any other iSeries-based Web server) and requests the named page.
2. When the HTTP server receives a request for a JSP, it passes that request to WebSphere Application Server. WebSphere Application Server passes the request to the JSP engine (PageCompile). Depending on the application architecture used, one of two courses of action take place:
   - If the JSP is the first page of an application, or the page only contains HTML, the JSP is invoked (steps 3, 3a, and 4), the HTML is generated (step 6), and a page is served to the client. In this case, the JSP is a little different from a normal HTML page.
   - If the page contains input controls, and the browser request is an action, the page is processed by the JSP and servlet engines as described below.

3. The served page may contain input fields and buttons. We assume here that the user performs a task, such as filling in the item number and clicking the List all items button in the ItemServlet example.
4. The JSP engine receives the process request. If the JSP has not yet been compiled, or the JSP has changed since the last time it was compiled (based on a file time stamp), step 3a occurs, and the JSP is compiled into a servlet.
5. From this point, the JSP is a servlet and is processed exactly like any other servlet.
6. Any data access that is typically carried out by data access JavaBeans is performed in the iSeries Java Virtual Machine. The results are returned to the JSP or servlet.
7. If any access was requested, the JSP or servlet receives the results of the data access. Otherwise, it receives a request to produce an output based on a bean passed within the data. The JSP or servlet then generates an HTML file based on the logic contained within the data results or bean.
8. The HTML is returned to the HTTP server and presented to the client browser.
9. The client browser only deals with the HTML from the Web server. Therefore, the user is unaware of the complexity of the operations being carried out on the server, making the client browser truly a thin client.

After it is compiled, the servlet is stored in memory on the server. When subsequent requests for that page are made, the server checks to see if the JSP file has changed. If it has not changed, the server uses the servlet stored in memory to generate the response to the client. Because the compiled servlet is stored in memory, the response is very fast. If the JSP file has changed, the server automatically recompiles the page file and replaces the servlet in memory. As with standard servlets, if the initial load time is long, the JSP can be compiled and loaded at server system start time.

2.6.2 JSP design

For simplification of National Language Support (NLS) or the good design strategy of separating the presentation layer from the business logic, perform business logic within a servlet and pass the response data to a JavaServer Page for display as shown Figure 2-20.

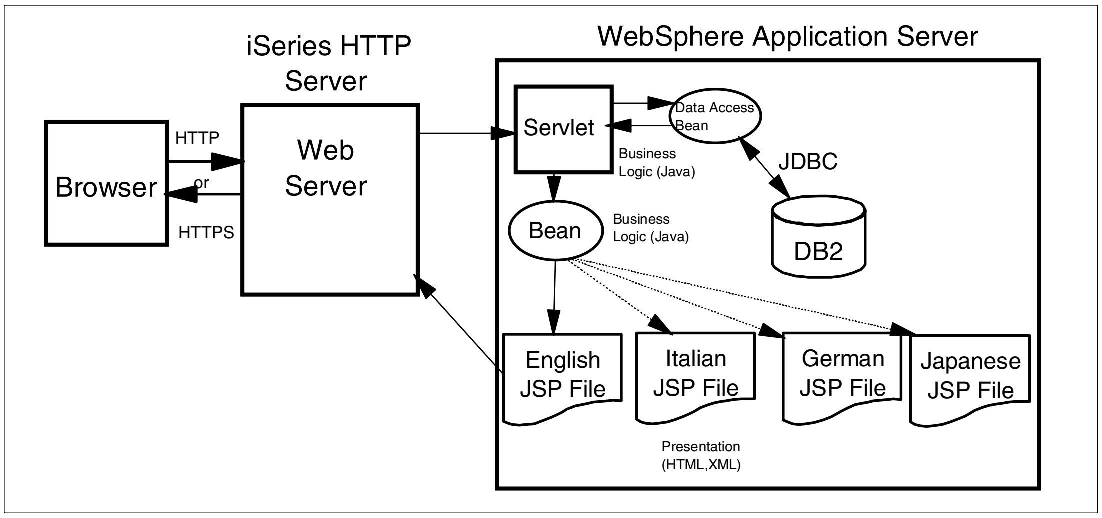


Figure 2-20 Servlet and JSP architecture

Under the servlet 2.1 and 2.2 API, the `setAttribute` method of the HttpServletRequest class is used to pass objects between a servlet and a JSP. A new interface, *javax.servlet.requestDisplatcher*, is used for each servlet or JSP to forward the response. and request objects to the specific servlet or JSP. This is similar to servlet filtering and shares some of the same restrictions. If a servlet retrieves a ServletOutputStream object or PrintWriter object from its response object, then an IllegalStateException exception is thrown in the application.

2.6.3 JSP servlet interface example

This section looks at a very simple example that demonstrates how a servlet interfaces with a JSP. In this example, CallJSP is a servlet that passes information to a JSP named *outputjsp.jsp* for display. As shown in Figure 2-21, the user client calls the CallJSP servlet. It creates an object named *DataBean*, which it passes to the outputjsp JavaServer Page. DataBean is a very simple class that provides methods to set a value and get a value. The JSP displays the information (that is passed to it) back to the user client.

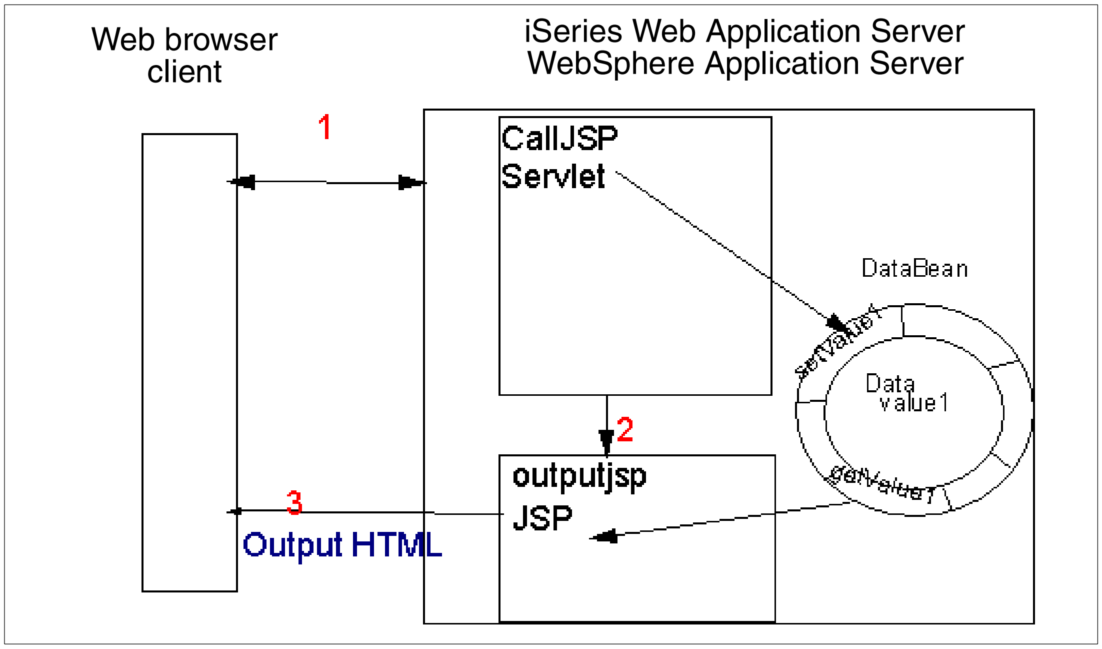


Figure 2-21 Servlet calling a JSP

Example 2-28 shows the `doGet` method of the CallJSP servlet.

Example 2-28 First part of the doPost method of the ItemJSPServlet

```
public void doGet(HttpServletRequest request, HttpServletResponse response) throws
ServletException, java.io.IOException {
      System.out.println("Inside CallJSP");
       DataBean dataBean = null; // Create an instance of DataBean
   try {
      dataBean = (DataBean) Beans.instantiate(this.getClass().getClassLoader(),
         "nservlets.DataBean");
   } catch (Exception ex) {
      throw new ServletException("CallJSP: doGet: Can't create bean of class DataBean: " +
ex.getMessage());
   }
   // Set some Bean properties (content generation)
   if (request.getParameter("value") == null)
      dataBean.setValue1("Something Important");
   else
      dataBean.setValue1(request.getParameter("value"));
   request.setAttribute("dataBean", dataBean);
   RequestDispatcher rd = getServletContext().getRequestDispatcher("/outputjsp.jsp");
   rd.forward(request, response);
}
```

This method performs the following actions:

- Instantiates an object named *dataBean*, which is based on the DataBean class from the nservlets package.
- Uses the DataBean `setValue1()` method to set the information to be passed to the JSP. If the CallJSP servlet is called with a parameter, it passes the parameter value in the dataBean object. Otherwise, it passes the default value of *Something Important*.
- Uses the `setAttribute()` method of the HttpServlet request object to set the object to pass to the JSP.
- Creates a RequestDispatcher object named *rd* using the ServletContext `getRequestDispacher()` method setting the name of the JSP to call.
- Uses the forward method of the request dispatcher object to call the JSP passing the request and response objects.

Example 2-29 shows the source of the JSP .91 version of the outputjsp.jsp JavaServer Page.

Example 2-29 Contents of the 0.91 version of outputjsp.jsp

```
<BEAN name="dataBean" type="nservlets.DataBean" create="no" scope="request">
</BEAN>

<HTML>
<HEAD><TITLE>Simple JSP with Bean</TITLE></HEAD>
<BODY>
<CENTER>
<CENTER><IMG SRC="/html/as400.gif" BORDER=2 X-SAS-UseImageWidth X-SAS-UseImageHeight
HEIGHT=120 WIDTH=120></CENTER>

<%
      out.println("The value of the parameter is " + dataBean.getValue1());
%>

</CENTER>
</BODY>
</HTML>
```

This JSP performs these tasks:

- Defines a Bean named *dataBean* based on the nservlets.DataBean class. A parameter of create=no is used because the Bean is passed to the JSP by the servlet in the request object.
- Uses HTML tags to display a graphic.
- Uses a JSP scriplet to create Java code that uses the DataBean `getValue1()` method to retrieve and display the information passed in the dataBean object.

When running the JSP on WebSphere Application Server V4.0, it fails with a compiler syntax error because WebSphere V4.0 only implements the JSP 1.1 specification. You should migrate the JSP page to be compatible with the JSP processor of WebSphere Application Server. Example 2-30 shows the JSP page we use after modification.

Example 2-30 Contents of the 1.1 version of outputjsp.jsp

```
<jsp:useBEAN id="dataBean" class="nservlets.DataBean"  scope="session" create="no" />


<HTML>
<HEAD><TITLE>Simple JSP with Bean</TITLE></HEAD>
<BODY>
<CENTER>
<CENTER><IMG SRC="as400.gif" BORDER=2 X-SAS-UseImageWidth X-SAS-UseImageHeight HEIGHT=120
WIDTH=120></CENTER>



<%
   System.out.println("Inside outputjsp");
   nservlets.DataBean theDataBean = (nservlets.DataBean) request.getAttribute("dataBean");
   out.println("The value of the parameter is " + theDataBean.getValue1());
%>

</CENTER>
</BODY>
</HTML>
```

2.6.4 Running the CallJSP servlet inside VisualAge for Java

Similar to the process in 2.4.6, “Running the ItemServlet inside VisualAge for Java” on page 39, we need to update the default_app.webapp file in VisualAge for Java test environment with a text editor (like Untapped). This is shown in Example 2-31.

Example 2-31 The default_app.webapp file

```
<servlet>
      <name>CallJSP</name>
      <description>CallJSP</description>
      <code>nservlets.CallJSP</code>
      <servlet-path>/webapp/OrderEntry/CallJSP</servlet-path>
       <autostart>false</autostart>
</servlet>
```

Once we save the file, we copy the outputjsp.jsp file into the <VAJ install root>\ide\project_resources\IBM WebSphere Test Environment\ hosts\default_host\default_app\web directory. The WebSphere Test Environment looks for the JSP file in this directory. This next part may be a bit more challengine. Since we use a image file in the JSP (as400.gif), we must also copy this file to the directory. However, because the context for this application is `/webapp/OrderEntry`, we cannot simply copy the image file to the

Web directory because the http server will not find it according to the context. We have to create a subdirectory under the Web directory named *webapp*. We then create a subdirectory under the webapp directory named *OrderEntry*. Now we copy the image file into the OrderEntry directory, as shown in Figure 2-22.

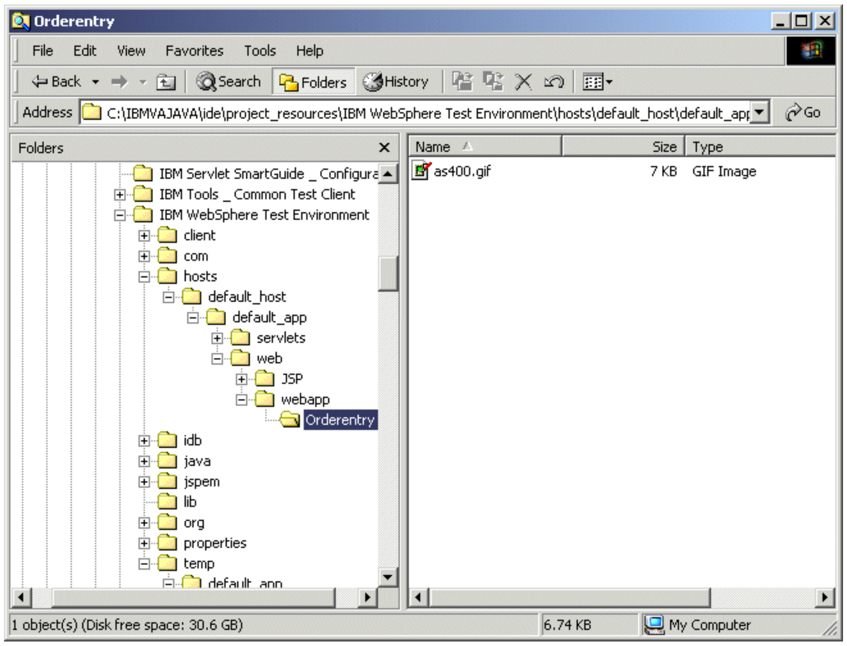
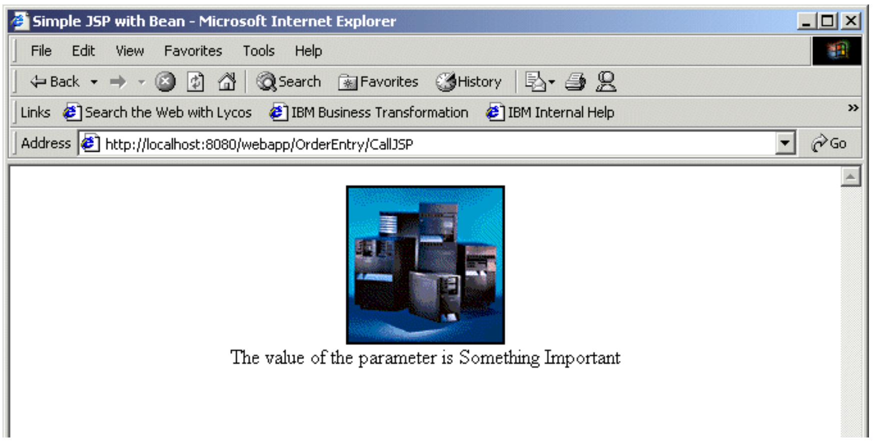

Orderentry
File Edit View Favorites Tools Help
Back Search Folders History
Address C:\IBMVAJAVA\ide\project_resources\IBM WebSphere Test Environment\hosts\default_host\default_app
Go
Folders
IBM Servlet SmartGuide _ Configura
IBM Tools _ Common Test Client
IBM WebSphere Test Environment
client
com
hosts
default_host
default_app
servlets
web
JSP
webapp
Orderentry
idb
java
jspem
lib
org
properties
temp
default_app
Name Size Type
as400.gif 7 KB GIF Image
1 object(s) (Disk free space: 30.6 GB)
6.74 KB
My Computer

Figure 2-22 Copying the image into WebSphere Testing Environment

We restart the servlet engine in the WebSphere Test Environment and access the servlet by using the following URL:

```
http://localhost:8080/webapp/OrderEntry/CallJSP
```

The result is shown in Example 2-23.


Simple JSP with Bean - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/webapp/OrderEntry/CallJSP
Go

The value of the parameter is Something Important

Figure 2-23 CallJSP result

We could change the URL to:

```
http://localhost:8080/webapp/OrderEntry/CallJSP?value=Test
```

In this case, we see the result page in which the message becomes:

```
The value of the parameter is Test
```

2.6.5 Exporting the CallJSP servlet from VisualAge for Java

Similar to ItemServlet, before we deploy our new servlet to WebSphere Application Server V4.0, we have to export it into JAR file that can be used by the Application Assembly Tool to build a Web application. In the VisualAge for Java Workbench, select the access and nservlets packages (use the Ctrl key to select both) and export them to a JAR file. See 2.3.4, “Exporting class files to a JAR file” on page 28. We export to a file named wswsjsp.jar.

We don’t include the JSP file in the JAR file. Later, we use AAT to add it into the Web application.

2.7 Session management

A *session* is a series of requests and their associated responses originating from the same user, at the same browser. HTTP is a *stateless protocol*. This means each request that arrives carries only its own request context. The individual requests are not related. This causes problems when we want to develop stateful applications. For example, for an online shopping application, we may surf different Web pages and decide to buy items from several different pages. Without session tracking, we would have to pay for each item individually. This is not natural. We want to put all the goods into a shopping cart and pay for them one time.

Sessions can be used to solve this problem. We can use a session object to store and maintain a Web “shopping cart”. A shopping cart is a good example of using session tracking.

2.7.1 Session tracking solutions

There are several ways to maintain a state across a series of requests. For all of them, the basic theory is simple, that is to send a token back and forth for the identity, as shown in Figure 2-24.

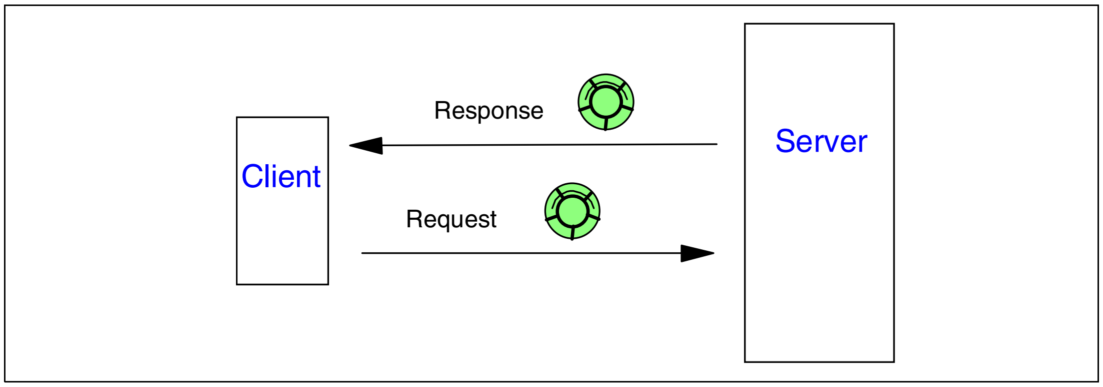


Figure 2-24 Session tracking

Now the question is where to put the token in the HTTP data stream. According to the HTTP frame shown as Figure 2-25, we can put this token either in the HTTP body, header, or Start Line (URL).

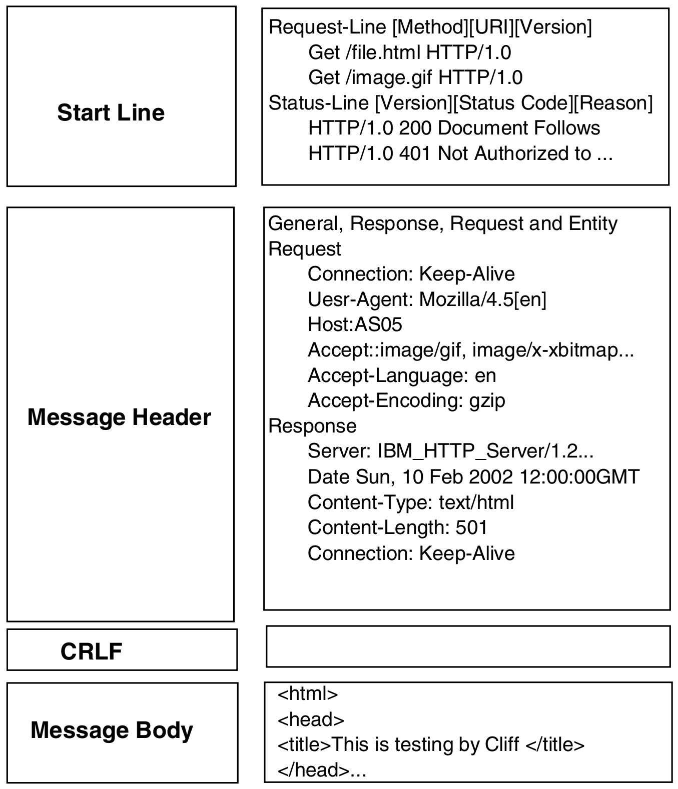

Start Line
Request-Line [Method][URI][Version]
Get /file.html HTTP/1.0
Get /image.gif HTTP/1.0
Status-Line [Version][Status Code][Reason]
HTTP/1.0 200 Document Follows
HTTP/1.0 401 Not Authorized to ...
Message Header
General, Response, Request and Entity
Request
Connection: Keep-Alive
Uesr-Agent: Mozilla/4.5[en]
Host:AS05
Accept::image/gif, image/x-xbitmap...
Accept-Language: en
Accept-Encoding: gzip
Response
Server: IBM_HTTP_Server/1.2...
Date Sun, 10 Feb 2002 12:00:00GMT
Content-Type: text/html
Content-Length: 501
Connection: Keep-Alive
CRLF
Message Body
<html>
<head>
<title>This is testing by Cliff </title>
</head>...

Figure 2-25 HTTP frame

There are three common approaches for session tracking:

- Hidden fields
- Cookies
- URL rewriting

Hidden fields

Hidden HTML fields are not displayed by the browser. They are displayed when you choose the option to view the HTML source. Hidden fields are declared with the attribute named type set to `hidden` as shown in the following code fragment:

```
<input type="hidden" name="partno" value=" " size=10 maxlength=10>
```

A servlet can generate HTML with hidden input fields. When the browser submits the HTML page, the information in the hidden HTML fields is available to the program that handles the HTTP request.

The main advantage of using hidden fields for session tracking is their simplicity. They do not require any user authentication, and they are supported on most, if not all, of the browsers.

Their main disadvantage is that, by their nature, they will work only for a sequence of dynamically generated HTML.

As you can see from the previous code fragment, there is an overhead defining a hidden field for each value you want to persist across a series of requests and the type of information that each such input field can hold is limited to textual information.

In addition, hidden fields are transmitted between the client and the server, when you really need them only at the server side. A solution to these deficiencies can be to use just one hidden input field that holds the session ID, and use it as a key to access the session state information from a database file located on the server.

Cookies

Cookie technology was developed by the Netscape Communications Corporation. This technology enables a Web server to store and retrieve information from the client. When the cookie information is sent to the server, it is put in the HTTP header.

A Web server generates a cookie using the `Set-Cookie` header as part of the HTTP response. The cookie holds a single-name value pair and a few attributes that describe the cookie properties, such as its version and the range of URLs for which it is valid. Upon receiving a cookie, the browser stores it and includes it in any future HTTP requests made to the originating server, according to rules that match the cookie's attributes and the requested URL.

The convenience class javax.servlet.http.Cookie represents a cookie and makes it easier to handle cookies within a servlet.

You create a cookie with the constructor:

```
javax.servlet.http.Cookie(name, value)
```

Then, you add it to the HTTP response with the method:

```
javax.servlet.http.HttpServletResponse.addCookie(cookie)
```

The `addCookie` method can be called multiple times to set more than one cookie. Browsers are expected to support only 20 cookies per host, of at least 4 KB each, so it is not a good practice to use many cookies.

The Cookie class provides getter and setter methods to retrieve and set the cookie value and attributes. As with HTML form hidden fields, even though the information stored in the cookie is needed on the server, it is stored on the client. This requires that it be sent to the server with each request. This is not a big problem, because the cookie size and number is limited. But, you may consider storing the session ID in a cookie and keeping the session state data on the server.

Since cookies are part of the HTML header, as for all HTML header fields, you need to add all the cookies to the response object before getting the PrintWriter object.

Cookies provide a nice way to implement sessions, but they suffer from some problems, for example, some users, either by choice or mandate, cannot receive cookies from Web sites. Also most browsers allow users to turn off the ability to receive cookies. Under this situation, an alternative technique, known as *URL encoding*, is available for passing user session IDs between the user and the Web application server instance.

URL rewriting

URL rewriting is a technique that embeds client-specific tokens within the URL of each request. For example, we can access our callJSP servlet by the URL:

```
http://sysname:port/OrderEntry/callJSP
```

We can also pass a specific value to the servlet by changing the URL to:

```
http://sysname:port/OrderEntry/callJSP?value=hello
```

This request sends the parameter `value` to the Web container; the container can obtain the value from this URL and do further processing. This kind of approach is called *URL rewriting* since it changes the URL to include client specific tokens. If we are working on an online shopping application, we do not want to put confidential information on the URL. In the Sun Servlet API specification, a parameter named *jsessionid* is available. It send the session identifier back and forth, while the actual session information is stored on the server.

URL rewriting requires the developer to use special encoding APIs and to set up the site page flow to avoid losing the encoded information. For example, if a servlet returns HTML directly to the requester (without using a JSP page), the servlet calls the following API to encode the returning content:

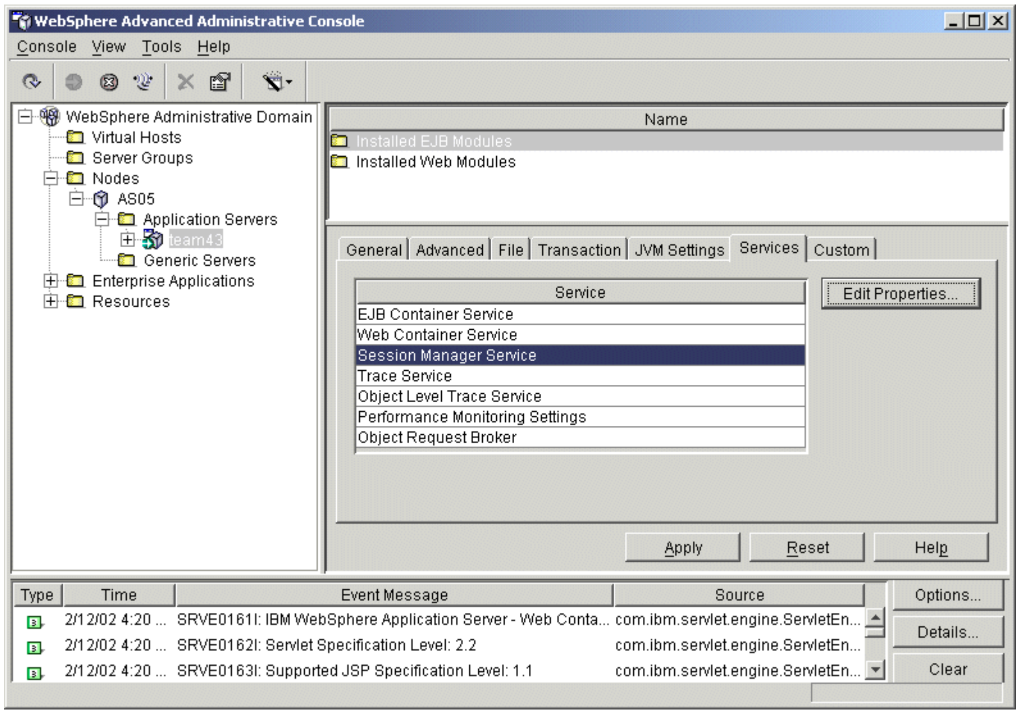
```
out.println("<a href=\"");
out.println(response.encodeURL("/OrderEntry/ItemServlet"));
out.println("\">Item Servlet</a>");
```

URL rewriting limits the flow of site pages exclusively to dynamically generated pages (such as pages generated by servlets and JSPs). WebSphere inserts the session ID into dynamic pages, but cannot insert it into static pages (.htm or .html pages).

2.7.2 HttpSession interface

The *javax.servlet.http.HttpSession* interface is implemented by WebSphere Application Server to provide session support. Under the covers, HttpSession information is maintained either by using cookies or by URL rewriting as described previously. The WebSphere Administrative Console is used to enable session support using URL rewriting or cookies.

For example, in WebSphere Application Server Version 4.0 Advanced Edition, you can select the server from the left pane of the console and click the **Services** tab in the right pane as shown in Figure 2-26. There are some session services you can edit. Select **Session Manager Service** and click **Edit Properties**.



Service
EJB Container Service
Web Container Service
Session Manager Service
Trace Service
Object Level Trace Service
Performance Monitoring Settings
Object Request Broker

Type	Time	Event Message	Source
	2/12/02 4:20 ...	SRVE0161I: IBM WebSphere Application Server - Web Conta...	com.ibm.servlet.engine.ServletEn...
	2/12/02 4:20 ...	SRVE0162I: Servlet Specification Level: 2.2	com.ibm.servlet.engine.ServletEn...
	2/12/02 4:20 ...	SRVE0163I: Supported JSP Specification Level: 1.1	com.ibm.servlet.engine.ServletEn...

Figure 2-26 Editing Session Manager properties

The Session Manager Service page displays. Under the General tab, you can enable the cookies support or URL rewriting support. It is possible to select both cookie support and URL rewriting support at the same time. In this case, cookies are used and preferred over URL rewriting.

Major changes in the servlet 2.2 API

In the servlet 2.2 API, session scoping is per Web application. Servlets in different Web applications running in the same servlet engine *cannot* share session information. In the servlet 2.1 API, session scoping is per servlet engine.

HTTPSession deprecation includes:

- `getValue(String)` replaced by `getAttribute(String)`
- `getValueNames()` replaced by `getAttributeNames()`
- `putValue(String, Object)` replaced by `setAttribute(String, Object)`
- `removeValue(String)` replaced by `removeAttribute(String)`

Creating sessions

You create a session by using the following method:

```
javax.servlet.http.HttpServletRequest.getSession(create)
```

If the value of the boolean parameter *create* is false, the method returns the current valid session associated with the request, if one exists. Otherwise, it returns null. If the value of *create* is true and a session does not exist, it is created.

Creating a session means that the server generates a unique session ID and sends it to the client browser as a cookie or by means of URL rewriting. The browser is expected to return this session ID on all subsequent requests made to this server from the same browser. This identifies the request as part of the session.

Using the HttpSession object

Once a session is created, values can be saved in the session object or retrieved from the session object, using either of the following two methods:

```
javax.servlet.http.HttpSession.setAttribute(name, value)
javax.servlet.http.HttpSession.getAttribute(name)
```

The `setAttribute()` method accepts a String for the name of the value and a Java object for the value. The `getAttribute()` method accepts a String for the name and it returns an object. Multiple values can be written to, or read from, the session. The `getAttributeNames()` method can be used to retrieve an Enumeration of names associated with a session. This Enumeration can be used to retrieve the objects themselves.

Objects can also be removed from the Session object by using:

```
javax.servlet.http.HttpSession.removeAttribute(name)
```

If there is a requirement that the sessions persist across server shutdowns, or they are used in a session cluster environment (where one WebSphere Application Server plays the role of a sessions server), the Java objects that you save to a session should implement the Serializable interface.

Invalidating sessions

Sessions exist until they are invalidated. Invalidating sessions is done automatically by WebSphere Application Server, if the session was not used for more than the Invalidate Time value, which defaults to 30 minutes. Sessions can also be manually invalidated by a call to the `invalidate()` method:

```
javax.servlet.http.HttpSession.invalidate()
```

2.7.3 ItemSessionServlet example

To demonstrate the use of sessions, we develop a shopping cart type application that uses session objects to hold an instance of a shopping cart and a vector of items queried from the database. Figure 2-27 shows the design of the application.

For this application, we use a Java ShoppingCart class that represents, as its name implies, a shopping cart. A ShoppingCart object holds the items that we choose to buy. This class is fully described later. For this context, it is enough to know about three methods that are implemented by this class:

- The `ShoppingCart()` constructor is used to create an instance of a ShoppingCart object.
- The `setItems(items)` method is used to set the content of the shopping cart.
- The `getItems()` method returns a Vector object that represents the content of the shopping cart.

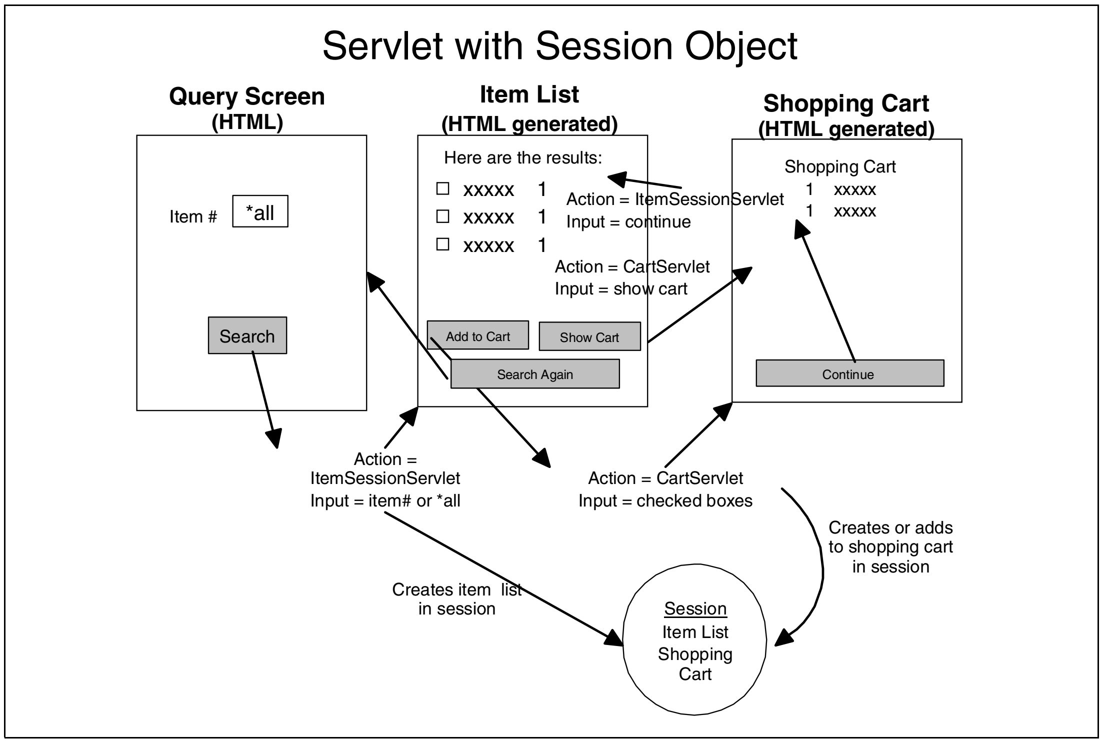
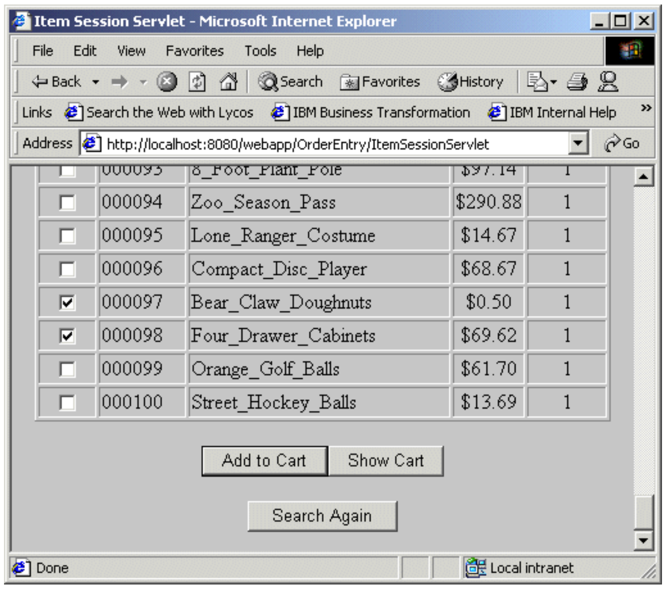


Figure 2-27 ItemSessionServlet diagram

Figure 2-27 shows the flow of the application. The application starts when the user is presented with the Query Screen HTML page. When the user clicks the Search button, the following sequence of jobs is performed:

1. A session object is created.
2. The Item file is queried according to the user selection (either for a specific item or all the items).
3. The vector that contains the items is placed in the Session object.
4. The Item list HTML, shown in Figure 2-28, is generated and sent to the user browser.

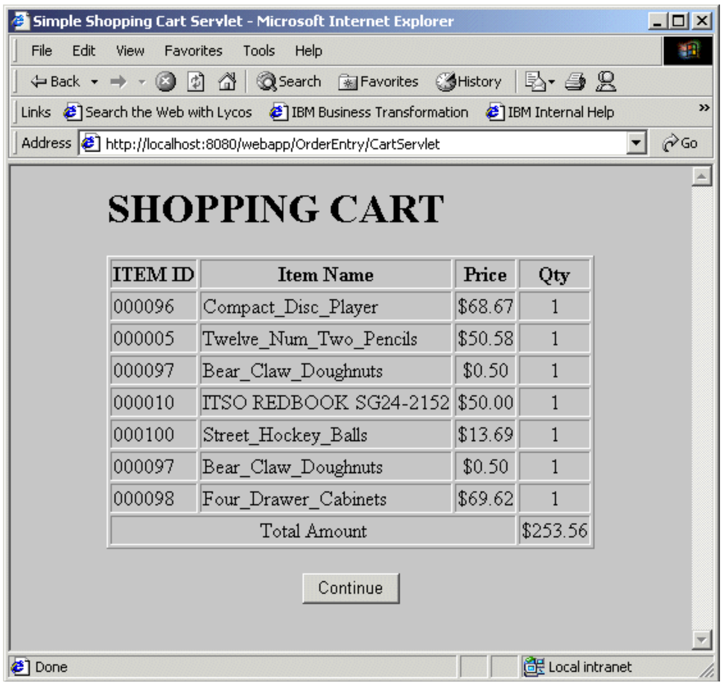

Item Session Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/webapp/OrderEntry/ItemSessionServlet Go
Add to Cart
Show Cart
Search Again
Done
Local intranet

☐	000093	8_Foot_Plant_Pole	$97.14	1
☐	000094	Zoo_Season_Pass	$290.88	1
☐	000095	Lone_Ranger_Costume	$14.67	1
☐	000096	Compact_Disc_Player	$68.67	1
☑	000097	Bear_Claw_Doughnuts	$0.50	1
☑	000098	Four_Drawer_Cabinets	$69.62	1
☐	000099	Orange_Golf_Balls	$61.70	1
☐	000100	Street_Hockey_Balls	$13.69	1

Figure 2-28 Item list HTML page

From the Item List HTML page, the user can choose any one of the following steps:

- Click the **Search Again** button to return to the Query Screen HTML page.
- Click the **Add to Cart** button, which triggers the following sequence of execution.
  a. The CartServlet is invoked.
  b. The vector of items is retrieved from the session.
  c. The shopping cart object is retrieved from the session. If one does not exist, a newly created shopping cart is added to the session.
  d. The items that are selected by the user in the HTML page are added to the shopping cart.
  e. The Shopping Cart HTML page is generated, as displayed in Figure 2-29, and sent to the user.
- Clicking **Show Cart** button, which triggers the same sequence of execution as in the previous option, except for adding the selected item to the cart.
- From the Shopping Cart HTML page, the user only has the option to click the Continue button that invokes the ItemSessionServlet again.


Simple Shopping Cart Servlet - Microsoft Internet Explorer

http://localhost:8080/webapp/OrderEntry/CartServlet

SHOPPING CART

ITEM ID	Item Name	Price	Qty
000096	Compact_Disc_Player	$68.67	1
000005	Twelve_Num_Two_Pencils	$50.58	1
000097	Bear_Claw_Doughnuts	$0.50	1
000010	ITSO REDBOOK SG24-2152	$50.00	1
000100	Street_Hockey_Balls	$13.69	1
000097	Bear_Claw_Doughnuts	$0.50	1
000098	Four_Drawer_Cabinets	$69.62	1
Total Amount			$253.56

Figure 2-29 Shopping cart HTML page

ItemSessionServlet class

The ItemSessionServlet class is based on the ItemPoolServlet class. It is modified to use a Session object. Only those modifications are described.

As shown in Example 2-32, the class imports the ShoppingCart class described previously. It implements a shopping cart.

Example 2-32 ItemSessionServlet class

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
import java.util.*;
import shopData.ShoppingCart.*;

public class ItemSessionServlet extends SuperServlet {
   private access.JDBCPoolCatalog aJDBCPoolCatalog;
}
```

ItemSessionServlet.doPost() method

The `ItemSessionServlet.doPost()` method processes the HTML POST requests to this servlet. The request can come from two different sources, including:

- From the Query Screen HTML page, in which case we want to retrieve the items data from the database, and save them to the Session object.
- From the Shopping Cart HTML page after the user clicks the Continue button, in which case we get the Vector of items from the Session object.

This logic is implemented with the if statements shown in Example 2-33.

Example 2-33 ItemSessionServlet parameter processing

```
   if (parameter.toUpperCase().equals("CONTINUE")) {
            flexLog("Continue shopping");
            parts = (Vector) session.getAttribute("ItemSessionServlet.parts");
         }  else {
            // retrieve all data from the database
            if (parameter.toUpperCase().equals("*ALL")) {
               parts = aJDBCPoolCatalog.getAllV();
            } else {
               parts = aJDBCPoolCatalog.getRecord(parameter);
            }
```

Why can we use a single `parameter` to check whether you click the Continue button or you input the part No. in the HTML page? That's because we give the Continue button a name "partno", the same as the input field in HTML page.

Note how a Session object is created, as shown in Example 2-34, using the `getSession()` method with the create parameter set to *true*. This is done because we want to create a session if one does not exist (if this is the first time we are on the Item List HTML page).

Example 2-34 ItemSessionServlet doPost method

```
public void doPost(HttpServletRequest request, HttpServletResponse response)
throws IOException {
   flexLog("do Post in ItemSessionServlet");
   boolean create = true;
   // Get the Session object
   HttpSession session = request.getSession(create);
   // set the MIME type to text/html
   response.setContentType("text/html");
   // create the output stream
   PrintWriter out = response.getWriter();
   try {
      // get the value from the input field named partno (see HTML file)
      // and check if value is valid
      //Only get the first parameter
      String parameter = null;
      if ((request.getParameter("partno")) == null) // partno not passed into servlet=>
            //set to *ALL
      {
         parameter = "*ALL";
      } else {
         parameter = request.getParameter("partno");
      }

      Vector parts = null;
      flexLog("ItemSessionServlet: parameter passed in from HTML is: " + parameter);
      // write the HTML header to the output stream
      outputHeader(out, getServletInfo());

      // retrieve all data from the session info if called from shopping cart
      // parts is a vector which each element is a string array length 4 with
      // item id, item name, price, and item information each of the string elements.

      // If it isn't a CONTINUE, you need to go to the database and retrieve.

      if (parameter.toUpperCase().equals("CONTINUE")) {
         flexLog("Continue shopping");
         parts = (Vector) session.getAttribute("ItemSessionServlet.parts");
      } else {
         // retrieve all data from the database
         if (parameter.toUpperCase().equals("*ALL")) {
            parts = aJDBCPoolCatalog.getAllV();
         } else {
            parts = aJDBCPoolCatalog.getRecord(parameter);
         }

         // save the vector to the Session Data
         flexLog("Putting the parts list in the session object; number of parts = : "+
              parts.size());
         session.setAttribute("ItemSessionServlet.parts", parts);

      flexLog("Now the table goes up");
      // write the HTML table to the output stream
      outputItemInformation(out, parts);
      out.close();
   } catch (Throwable e) {...
         }
} // end of doPost()\
```

ItemSessionServlet.outputItemInformation() method

The `ItemSessionServlet.outputItemInformation()` method generates the Item List HTML page. As shown in Figure 2-28, two different servlets can be invoked from this generated HTML file. This is why two HTML FORM tags are generated. The form that invokes the CartServlet contains two buttons, one to add items to the cart, and the second just to show the cart. The two buttons share the same name "command," but they have different values that are checked in the CartServlet.

We add a Select check box to each item line to enable the user to choose the items to purchase, shown as Example 2-35.

Example 2-35 ItemSessionServlet outputItemInformation() method

```
private void outputItemInformation(PrintWriter out, Vector partsVector)
throws IOException {
   flexLog("ItemSessionServlet: outputItemInformation()...");
   Enumeration parts = partsVector.elements();

   // Add to cart button will invoke the cart servlet.
   out.println("<FORM  METHOD=POST   ACTION=\"/webapp/OrderEntry/CartServlet\" >");
   out.println("<CENTER>");
   out.println("<TABLE BORDER>");
   out.println("<P><CENTER><B><FONT SIZE=+3>Here are the results of your
      query:</FONT></B></P>");
   out.println("<TR>");
   out.print("<TH>Select</TH><TH>ITEM ID</TH><TH>ItemName</TH>
     <TH>Price</TH><TH>Quantity</TH>");
   out.println("</TR>");
   int i = 0;
   while (parts.hasMoreElements()) {
      String[] aPart = ((String[]) parts.nextElement());
      out.print("<TD><CENTER><INPUT TYPE = checkbox name = index value = " + i + "
    ></CENTER></TD>");
      out.print("<TD>" + aPart[0] + "</TD>");
      out.print("<TD>" + aPart[1] + "</TD>");
      out.print("<TD><CENTER>$" + aPart[2] + "</CENTER></TD>");
      out.print("<TD><CENTER>1</CENTER></TD>");
      out.println("</TR>");
      i++;
   }; // end while
   out.println("</TABLE>");
   out.println("</CENTER>");
   out.print("<P><CENTER><INPUT TYPE=submit value=\"Add to Cart\" name=\"command\">");
   out.println("<INPUT TYPE=submit value=\"Show Cart\" name=\"command\"></CENTER>");
   out.println("</FORM>");

   // Continue Shopping button - just go back to main HTML page
   out.println("<FORM  action=\"/itemSessionservlet.html\" method=\"GET\">");
   out.println("<P><INPUT TYPE=submit value=\"Search Again\" name=\"command\">");
   out.println("</CENTER>");
   out.println("</FORM>");
   out.println("</FONT></BODY></HTML>");
   flexLog("ItemSessionServlet: outputItemInformation() executed.");
} // end outputPartsInformation()
```

CartServlet class

The CartServlet class is responsible for adding the selected items (stored in the session) to the cart and displaying the cart content by generating an HTML page.

Most of the work is done by the `doPost()` method, which is described in the following section.

CartServlet.doPost() method

The `cartServlet.doPost()` method, shown in Example 2-36, starts by getting the Session object associated with the HTTP request. In this case, the value of the create parameter of the `getSession()` method is set to *false*, because the session should already have been created by ItemSessionServlet. If the session does not exist, it is an indication of some kind of problem.

Next, the method tries to retrieve the vector that contains the items from the session. Since all the values saved in the session object are shared among all servlets in the session, it is common practice to prefix the session value name with the servlet name to avoid naming collisions. This is why the vector that contains the items name is prefixed with ItemSessionServlet.

Example 2-36 CartServlet doPonst() method

```
public void doPost(HttpServletRequest request, HttpServletResponse response) throws
IOException {
   flexLog("CartServlet: doPost");

   // Session should already be available
   boolean create = false;
   // Get the Session object

   HttpSession session = request.getSession(create);
```

```
    // set the MIME type to text/html
    response.setContentType("text/html");

    // create the output stream
    PrintWriter out = response.getWriter();
    try {
       // Get the list of the parts queried from the database from the session object.
       flexLog("Getting the items from the session");
       Vector parts = (Vector) session.getAttribute("ItemSessionServlet.parts");
       if (parts == null) {
          flexLog("parts is null!");
       } else {
          flexLog("Parts retrieved successfully from session, it has " + parts.size() + "
        elements");
       }

       //Get the command parameter to determine if this is an add or a show cart
       String parameter = request.getParameter("command");
       flexLog("CartServlet: parameter passed in from ItemSessionServlet is: " +
        parameter);
       String[] value = request.getParameterValues("index");
       ShoppingCart cart = (ShoppingCart) session.getAttribute("shopcart.selected");

       if (cart == null) {
          cart = new ShoppingCart();
          flexLog("cart did not exist in session at this time");
       } else {
          flexLog("cart retrieved from session successfully, it has " +
            cart.getItems().size() + " elements");
       }

       // If "Add to Cart" was selected and items are checked, add the items to the cart
       if ((parameter.equalsIgnoreCase("Add to Cart")) && (value != null)) {
          int j = 0;
          for (int i = 0; i < value.length; i++) {
             j = Integer.parseInt(value[i]);
             flexLog("i: " + i + " value: " + j);
             String[] data = (String[]) parts.elementAt(j);
             CartItem aCartItem = new CartItem(data[0], data[1], data[2], data[3], new
               Integer(1));
             cart.getItems().addElement(aCartItem);
          }

          // save the vector to the Session Data
          session.setAttribute("shopcart.selected", cart);
       }

       // write the HTML header to the output stream
       outputHeader(out, getServletInfo());

       // write the HTML table to the output stream
       outputItemInformation(out, cart);
       out.close();
    } catch (Throwable e) {
       printError(out, e);
    }
} // end of doPost()
```

This servlet can either add the items to the cart and display the cart, or just display the cart. This functionality is determined according to the value of the command parameter. If the command parameter value is *Add to cart*, after adding the items to the cart, the cart is saved again to the session object.

2.7.4 Running the ItemSessionServlet servlet inside VisualAge for Java

Similar to the servlet testing previously in VisualAge for Java, we need to update the default_app.webapp file in the VisualAge for Java test environment with a text editor (like Notepad). This is shown in Example 2-37.

Example 2-37 The default_app.webapp file

```
<servlet>
      <name>ItemSessionServlet</name>
      <description>ItemSessionServlet</description>
      <code>nservlets.ItemSessionServlet</code>
      <servlet-path>/webapp/OrderEntry/ItemSessionServlet</servlet-path>
       <init-parameter>
         <name>user</name>
         <value>Team43</value>
      </init-parameter>
      <init-parameter>
         <name>password</name>
         <value>win4ibm</value>
      </init-parameter>
      <init-parameter>
         <name>datasource</name>
         <value>jdbc/NativeDS</value>
      </init-parameter>
       <autostart>false</autostart>
</servlet>
<servlet>
      <name>CartServlet</name>
      <description>CartServet</description>
      <code>nservlets.CartServlet</code>
      <servlet-path>/webapp/OrderEntry/CartServlet</servlet-path>
      <autostart>false</autostart>
   </servlet>
```

Once we save the property file, we copy the HTML page, itemsessionservlet.html file, into the <VAJ install root>\ide\project_resources\IBM WebSphere Test Environment\hosts\default_host\default_app\web directory. It is used to accept input as shown as Example 2-38. We restart the servlet engine of the WebSphere Test Environment.

Example 2-38 ItemSessionServlet.html page

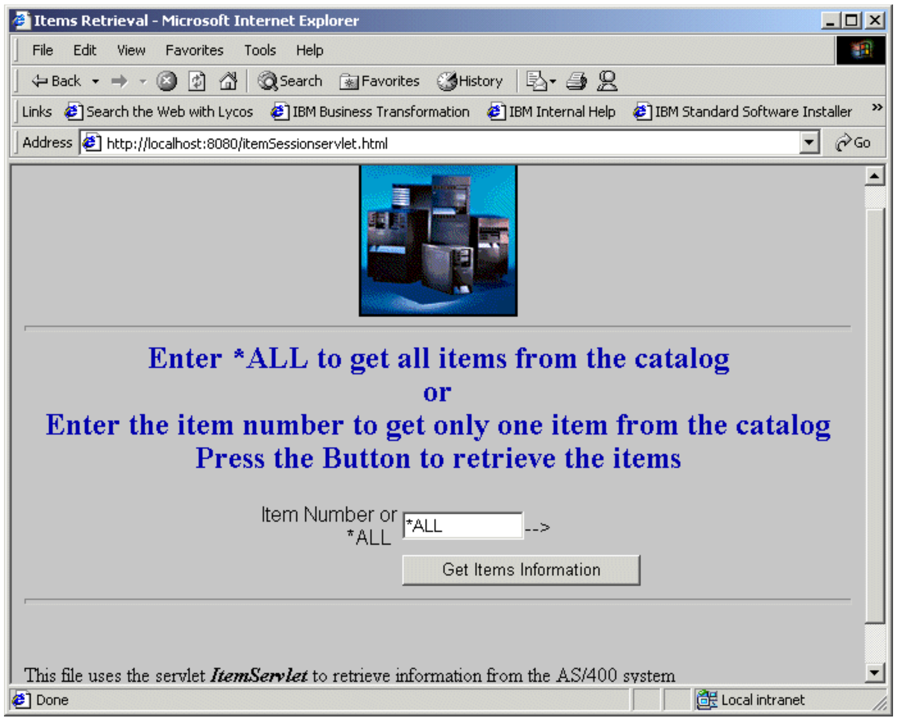
```
<HTML>
<HEAD>
   <META HTTP-EQUIV="Content-Type" CONTENT="text/html; charset=iso-8859-1">
   <META NAME="GENERATOR" CONTENT="Mozilla/4.04 [en] (WinNT; I) [Netscape]">
   <TITLE>Items Retrieval</TITLE>
<!--This file created 3:28 PM  2/11/98 by Claris Home Page version 2.0-->
<X-SAS-WINDOW TOP=79 BOTTOM=699 LEFT=12 RIGHT=845>
</HEAD>
```

```
<BODY BGCOLOR="#C0C0C0">
<FORM method="POST" action="/webapp/OrderEntry/ItemSessionServlet">
<CENTER><IMG SRC="as400.gif" BORDER=2 X-SAS-UseImageWidth X-SAS-UseImageHeight HEIGHT=120
WIDTH=120></CENTER>
<CENTER>
<HR SIZE="5"></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Enter *ALL to get all items
from the catalog</FONT></FONT></B></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>or</FONT></FONT></B></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Enter the item number to
get only one item from the catalog</FONT></FONT></B></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Press the Button to retrieve
the items</FONT></FONT></B></CENTER>
<CENTER>&nbsp;</CENTER>
<CENTER><TABLE BORDER=0 WIDTH="50%" HEIGHT="1" >
<TR>
<TD WIDTH="169" HEIGHT="14">
<DIV ALIGN=right><FONT FACE="Arial,Helvetica">Item Number or *ALL</FONT>&nbsp;</DIV>
</TD>
<TD WIDTH="118" HEIGHT="14"><!-- Add the input field after this line -->
 <INPUT TYPE="text" NAME="partno" VALUE="*ALL" SIZE=10 MAXLENGTH=10>--></TD>
</TR>
<TR>
<TD WIDTH="169"></TD>
<TD WIDTH="118"><INPUT TYPE="submit" NAME="Submit" VALUE="Get Items Information"></TD>
</TR>
</TABLE></CENTER>
<CENTER>
<HR SIZE="5"></CENTER>
</FORM>
<BR>This file uses the servlet <B><I>ItemServlet</I></B> to retrieve information
from the AS/400 system<BR>
<HR SIZE=5 WIDTH="100%">
</BODY>
</HTML>
```

Now we access the ItemSessionServlet application by entering the following URL:

```
http://localhost:8080/ItemSessionServlet.html
```

The input HTML page appears as shown in Figure 2-30.


Items Retrieval - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://localhost:8080/itemSessionservlet.html
Go

Enter *ALL to get all items from the catalog
or
Enter the item number to get only one item from the catalog
Press the Button to retrieve the items

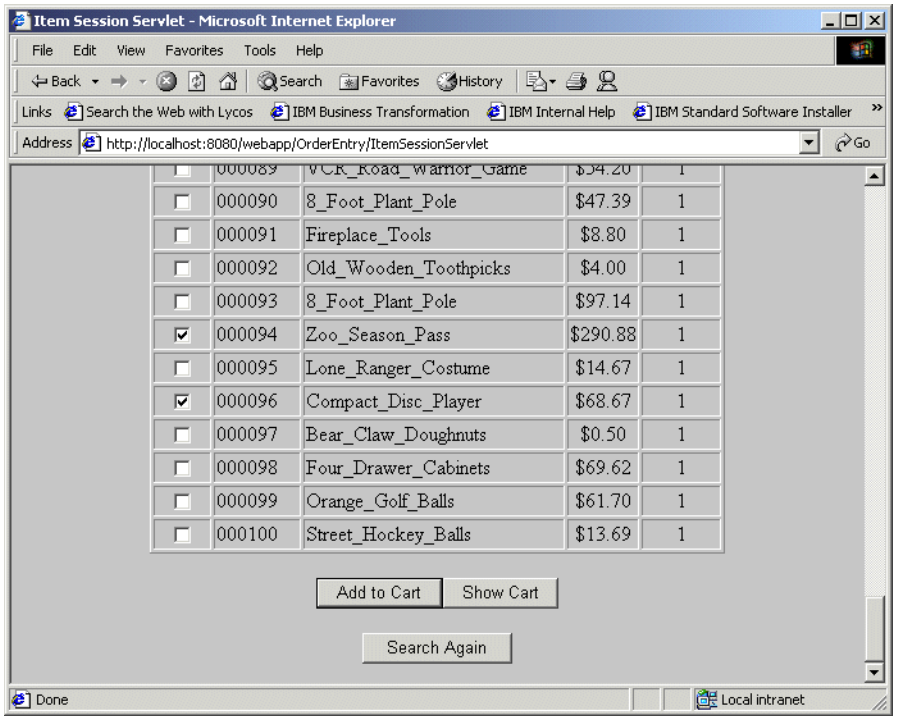
Item Number or *ALL: *ALL -->

Get Items Information

This file uses the servlet *ItemServlet* to retrieve information from the AS/400 system

Figure 2-30 ItemSessionServlet input page

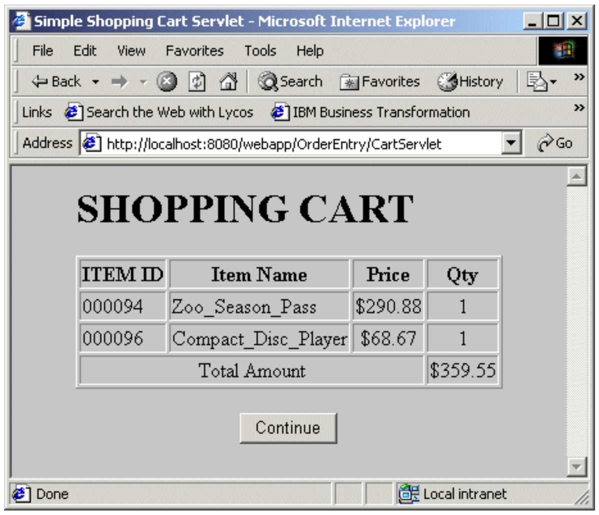
We click the **Get Items Information** button. It shows all the items that we can select, as shown in Figure 2-31. We select several items and click the **Add to Cart** button.


Item Session Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://localhost:8080/webapp/OrderEntry/ItemSessionServlet
Go

☐	000089	VCR_Road_Warrior_Game	$54.20	1
☐	000090	8_Foot_Plant_Pole	$47.39	1
☐	000091	Fireplace_Tools	$8.80	1
☐	000092	Old_Wooden_Toothpicks	$4.00	1
☐	000093	8_Foot_Plant_Pole	$97.14	1
☑	000094	Zoo_Season_Pass	$290.88	1
☐	000095	Lone_Ranger_Costume	$14.67	1
☑	000096	Compact_Disc_Player	$68.67	1
☐	000097	Bear_Claw_Doughnuts	$0.50	1
☐	000098	Four_Drawer_Cabinets	$69.62	1
☐	000099	Orange_Golf_Balls	$61.70	1
☐	000100	Street_Hockey_Balls	$13.69	1

Figure 2-31 ItemSessionServlet selection page

The next page (Figure 2-32) shows the items we selected in a shopping cart. You can click **Continue** to select more items.


Simple Shopping Cart Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation
Address http://localhost:8080/webapp/OrderEntry/CartServlet
Go
Continue
Done
Local intranet

SHOPPING CART

ITEM ID	Item Name	Price	Qty
000094	Zoo_Season_Pass	$290.88	1
000096	Compact_Disc_Player	$68.67	1
Total Amount			$359.55

Figure 2-32 ItemSessionServlet shopping cart

2.7.5 Exporting the ItemSessionServlet from VisualAge for Java

Similar to ItemServlet, before we deploy our new servlet to WebSphere Application Server V4.0, we have to export it into JAR file that can be used by the Application Assembly Tool to build a Web application.

In the VisualAge for Java Workbench, select the access, nservlets, and shopData packages (use the Ctrl key to select all three) and export them to a JAR file. See 2.3.4, “Exporting class files to a JAR file” on page 28. We export to a file named wswssession.jar.

3

WebSphere V4.0 assembly and deployment tools

In Chapter 2, “Servlet and JSP development using VisualAge for Java” on page 21, we developed several servlet and JSP applications and tested them inside VisualAge for Java V4.0. We exported the servlet examples from VisualAge for Java into JAR files:

- **wsws.jar**: MyHelloWorldServlet
- **wswsitem.jar**: ItemServlet
- **wswspool.jar**: ItemPoolServlet
- **wswsjsp.jar**: CallJSP
- **wswssession.jar**: ItemSessionServlet

Tools that are not J2EE compliant, like VisualAge for Java 4.0, cannot package applications into the proper format for installation under WebSphere Application Server 4.0. It is necessary to use a tool, like the Application Assembly Tool (AAT), to package them into J2EE format before they can be installed. This chapter explains how to use AAT to do this.

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3.1 WebSphere 4.0 application packaging overview

WebSphere Application Server Version 4.0 is fully J2EE 1.2 compliant. To deploy an application on WebSphere Application Server 4.0, we cannot simply copy the servlet or JSP files into the server directory. J2EE requires that all your code, whether it is EJBs, JSPs, servlets, image files, JAR files, and so on, be packaged into modules with deployment descriptors provided for each module.

There are three types of modules in J2EE:

- **Web module**: This is a deployable archive file tat includes Java servlets, JSP pages, JAR files, HTML files, images, and so on. We call this file a Web Archive file or WAR file. The extension of the file is .war. There is a deployment descriptor file, *web.xml* in the WEB-INF directory of the archive that contains the deployment description for the WAR file.
- **EJB module**: This is a deployable archive file that includes EJBs and the associated JAR files. The extension of the file is .jar. The deployment descriptor, *ejb-jar.xml* is also included in the META-INF directory of the archive.
- **Client module**: This is a JAR file that contains Java client classes and a deployment descriptor named *application-client.xml*.

A J2EE enterprise application consists of one or more of these three modules packaged into an Enterprise Archive (EAR) file. The EAR file also contains an XML file named aplication.xml that describes the application. The extension of the EAR file is .ear.

For enterprise applications running on WebSphere Application Server Version 4.0, we also package some WebSphere specific extensions into the EAR file, which are not included in the J2EE specification. Examples include transaction isolation attributes, Web application reloading, file serving, and servlet invoker by classname information. These extensions generate additional deployment descriptors, like `ejb-jar.xml`, `ibm-ejb-jar-ext.xmi`, and `ibm-ejb-jar-bnd.xmi`.

The complete picture of WebSphere 4.0-based application packaging is shown in Figure 3-1. To deploy applications developed with VisualAge for Java, WebSphere Studio, or other non-J2EE compliant tools, we need to package them into Web modules, EJB modules, client modules, and eventually enterprise archive files. IBM provides a tool to help with this process. It is called the *IBM Application Assembly Tool* and is available in WebSphere Version 4.0.

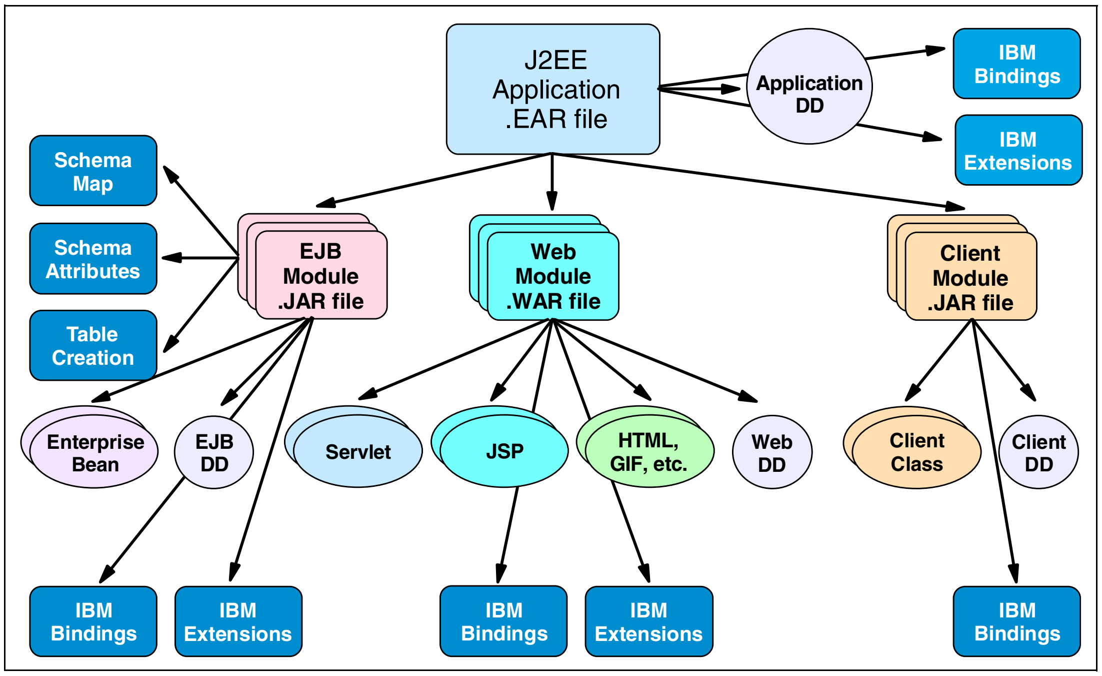


Figure 3-1 WebSphere 4.0-based application packaging

3.2 Application Assembly Tool overview

Application Assembly Tool is a graphical user interface (GUI) tool provided with WebSphere V4.0 to perform application assembly for WebSphere applications. The process for AAT consists of two steps:

1. Create archive files that contain all of the files that belong to a specific application. The archive files can be WAR files, EJB modules, and client modules.
2. Configure the runtime behavior of the application. This generates the XML-based deployment descriptors that list the contents and characteristics of the modules and contain instructions for how the modules are deployed in the runtime environment.

AAT has rich functions. Some of the following features are very useful for building applications that will be deployed on WebSphere 4.0:

- Create/Edit J2EE applications (EARs) from J2EE modules.
- Create/Edit J2EE modules.
  - Web modules (.war files) for servlets, JSPs, HTML
  - EJB modules (.jar files) for EJB and associated JAR files
  - Client modules (.jar files) for Java application client classes
- Modify the deployment descriptor information.
- Modify the binding information attributes.
- Modify the IBM extension attributes.
- Convert EJB JAR files from the EJB 1.0 specification to the EJB 1.1 specification.

AAT is shipped with the WebSphere 4.0 client support. Because it does not run on the iSeries server, you must install it on a workstation.

To start AAT, open a command prompt session and change directories to the <WebSphere install>\AppServer\bin directory, enter `assembly` to start the AAT.

The AAT welcome page displays as shown in Figure 3-2. You can click one of the icons to directly go to the specific function, or click Cancel to use the main menu.

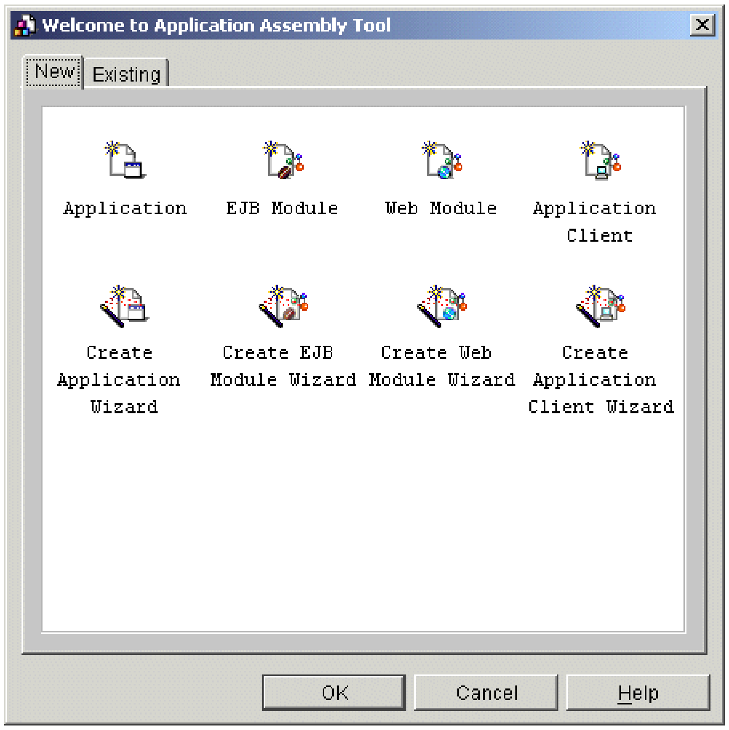


Figure 3-2 Application Assembly Tool welcome page

From the main menu, you can either use the menu items or simply click the smarticons, as shown in Figure 3-3.

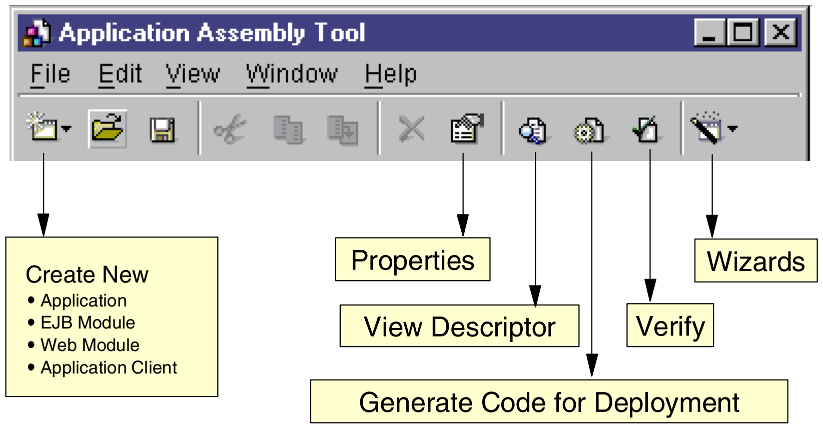


Figure 3-3 Application Assembly Tool smarticons

Some icons are greyed out. This means these icons take effect only if you invoke some specific functions.

3.3 Application packaging and deploying scenario

In this section, we package the JAR files created with VisualAge for Java using AAT. The JAR files are:

- **wsws.jar**: Contains MyHelloWorldServlet
- **wswsitem.jar**: Contains ItemServlet
- **wswspool.jar**: Contains ItemPoolServlet
- **wswsjsp.jar**: Contains CallJSP servlet

We package the JAR files into Web applications and deploy the Web applications on WebSphere Application Server. We test the deployed applications using the internal WebSphere HTTP server.

We also build an enterprise application based on the EJB code developed in Chapter 8, “iSeries EJB application development scenario” on page 245. We go through the steps of building individual EJB modules, Web modules, and client modules, and then generate the EAR file. We deploy it on WebSphere Application Server Version 4.0 Advanced Edition and test it through the internal WebSphere HTTP server.

3.3.1 Packaging MyHelloWorldServlet

Here are the steps to deploy the MyHelloWorldServlet example:

1. Start the Application Assembly Tool.
2. Once the welcome page displays, select **Web Module** and click **OK**.
3. In the Application Assembly window, right-click **Web Components** and select **New** (Figure 3-4).

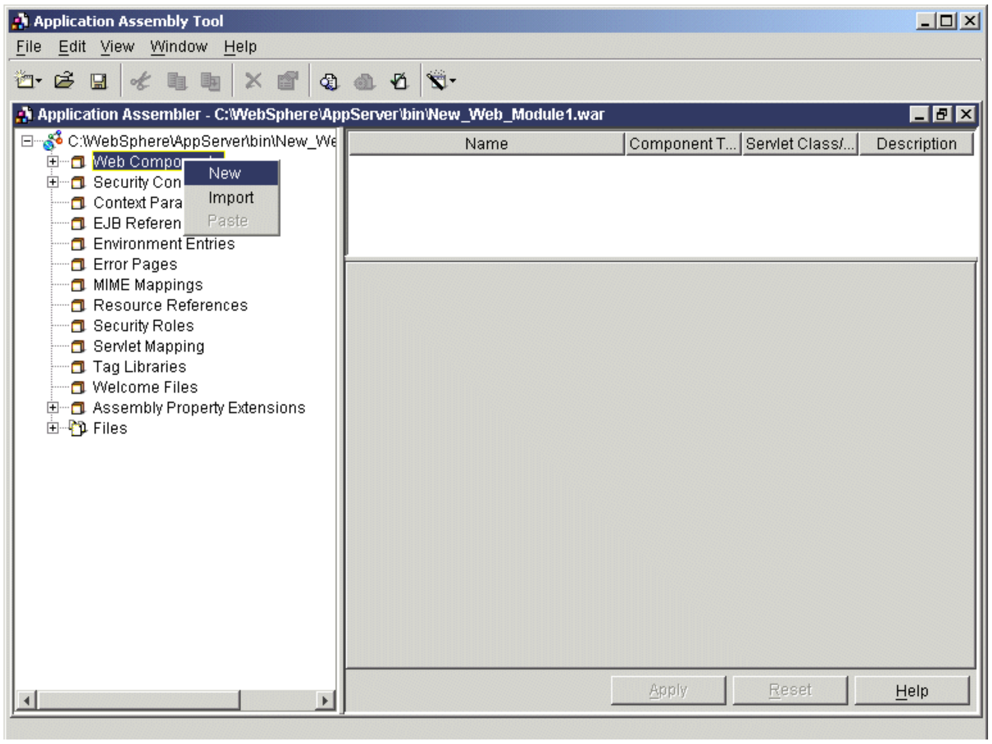
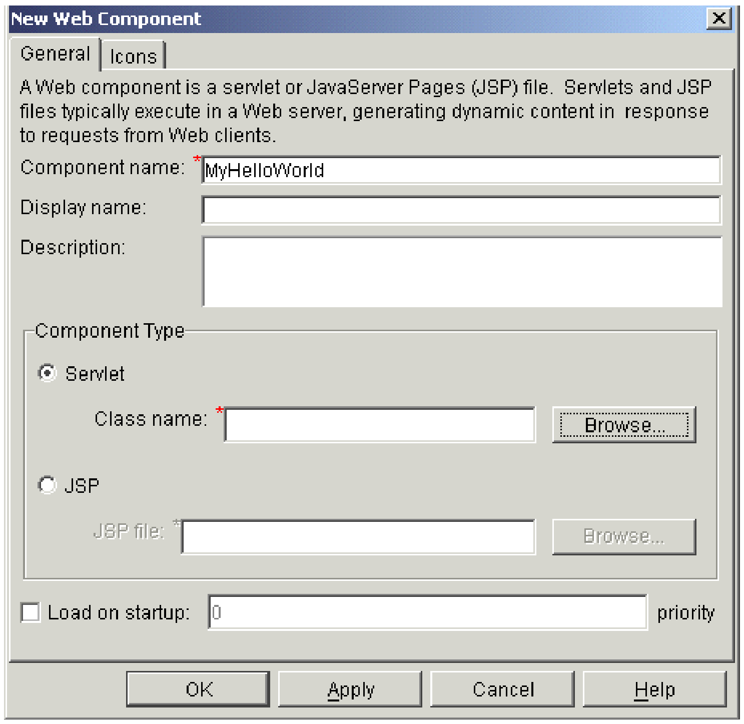


Figure 3-4 Creating a new Web component

4. In the New Web Component window (Figure 3-5), enter `MyHelloWorld` as the Component name. Select the **Servlet** radio button and click the **Browse** button to add the servlet name.


New Web Component

General | Icons

A Web component is a servlet or JavaServer Pages (JSP) file. Servlets and JSP files typically execute in a Web server, generating dynamic content in response to requests from Web clients.

Component name: * MyHelloWorld

Display name:

Description:

Component Type

(●) Servlet

Class name: *

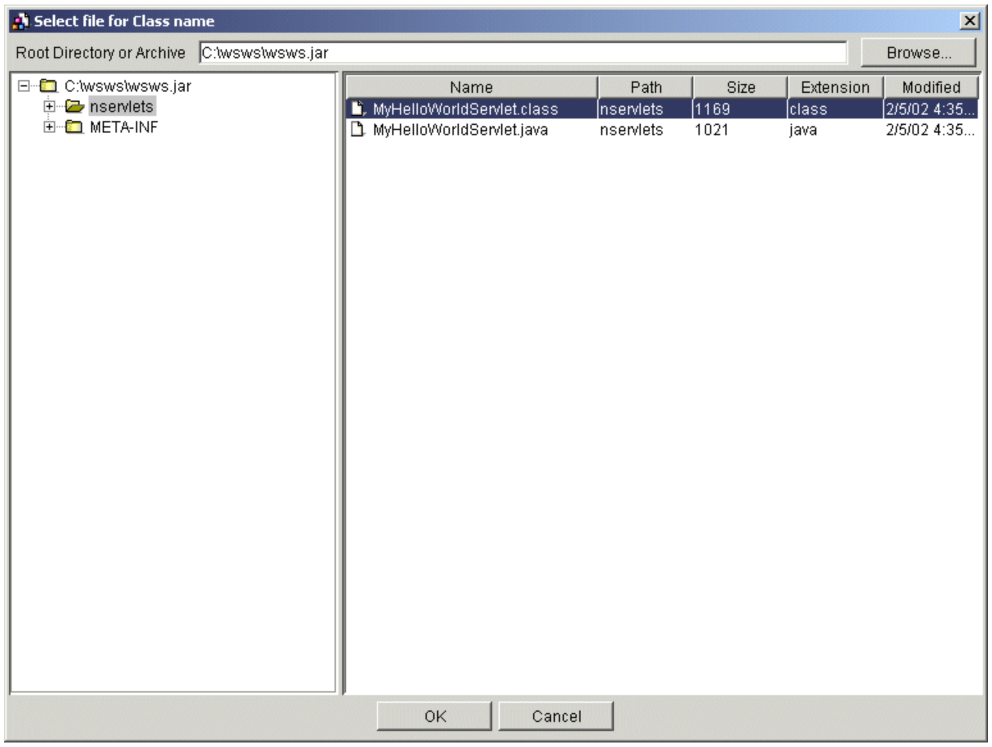
( ) JSP

JSP file: *

[ ] Load on startup: 0 priority

Figure 3-5 Creating a new Web component

5. In the Select file for Class name window, click **Browse** to locate the JAR file (c:\wsws\wsws.jar) that you exported from VisualAge for Java. In our example, we placed the JAR files in the wsws directory.
6. After you select the JAR file, you return to the Select file for Class name window (Figure 3-6). Select the **nservlets** package in the left pane and then select the **MyHelloWorldServlet.class** file in the right pane (make sure you select the class file). Click **OK**.



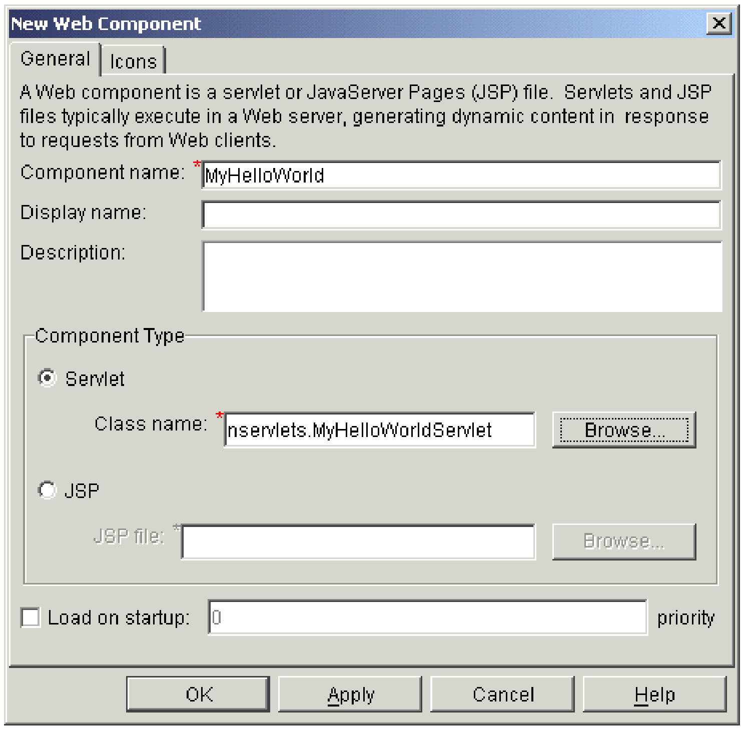
Root Directory or Archive: C:\wsws\wsws.jar

C:\wsws\wsws.jar
nservlets
META-INF

Name	Path	Size	Extension	Modified
MyHelloWorldServlet.class	nservlets	1169	class	2/5/02 4:35...
MyHelloWorldServlet.java	nservlets	1021	java	2/5/02 4:35...

Figure 3-6 Selecting the servlet class file

This takes you back to New Web Component window. The window now contains a component name and a class name as shown in Figure 3-7.



A Web component is a servlet or JavaServer Pages (JSP) file. Servlets and JSP files typically execute in a Web server, generating dynamic content in response to requests from Web clients.

Component name: * MyHelloWorld

Display name:

Description:

Component Type

[✓ Servlet]

Class name: * nservlets.MyHelloWorldServlet

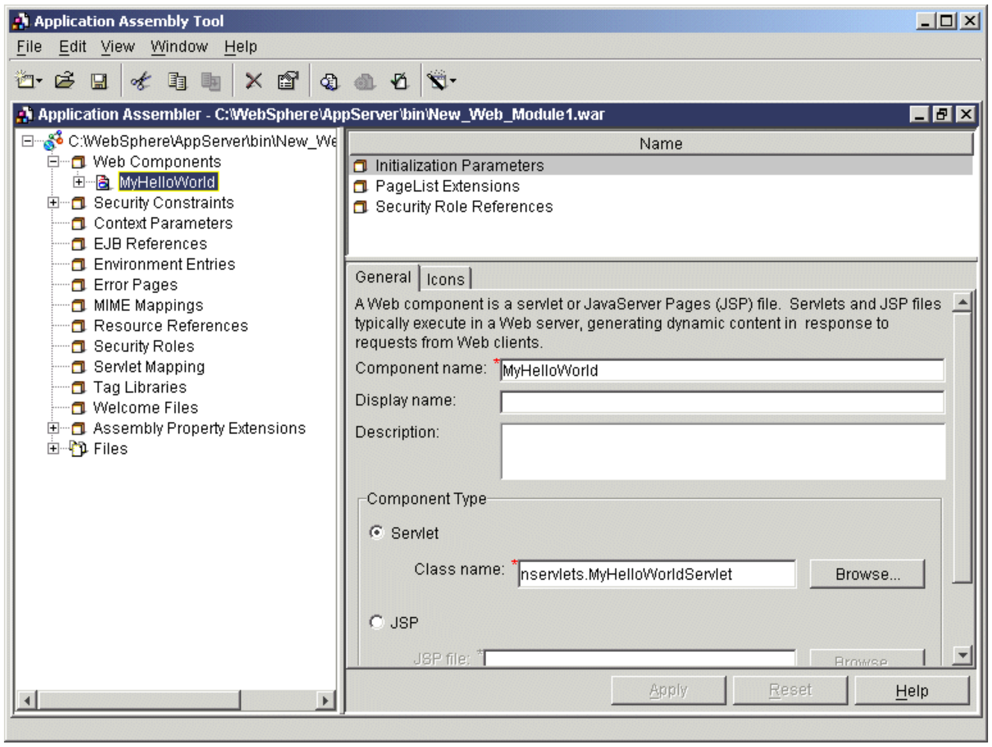
JSP

JSP file: *

Load on startup: 0 priority

Figure 3-7 New Web Component window

7. Click **OK** to save the settings. Now you see MyHelloWorld listed as a Web Component, as shown in Figure 3-8.



A Web component is a servlet or JavaServer Pages (JSP) file. Servlets and JSP files typically execute in a Web server, generating dynamic content in response to requests from Web clients.

Component name: MyHelloWorld
Display name:
Description:

Component Type
(●) Servlet
Class name: nservlets.MyHelloWorldServlet
( ) JSP
JSP file:

Figure 3-8 AAT with a Web Component

8. Create a servlet mapping that is similar to an alias in WebSphere 3.5 for this servlet. Right-click **Servlet Mapping** in the left panel and select **New**. The New Servlet Mapping window displays, as shown in Figure 3-9.

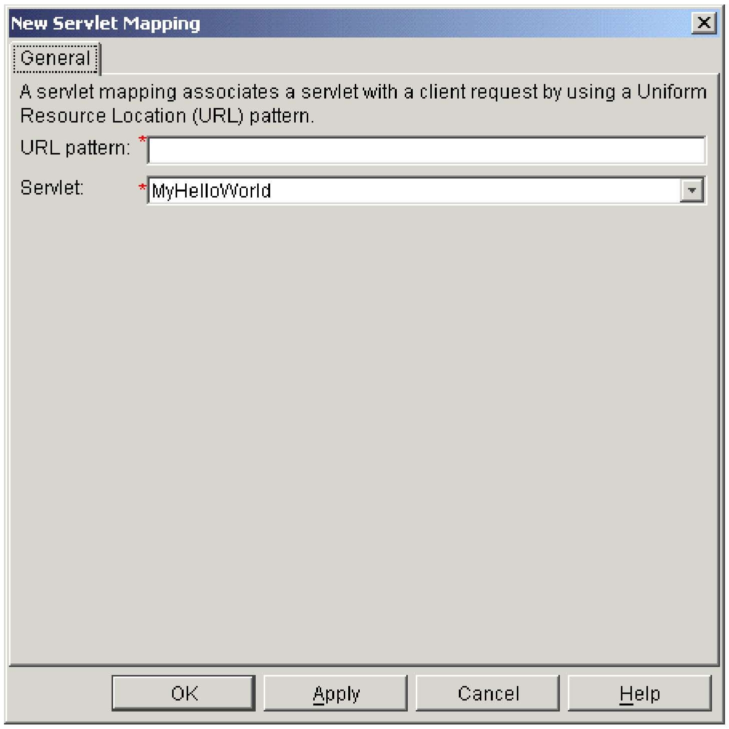

New Servlet Mapping
General
A servlet mapping associates a servlet with a client request by using a Uniform Resource Location (URL) pattern.
URL pattern: *
Servlet: * MyHelloWorld
OK
Apply
Cancel
Help

Figure 3-9 Setting servlet mappings

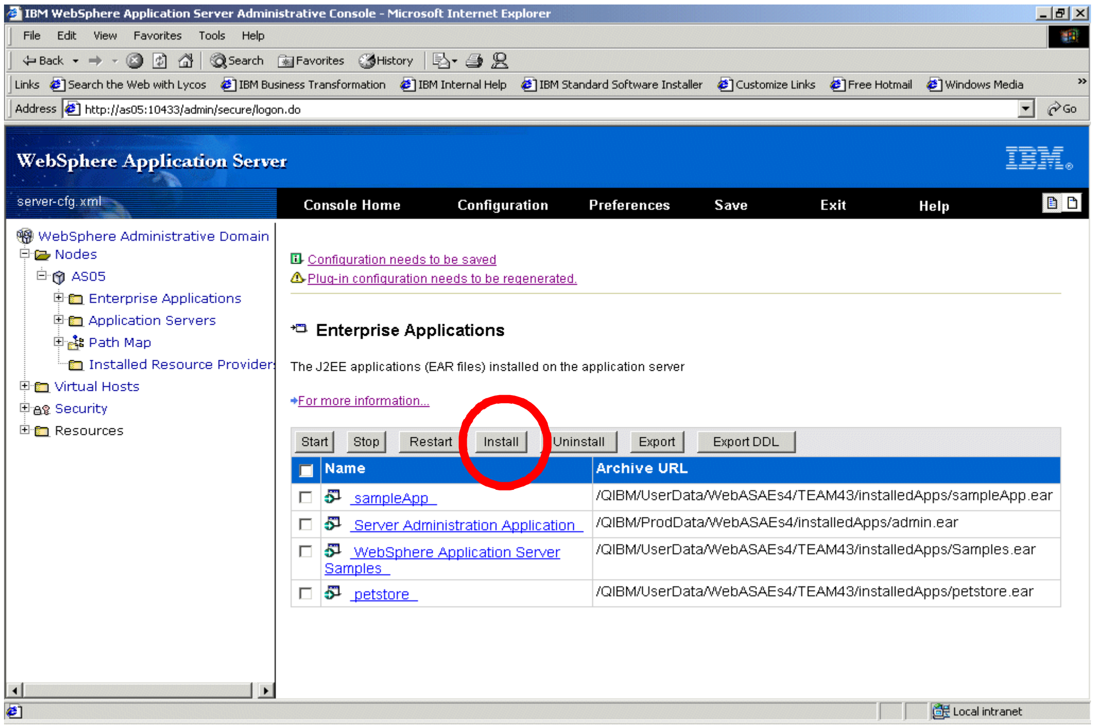
9. Enter `MyHello` for the URL pattern and select **MyHelloWorld** as the servlet. Click **OK** to save the settings.
10. The configuration of MyHelloWorldServlet is complete. It is time to deploy the Web application. Select **File-> Save As**. We save our work in the wsws directory as wsws.war.

Next we use the WebSphere Application Server Version 4.0 Advanced Single Server Edition Administrative Console to install the Web module so it can be run under WebSphere Application Server Single Server.

3.3.2 Installing the MyHello Web module under the Single Server

To begin, start the Web-based console. Then follow these steps:

1. Click the plus (+) sign in front of Nodes to reveal the topology. You see the iSeries server name for Node name. Drill down to the next level and click **Enterprise Applications**. All the installed applications are displayed, as shown in Figure 3-10.



IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
Address http://as05:10433/admin/secure/logon.do
WebSphere Application Server
server-cfg.xml
Console Home
Configuration
Preferences
Save
Exit
Help
WebSphere Administrative Domain
Nodes
AS05
Enterprise Applications
Application Servers
Path Map
Installed Resource Providers
Virtual Hosts
Security
Resources
Configuration needs to be saved
Plug-in configuration needs to be regenerated.
Start
Stop
Restart
Install
Uninstall
Export
Export DDL
Local intranet

Enterprise Applications

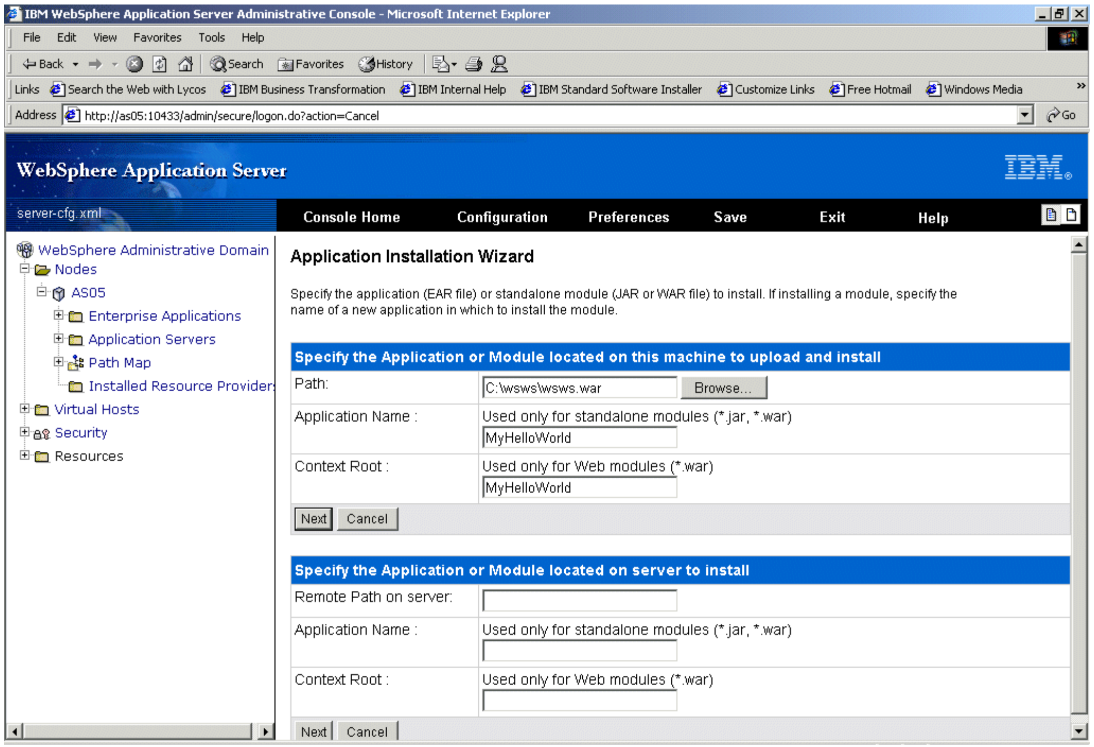
The J2EE applications (EAR files) installed on the application server

For more information...

Name	Archive URL
sampleApp	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/sampleApp.ear
Server Administration Application	/QIBM/ProdData/WebASAEs4/installedApps/admin.ear
WebSphere Application Server Samples	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/Samples.ear
petstore	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/petstore.ear

Figure 3-10 Enterprise applications in WebSphere 4.0 Single Server Edition

2. Install the Web module from this page. Click the **Install** button to start the process. When the Application Installation Wizard page displays, use the **Browse** button to locate the wsws.war file in the wsws directory. As shown in Figure 3-11, enter `MyHelloWorld` for both Application Name and Context Root and click **Next**.



IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
Address http://as05:10433/admin/secure/logon.do?action=Cancel
WebSphere Application Server
server-cfg.xml
Console Home
Configuration
Preferences
Save
Exit
Help
WebSphere Administrative Domain
Nodes
AS05
Enterprise Applications
Application Servers
Path Map
Installed Resource Providers
Virtual Hosts
Security
Resources
Browse...
Next
Cancel

Application Installation Wizard

Specify the application (EAR file) or standalone module (JAR or WAR file) to install. If installing a module, specify the name of a new application in which to install the module.

Specify the Application or Module located on this machine to upload and install

Path:	C:\wsws\wsws.war
Application Name :	Used only for standalone modules (*.jar, *.war) MyHelloWorld
Context Root :	Used only for Web modules (*.war) MyHelloWorld

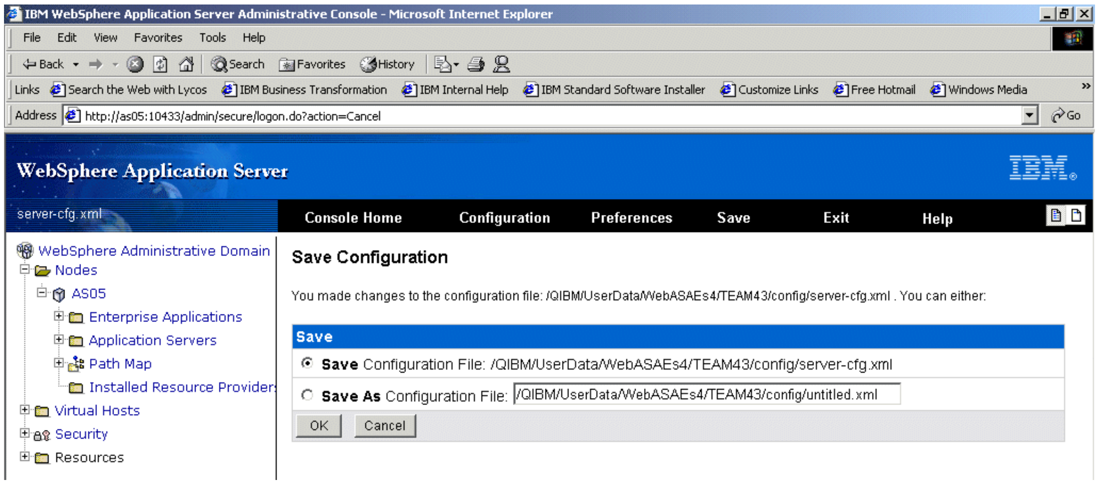
Specify the Application or Module located on server to install

Remote Path on server:	
Application Name :	Used only for standalone modules (*.jar, *.war)
Context Root :	Used only for Web modules (*.war)

Figure 3-11 Installing a Web Module under WebSphere 4.0 Single Server Edition

3. Click **Next** again when you see the Specifying Virtual Host names and Precompiled JSP option for the Web Modules page. When you see the confirmation dialog, click the **Finish** button.

4. Click the **Save** button on the top of this page to save the configuration. Select the **Save Configuration** radio button and click **OK**, as shown in Figure 3-12.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://as05:10433/admin/secure/logon.do?action=Cancel
WebSphere Application Server
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrative Domain
Nodes
AS05
Enterprise Applications
Application Servers
Path Map
Installed Resource Providers
Virtual Hosts
Security
Resources

Save Configuration

You made changes to the configuration file: /QIBM/UserData/WebASAEs4/TEAM43/config/server-cfg.xml . You can either:

Save

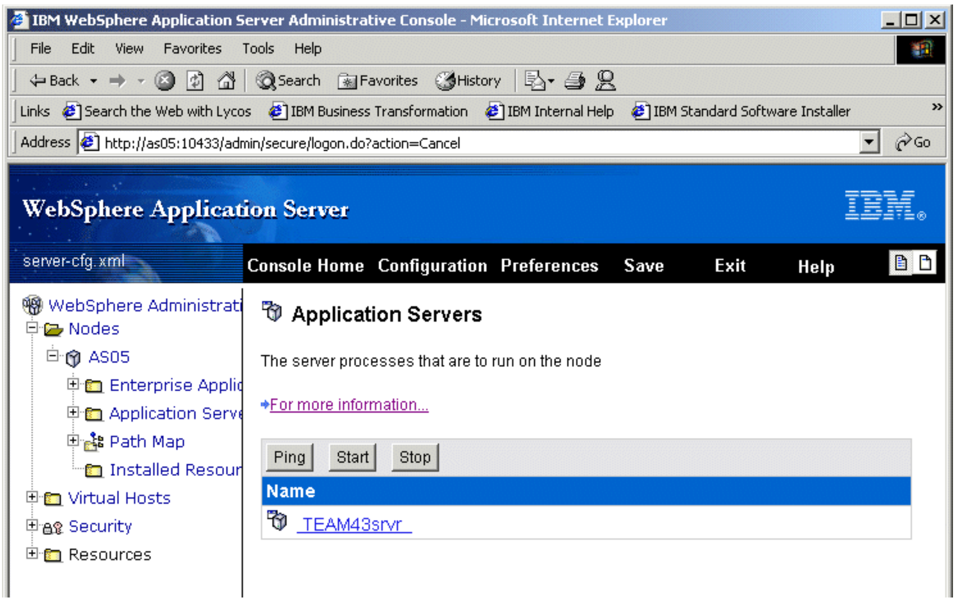
(●) **Save** Configuration File: /QIBM/UserData/WebASAEs4/TEAM43/config/server-cfg.xml

( ) **Save As** Configuration File: /QIBM/UserData/WebASAEs4/TEAM43/config/untitled.xml

OK Cancel

Figure 3-12 Saving the configuration for WebSPhere 4.0 Single Server Edition

5. Stop and restart the application server to make the application available. Select **Application Servers** in the left pane and click **Stop** in the right pane, as shown in Figure 3-13.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://as05:10433/admin/secure/logon.do?action=Cancel
WebSphere Application Server
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrati
Nodes
AS05
Enterprise Applic
Application Serve
Path Map
Installed Resour
Virtual Hosts
Security
Resources
Ping Start Stop

Application Servers

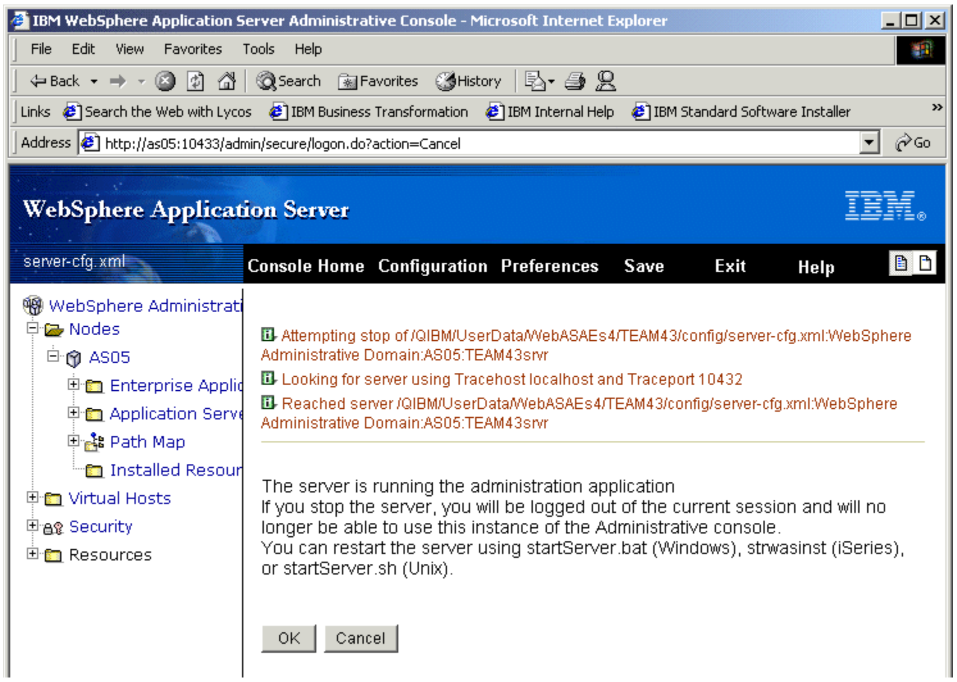
The server processes that are to run on the node

For more information...

Name
TEAM43srvr

Figure 3-13 Stopping the application server

6. You may see the warning dialog, shown in Figure 3-14. Click **OK** and wait for the application to stop. You will lose the session in your browser.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://as05:10433/admin/secure/logon.do?action=Cancel
WebSphere Application Server
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrati
Nodes
AS05
Enterprise Applic
Application Serve
Path Map
Installed Resour
Virtual Hosts
Security
Resources
OK
Cancel

Attempting stop of /QIBM/UserData/WebASAEs4/TEAM43/config/server-cfg.xml:WebSphere Administrative Domain:AS05:TEAM43srvr

Looking for server using Tracehost localhost and Traceport 10432

Reached server /QIBM/UserData/WebASAEs4/TEAM43/config/server-cfg.xml:WebSphere Administrative Domain:AS05:TEAM43srvr

The server is running the administration application
If you stop the server, you will be logged out of the current session and will no longer be able to use this instance of the Administrative console.
You can restart the server using startServer.bat (Windows), strwasinst (iSeries), or startServer.sh (Unix).

Figure 3-14 The warning dialog when stopping the application server

7. Start WebSphere Application Server. Open an iSeries 5250 session and ensure that your application server has ended. You can use the WRKACTJOB command to check the QEJBAES4 subsystem. Then follow these steps:
   a. Enter `qsh` to start a Qshell session.
   b. Enter the following command to change directories:

   ```
   cd /qibm/proddata/webasaes4/bin
   ```

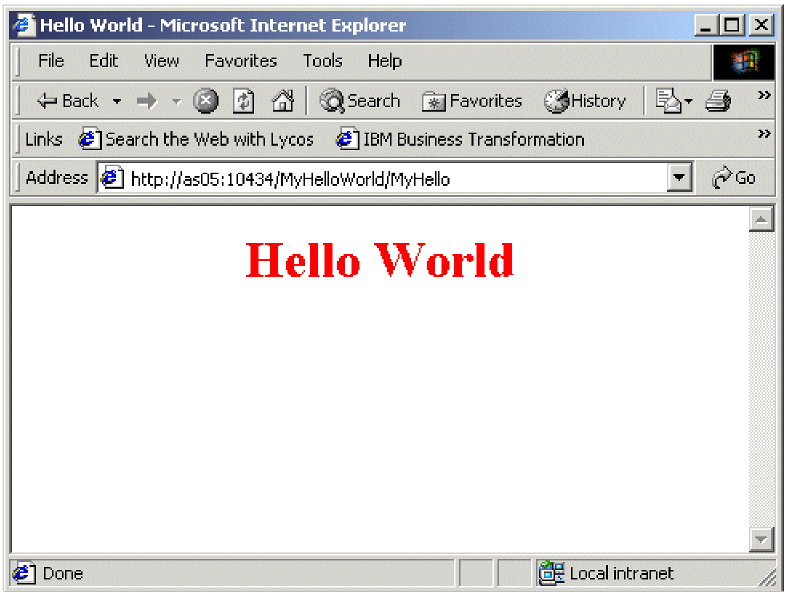
   c. Enter the following command to start the WebSphere instance (where *yourinstance* is the name the WebSphere instance):

   ```
   strwasinst -instance yourinstance
   ```

8. Once the application server starts, test the new Web application. Open a browser session and enter the URL as:

   ```
   http://sysname:port/MyHelloWorld/MyHello
   ```

   Replace *sysname* with your server name and *port* with the internal WebSphere HTTP server port. Figure 3-15 shows the results.

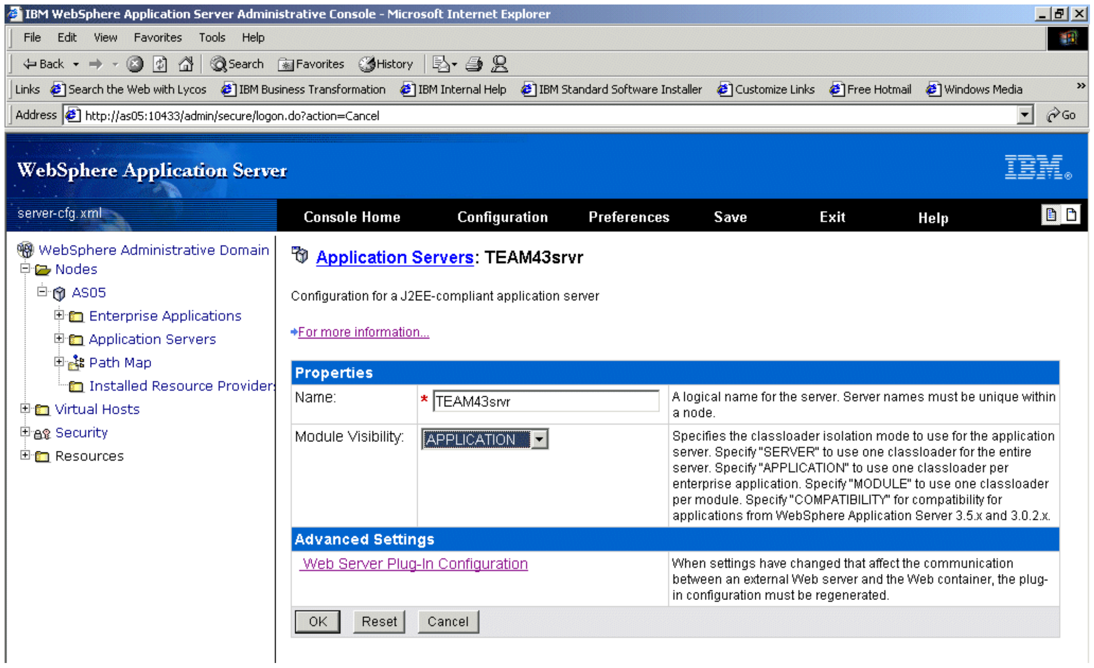

Hello World - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation
Address http://as05:10434/MyHelloWorld/MyHello
Go
Done
Local intranet

Hello World

Figure 3-15   MyHello Servlet

9. If you want to use an external HTTP server to test this application, you need to re-generate the Web server plug-in configuration.

   From the Administrative Console, expand **Nodes** and drill down to **Application Servers**. Expand **Application Servers** and select the instance application server in the left pane. In the properties page on the right, click **Web Server Plug-in Configuration**, as shown in Figure 3-16.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer Customize Links Free Hotmail Windows Media
Address http://as05:10433/admin/secure/logon.do?action=Cancel
Go
WebSphere Application Server
IBM
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrative Domain
Nodes
AS05
Enterprise Applications
Application Servers
Path Map
Installed Resource Provider
Virtual Hosts
Security
Resources
OK Reset Cancel

Application Servers: TEAM43srvr

Configuration for a J2EE-compliant application server

For more information...

Properties		
Name:	* TEAM43srvr	A logical name for the server. Server names must be unique within a node.
Module Visibility:	APPLICATION	Specifies the classloader isolation mode to use for the application server. Specify "SERVER" to use one classloader for the entire server. Specify "APPLICATION" to use one classloader per enterprise application. Specify "MODULE" to use one classloader per module. Specify "COMPATIBILITY" for compatibility for applications from WebSphere Application Server 3.5.x and 3.0.2.x.

Advanced Settings	
Web Server Plug-In Configuration	When settings have changed that affect the communication between an external Web server and the Web container, the plug-in configuration must be regenerated.

Figure 3-16   Web Server Plug-in configuration

10. Click **Generate** on the Web Server Plug-in Configuration page. It re-generates the plug-in configuration for the external HTTP server.

Now we can access our application by the external HTTP port:

```
http: //sysname:port/MyHelloWorld/MyHello
```

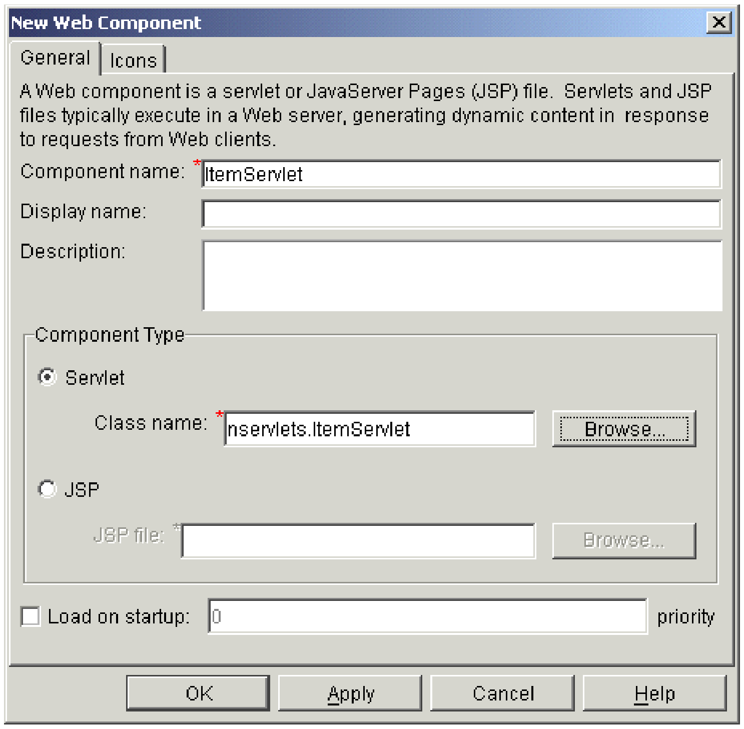
Here *sysname* is the iSeries server name and *port* is the external HTTP server port.

Tip: If the HTTP server fails to find the servlet, you may need to restart the external HTTP server.

3.3.3 Packaging ItemServlet

Next, we package ItemServlet into a Web module with Application Assembly Tool. This is very similar to the steps in 3.3.1, “Packaging MyHelloWorldServlet” on page 79. We focus on the differences here.

1. Start Application Assembly Tool.
2. Click **Cancel** on the AAT welcome page.
3. From the main menu, select **File-> Open** to open the wsws.war file in the wsws directory. This WAR file was created in 3.3.1, “Packaging MyHelloWorldServlet” on page 79.
4. Right-click **Web Components** and select **New** to add a new component.
5. Enter `ItemServlet` in the input field for Component Name and locate the ItemServlet.class from the wswsitem.jar file for the class name. The result should look like the example in Figure 3-17.



A Web component is a servlet or JavaServer Pages (JSP) file. Servlets and JSP files typically execute in a Web server, generating dynamic content in response to requests from Web clients.

Component name: * ItemServlet

Display name:

Description:

Component Type

(●) Servlet

Class name: * nservlets.ItemServlet

( ) JSP

JSP file: *

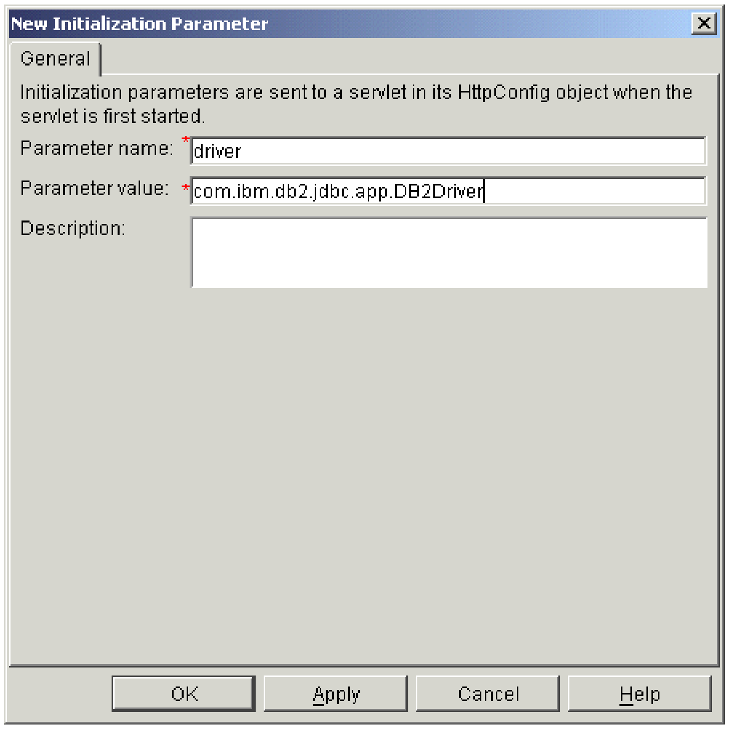
☐ Load on startup: 0 priority

Figure 3-17 Adding a Web Component for ItemServlet

6. Click **OK** to save the settings.
7. Create the Servlet Mapping by right-clicking the Web component and selecting **New**. We enter `ItemServlet` for the URL pattern and select **ItemServlet** for the servlet.

Once we finish this, we see the difference from the MyHelloWorld application. ItemServlet uses initialization parameters for userid, password, JDBC url and JDBC driver.

8. Now we configure the parameters through AAT. Select **Web Components->ItemServlet**.
   a. Right click **Initialization Parameters** and select **New**.
   b. As shown in Figure 3-18, enter `driver` as the Parameter Name and `com.ibm.db2.jdbc.app.DB2Driver` as the Parameter Value. Click **Apply**.



Initialization parameters are sent to a servlet in its HttpConfig object when the servlet is first started.

Parameter name: * driver

Parameter value: * com.ibm.db2.jdbc.app.DB2Driver

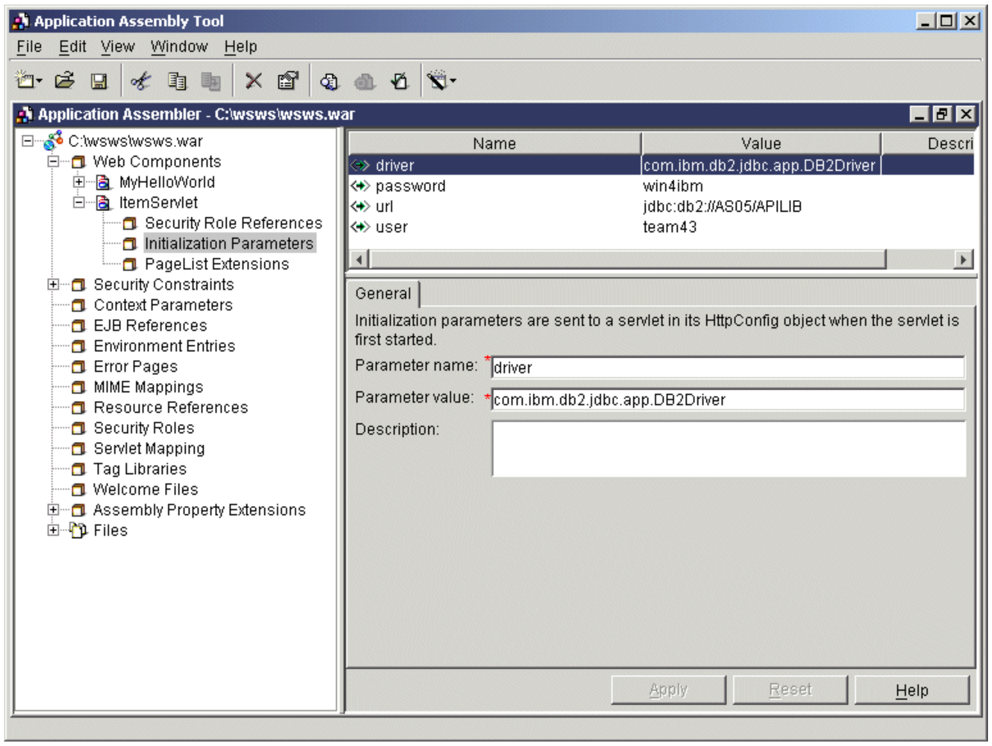
Description:

Figure 3-18 Setting the initialization parameters

Use the same technique to enter the following parameter values:

- User: Your user ID
- Password: Your password
- URL: `jdbc:db2://`*`sysname`*`/`*`library`* where *sysname* is the iSeries server name and *library* is the library name for the ITEM table.

A total of four parameters are configured as shown in Figure 3-19.



Name	Value	Descri
driver	com.ibm.db2.jdbc.app.DB2Driver	
password	win4ibm	
url	jdbc:db2://AS05/APILIB	
user	team43	

Initialization parameters are sent to a servlet in its HttpConfig object when the servlet is first started.

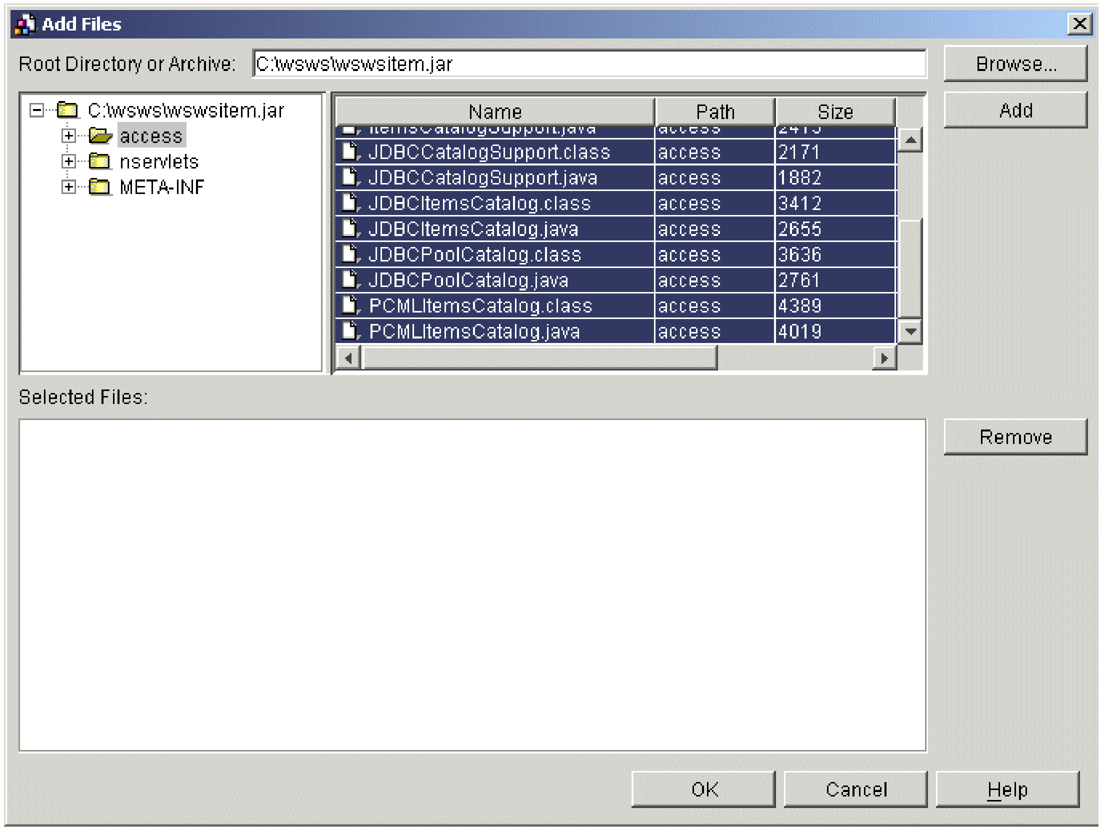
Parameter name: * driver

Parameter value: * com.ibm.db2.jdbc.app.DB2Driver

Description:

Figure 3-19 Setting the initialization parameters

9. ItemServet uses some classes from the access package. The next step to add these supporting classes. Select **Files-> Class Files-> Add Files**.
10. In the Add Files window, click **Browse** to locate the wswsitem.jar file in the wsws directory.
11. Select the **access** package in the left pane and then select all the classes in the right pane. To do this, simply select the first class and then, holding down the Shift key, click to select the last class. All classes are then selected, as shown in Figure 3-20.
12. Click **Add** to add the files.



Name	Path	Size
ItemsCatalogSupport.java	access	2415
JDBCCatalogSupport.class	access	2171
JDBCCatalogSupport.java	access	1882
JDBCItemsCatalog.class	access	3412
JDBCItemsCatalog.java	access	2655
JDBCPoolCatalog.class	access	3636
JDBCPoolCatalog.java	access	2761
PCMLItemsCatalog.class	access	4389
PCMLItemsCatalog.java	access	4019

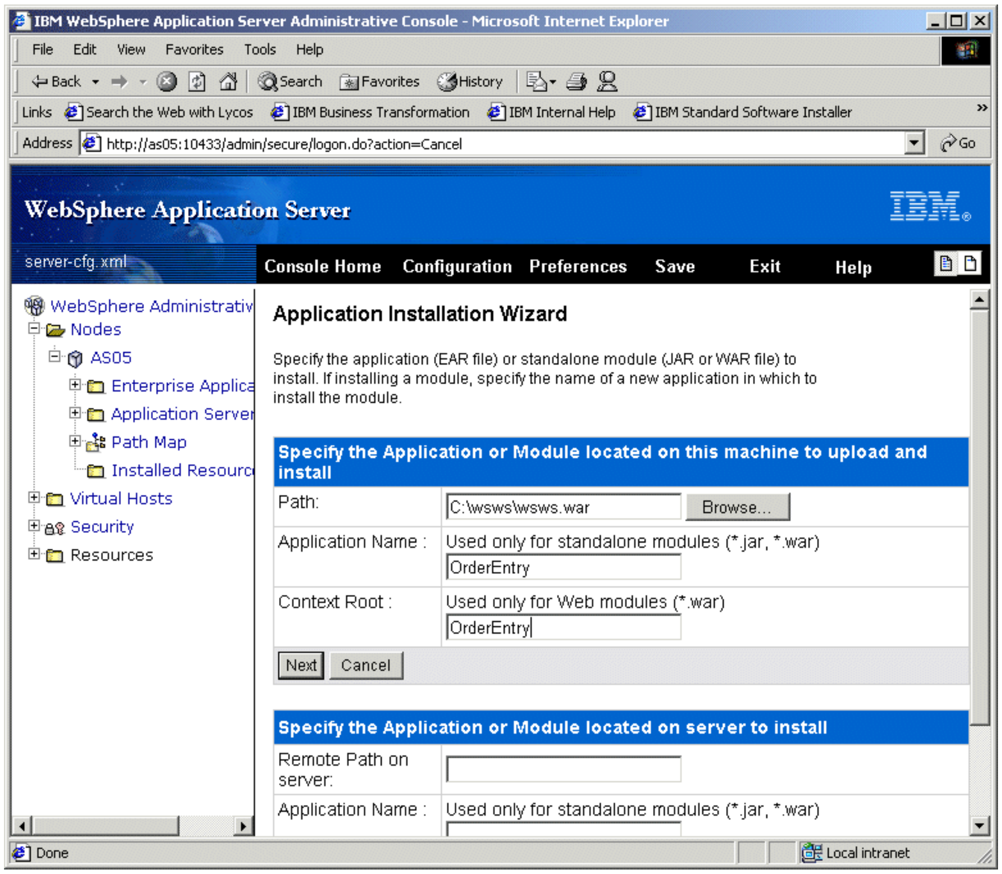
Figure 3-20 Adding the supporting classes

13. Using the same technique, add the SuperServlet class to the supporting classes. To do this, click the **nservlets** package in the left pane, click the **SuperServlet.class** file in the right pane, and click **Add**.
14. Click **OK** to save the settings and return to the AAT main page.
15. Now the ItemServlet is complete. We can export it to a WAR file. Select **File-> Save As** and save the work in the wsws directory as wsws.war. Click **Yes** to the confirmation dialog and exit AAT.

3.3.4 Installing the ItemServlet Web module on the Single Server

We have done most of the work with AAT. The installation on WebSphere Application Server is relatively simple and similar to the steps in 3.3.2, "Installing the MyHello Web module under the Single Server" on page 83.

1. Open the WebSphere Administrative Console through the browser. Click the plus (+) sign in front of **Nodes**. Drill down to **Enterprise Applications** and click it. Then click the **Install** button on the right pane.
2. In the Application Installation Wizard page, use the Browse button to locate the wsws.war file for the Path. Enter `OrderEntry` for both Application Name Context Root (it's case sensitive), as shown in Figure 3-21. Click the **Next** button.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://as05:10433/admin/secure/logon.do?action=Cancel
WebSphere Application Server
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrativ
Nodes
AS05
Enterprise Applica
Application Server
Path Map
Installed Resourc
Virtual Hosts
Security
Resources
Done
Local intranet

Application Installation Wizard

Specify the application (EAR file) or standalone module (JAR or WAR file) to install. If installing a module, specify the name of a new application in which to install the module.

Specify the Application or Module located on this machine to upload and install

Path:	C:\wsws\wsws.war Browse...
Application Name :	Used only for standalone modules (*.jar, *.war) OrderEntry
Context Root :	Used only for Web modules (*.war) OrderEntry

Next Cancel

Specify the Application or Module located on server to install

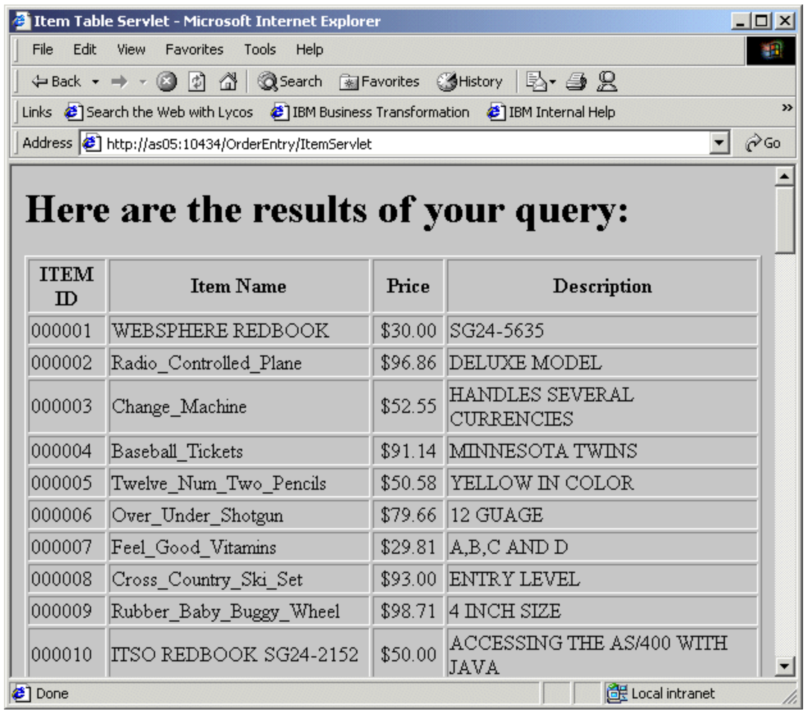
Remote Path on server:	
Application Name :	Used only for standalone modules (*.jar, *.war)

Figure 3-21 Installing a Web module under WebSphere Single Server Edition

3. Click the **Next** button again on the Specifying Virtual Host names and precompiled JSP option for Web Modules dialog.
4. Click **Finish** on the confirmation dialog.
5. Don't forget to click the **Save** button on top of the page to save the settings.
6. As in 3.3.2, "Installing the MyHello Web module under the Single Server" on page 83, you should stop and restart the application server to make the application available.
7. After the server is restarted, access the application by entering the following URL:

   http://*sysname*:*port*/OrderEntry/ItemServlet

   Here *sysname* is the iSeries server name and *port* is the internal HTTP server. The results are shown in Figure 3-22.


Item Table Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:10434/OrderEntry/ItemServlet
Go
Done
Local intranet

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D
000008	Cross_Country_Ski_Set	$93.00	ENTRY LEVEL
000009	Rubber_Baby_Buggy_Wheel	$98.71	4 INCH SIZE
000010	ITSO REDBOOK SG24-2152	$50.00	ACCESSING THE AS/400 WITH JAVA

Figure 3-22 ItemServlet running on the iSeries

If you want to use the external HTTP server, follow steps in 3.3.2, “Installing the MyHello Web module under the Single Server” on page 83.

3.3.5 Running ItemServlet from an HTML file

So far, we have accessed the servlet directly from the browser. In most cases, the interface we deal with is an HTML page or JSP page. In this section, we use an HTML page for data input. When you click the Submit button, the data is sent to the ItemServlet, and the servlet accesses and displays the database information.

The HTML page is shown in Example 3-1.

Example 3-1 ItemServlet.html page

```
<HTML>
<HEAD>
   <META HTTP-EQUIV="Content-Type" CONTENT="text/html; charset=iso-8859-1">
   <META NAME="GENERATOR" CONTENT="Mozilla/4.04 [en] (WinNT; I) [Netscape]">
   <TITLE>Items Retrieval</TITLE>
<!--This file created 3:28 PM  2/11/98 by Claris Home Page version 2.0-->
<X-SAS-WINDOW TOP=79 BOTTOM=699 LEFT=12 RIGHT=845>
</HEAD>
<BODY BGCOLOR="#C0C0C0">
<FORM method="POST" action="/OrderEntry/ItemServlet">
<CENTER><IMG SRC="as400.gif" BORDER=2 X-SAS-UseImageWidth X-SAS-UseImageHeight HEIGHT=120
WIDTH=120></CENTER>
<CENTER>
<HR SIZE="5"></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Enter *ALL to get all items
from the catalog</FONT></FONT></B></CENTER>
```

```
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>or</FONT></FONT></B></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Enter the item number to
get only one item from the catalog</FONT></FONT></B></CENTER>
<CENTER><B><FONT COLOR="#0000AF"><FONT SIZE=+2>Press the Button to retrieve
the items</FONT></FONT></B></CENTER>
<CENTER>&nbsp;</CENTER>
<CENTER><TABLE BORDER=0 WIDTH="50%" HEIGHT="1" >
<TR>
<TD WIDTH="169" HEIGHT="14">
<DIV ALIGN=right><FONT FACE="Arial,Helvetica">Item Number or *ALL</FONT>&nbsp;</DIV>
</TD>
<TD WIDTH="118" HEIGHT="14"><!-- Add the input field after this line -->
 <INPUT TYPE="text" NAME="partno" VALUE="*ALL" SIZE=10 MAXLENGTH=10>--></TD>
</TR>
<TR>
<TD WIDTH="169"></TD>
<TD WIDTH="118"><INPUT TYPE="submit" NAME="Submit" VALUE="Get Items Information"></TD>
</TR>
</TABLE></CENTER>
<CENTER>
<HR SIZE="5"></CENTER>
</FORM>
<BR>This file uses the servlet <B><I>ItemServlet</I></B> to retrieve information
from the AS/400 system
<BR>
<HR SIZE=5 WIDTH="100%">
</BODY>
</HTML>
```

In the FORM tag, the ItemServlet is specified to process the request from this HTML page. The input field “partno” has a default value of *ALL, which means if you don’t enter a value, the servlet will retrieve all records from the ITEM table.

Next we use AAT to add the HTML file to the Web archive file (wsws.war):

1. Use AAT to open the **wsws.war** file.
2. Select **Files-> ResourceFiles-> Add Files**, as shown in Figure 3-23.

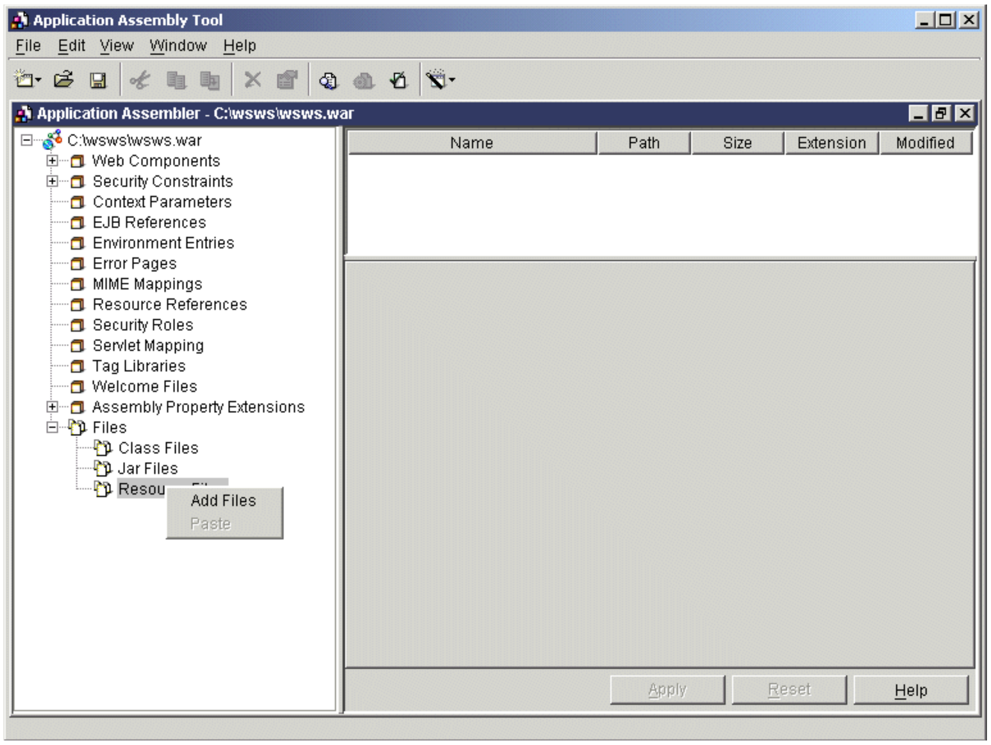
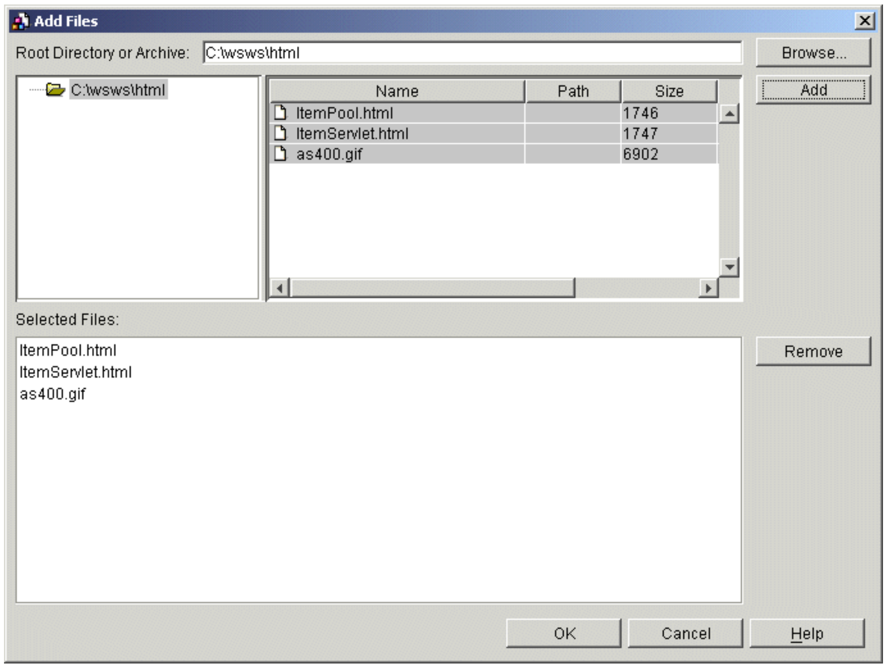


Figure 3-23 Adding HTML pages to WAR file

3. As shown in Figure 3-24, locate the directory that includes the HTML pages and images. Click the directory on the left pane, and select all the files in the right pane. Click **Add** to add these files, and click **OK** to save the settings.
4. In the main AAT window, select **File-> Save** to save the changes to the wsws.war Web module.



Root Directory or Archive: C:\wsws\html

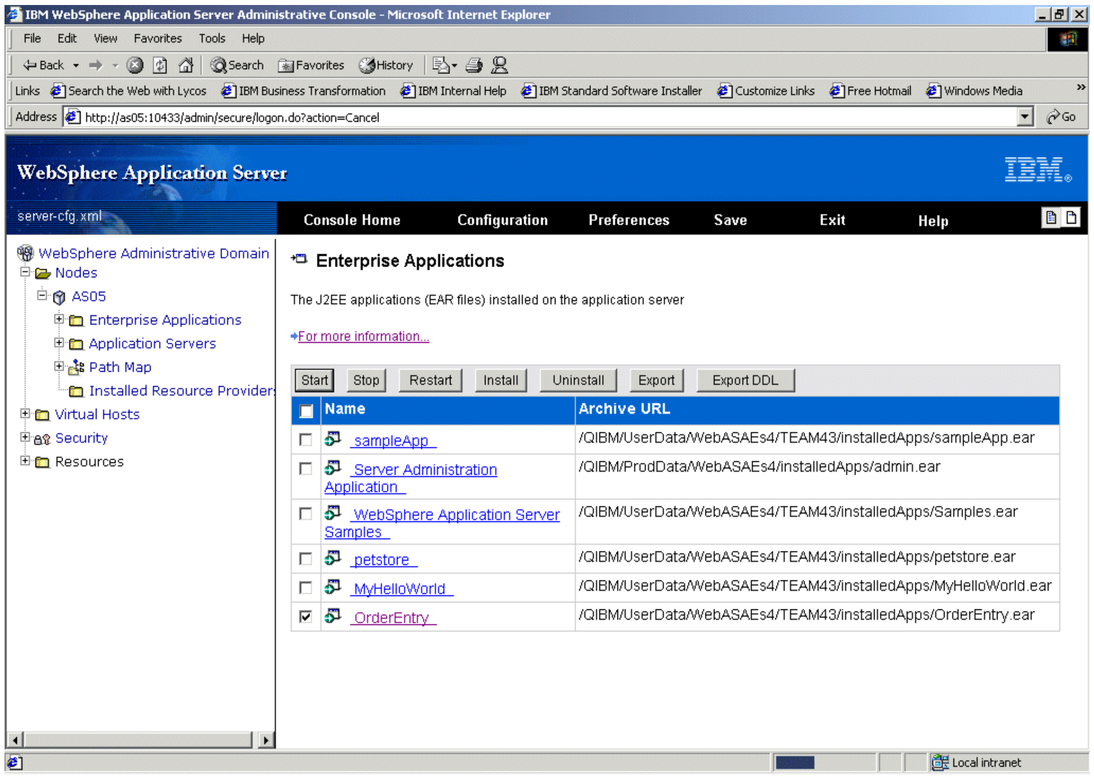
Name	Path	Size
ItemPool.html		1746
ItemServlet.html		1747
as400.gif		6902

Selected Files:

ItemPool.html
ItemServlet.html
as400.gif

Figure 3-24 Adding HTML pages into the Web module

5. Before re-deploying this Web module on WebSphere Application Server, uninstall the old OrderEntry application. Open the browser-based WebSphere console.
6. Select **Nodes** and drill down until you can select **Enterprise Applications** in the left pane.
7. Select the **OrderEntry** application in the right panel and click **Stop**. SeeFigure 3-25.



IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer

Address: http://as05:10433/admin/secure/logon.do?action=Cancel

WebSphere Application Server

server-cfg.xml

Console Home | Configuration | Preferences | Save | Exit | Help

WebSphere Administrative Domain
- Nodes
  - AS05
    - Enterprise Applications
    - Application Servers
    - Path Map
    - Installed Resource Provider
- Virtual Hosts
- Security
- Resources

Enterprise Applications

The J2EE applications (EAR files) installed on the application server

For more information...

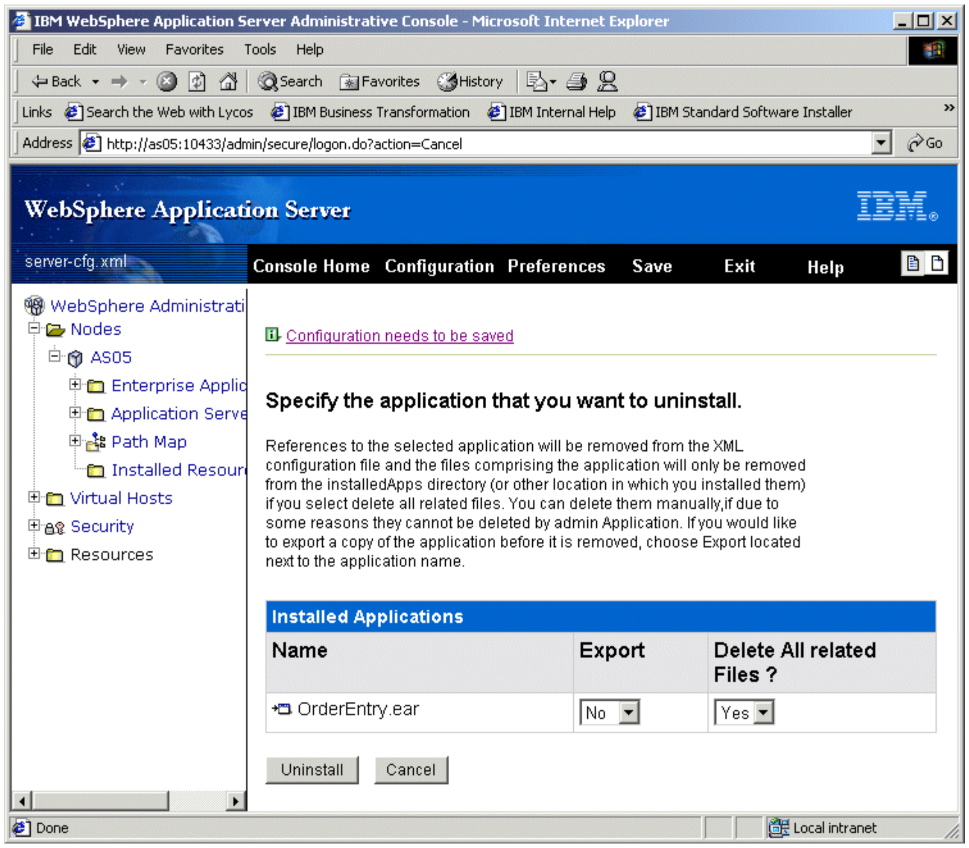
Start | Stop | Restart | Install | Uninstall | Export | Export DDL

	Name	Archive URL
☐	sampleApp	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/sampleApp.ear
☐	Server Administration Application	/QIBM/ProdData/WebASAEs4/installedApps/admin.ear
☐	WebSphere Application Server Samples	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/Samples.ear
☐	petstore	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/petstore.ear
☐	MyHelloWorld	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/MyHelloWorld.ear
☑	OrderEntry	/QIBM/UserData/WebASAEs4/TEAM43/installedApps/OrderEntry.ear

Local intranet

Figure 3-25 Stopping the OrderEntry application

8. Once the application is stopped, select the **OrderEntry** application and click **Uninstall**.
9. On the next page, accept the defaults as shown in Figure 3-26 and click **Uninstall** again.


IBM WebSphere Application Server Administrative Console - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://as05:10433/admin/secure/logon.do?action=Cancel
Go
WebSphere Application Server
IBM
server-cfg.xml
Console Home Configuration Preferences Save Exit Help
WebSphere Administrati
Nodes
AS05
Enterprise Applic
Application Serve
Path Map
Installed Resour
Virtual Hosts
Security
Resources
Done
Local intranet

Configuration needs to be saved

Specify the application that you want to uninstall.

References to the selected application will be removed from the XML configuration file and the files comprising the application will only be removed from the installedApps directory (or other location in which you installed them) if you select delete all related files. You can delete them manually,if due to some reasons they cannot be deleted by admin Application. If you would like to export a copy of the application before it is removed, choose Export located next to the application name.

Installed Applications

Name	Export	Delete All related Files ?
OrderEntry.ear	No	Yes

Uninstall Cancel

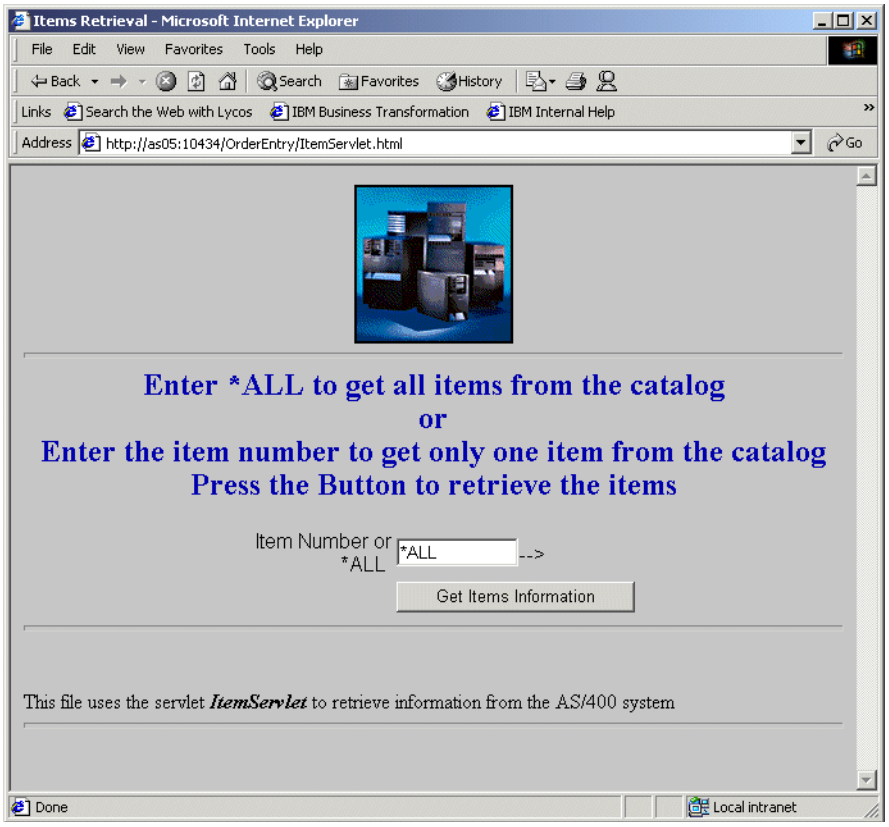
Figure 3-26 Uninstalling the OrderEntry application

10.We uninstalled the OrderEntry application from WebSphere Application Server. Now, we install it again. The steps to install the application are exactly the same as those explained 3.3.4, “Installing the ItemServlet Web module on the Single Server” on page 91. After you install the application, don’t forget to restart the server.

11.Now you can access the HTML page by entering the following URL:

```
http://sysname:port/OrderEntry/ItemServlet.html
```

Here *sysname* is the iSeries server name and *port* is the internal HTTP server port. The page shown in Figure 3-27 appears.


Items Retrieval - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:10434/OrderEntry/ItemServlet.html
Go
Done
Local intranet

Enter *ALL to get all items from the catalog
or
Enter the item number to get only one item from the catalog
Press the Button to retrieve the items

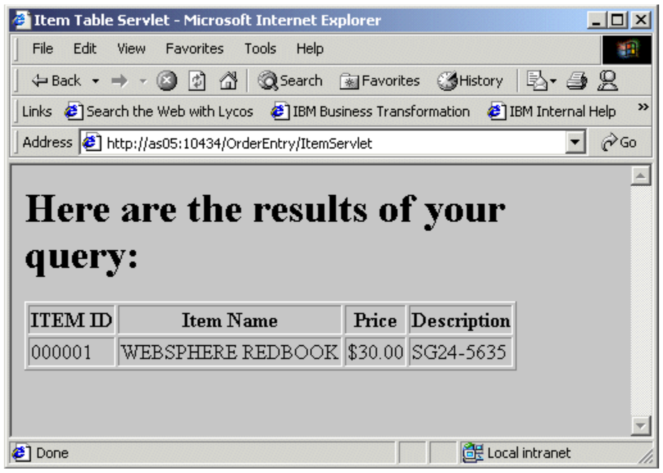
Item Number or *ALL: *ALL -->

Get Items Information

This file uses the servlet *ItemServlet* to retrieve information from the AS/400 system

Figure 3-27 HTML page in OrderEntry application

12.The default value for Part No. is *ALL. We can change it to different value, for example 000001 and click the **Get Items Information** button. The record is returned from ItemServlet and displayed on the browser as shown in Figure 3-28.


Item Table Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:10434/OrderEntry/ItemServlet
Go
Done
Local intranet

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635

Figure 3-28 Query result from ItemServlet

3.3.6 Packaging ItemPoolServlet

Packaging ItemPoolServlet into the Web module with Application Assembly Tool requires almost the same steps as those in 3.3.3, “Packaging ItemServlet” on page 88.

We add it to the wsws.war file. We define a new Web component named *ItemPoolServlet* to point to the servlet named *nservlets.ItemPoolServlet* in the wswspool.jar file. We then define a Servlet Mapping that maps ItemPool to the ItemPoolServlet component.

Then we define the initialization parameters for the ItemPoolServlet component. Three parameters are required as listed in Table 3-1.

Table 3-1 ItemPoolServlet initialization parameters

Name	Value
datasource	jdbc/NativeDS
user	A valid user ID
password	A valid password

Finally we add supporting classes by selecting **Files-> Classes Files->Add Files**. We add all the classes from the access package of the wswspool.jar file.

3.3.7 Installing the ItemPool Web module on the Single Server

The process to install ItemPool Web module on WebSphere Application Server is similar to the one outlined in 3.3.4, "Installing the ItemServlet Web module on the Single Server" on page 91.

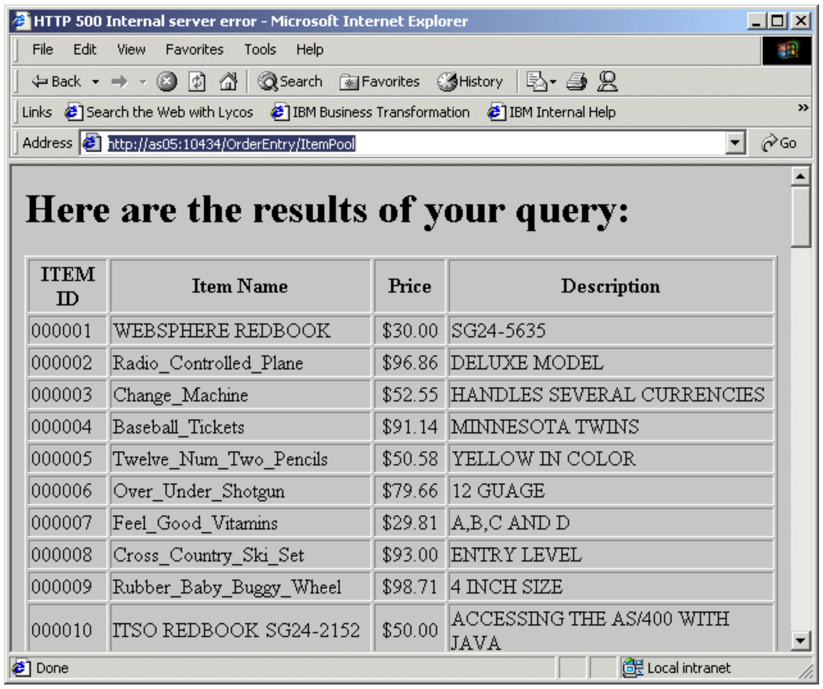
We first stop the OrderEntry application and uninstall it. We then install the OrderEntry application again according to the steps in 3.3.4, "Installing the ItemServlet Web module on the Single Server" on page 91.

Before we stop the server and restart it, we need to create the JDBC driver for iSeries and define the data source used by the ItemPool application. An example of creating a data source for WebSphere Application Server Version 4.0 Advanced Single Server Edition is shown in Chapter 3 in the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815.

After creating the data source, we stop and restart the server according to the steps in 3.3.4, "Installing the ItemServlet Web module on the Single Server" on page 91. After the server is started, we access the ItemPool application by using the following URL:

```
http://sysname:port/OrderEntry/ItemPool
```

The output is shown in Figure 3-29.


HTTP 500 Internal server error - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:10434/OrderEntry/ItemPool
Go
Done
Local intranet

Here are the results of your query:

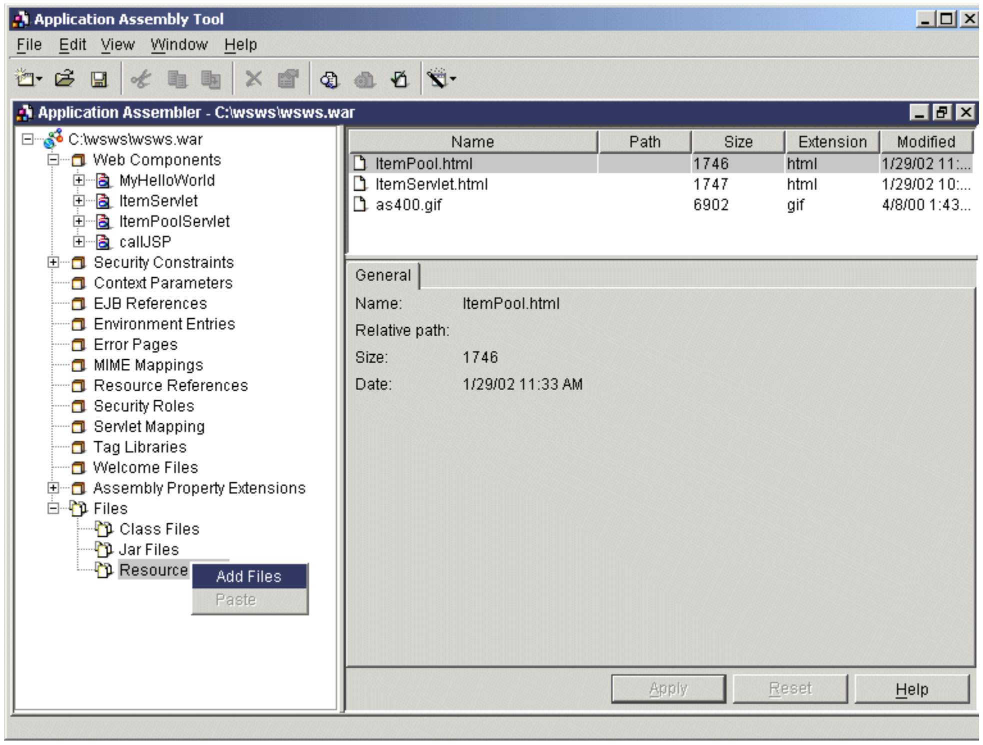
ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D
000008	Cross_Country_Ski_Set	$93.00	ENTRY LEVEL
000009	Rubber_Baby_Buggy_Wheel	$98.71	4 INCH SIZE
000010	ITSO REDBOOK SG24-2152	$50.00	ACCESSING THE AS/400 WITH JAVA

Figure 3-29 ItemPool result page

3.3.8 Packaging and deploying CallJSP

Packaging CallJSP into a Web module with Application Assembly Tool is similar to the process that is explained in 3.3.6, “Packaging ItemPoolServlet” on page 98. We do not go through it in detail here.

After you define the component and Servlet Mapping, you must add supporting classes, which include the DataBean class in the nservlets package. To add JSP pages into a Web module, select **Files->Resource Files->Add Files** as shown in Figure 3-30.



Name	Path	Size	Extension	Modified
ItemPool.html		1746	html	1/29/02 11:...
ItemServlet.html		1747	html	1/29/02 10:...
as400.gif		6902	gif	4/8/00 1:43...

Name: ItemPool.html
Relative path:
Size: 1746
Date: 1/29/02 11:33 AM

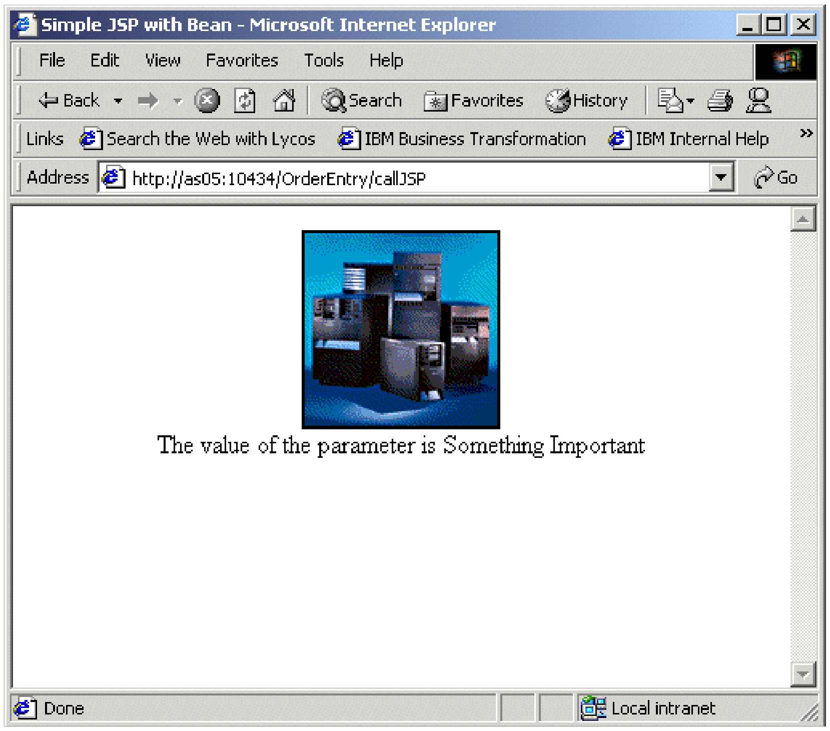
Figure 3-30 Adding JSP pages into the Web module

Select the directory that includes the outputjsp.jsp page and add it into this Web module. Save the new WAR file.

The process to install it on WebSphere Application Server is exactly the same as the one that is explained in 3.3.7, “Installing the ItemPool Web module on the Single Server” on page 99. After the installation, restart the server and access the application by using the following URL:

```
http://sysname:port/OrderEntry/callJSP
```

The result page is shown as Figure 3-31.


Simple JSP with Bean - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:10434/OrderEntry/callJSP
Go
Done
Local intranet

The value of the parameter is Something Important

Figure 3-31 The callJSP result page

You can also call it with a parameter, such as:

```
http://sysname:port/OrderEntry/callJSP?value=hello
```

3.3.9 Packaging and deploying ItemSessionServlet

Since the steps of packaging and deploying ItemSessionServlet are similar to the steps that are outlined in the previous sections, we do not go through them again. The Session Manager of WebSphere is enabled to support cookies by default, so it is not necessary to make any changes to WebSphere Application Server settings.

3.3.10 Installing the OrderEntry application on Advanced Edition

In this section, we install the Web application under WebSphere Application Server Version 4.0 Advanced Edition. We use the Advanced Edition Administrative Console, which is not browser based, but a client application.

1. To start the Advanced Edition console, open a workstation command prompt window and change directory as shown here:

   ```
   cd \<WebSphere install>\AppServer\bin
   ```

2. Enter the following command to start the WebSphere Administrative Console:

   ```
   adminclient sysname port
   ```

   Here *sysname* is name of iSeries server name and *port* is the administrative server port. Wait until you see the message `Console Ready` in the Administrative Console, as shown in Figure 3-32. Now, you can start to deploy the code.

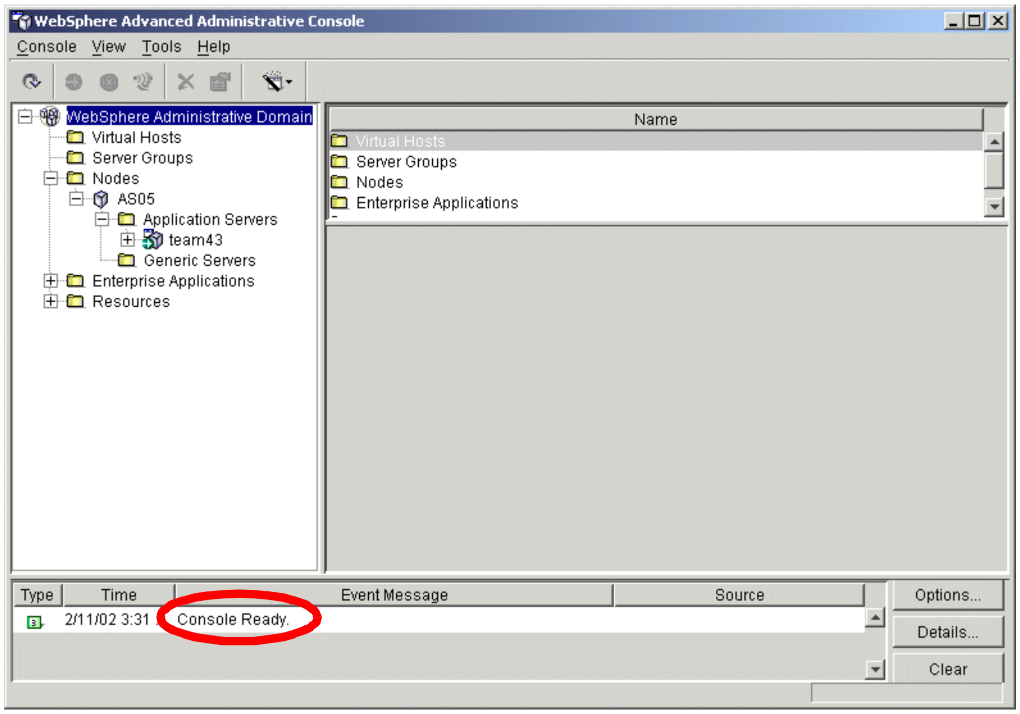
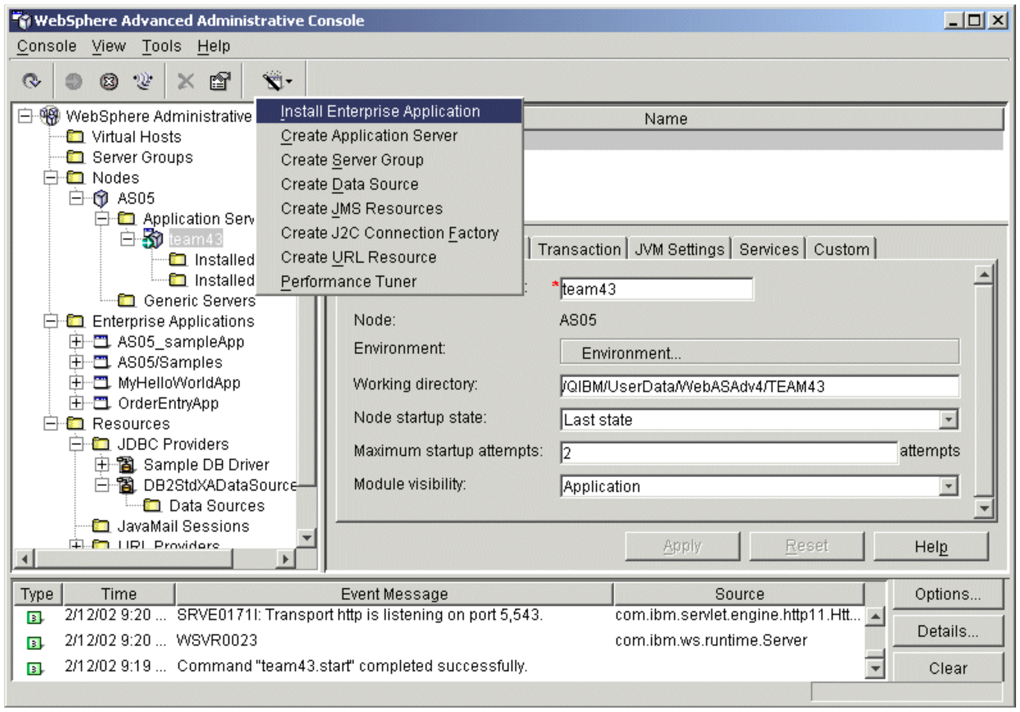


Figure 3-32 Administrative Console for WebSphere Application Server Version 4.0 Advanced Edition

3. Since the OrderEntry application needs a data source to access the iSeries database, we need to define a data source. For information about how to create a data source, see Chapter 3 in the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815.
4. Install the OrderEntry application using the Administrative Console. To do this, copy the wsws.war file from the local workstation drive to the IFS directory (named wsws) on the iSeries. The console can now access this file for the installation.
5. On the console, select the wizards icon and click **Install Enterprise Application**, as shown in Figure 3-33.


WebSphere Advanced Administrative Console
Console View Tools Help
Install Enterprise Application
Create Application Server
Create Server Group
Create Data Source
Create JMS Resources
Create J2C Connection Factory
Create URL Resource
Performance Tuner
Name
Transaction | JVM Settings | Services | Custom
Apply Reset Help
Options... Details... Clear

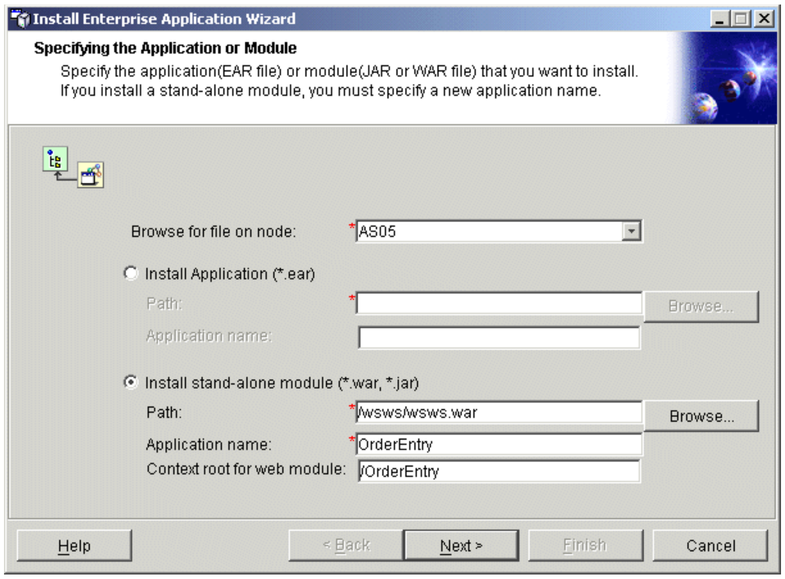
WebSphere Administrative
- Virtual Hosts
- Server Groups
- Nodes
  - AS05
    - Application Serv
      - team43
        - Installed
        - Installed
    - Generic Servers
- Enterprise Applications
  - AS05_sampleApp
  - AS05/Samples
  - MyHelloWorldApp
  - OrderEntryApp
- Resources
  - JDBC Providers
    - Sample DB Driver
    - DB2StdXADataSource
      - Data Sources
  - JavaMail Sessions
  - URL Providers

*	team43
Node:	AS05
Environment:	Environment...
Working directory:	/QIBM/UserData/WebASAdv4/TEAM43
Node startup state:	Last state
Maximum startup attempts:	2 attempts
Module visibility:	Application

Type	Time	Event Message	Source
	2/12/02 9:20 ...	SRVE0171I: Transport http is listening on port 5,543.	com.ibm.servlet.engine.http11.Htt...
	2/12/02 9:20 ...	WSVR0023	com.ibm.ws.runtime.Server
	2/12/02 9:19 ...	Command "team43.start" completed successfully.	

Figure 3-33 Creating an enterprise application

6. The Install Enterprise Application Wizard page appears as shown in Figure 3-34. Make sure the **Install stand-alone module** radio button is selected. Click the **Browse** button next to Path to locate the wsws.war file in the wsws IFS directory. Enter `OrderEntry` for Application name and `/OrderEntry` for the Context root.


Install Enterprise Application Wizard
Browse...
Browse...
Help < Back Next > Finish Cancel

Specifying the Application or Module

Specify the application(EAR file) or module(JAR or WAR file) that you want to install.
If you install a stand-alone module, you must specify a new application name.

Browse for file on node: * AS05

( ) Install Application (*.ear)

Path: *

Application name:

(•) Install stand-alone module (*.war, *.jar)

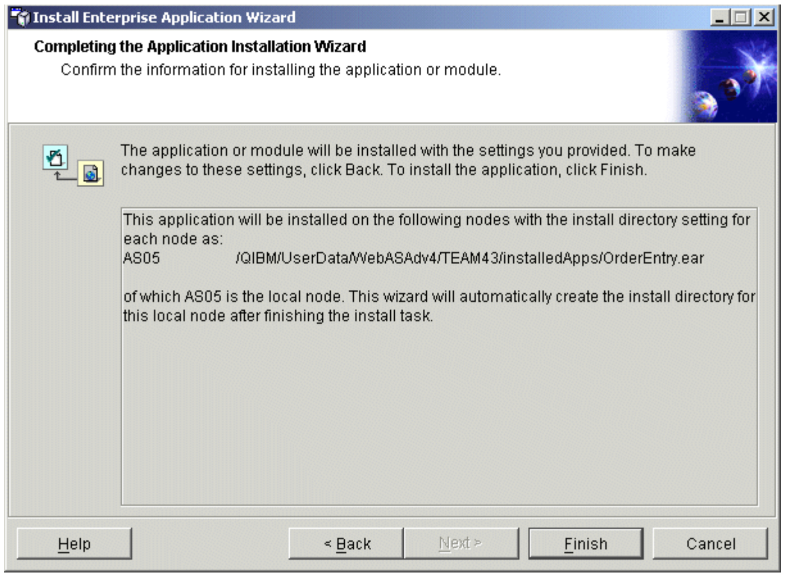
Path: * /wsws/wsws.war

Application name: * OrderEntry

Context root for web module: /OrderEntry

Figure 3-34 Specifying the application

7. Once you enter all these parameters, click the **Next** button, until you see the Completing the Application Installation window as shown in Figure 3-35. Click **Finish** and then **OK** on the confirmation dialog to install the application.


Install Enterprise Application Wizard
Completing the Application Installation Wizard
Confirm the information for installing the application or module.
Help
< Back
Next >
Finish
Cancel

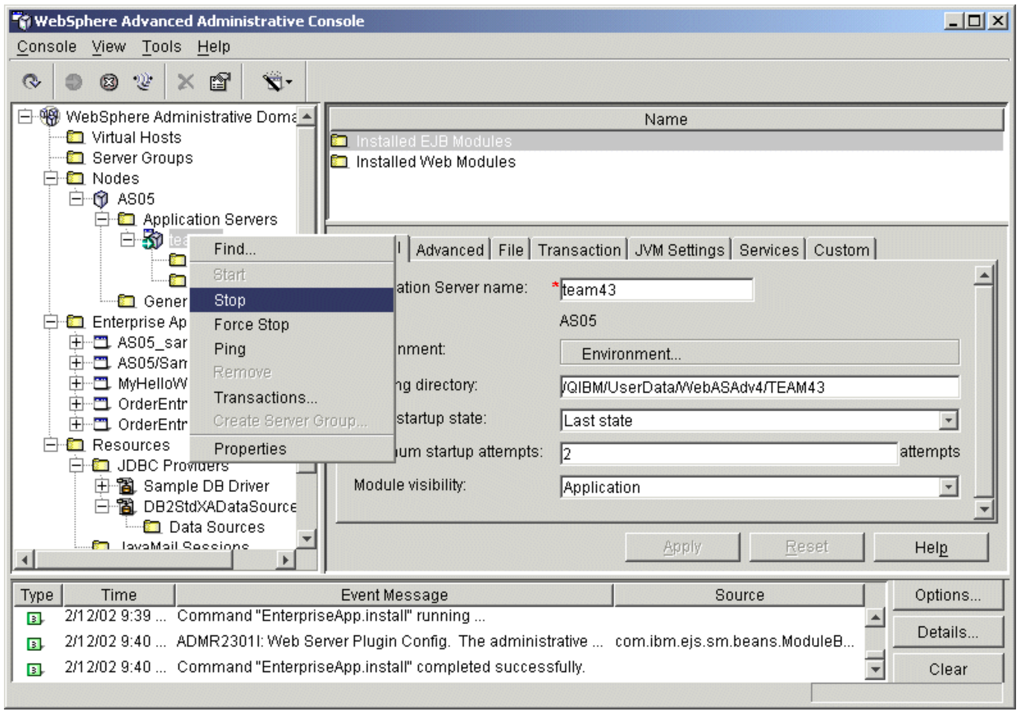
The application or module will be installed with the settings you provided. To make changes to these settings, click Back. To install the application, click Finish.

This application will be installed on the following nodes with the install directory setting for each node as:
AS05 /QIBM/UserData/WebASAdv4/TEAM43/installedApps/OrderEntry.ear

of which AS05 is the local node. This wizard will automatically create the install directory for this local node after finishing the install task.

Figure 3-35 Completing the application installation

8. Stop and restart the application server to make the application available. As shown in Figure 3-36, right-click the server and select **Stop**. After it stops, select **Start** to start it again.

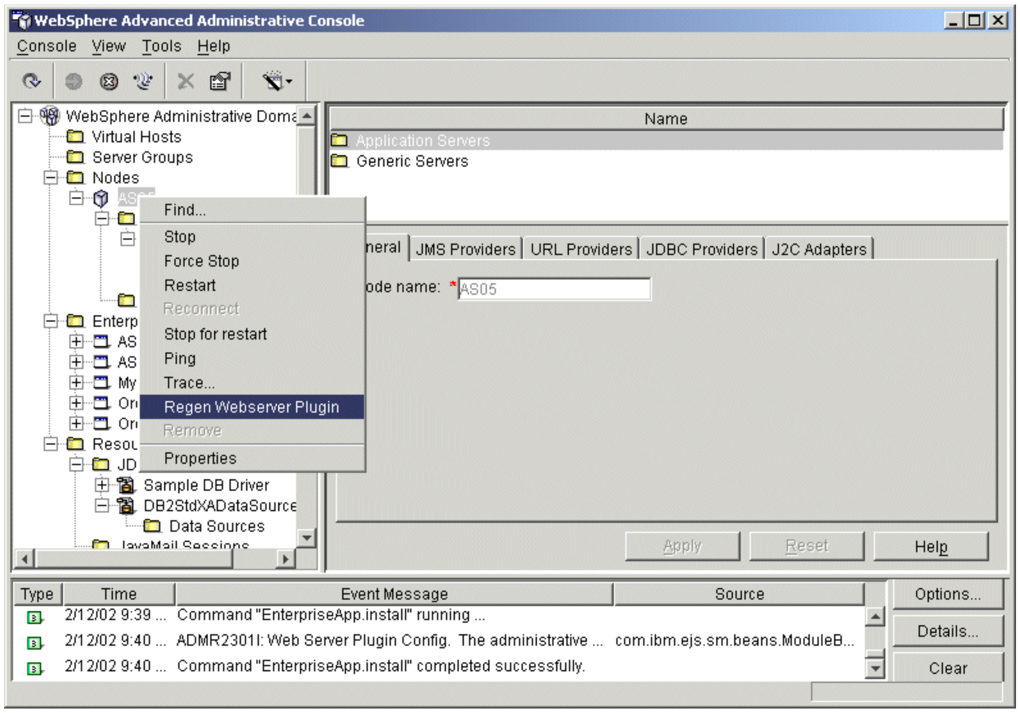


ation Server name: * team43
AS05
nment: Environment...
ng directory: /QIBM/UserData/WebASAdv4/TEAM43
startup state: Last state
um startup attempts: 2 attempts
Module visibility: Application

Type	Time	Event Message	Source
	2/12/02 9:39 ...	Command "EnterpriseApp.install" running ...	
	2/12/02 9:40 ...	ADMR2301I: Web Server Plugin Config. The administrative ...	com.ibm.ejs.sm.beans.ModuleB...
	2/12/02 9:40 ...	Command "EnterpriseApp.install" completed successfully.	

Figure 3-36 Stopping and starting the application server

9. Once the application server is ready, we can test through either the internal HTTP server or an external HTTP server. For the external HTTP server, there is an additional step to perform. You must re-generate the plug-in configuration. To do this, use the topology pane on the left to display the node, right-click and select **Regen Webserver Plugin**, as shown in Figure 3-37. A completion message shows if the re-generation is successful.



ode name: *AS05

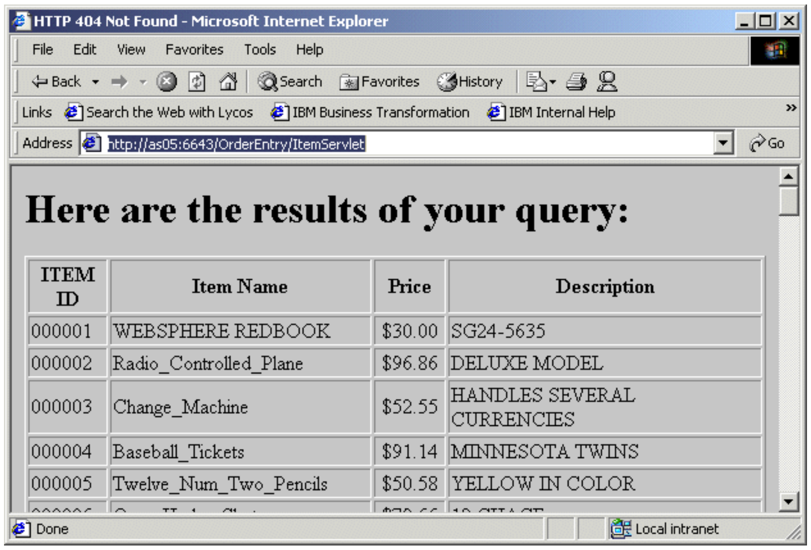
Type	Time	Event Message	Source
	2/12/02 9:39 ...	Command "EnterpriseApp.install" running ...	
	2/12/02 9:40 ...	ADMR2301I: Web Server Plugin Config. The administrative ...	com.ibm.ejs.sm.beans.ModuleB...
	2/12/02 9:40 ...	Command "EnterpriseApp.install" completed successfully.	

Figure 3-37   Re-generating the Web server plug-in

10. Test the OrderEntry application by entering the following URL:

```
http://sysname:port/OrderEntry/ItemServlet
```

Here *sysname* is the name of iSeries server and *port* is the internal or external HTTP server port for the WebSphere Advanced Edition server instance. The output is displayed in the browser, as shown in Figure 3-38.


HTTP 404 Not Found - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address
Go
Done
Local intranet

http://as05:6643/OrderEntry/ItemServlet

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR

Figure 3-38   ItemServlet result

Tip: If the external HTTP server fails to find the servlet, you may need to restart the HTTP server.

We can also test ItemPool or callJSP by using the following URLs:

```
http://sysname:port/OrderEntry/ItemPool
http://sysname:port/OrderEntry/callJSP
```

3.3.11 Packaging the MyHelloWorldApp enterprise application

Deploying applications that contain EJBs is different than deploying applications that contain only servlets or JSPs. They must be deployed using EAR files.

In Chapter 10, “Building Java applications with Enterprise JavaBeans” on page 315, we develop the MyHelloWorldApp application, which uses Java clients, servlets, and EJBs. We use WebSphere Studio Application Developer for the development. With Application Developer, it is not necessary to go through Application Assembly Tool to package the modules. Application Developer is capable of creating EAR files directly that can be deployed on WebSphere Application Server 4.0.

Since Application Developer is a new tool, many Java developers still work with non-J2EE compliant tools like VisualAge for Java to develop EJB-based applications. In this case, AAT is the next step to create an EAR file for deployment on WebSphere Application Server 4.0. In this section, we show how to combine EJBs, servlets, and Java applications into an .ear file.

Here, it is understood that we have already developed the same MyHelloWorldApp application with VisualAge for Java 4.0 and now want to deploy it. We follow these steps:

1. Export the EJB part. As shown in Figure 3-39, click the **EJB** tab in VisualAge for Java. Select the **EJB group**, and then right-click and select **Export-> EJB 1.1 JAR**.

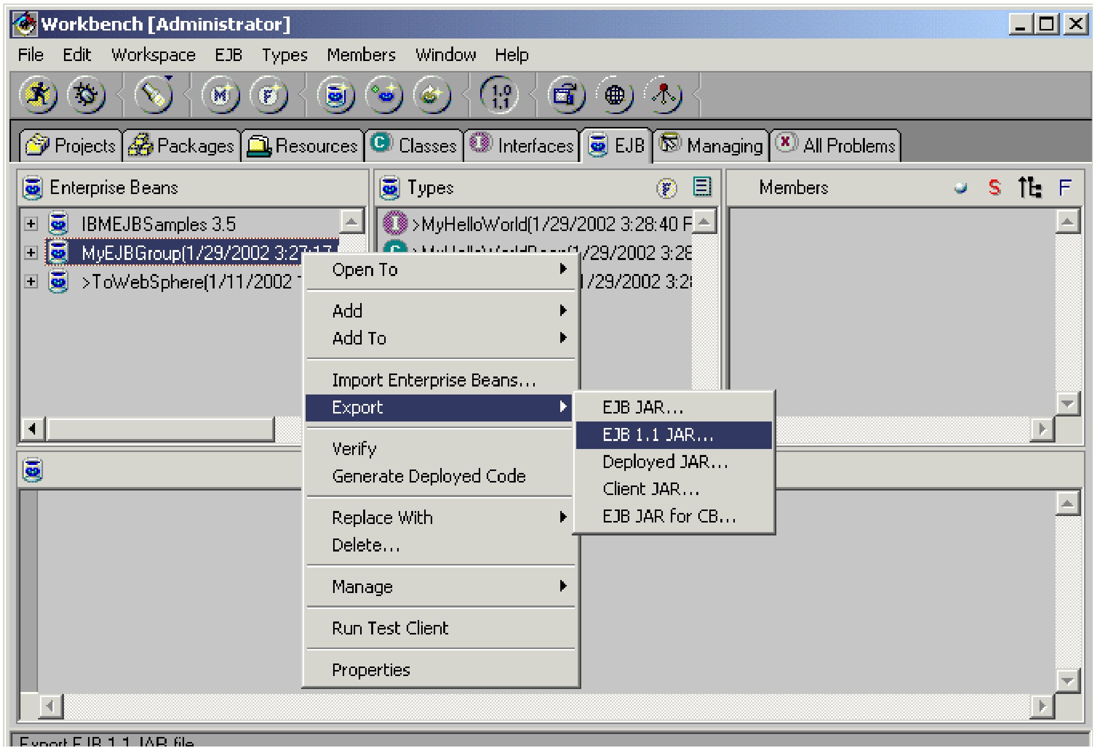
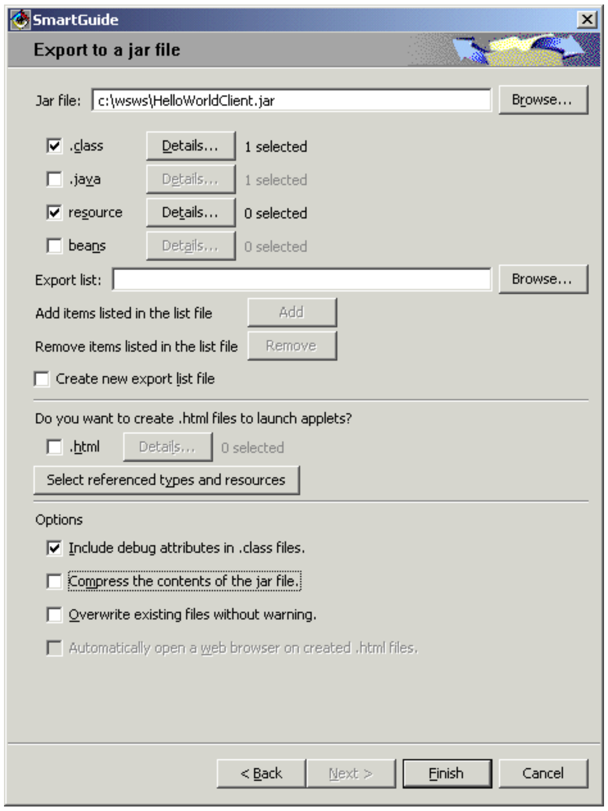


Figure 3-39 Exporting the EJB group to the EJB 1.1 Jar

Export to the MyEJBs.jar file in the wsws directory. We export both class and Java source into the JAR file.

2. Export the EJB client application. Just like exporting servlets, simply right-click the **HelloWorldClient** application and select **Export**, as shown in Figure 3-40. Save it as `HelloWorldClient.jar` in the wsws directory.


SmartGuide
Export to a jar file

Jar file: c:\wsws\HelloWorldClient.jar

- [✓] .class — 1 selected
- [ ] .java — 1 selected
- [✓] resource — 0 selected
- [ ] beans — 0 selected

Export list:

Add items listed in the list file

Remove items listed in the list file

[ ] Create new export list file

Do you want to create .html files to launch applets?

[ ] .html — 0 selected

Options

- [✓] Include debug attributes in .class files.
- [ ] Compress the contents of the jar file.
- [ ] Overwrite existing files without warning.
- [ ] Automatically open a web browser on created .html files.

Figure 3-40 Exporting HelloWorldClient to a JAR file

3. Export the servlet. We select the **HelloEJBServlet** servlet and save it to HelloEJBServlet.jar file in the wsws directory.

   We now have three JAR files:

   – MyEJBs.jar: Includes all the EJBs
   – HelloWorldClient.jar: Includes the EJB client application
   – HelloEJBServlet.jar: Includes the servlet

4. Create an enterprise application based on these three JAR files. We create modules for each JAR file and then bundle them together. Figure 3-41 shows the flow we follow to create the enterprise application:

   a. Create an EJB module from the EJBs exported from VisualAge for Java (MyEJBs.jar).

   b. Create an Application client module from the applications exported from VisualAge for Java (HelloWorldClient.jar).

   c. Create a Web module from the servlets exported from VisualAge for Java (HelloEJBServlet.jar).

   d. Combine the modules into an enterprise application.

   e. Deploy the Enterprise Application in WebSphere Application Server 4.0. We deploy to WebSphere Application Server Version 4.0 Advanced Edition.

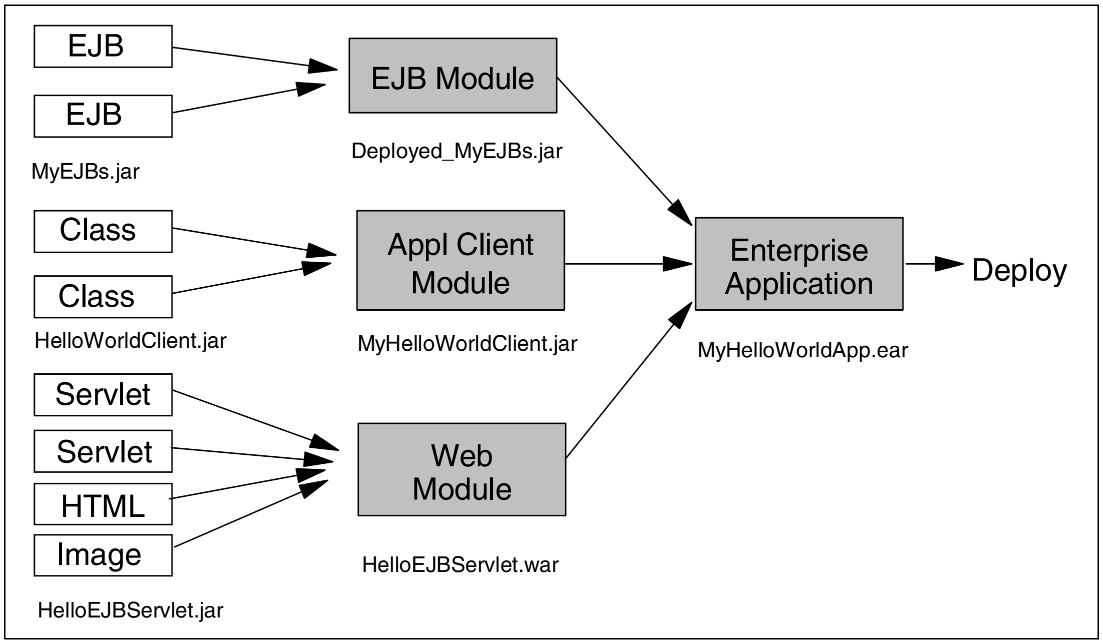
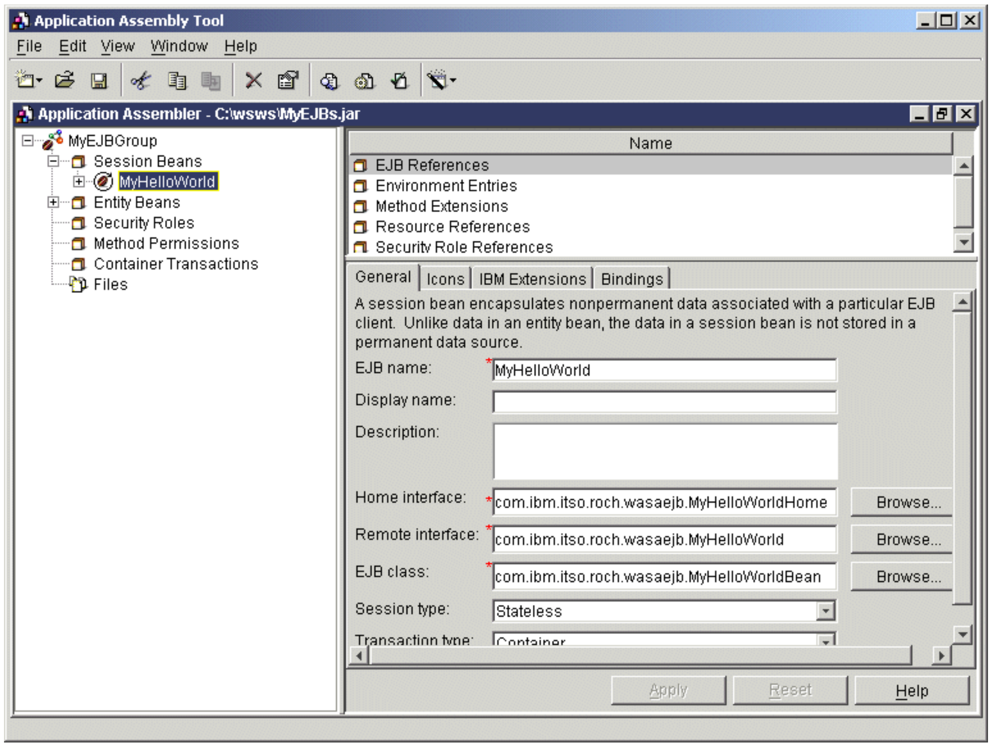


Figure 3-41 Creating an enterprise application

Creating the EJB module for MyEJBs.jar

First we create an EJB module to hold the EJBs that we exported. Then we follow these steps:

1. Start Application Assembly Tool (AAT). In the welcome page, click **Cancel**.
2. Open the **MyEJBs.jar** file in the wsws directory.
3. Select **Session Beans-> MyHelloWorld** as shown in Figure 3-42.


Application Assembly Tool

Application Assembler - C:\wsws\MyEJBs.jar

- MyEJBGroup
  - Session Beans
    - MyHelloWorld
  - Entity Beans
  - Security Roles
  - Method Permissions
  - Container Transactions
  - Files

Name
EJB References
Environment Entries
Method Extensions
Resource References
Security Role References

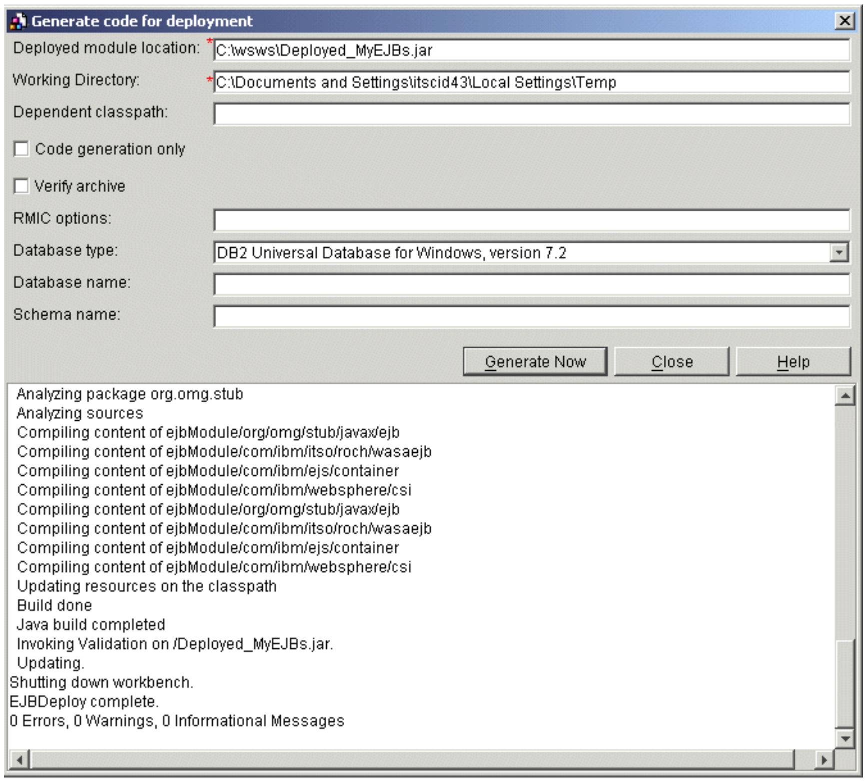
General | Icons | IBM Extensions | Bindings

A session bean encapsulates nonpermanent data associated with a particular EJB client. Unlike data in an entity bean, the data in a session bean is not stored in a permanent data source.

EJB name:	MyHelloWorld
Display name:	
Description:	
Home interface:	com.ibm.itso.roch.wasaejb.MyHelloWorldHome
Remote interface:	com.ibm.itso.roch.wasaejb.MyHelloWorld
EJB class:	com.ibm.itso.roch.wasaejb.MyHelloWorldBean
Session type:	Stateless
Transaction type:	Container

Figure 3-42 Adding EJBs

4. You can now see the details about the EJB. Select the **Bindings** tab and make sure that the JNDI name is `MyHelloWorld`.
5. We need to generate the EJB deployment code. This includes all the remote method invocation (RMI) code necessary to allow the EJB to communicate through an RMI/IIOP interface. Select **File-> Generate Code for Deployment**. In the Generate code for deployment window (Figure 3-43), click the **Generate Now** button.



Deployed module location: * C:\wsws\Deployed_MyEJBs.jar
Working Directory: * C:\Documents and Settings\itscid43\Local Settings\Temp
Dependent classpath:
☐ Code generation only
☐ Verify archive
RMIC options:
Database type: DB2 Universal Database for Windows, version 7.2
Database name:
Schema name:

```
 Analyzing package org.omg.stub
 Analyzing sources
 Compiling content of ejbModule/org/omg/stub/javax/ejb
 Compiling content of ejbModule/com/ibm/itso/roch/wasaejb
 Compiling content of ejbModule/com/ibm/ejs/container
 Compiling content of ejbModule/com/ibm/websphere/csi
 Compiling content of ejbModule/org/omg/stub/javax/ejb
 Compiling content of ejbModule/com/ibm/itso/roch/wasaejb
 Compiling content of ejbModule/com/ibm/ejs/container
 Compiling content of ejbModule/com/ibm/websphere/csi
 Updating resources on the classpath
 Build done
 Java build completed
 Invoking Validation on /Deployed_MyEJBs.jar.
 Updating.
Shutting down workbench.
EJBDeploy complete.
0 Errors, 0 Warnings, 0 Informational Messages
```

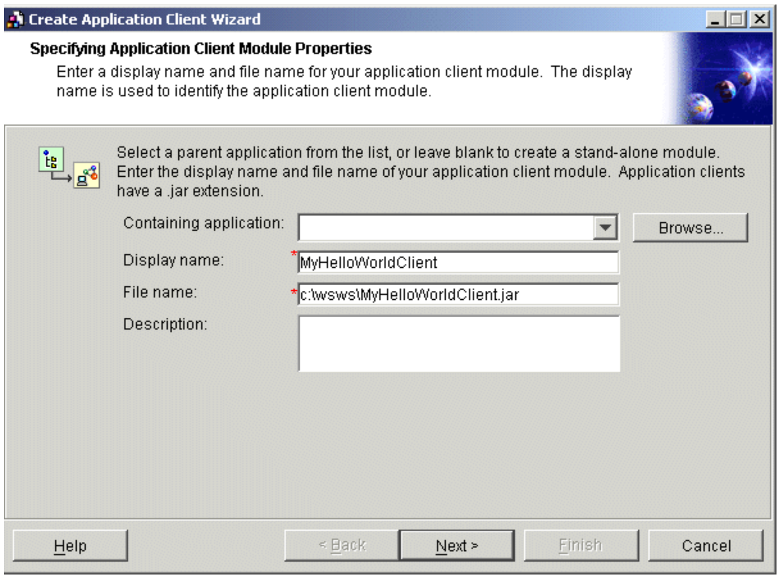
Figure 3-43 Generating code for deployment

6. While the code generation is being processed, the Generate Now button is grayed out. Wait for the code generation to finish. When it is done, scroll down the messages pane and ensure that you have no errors.
7. Close the Generate code for deployment window and check the wsws directory for Deployed_MyEJBs.jar file. It contains all the code necessary to actually run the EJBs.

Creating the client module for HelloWorldClient.jar

Next, we create a client application to hold the Java application. Follow these steps:

1. In AAT, select **File-> Wizards->Create Application Client Wizard**.
2. In the wizard page (Figure 3-44), enter `MyHelloWorldClient` for Display Name and `x:\wsws\MyHelloWorldClient.jar` for File Name. Replace *x* with the drive letter where the wsws directory is stored. Then click **Next**.


Create Application Client Wizard

Specifying Application Client Module Properties

Enter a display name and file name for your application client module. The display name is used to identify the application client module.

Select a parent application from the list, or leave blank to create a stand-alone module. Enter the display name and file name of your application client module. Application clients have a .jar extension.

Containing application:

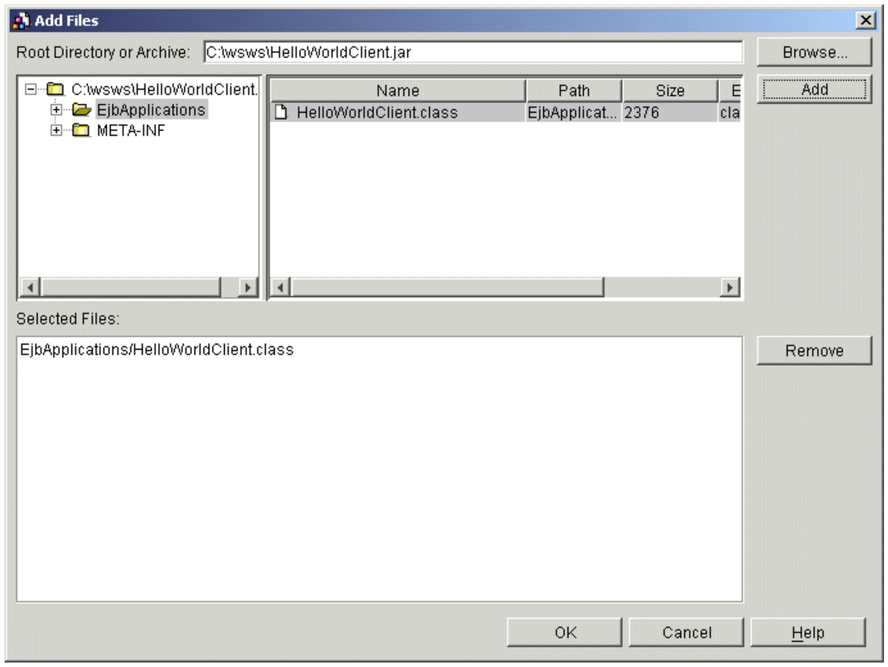
Display name: MyHelloWorldClient

File name: c:\wsws\MyHelloWorldClient.jar

Description:

Figure 3-44 Creating a client module for MyHelloWorldClient.jar

3. In the Create Client Application: Adding Files window, click **Add** to display the Add File window.
4. In the Add Files window (Figure 3-45), click the **Browse** button to locate the **HelloWorldClient.jar** file in the wsws directory.


Add Files

Root Directory or Archive: C:\wsws\HelloWorldClient.jar

C:\wsws\HelloWorldClient.
EjbApplications
META-INF

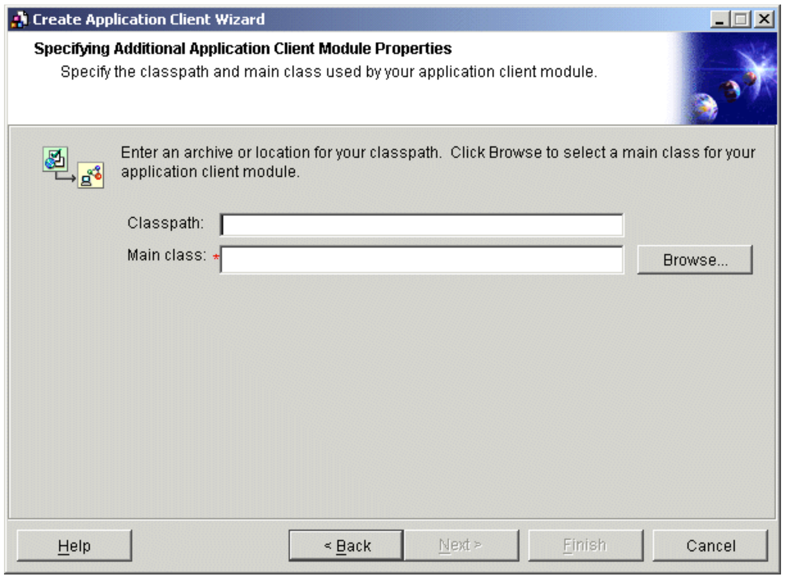
Name	Path	Size	E
HelloWorldClient.class	EjbApplicat...	2376	cla

Selected Files:

EjbApplications/HelloWorldClient.class

Figure 3-45 Selecting the client program

5. Select the **HelloWorldClient.class** file in the right pane and click **Add** to add it to the selected files pane. Click **OK** to return to the previous page and then click **Next**.
6. In the Specifying Additional Application Client Module Properties window (Figure 3-46), we need to specify the main class that client container can invoke. Click the **Browse** button.


Create Application Client Wizard

Specifying Additional Application Client Module Properties

Specify the classpath and main class used by your application client module.

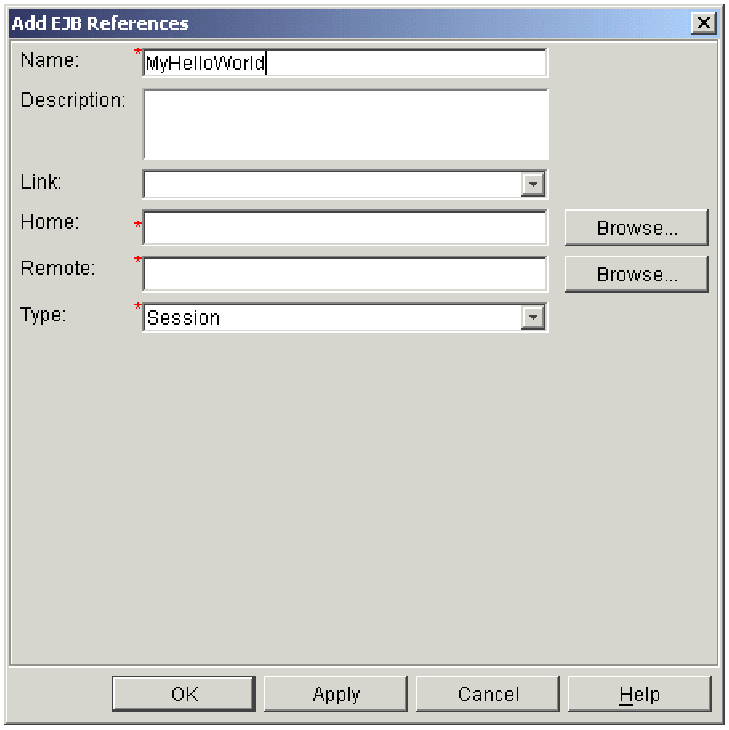
Enter an archive or location for your classpath. Click Browse to select a main class for your application client module.

Classpath:

Main class: *

Figure 3-46 Specifying additional application properties

7. In the Select file for Main class window, select the **HelloWorldClient.class** file and click **OK**. We now see that the Main Class has been filled in. Click **Next**.
8. In the Choosing Application Icons window, click **Next** again.
9. Once you see the Adding EJB References window, click the **Add** button. The Add EJB References window appears (Figure 3-47).


Add EJB References

Name: * MyHelloWorld

Description:

Link:

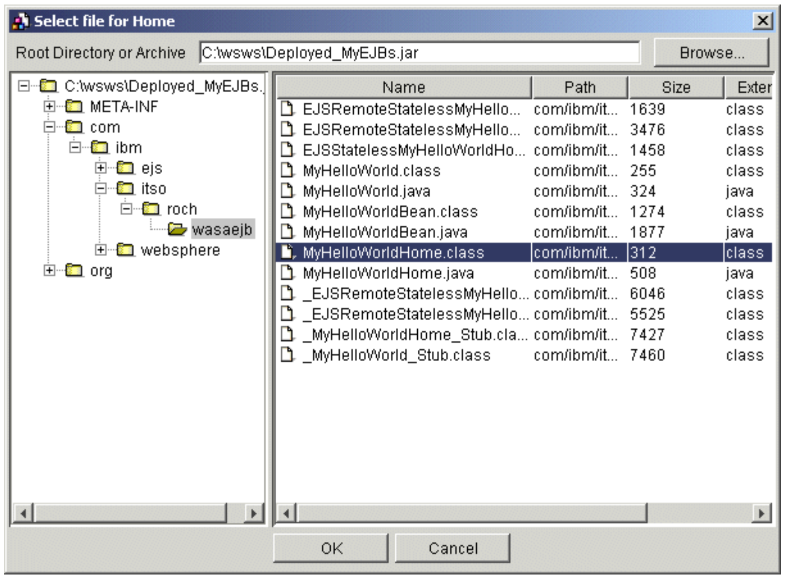
Home: *

Remote: *

Type: * Session

Figure 3-47 Adding EJB references

10. Enter `MyHelloWorld` in the Name field. Click the **Browse** button next to Home to locate the Deployed_MyEJBs.jar. As shown in Figure 3-48, select **MyHelloWorldHome.class** as the Home interface class and click **OK**.


Select file for Home

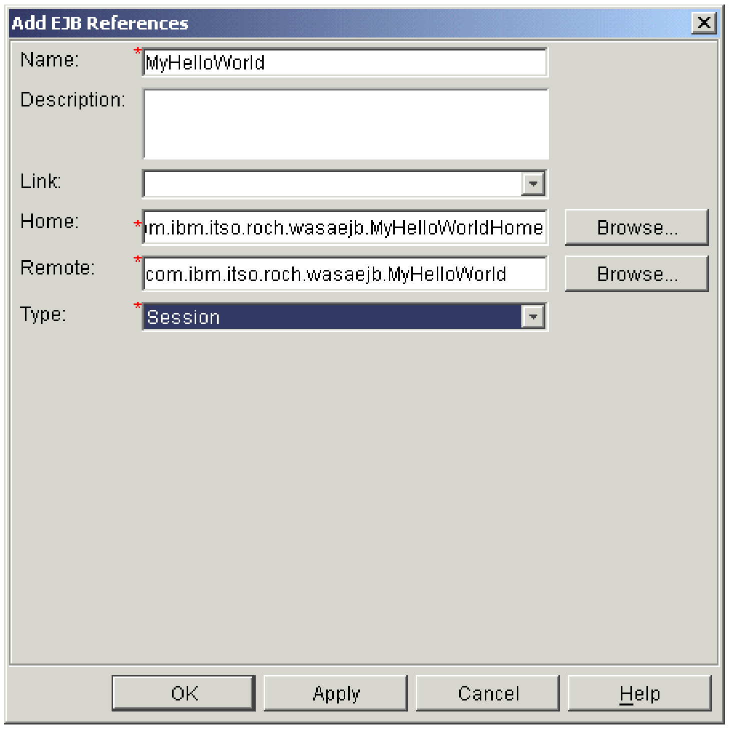
Root Directory or Archive: C:\wsws\Deployed_MyEJBs.jar

Name	Path	Size	Exter
EJSRemoteStatelessMyHello...	com/ibm/it...	1639	class
EJSRemoteStatelessMyHello...	com/ibm/it...	3476	class
EJSStatelessMyHelloWorldHo...	com/ibm/it...	1458	class
MyHelloWorld.class	com/ibm/it...	255	class
MyHelloWorld.java	com/ibm/it...	324	java
MyHelloWorldBean.class	com/ibm/it...	1274	class
MyHelloWorldBean.java	com/ibm/it...	1877	java
MyHelloWorldHome.class	com/ibm/it...	312	class
MyHelloWorldHome.java	com/ibm/it...	508	java
_EJSRemoteStatelessMyHello...	com/ibm/it...	6046	class
_EJSRemoteStatelessMyHello...	com/ibm/it...	5525	class
_MyHelloWorldHome_Stub.cla...	com/ibm/it...	7427	class
_MyHelloWorld_Stub.class	com/ibm/it...	7460	class

Figure 3-48 Selecting MyHelloWorldHome.class for Home

11. Use the same technique to select **MyHelloWorld.class** as the Remote Interface from Deployed_MyEJBs.jar file. Make sure the EJB type is set to **Session**.

12. As shown in Figure 3-49, the EJB Home, Remote, and Type parameters are set. Click **OK** to save the settings.


Add EJB References

Name:	MyHelloWorld
Description:	
Link:	
Home:	m.ibm.itso.roch.wasaejb.MyHelloWorldHome
Remote:	com.ibm.itso.roch.wasaejb.MyHelloWorld
Type:	Session

Figure 3-49 EJB references result

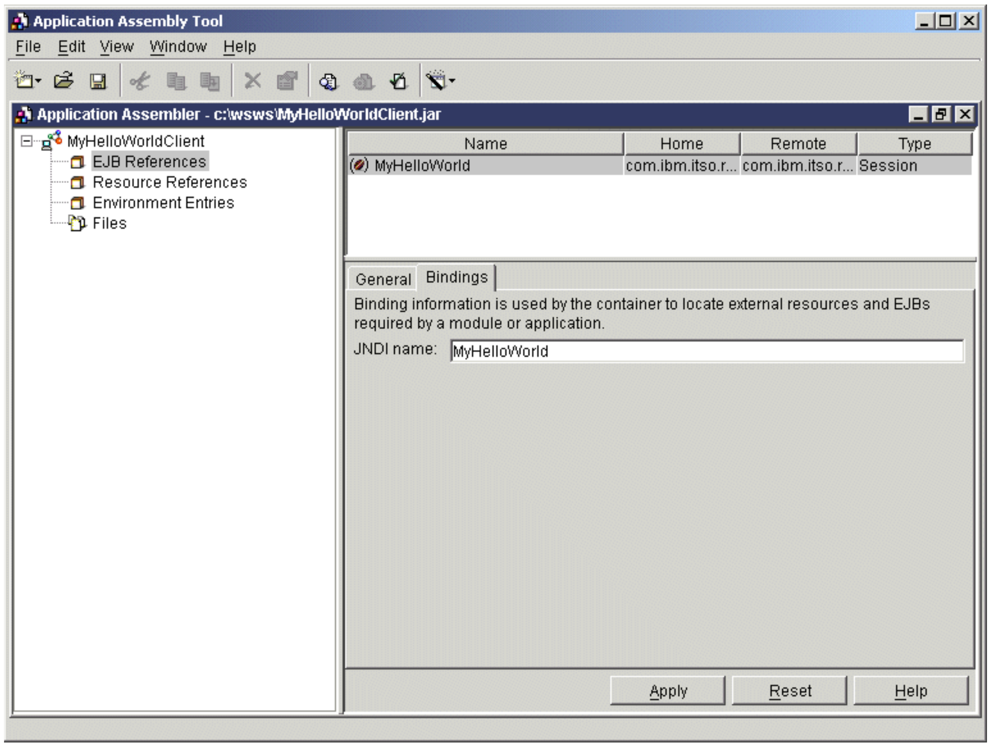
13.In the Create Application Client Wizard window, click **Next**.

14.Click **Next** again on the Adding Resource References window.

15.Click **Finish** to create the EJB application client module.

16.Set the EJB bindings for the client application. In the AAT window, click **EJB References** on the left pane and click the **Bindings** tab on the right for the MyHelloWorld bean. As shown as Figure 3-50, enter `MyHelloWorld` for the JNDI name and click **Apply**.

17.The application client is now complete. We save it by selecting **File-> Save** to save the work as MyHelloWorldClient.jar in the wsws directory.


Application Assembly Tool
File Edit View Window Help
Application Assembler - c:\wsws\MyHelloWorldClient.jar
MyHelloWorldClient
EJB References
Resource References
Environment Entries
Files
General
Bindings
Apply
Reset
Help

Name	Home	Remote	Type
MyHelloWorld	com.ibm.itso.r...	com.ibm.itso.r...	Session

Binding information is used by the container to locate external resources and EJBs required by a module or application.

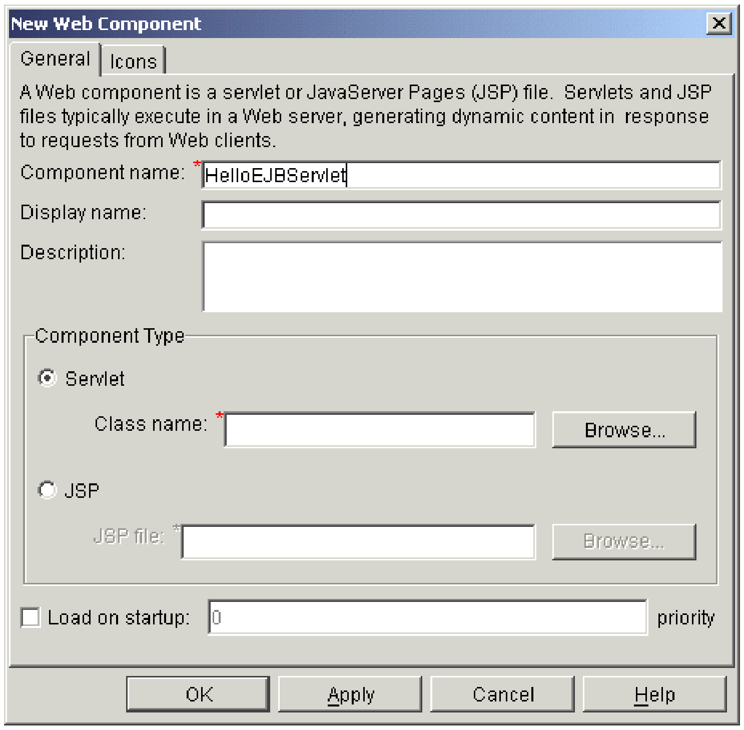
JNDI name: MyHelloWorld

Figure 3-50 Setting the bindings for an application client

Creating a Web module for HelloEJBServlet.jar

Next, we create a Web module that contains the HelloEJBServlet:

1. Select **File-> New-> Web Module**.
2. In the main AAT window, right-click **Web Components** and select **New** to create a component based on HelloEJBServlet.
3. In the New Web Component window, shown as Figure 3-51, enter `HelloEJBServlet` for Component name. Click the **Browse** button to locate the **HelloEJBServlet.jar** file in the wsws directory.



A Web component is a servlet or JavaServer Pages (JSP) file. Servlets and JSP files typically execute in a Web server, generating dynamic content in response to requests from Web clients.

Component name: * HelloEJBServlet

Display name:

Description:

Component Type

(●) Servlet

Class name: *

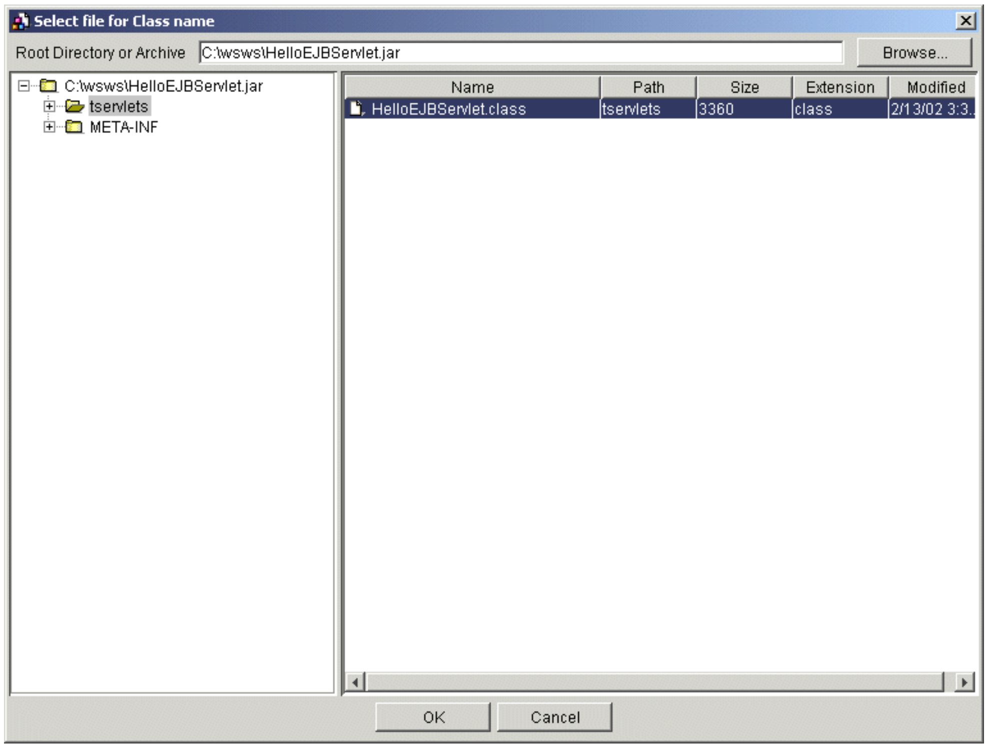
( ) JSP

JSP file: *

[ ] Load on startup: 0 priority

Figure 3-51   Creating a new Web component in AAT

4. In the Select file for classname window, shown as Figure 3-52, select the **HelloEJBServlet.class** servlet from **tservlets** package. Click **OK**.



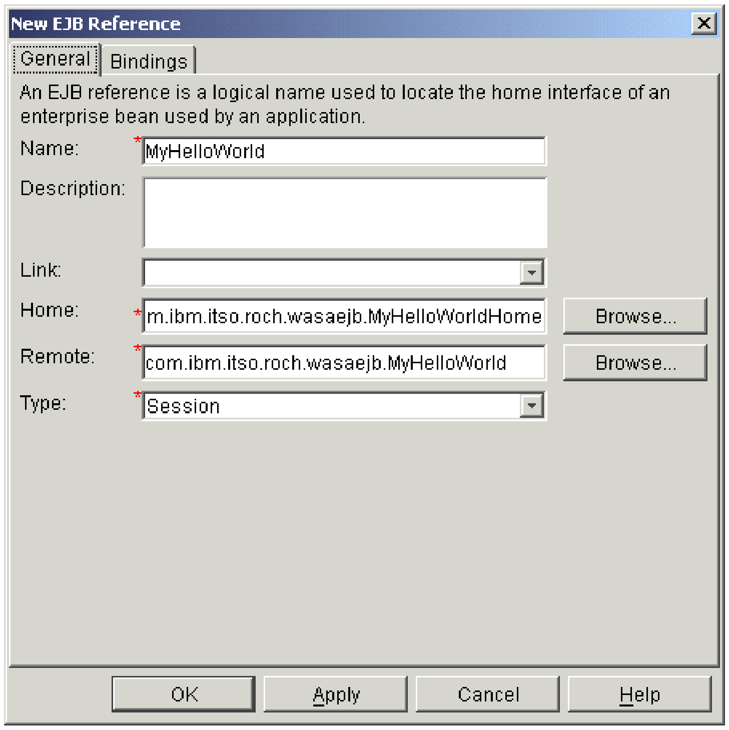
Root Directory or Archive C:\wsws\HelloEJBServlet.jar

C:\wsws\HelloEJBServlet.jar
- tservlets
- META-INF

Name	Path	Size	Extension	Modified
HelloEJBServlet.class	tservlets	3360	class	2/13/02 3:3

Figure 3-52   Selecting the file for classname

5. The New Web Component window now contains a component name and a Class name. Click **OK** to save the settings.
6. Define the Servlet Mappings. We define `HelloEJBServlet` as the URL pattern for the `HelloEJBServlet` servlet.
7. Define the EJB references:
   a. Right-click **EJB Reference** and select **New**.
   b. In the EJB Reference window, shown as Figure 3-53, enter `MyHelloWorld` in the Name field.
   c. Click the **Browse** button next to Home. Locate the **Deployed_MyEJBs.jar** file in the wsws directory.
   d. Select **MyHelloWorldHome.class** for Home interface.
   e. Use the same technique to select **MyHelloWorld.class** for Remote interface.
   f. Make sure the Type is **Session**.
   g. Click the **Bindings** tab. Enter `MyHelloWorld` as the JNDI name, and click **OK** to save the settings.



An EJB reference is a logical name used to locate the home interface of an enterprise bean used by an application.

Name: MyHelloWorld
Description:
Link:
Home: m.ibm.itso.roch.wasaejb.MyHelloWorldHome
Remote: com.ibm.itso.roch.wasaejb.MyHelloWorld
Type: Session

Figure 3-53 Setting the EJB references

8. The Web module packaging is complete. Select **File-> Save As** to save it as HelloEJBServlet.war in the wsws directory.

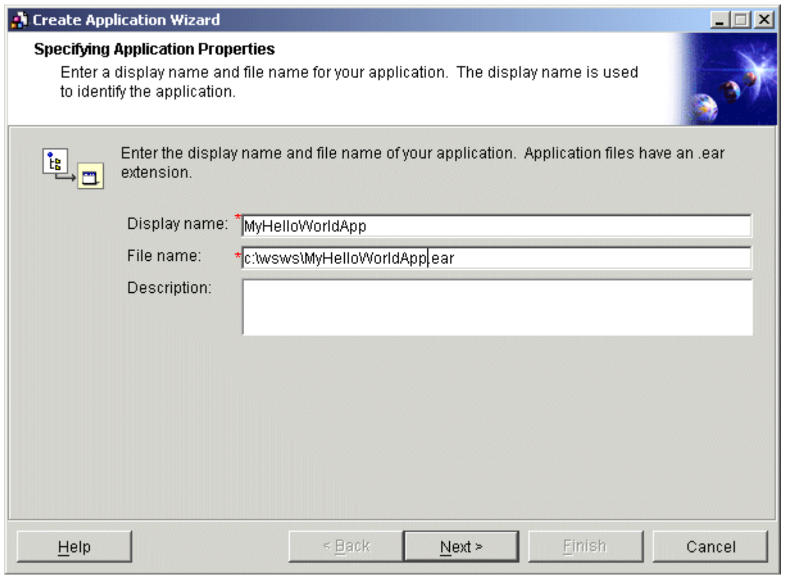
Creating the MyHelloWorldApp enterprise application

We now have three modules:

- `Deployed_MyEJBs.jar` as the EJB module
- `MyHelloWorldClient.jar` as the client module
- `HelloEJBServlet.war` as a Web module

We also set the EJB local bindings in the Web module and client modules. We need to assemble them together as an enterprise application:

1. In AAT, select **File->Wizard -> Create Application Wizard**.
2. In the main Create Application wizard window (Figure 3-54), enter `MyHelloWorldApp` for Display Name and `x:\wsws\MyHelloWorldApp.ear` for File Name. Replace *x* with the drive letter where the wsws directory is stored.



Enter a display name and file name for your application. The display name is used to identify the application.

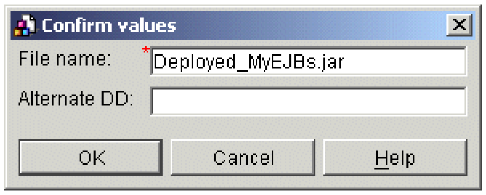
Enter the display name and file name of your application. Application files have an .ear extension.

Display name: * MyHelloWorldApp
File name: * c:\wsws\MyHelloWorldApp.ear
Description:

Figure 3-54 Specifying enterprise application properties

3. Keep clicking the **Next** button until you reach the Adding EJB Modules window. Click **Add** and locate the **Deployed_MyEJBs.jar** file in the wsws directory. Click **Open**.

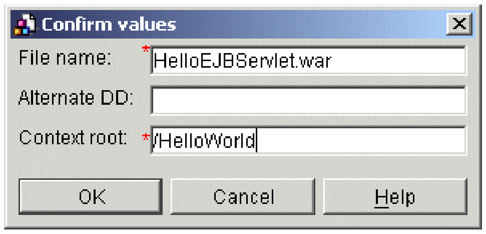
   In the Confirm values window, shown as Figure 3-55, leave Alternate DD blank (represents an alternate Deployment Descriptor). Click **OK** and then **Next**.



File name: * Deployed_MyEJBs.jar
Alternate DD:

Figure 3-55 Confirming the values for the EJB modules

4. Add the Web modules. In the Adding Web Modules window, use the same technique to select the **HelloEJBServlet.war** file in the wsws directory. When the Confirm values window (Figure 3-56) appears, leave Alternate DD blank and enter `/HelloWorld` for the Context root. Click **OK** and then **Next**.


Confirm values

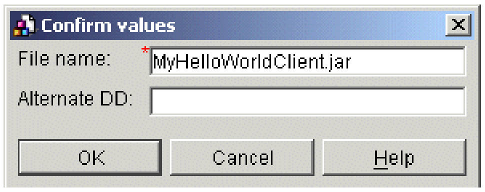
File name: HelloEJBServlet.war

Alternate DD:

Context root: /HelloWorld

Figure 3-56 Confirming the values for Web modules

5. In the Adding Application Clients Modules window, use the same technique to select the **MyHelloWorldClient.jar** file in the wsws directory. When the Confirm values window (Figure 3-57) appears, leave Alternate DD blank. Click **OK** and then **Next**.

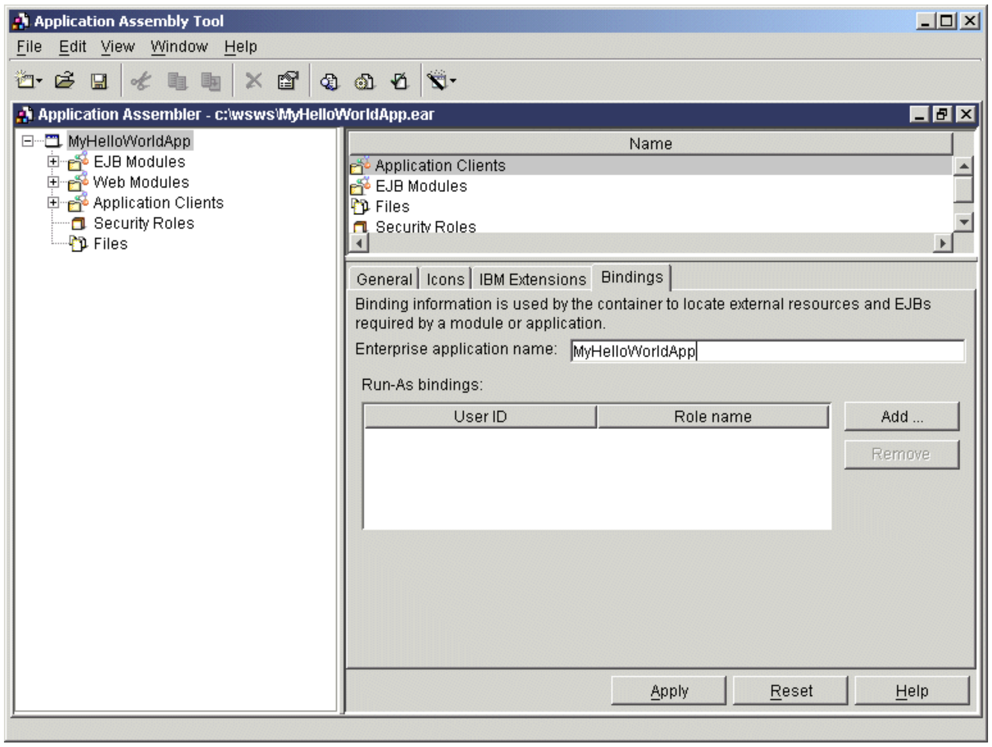

Confirm values

File name: MyHelloWorldClient.jar

Alternate DD:

Figure 3-57 Confirming values for client modules

6. We have now added the three modules. Click **Finish** to save the settings.
7. You return to the AAT main window with the newly created enterprise application, as shown in Figure 3-58. Click the **Bindings** tab and set the application name to `MyHelloWorldApp`. Click **Apply** to save the change.



Binding information is used by the container to locate external resources and EJBs required by a module or application.

Enterprise application name: MyHelloWorldApp

Run-As bindings:

User ID	Role name

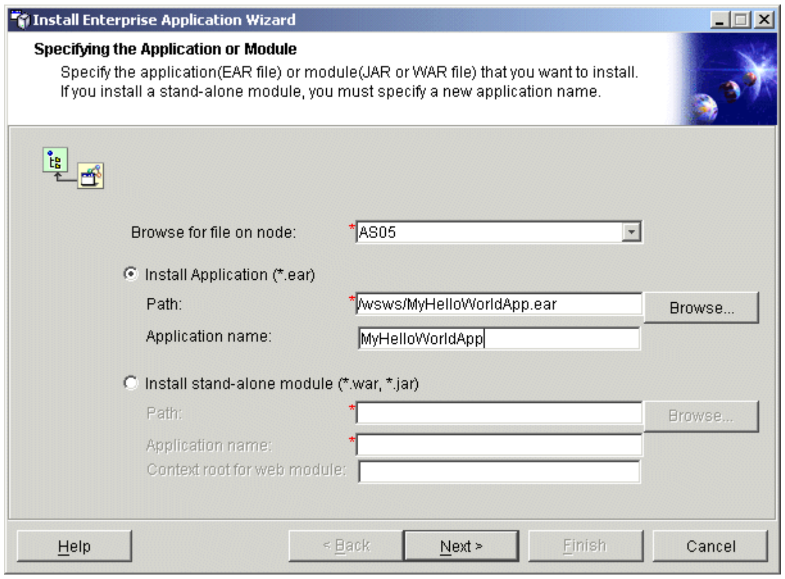
Figure 3-58 Setting the bindings for enterprise applications

8. Save the configuration by selecting **File-> Save** to save it to the MyHelloWorldApp.ear file in the wsws directory.

3.3.12 Installing the MyHelloWorldApp application on Advanced Edition

In this section, we install the MyHelloWorldApp enterprise application on WebSphere Application Server Version 4.0 Advanced Edition using the Administrative Console.

1. Copy the **MyHelloWorldApp.ear** file from our local drive to the iSeries IFS wsws directory, so the Administrative Console can access it when creating enterprise applications.
2. As in 3.3.10, “Installing the OrderEntry application on Advanced Edition” on page 102, open a command prompt window to start the Administrative Console. Wait until you see the `Console Ready in the Console` message.
3. In the Console, select the wizard icon and click **Install Enterprise Application**.
4. The Specifying the Application or Module window (Figure 3-59) appears. Make sure that the **Install Application** radio button is selected. Click the **Browse** button next to Path to locate the **MyHelloWorldApp.ear** in the wsws directory. Enter `MyHelloWorldApp` for the Application name.



Install Enterprise Application Wizard

Specifying the Application or Module

Specify the application(EAR file) or module(JAR or WAR file) that you want to install.
If you install a stand-alone module, you must specify a new application name.

Browse for file on node: * AS05

(●) Install Application (*.ear)

Path: * /wsws/MyHelloWorldApp.ear

Application name: MyHelloWorldApp

( ) Install stand-alone module (*.war, *.jar)

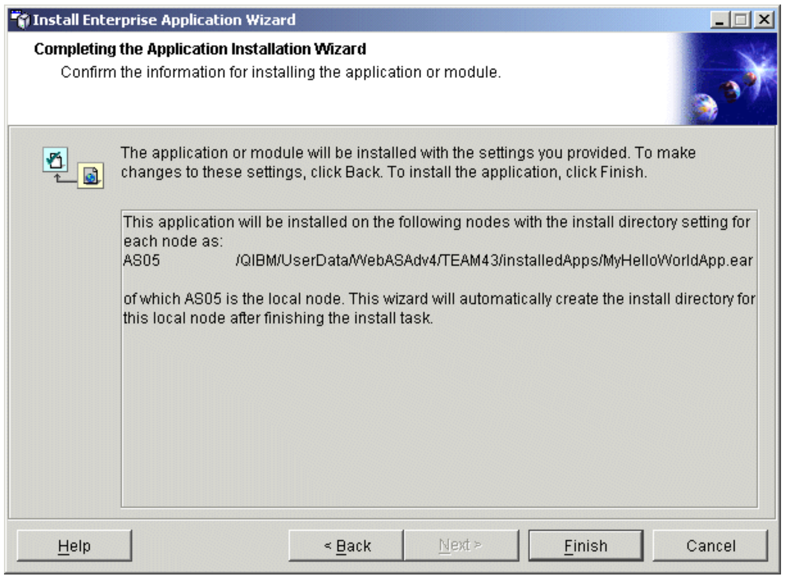
Path: *

Application name: *

Context root for web module:

Figure 3-59 Specifying the application parameters

5. Keep clicking **Next** until you reach the Completing the Application Installation window (Figure 3-60). Click **Finish** to complete the installation. Click **No** to the Regenerate the application dialog and click **OK** on the confirmation dialog.



Completing the Application Installation Wizard

Confirm the information for installing the application or module.

The application or module will be installed with the settings you provided. To make changes to these settings, click Back. To install the application, click Finish.

```
This application will be installed on the following nodes with the install directory setting for
each node as:
AS05            /QIBM/UserData/WebASAdv4/TEAM43/installedApps/MyHelloWorldApp.ear

of which AS05 is the local node. This wizard will automatically create the install directory for
this local node after finishing the install task.
```

Figure 3-60 Completing the application installation

6. As in 3.3.10, "Installing the OrderEntry application on Advanced Edition" on page 102, stop and restart the application server. To support this new application with an external HTTP server, you must regenerate the plug-in configuration.

3.3.13 Testing the MyHelloWorldApp application

Now that we have successfully installed the MyHelloWorldApp application on WebSphere Application Server Version 4.0 Advanced Edition, we need to test it. Since we have two kinds of EJB clients – application clients and servlets – we test both of them.

Testing the application client

Open a workstation command prompt session and change the directory to:

```
\<WebSphere install>\AppServer\bin
```

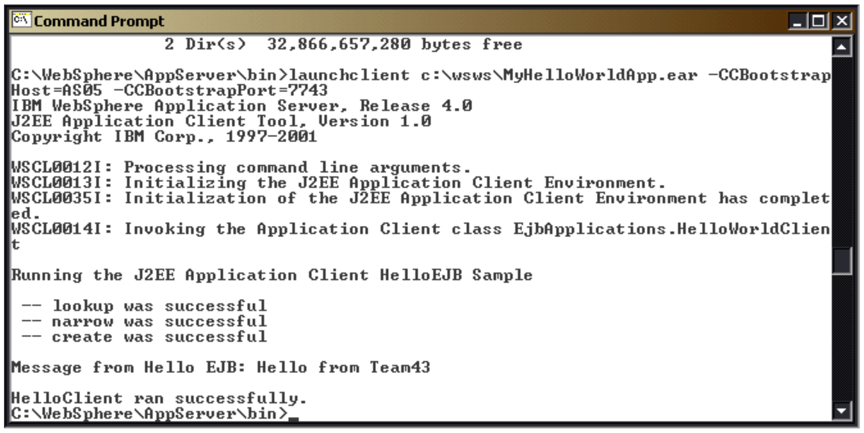
Enter the following command:

```
launchclient x:\wsws\myhelloworldapp.ear -CCBootstrapHost=sysname -CCBootstrapPort=port
```

Here *x* is the drive where the wsws directory is stored, *sysname* is the name of iSeries server, and *port* is the administrative server bootstrap port.

As shown in Figure 3-61, if everything is working, the following messages are written to the command session:

```
Running the J2EE Application Client HelloEJB Sample
--lookup was successful
--narrow was successful
--create was successful
Message from HelloEJB: Hello from teamxx
HelloClient ran successfully
```



```
                2 Dir(s)  32,866,657,280 bytes free

C:\WebSphere\AppServer\bin>launchclient c:\wsws\MyHelloWorldApp.ear -CCBootstrap
Host=AS05 -CCBootstrapPort=7743
IBM WebSphere Application Server, Release 4.0
J2EE Application Client Tool, Version 1.0
Copyright IBM Corp., 1997-2001

WSCL0012I: Processing command line arguments.
WSCL0013I: Initializing the J2EE Application Client Environment.
WSCL0035I: Initialization of the J2EE Application Client Environment has complet
ed.
WSCL0014I: Invoking the Application Client class EjbApplications.HelloWorldClien
t

Running the J2EE Application Client HelloEJB Sample

 -- lookup was successful
 -- narrow was successful
 -- create was successful

Message from Hello EJB: Hello from Team43

HelloClient ran successfully.
C:\WebSphere\AppServer\bin>_
```

Figure 3-61 Running the application client for MyHelloWorldApp

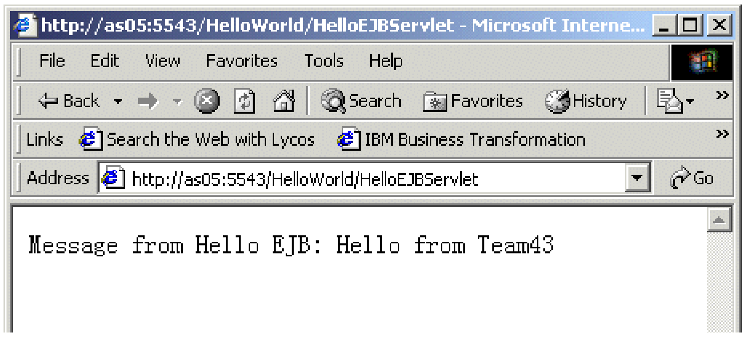
Testing the servlet

Now we test the servlet. Open a browser and enter the URL:

http://*sysname*:*port*/HelloWorld/HelloEJBServlet

Here *sysname* is the name of iSeries server and *port* is your HTTP server port (it can be either an external HTTP server port or internal HTTP server port).

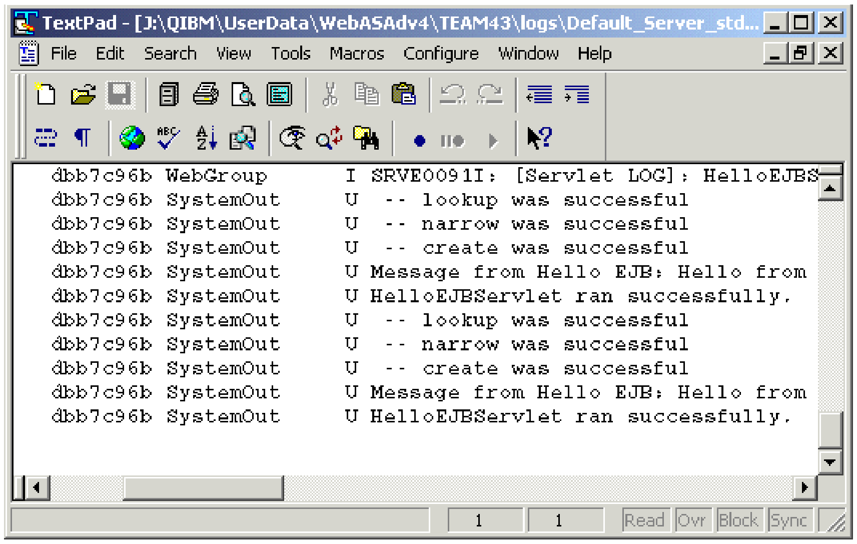
If everything works properly, the message appears in the browser, as shown in Figure 3-62.


http://as05:5543/HelloWorld/HelloEJBServlet - Microsoft Interne...
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation
Address http://as05:5543/HelloWorld/HelloEJBServlet
Go

```
Message from Hello EJB: Hello from Team43
```

Figure 3-62 Testing servlet for MyHelloWorldApp

To view the output from the System.out.println statements, we can look in the WebSphere log file that is located in the /QIBM/UserData/WebASAdv4/*xxxx*/logs directory (*xxxx* is your WebSphere instance name). Use a workstation editor to view the ServerName_stdout.log file and scroll to the end of the file. As shown in Figure 3-63, you see the messages from the servlet.


TextPad - [J:\QIBM\UserData\WebASAdv4\TEAM43\logs\Default_Server_std...
File Edit Search View Tools Macros Configure Window Help
1 1 Read Ovr Block Sync

```
dbb7c96b WebGroup       I SRVE0091I: [Servlet LOG]: HelloEJBS
dbb7c96b SystemOut      U  -- lookup was successful
dbb7c96b SystemOut      U  -- narrow was successful
dbb7c96b SystemOut      U  -- create was successful
dbb7c96b SystemOut      U Message from Hello EJB: Hello from
dbb7c96b SystemOut      U HelloEJBServlet ran successfully.
dbb7c96b SystemOut      U  -- lookup was successful
dbb7c96b SystemOut      U  -- narrow was successful
dbb7c96b SystemOut      U  -- create was successful
dbb7c96b SystemOut      U Message from Hello EJB: Hello from
dbb7c96b SystemOut      U HelloEJBServlet ran successfully.
```

Figure 3-63 WebSphere log file

Now we have finished installing and testing the MyHelloWorldApp enterprise application.

3.3.14 Packaging the OrderEntryApp enterprise application

In Chapter 10, “Building Java applications with Enterprise JavaBeans” on page 315, we develop another enterprise application, OrderEntryApp, which integrates Java clients, servlets, and EJBs. The MyHelloWorldApp application is very simple and only uses only one session bean. In OrderEntryApp, we use multiple session beans and entity beans (both container-managed persistence and bean-managed persistence) to simulate a more complex transaction-based application. It is shown in Figure 3-64.

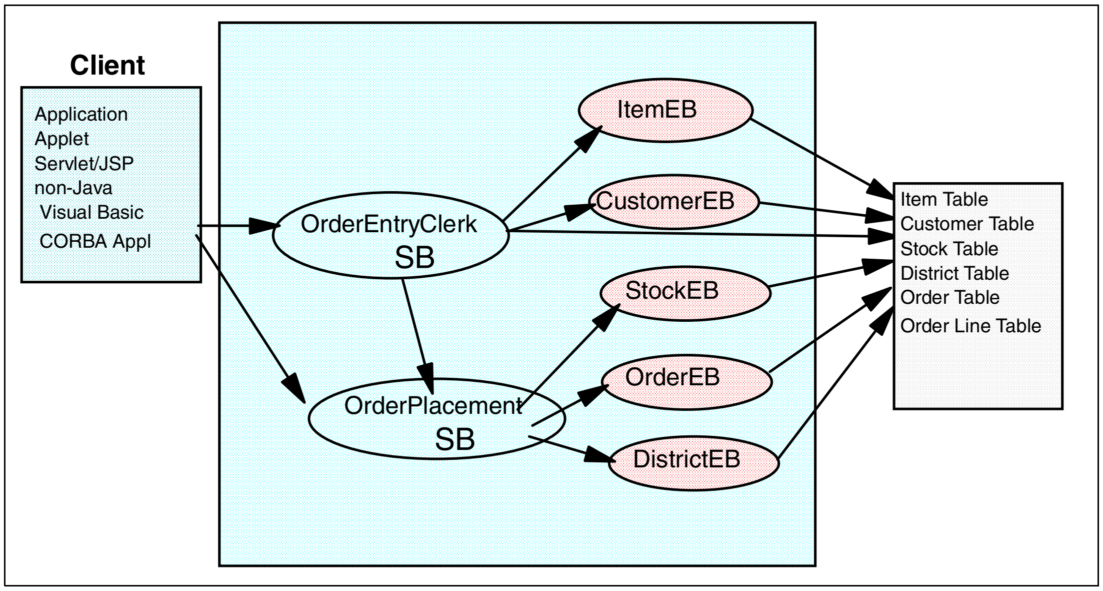


Figure 3-64 OrderEntryApp diagram

OrderEntryClerk and OrderPlacement are session beans. ItemEB, CustomerEB, StockEB, OrderEB, and DistrictEB are entity beans. We use Java applications and servlets as EJB clients. We can also treat session beans as clients of entity beans, where session beans represent business logic and entity beans represent data. When we package the application with AAT, we configure the bindings for Java application clients and servlets to find the EJBs. We also need to configure the bindings for session beans to find the entity beans.

Assume we have developed the OrderEntryApp application with VisualAge for Java 4.0, not with WebSphere Studio Application Developer. Application Developer is capable of packaging .ear files directly. We export our code into JAR files. We create four JAR files:

- OrderEntryBeans.jar: Includes all the EJB beans
- OrderEntryClient.jar: Includes the EJB client application
- OrderEntryWar.jar: Includes the servlet
- nonejb.jar: Includes supporting classes for the EJBs

Next, we create an enterprise application based on these JAR files. We create modules for each JAR file and then bundle them together.

Figure 3-65 shows the flow of the application packaging. Since the packaging process is very similar with the one explained in 3.3.11, “Packaging the MyHelloWorldApp enterprise application” on page 107, we only focus on the differences for the OrderEntryApp application.

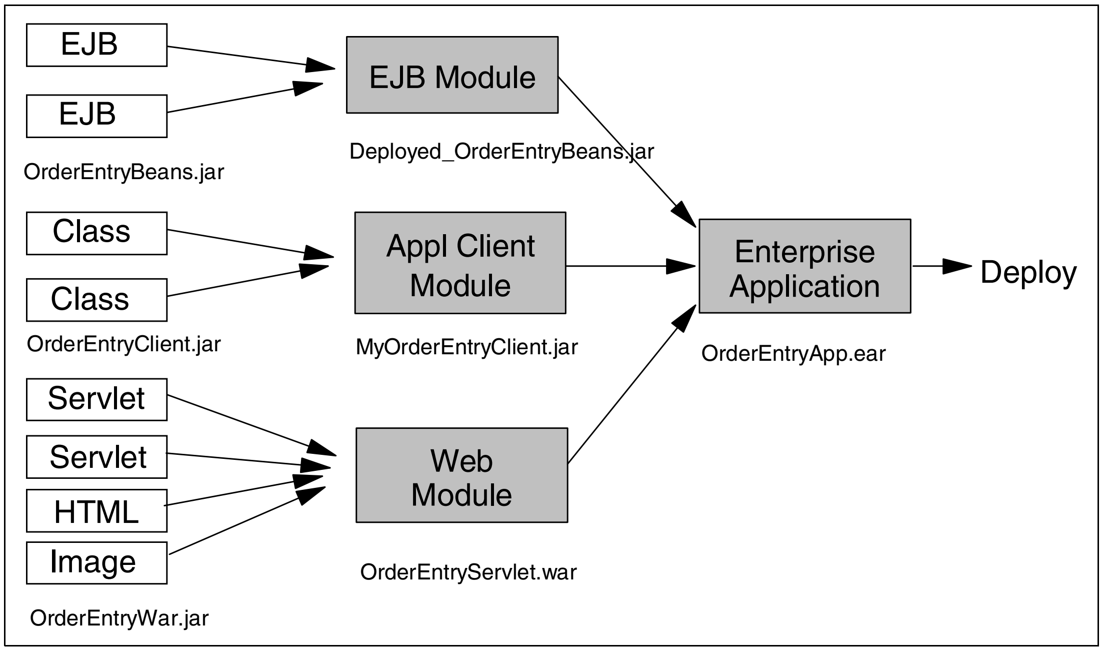
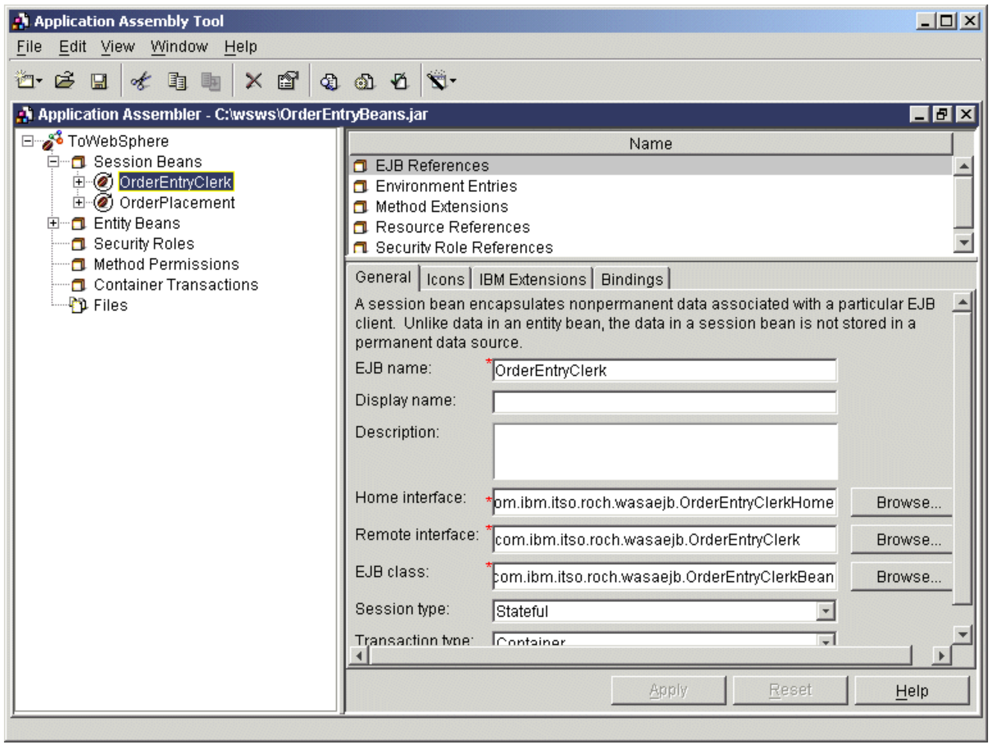


Figure 3-65 Creating OrderEntryApp enterprise application

Creating the EJB module for OrderEntryBeans.jar

As in “Creating the EJB module for MyEJBs.jar” on page 109, start AAT and then follow these steps:

1. Open the **OrderEntryBeans.jar** file.
2. Select **Session Beans-> OrderEntryClerk**. You see the details of the bean as shown in Figure 3-66.

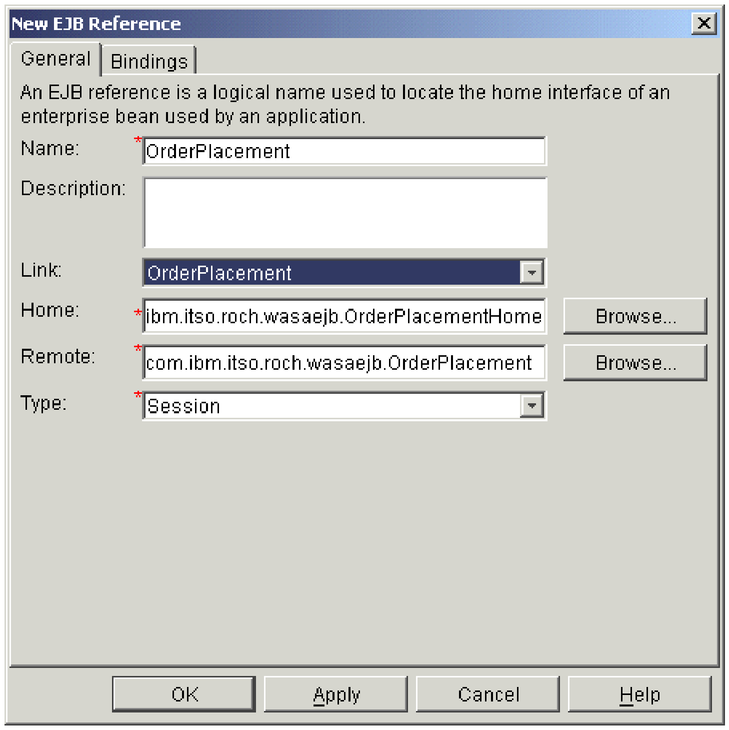


A session bean encapsulates nonpermanent data associated with a particular EJB client. Unlike data in an entity bean, the data in a session bean is not stored in a permanent data source.

EJB name: OrderEntryClerk
Display name:
Description:
Home interface: om.ibm.itso.roch.wasaejb.OrderEntryClerkHome
Remote interface: com.ibm.itso.roch.wasaejb.OrderEntryClerk
EJB class: com.ibm.itso.roch.wasaejb.OrderEntryClerkBean
Session type: Stateful
Transaction type: Container

Figure 3-66 OrderEntryClerk Session Bean

3. Click the **Bindings** tab and make sure the JNDI name is `OrderEntryClerk`.
4. Repeat this for the OrderPlacement session bean and make sure the JNDI name is `OrderPlacement`.
5. Use the same technique to select the Customer, District, Item, Order, and Stock entity beans under **Entity Beans**, and make sure their JNDI names are `Customer`, `District`, `Item`, `Order`, and `Stock` respectively.
6. Add EJB references. Because the OrderEntryClerk session bean invokes the OrderPlacement session bean for placing orders in our application, add this reference for OrderEntryClerk. Select **Session Beans-> OrderEntryClerk-> EJB References-> New**. As shown in Figure 3-67, enter `OrderPlacement` for Name and click the link pulldown to select the **OrderPlacement** bean. Then click **OK**.


New EJB Reference

General | Bindings

An EJB reference is a logical name used to locate the home interface of an enterprise bean used by an application.

Name: OrderPlacement

Description:

Link: OrderPlacement

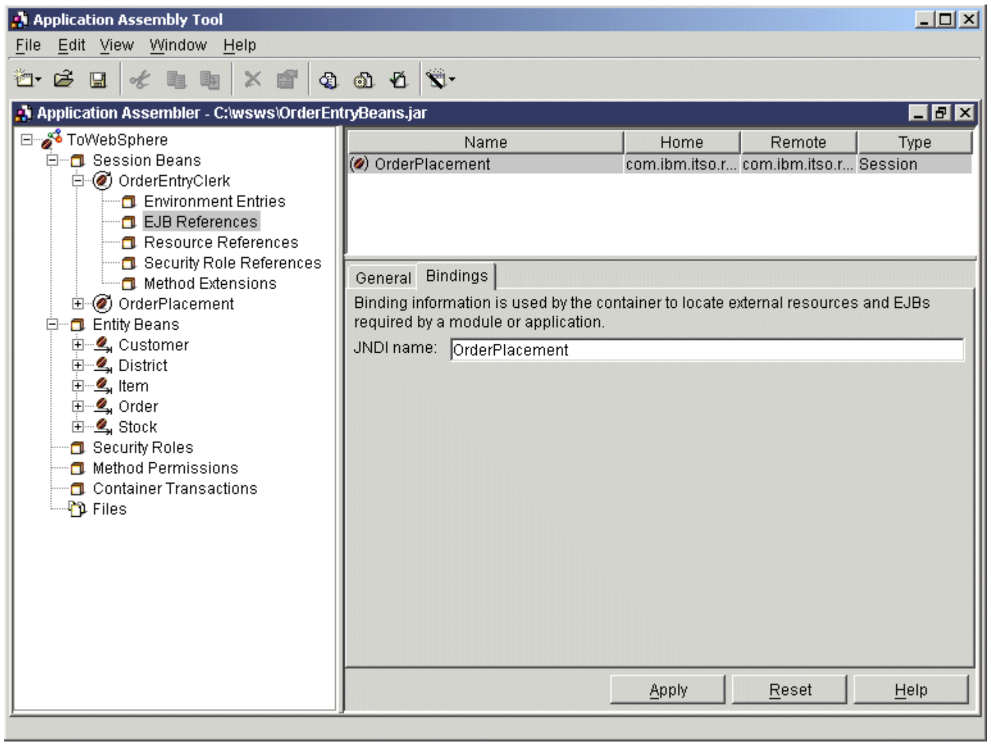
Home: ibm.itso.roch.wasaejb.OrderPlacementHome

Remote: com.ibm.itso.roch.wasaejb.OrderPlacement

Type: Session

Figure 3-67 Adding a EJB reference for OrderEntryClerk

7. As shown in Figure 3-68, select **EJB References-> OrderPlacement-> Bindings**. Enter `OrderPlacement` for the JNDI Name and click **Apply**.


Application Assembly Tool

Application Assembler - C:\wsws\OrderEntryBeans.jar

Name	Home	Remote	Type
OrderPlacement	com.ibm.itso.r...	com.ibm.itso.r...	Session

General | Bindings

Binding information is used by the container to locate external resources and EJBs required by a module or application.

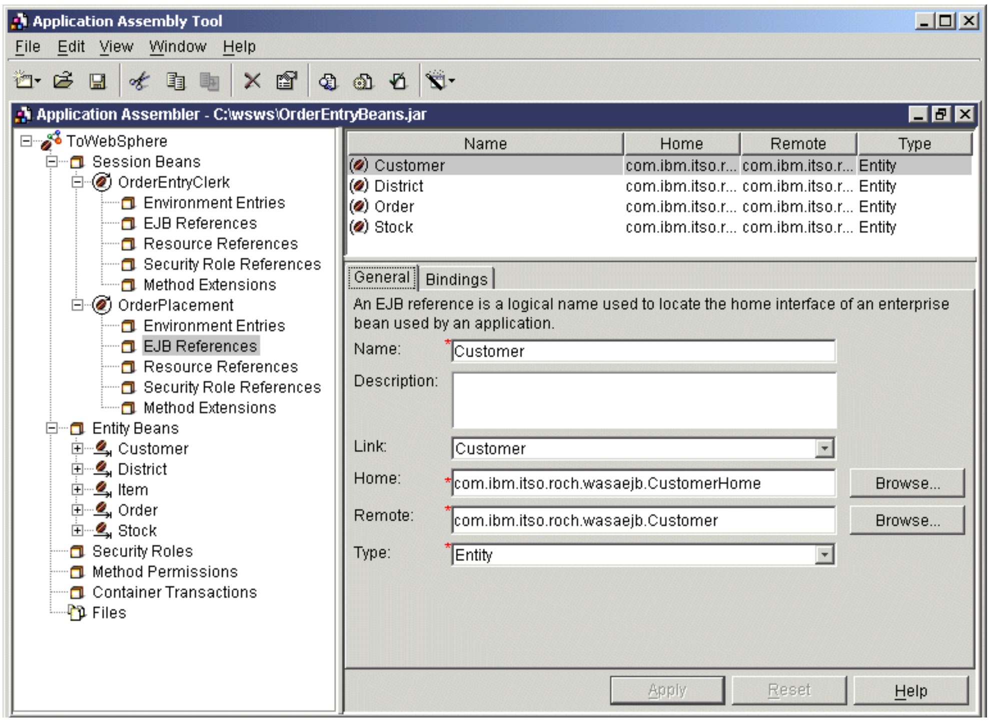
JNDI name: OrderPlacement

Figure 3-68 Setting the EJB reference bindings

8. The OrderPlacement session bean invokes entity beans such as Customer, District, Order, and Stock in the application. We need to add EJB references for all these entity beans to the OrderPlacement session bean. Select **Session Beans-> OrderPlacement-> EJB References-> New**. Use the same technique to add EJB references to the OrderPlacement bean for the following EJBs:

   – Customer
   – District
   – Order
   – Stock

   Figure 3-69 shows the detailed EJB references for the OrderPlacement bean. Don't forget to click the **Bindings** tab to set the JNDI name for each EJB reference.



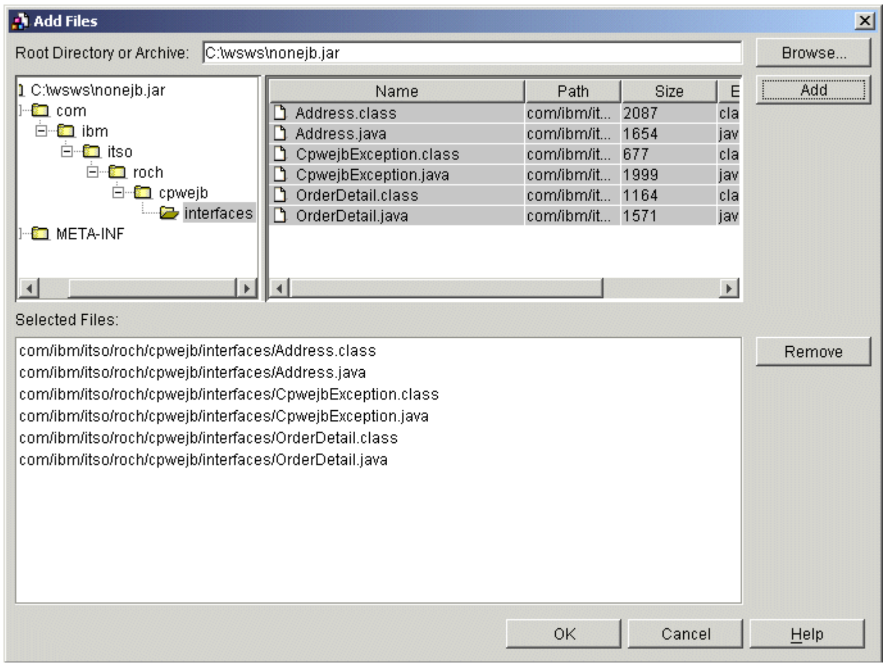
Name	Home	Remote	Type
Customer	com.ibm.itso.r...	com.ibm.itso.r...	Entity
District	com.ibm.itso.r...	com.ibm.itso.r...	Entity
Order	com.ibm.itso.r...	com.ibm.itso.r...	Entity
Stock	com.ibm.itso.r...	com.ibm.itso.r...	Entity

An EJB reference is a logical name used to locate the home interface of an enterprise bean used by an application.

Name: * Customer
Description:
Link: Customer
Home: * com.ibm.itso.roch.wasaejb.CustomerHome
Remote: * com.ibm.itso.roch.wasaejb.Customer
Type: * Entity

Figure 3-69 OrderPlacement EJB references

9. Add supporting classes into the module for the EJBs. Right-click **Files** and select **Add Files**. In the Add Files window, shown as Figure 3-70, click the **Browse** button to locate the **nonejb.jar** file in the wsws directory. Select all the files in the interfaces package and click **Add**. Then click **OK** to return to the main AAT window.



Name	Path	Size	E
Address.class	com/ibm/it...	2087	cla
Address.java	com/ibm/it...	1654	jav
CpwejbException.class	com/ibm/it...	677	cla
CpwejbException.java	com/ibm/it...	1999	jav
OrderDetail.class	com/ibm/it...	1164	cla
OrderDetail.java	com/ibm/it...	1571	jav

```
com/ibm/itso/roch/cpwejb/interfaces/Address.class
com/ibm/itso/roch/cpwejb/interfaces/Address.java
com/ibm/itso/roch/cpwejb/interfaces/CpwejbException.class
com/ibm/itso/roch/cpwejb/interfaces/CpwejbException.java
com/ibm/itso/roch/cpwejb/interfaces/OrderDetail.class
com/ibm/itso/roch/cpwejb/interfaces/OrderDetail.java
```

Figure 3-70 Adding the supporting classes

10. Generate the deployed code. Select **File-> Generate Code for Deployment**. In the Generate code for deployment window (Figure 3-71), leave Working Directory as the default. The EJBs use classes from other packages like:

    – IBM Toolbox for Java (jt400.jar)
    – Application supporting classes(nonejb.jar)
    – WebSphere Command package (ace.jar)

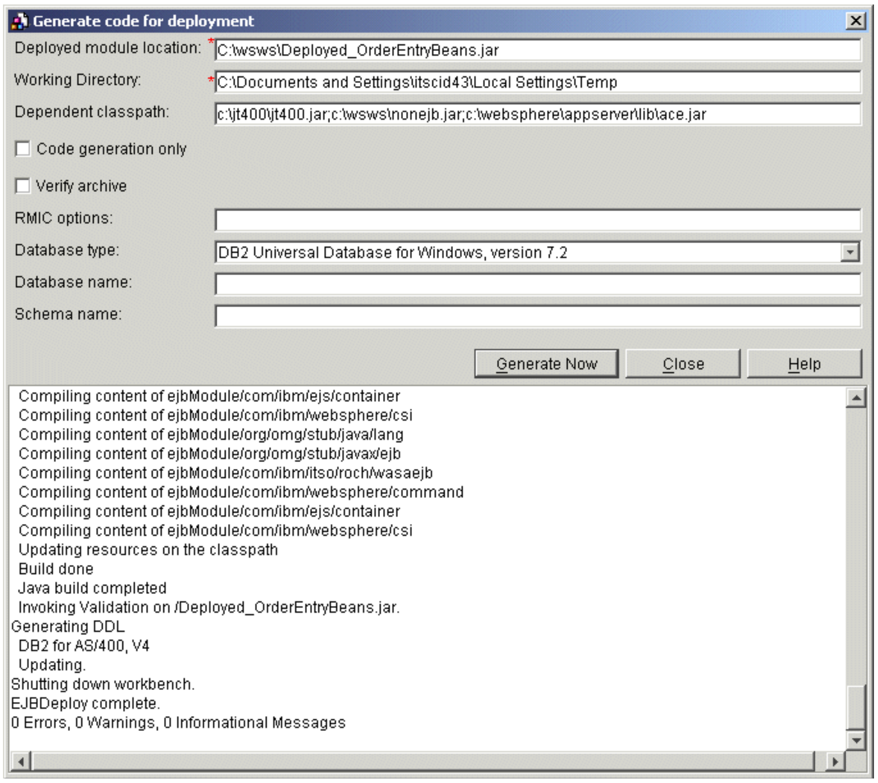
    We need to add them into the classpath with the following entry so they can be found:

    ```
    x:\jt400\jt400.jar;x:\wsws\nonejb.jar;x:\WebSphere\AppServer\lib\ace.jar
    ```

    Here *x* is the workstation drive on which these files are stored.

    We click the **Generate Now** button to generate the deployed code. Wait for the code generation to finish. When it is done, scroll down the messages and make sure that you have no errors.

11. Close the Generate code for deployment window. Check the wsws directory. There is a new file named Deployed_OrderEntryBeans.jar, which contains all the code necessary to actually run the EJBs.



Deployed module location: C:\wsws\Deployed_OrderEntryBeans.jar
Working Directory: C:\Documents and Settings\itscid43\Local Settings\Temp
Dependent classpath: c:\jt400\jt400.jar;c:\wsws\nonejb.jar;c:\websphere\appserver\lib\ace.jar
Code generation only
Verify archive
RMIC options:
Database type: DB2 Universal Database for Windows, version 7.2
Database name:
Schema name:

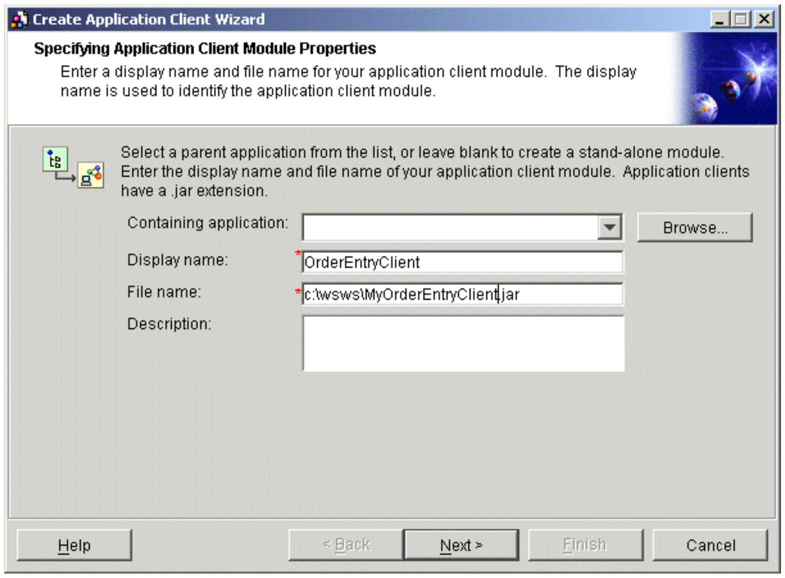
```
 Compiling content of ejbModule/com/ibm/ejs/container
 Compiling content of ejbModule/com/ibm/websphere/csi
 Compiling content of ejbModule/org/omg/stub/java/lang
 Compiling content of ejbModule/org/omg/stub/javax/ejb
 Compiling content of ejbModule/com/ibm/itso/roch/wasaejb
 Compiling content of ejbModule/com/ibm/websphere/command
 Compiling content of ejbModule/com/ibm/ejs/container
 Compiling content of ejbModule/com/ibm/websphere/csi
 Updating resources on the classpath
 Build done
 Java build completed
 Invoking Validation on /Deployed_OrderEntryBeans.jar.
Generating DDL
 DB2 for AS/400, V4
 Updating.
Shutting down workbench.
EJBDeploy complete.
0 Errors, 0 Warnings, 0 Informational Messages
```

Figure 3-71 Generating code for deployment

Creating the client module for OrderEntryClient.jar

In AAT, follow these steps:

1. Select **File-> Wizards-> Create Application client Wizard**. On the following page (Figure 3-72), enter `OrderEntryClient` for Display Name and `x:\wsws\MyOrderEntryClient.jar` for File name (replace *x* with the drive letter where the wsws directory is stored). Click **Next**.



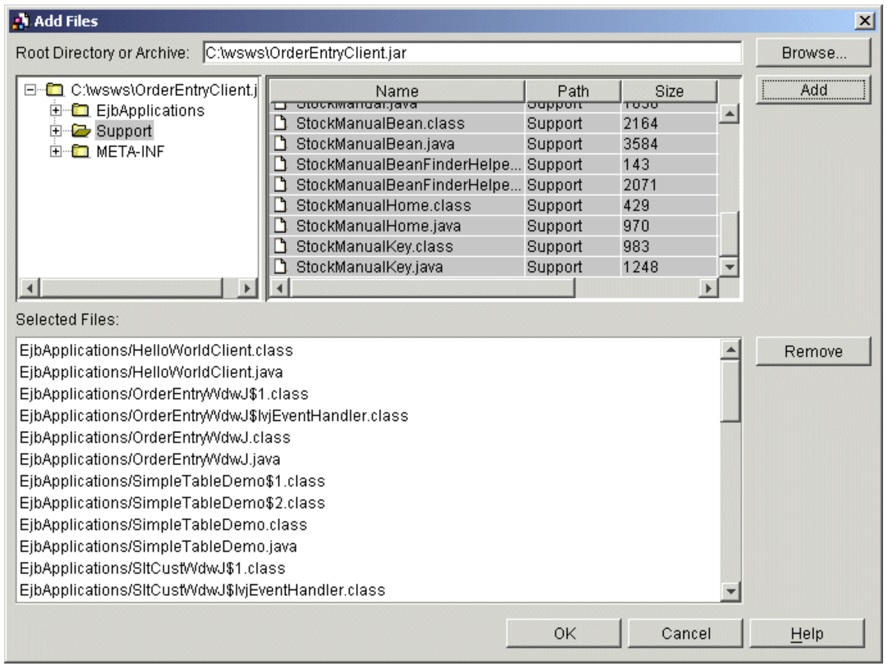
Specifying Application Client Module Properties
Enter a display name and file name for your application client module. The display name is used to identify the application client module.

Select a parent application from the list, or leave blank to create a stand-alone module. Enter the display name and file name of your application client module. Application clients have a .jar extension.

Containing application:
Display name: OrderEntryClient
File name: c:\wsws\MyOrderEntryClient.jar
Description:

Figure 3-72 Creating the client module for OrderEntryApp

2. On the Create Client Application Add Files window, click the **Add** button. On the Add Files window, click **Browse** to locate the **OrderEntryClient.jar** file in the wsws directory. As shown in Figure 3-73, select all the files from the EJBApplications package and click **Add**. Use the same technique to add all the files from the Support package. Click **OK** to return to the Add Files window.



Root Directory or Archive: C:\wsws\OrderEntryClient.jar

- C:\wsws\OrderEntryClient.j
  - EjbApplications
  - Support
  - META-INF

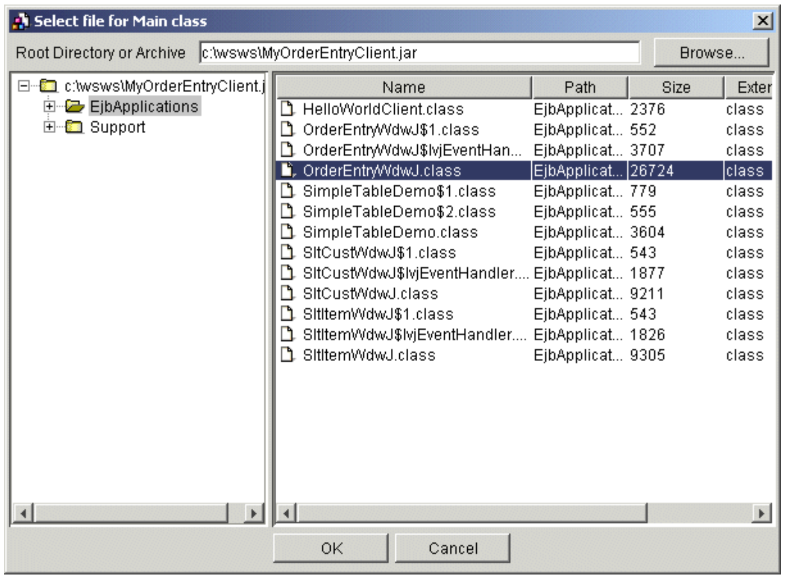
Name	Path	Size
StockManualBean.class	Support	2164
StockManualBean.java	Support	3584
StockManualBeanFinderHelpe...	Support	143
StockManualBeanFinderHelpe...	Support	2071
StockManualHome.class	Support	429
StockManualHome.java	Support	970
StockManualKey.class	Support	983
StockManualKey.java	Support	1248

Selected Files:

EjbApplications/HelloWorldClient.class
EjbApplications/HelloWorldClient.java
EjbApplications/OrderEntryWdwJ$1.class
EjbApplications/OrderEntryWdwJ$IvjEventHandler.class
EjbApplications/OrderEntryWdwJ.class
EjbApplications/OrderEntryWdwJ.java
EjbApplications/SimpleTableDemo$1.class
EjbApplications/SimpleTableDemo$2.class
EjbApplications/SimpleTableDemo.class
EjbApplications/SimpleTableDemo.java
EjbApplications/SltCustWdwJ$1.class
EjbApplications/SltCustWdwJ$IvjEventHandler.class

Figure 3-73 Adding class files into client module

3. Click **Next**. In the Specifying Additional Application Client Module Properties window, click **Browse**. Select the **OrderEntryWdwJ.class** from the EJBApplications package as the Main class as shown in Figure 3-74. Click **OK**. You return to the previous page.



Root Directory or Archive c:\wsws\MyOrderEntryClient.jar

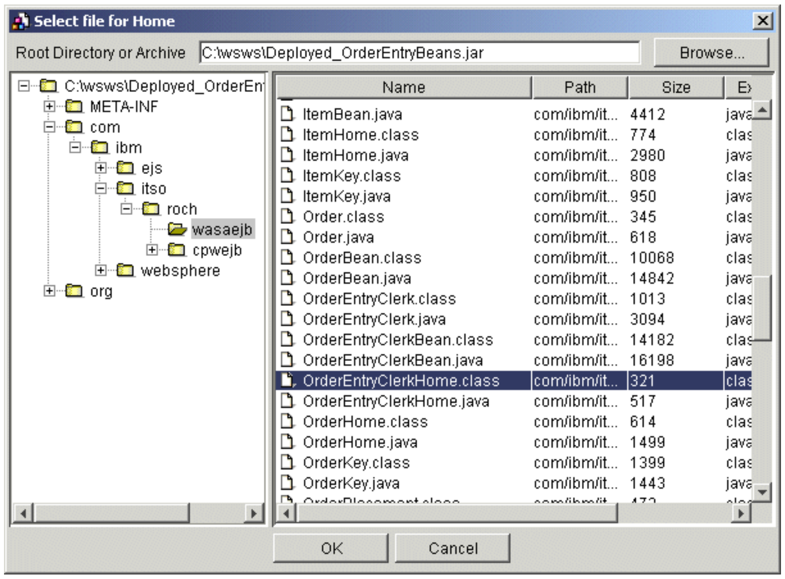
- c:\wsws\MyOrderEntryClient.j
  - EjbApplications
  - Support

Name	Path	Size	Exter
HelloWorldClient.class	EjbApplicat...	2376	class
OrderEntryWdwJ$1.class	EjbApplicat...	552	class
OrderEntryWdwJ$IvjEventHan...	EjbApplicat...	3707	class
OrderEntryWdwJ.class	EjbApplicat...	26724	class
SimpleTableDemo$1.class	EjbApplicat...	779	class
SimpleTableDemo$2.class	EjbApplicat...	555	class
SimpleTableDemo.class	EjbApplicat...	3604	class
SltCustWdwJ$1.class	EjbApplicat...	543	class
SltCustWdwJ$IvjEventHandler....	EjbApplicat...	1877	class
SltCustWdwJ.class	EjbApplicat...	9211	class
SltItemWdwJ$1.class	EjbApplicat...	543	class
SltItemWdwJ$IvjEventHandler....	EjbApplicat...	1826	class
SltItemWdwJ.class	EjbApplicat...	9305	class

Figure 3-74 Specifying the main class for the client module

4. Keep clicking **Next** until you reach the Adding EJB References window. Click **Add** and on the following page, enter `OrderEntryClerk` in the Name field. Click **Browse** next to Home

to locate the **Deployed_OrderEntryBeans.jar** file in the wsws directory. As shown in Figure 3-75, select the **OrderEntryClerkHome.class** file and click **OK**.


Select file for Home

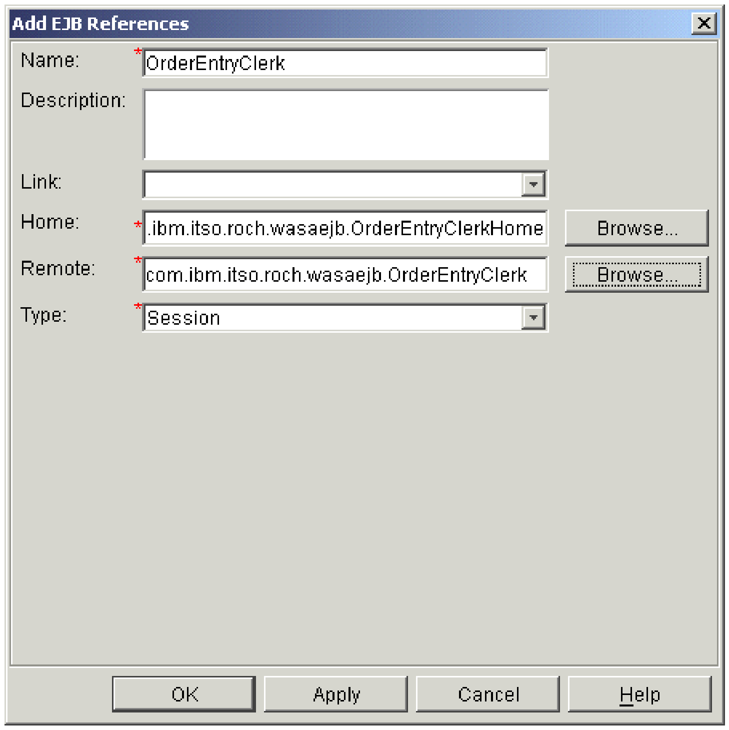
Root Directory or Archive: C:\wsws\Deployed_OrderEntryBeans.jar

Name	Path	Size	Ex
ItemBean.java	com/ibm/it...	4412	java
ItemHome.class	com/ibm/it...	774	clas
ItemHome.java	com/ibm/it...	2980	java
ItemKey.class	com/ibm/it...	808	clas
ItemKey.java	com/ibm/it...	950	java
Order.class	com/ibm/it...	345	clas
Order.java	com/ibm/it...	618	java
OrderBean.class	com/ibm/it...	10068	clas
OrderBean.java	com/ibm/it...	14842	java
OrderEntryClerk.class	com/ibm/it...	1013	clas
OrderEntryClerk.java	com/ibm/it...	3094	java
OrderEntryClerkBean.class	com/ibm/it...	14182	clas
OrderEntryClerkBean.java	com/ibm/it...	16198	java
OrderEntryClerkHome.class	com/ibm/it...	321	clas
OrderEntryClerkHome.java	com/ibm/it...	517	java
OrderHome.class	com/ibm/it...	614	clas
OrderHome.java	com/ibm/it...	1499	java
OrderKey.class	com/ibm/it...	1399	clas
OrderKey.java	com/ibm/it...	1443	java

Figure 3-75 Adding the Home interface for EJB reference

Use the same technique to set the OrderEntryClerk class file for the Remote interface.

5. Now we have set all the values for EJB reference. As shown in Figure 3-76, make sure that Type is set to **Session**.

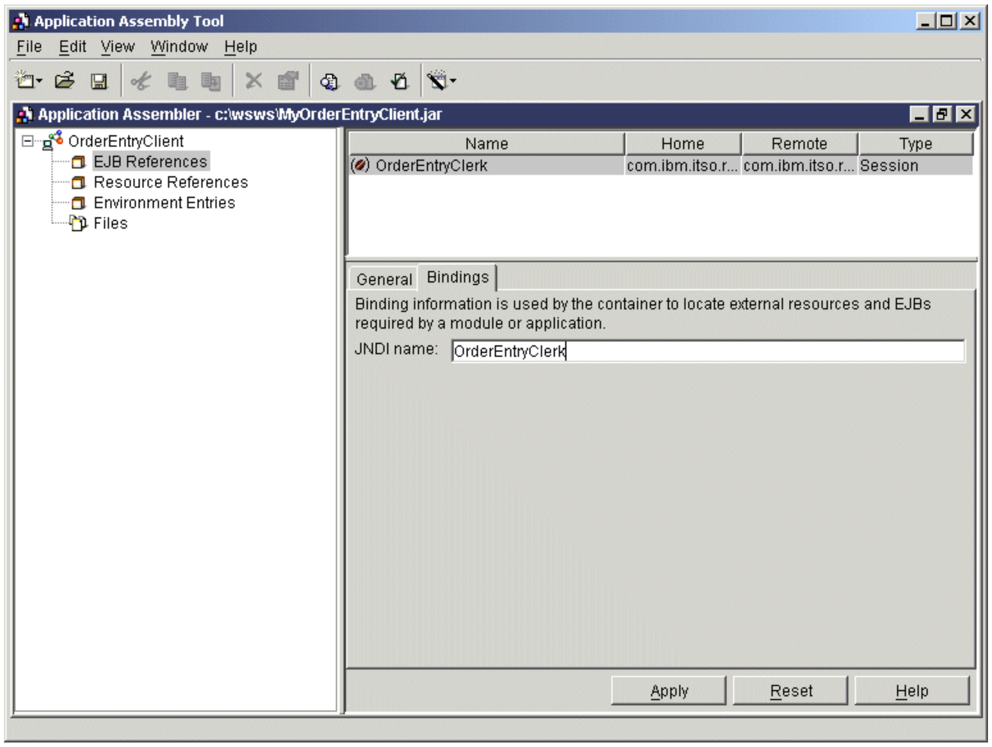

Add EJB References

Name: *	OrderEntryClerk
Description:	
Link:	
Home: *	.ibm.itso.roch.wasaejb.OrderEntryClerkHome
Remote: *	com.ibm.itso.roch.wasaejb.OrderEntryClerk
Type: *	Session

Figure 3-76 Setting the EJB reference

6. Keep clicking **Next** until you see a **Finish** button. Click it to finish the settings.

7. In the AAT main window, click **EJB References** on the left pane and click the **Bindings** tab for the OrderEntryClerk bean. As shown in Figure 3-77, enter `OrderEntryClerk` for JNDI name and click **Apply** to save the settings.



Application Assembly Tool
File Edit View Window Help
Application Assembler - c:\wsws\MyOrderEntryClient.jar
OrderEntryClient
EJB References
Resource References
Environment Entries
Files
General
Bindings
Apply
Reset
Help

Name	Home	Remote	Type
OrderEntryClerk	com.ibm.itso.r...	com.ibm.itso.r...	Session

Binding information is used by the container to locate external resources and EJBs required by a module or application.

JNDI name: OrderEntryClerk

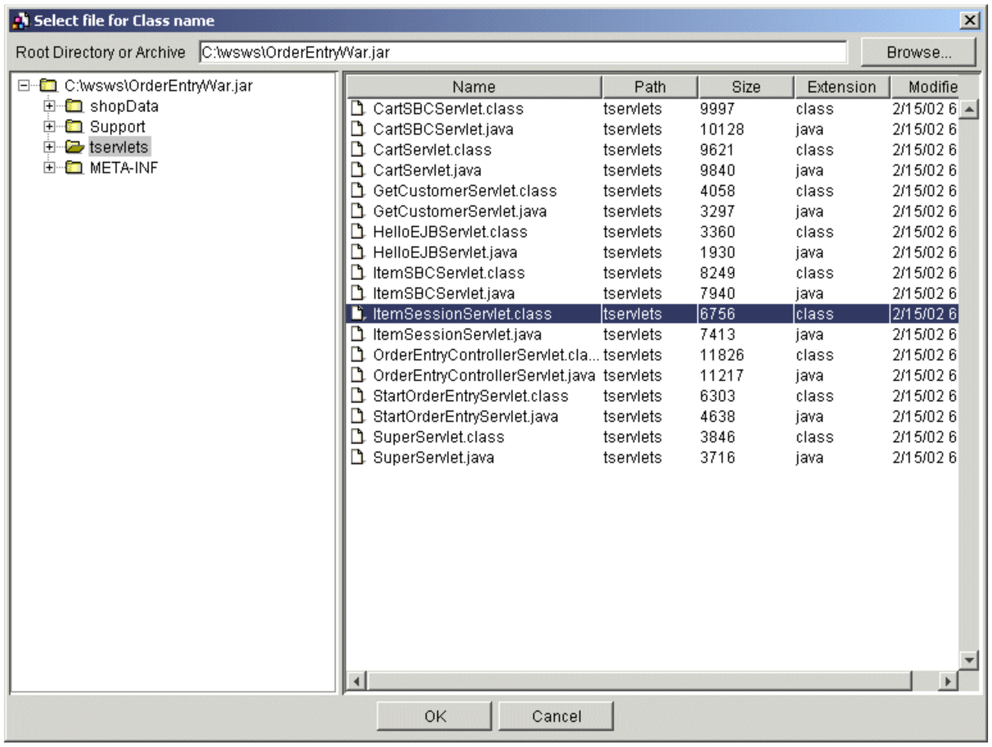
Figure 3-77 Setting the bindings for EJB references

8. The Application Client is now complete. Select **File-> Save** to save the work in the wsws directory as MyOrderEntryClient.jar.

Creating a Web module for OrderEntryWar.jar

In AAT, follow these steps:

1. Select **File-> New-> Web Module**. In the AAT main window, right-click **Web Components** and select **New** to create a new component. In the New Web Component window, enter `ItemSessionServlet` for the Component name. Click **Browse** next to Class name to add the servlet class.
2. In the Select file class name window, click the **Browse** button to locate the **OrderEntryWar.jar** file in the wsws directory. Select **ItemSessionServlet.class** in the **tservlets** package as the servlet, as shown in Figure 3-78. Click **OK** to finish the selection.



C:\wsws\OrderEntryWar.jar

- C:\wsws\OrderEntryWar.jar
  - shopData
  - Support
  - tservlets
  - META-INF

Name	Path	Size	Extension	Modifie
CartSBCServlet.class	tservlets	9997	class	2/15/02 6
CartSBCServlet.java	tservlets	10128	java	2/15/02 6
CartServlet.class	tservlets	9621	class	2/15/02 6
CartServlet.java	tservlets	9840	java	2/15/02 6
GetCustomerServlet.class	tservlets	4058	class	2/15/02 6
GetCustomerServlet.java	tservlets	3297	java	2/15/02 6
HelloEJBServlet.class	tservlets	3360	class	2/15/02 6
HelloEJBServlet.java	tservlets	1930	java	2/15/02 6
ItemSBCServlet.class	tservlets	8249	class	2/15/02 6
ItemSBCServlet.java	tservlets	7940	java	2/15/02 6
ItemSessionServlet.class	tservlets	6756	class	2/15/02 6
ItemSessionServlet.java	tservlets	7413	java	2/15/02 6
OrderEntryControllerServlet.cla...	tservlets	11826	class	2/15/02 6
OrderEntryControllerServlet.java	tservlets	11217	java	2/15/02 6
StartOrderEntryServlet.class	tservlets	6303	class	2/15/02 6
StartOrderEntryServlet.java	tservlets	4638	java	2/15/02 6
SuperServlet.class	tservlets	3846	class	2/15/02 6
SuperServlet.java	tservlets	3716	java	2/15/02 6

Figure 3-78 Selecting the file for classname

3. You return to the New Web Component window. Click **OK** the save the settings.
4. Create a new servlet mapping. We use `ItemSessionServlet` as the URL pattern and select `ItemSessionServlet` as the servlet.
5. Since this servlet invokes the OrderEntryClerk Session Bean for the transactions, we need to add EJB References for it. Using the same steps in "Creating the client module for OrderEntryClient.jar" on page 129, we create an EJB reference to the OrderEntryClerk session bean and also make sure the Bindings value is set to `OrderEntryClerk`.
6. ItemSessionServlet uses initialization parameters for userid, password, system name, and bootstrap port. We need to configure them.
   a. Select **Web Components-> ItemSessionServlet-> Initialization Parameters-> New**. Add the parameter Name/Value pairs as listed in Table 3-2.

Table 3-2 ItemSessionServlet initialization parameters

Name	Value
userid	A valid user ID
password	A valid password
system	iSeries server name
port	WebSphere Application Server bootstrap port

   b. Select **File-> Save As** to save the work in the wsws directory as OrderEntryServlet.war.
   c. Since we use another servlet named CartServlet for shopping cart processing, follow the same procedure to add the CartServlet.

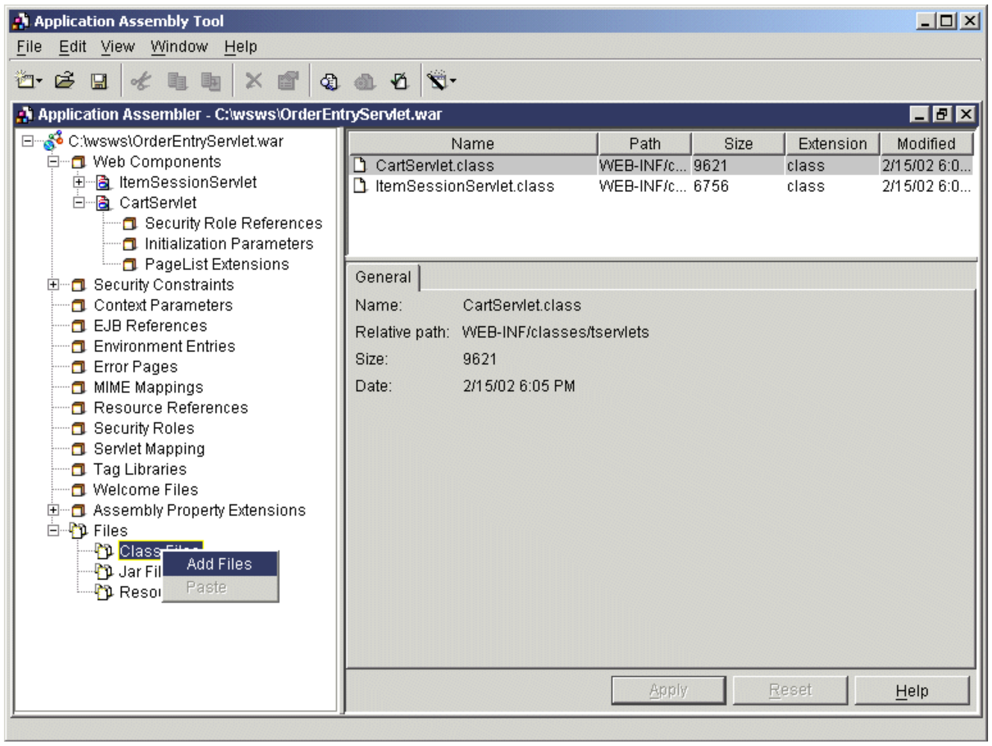
i. Add a new Web Component CartServlet to point to CartServlet in tservlets package (same as with defining ItemSessionServlet).

ii. Create a new Servlet Mapping called `CartServlet` to specify the CartServlet component.

iii. Because CartServlet invokes the `OrderPlacement` session bean for transactions, we need to add a new EJB reference for CartServlet. Using the same technique as for creating an EJB reference to the OrderEntryClerk session bean, we create an EJB reference called *OrderPlacement* to point to OrderPlacement session bean. We set the binding as `OrderPlacement`.

iv. CartServlet also uses initialization parameters when calling the `init()` method. The parameters are the same as those for ItemSessionServlet. Following the same steps, we define the initial parameters of userid, password, system and port for CartServlet.

7. We need to add the supporting classes for the Web module. In AAT, expand **Files** in the left pane, right-click **Class Files**, and then select **Add Files**, as shown in Figure 3-79.



Name	Path	Size	Extension	Modified
CartServlet.class	WEB-INF/c...	9621	class	2/15/02 6:0...
ItemSessionServlet.class	WEB-INF/c...	6756	class	2/15/02 6:0...

Name: CartServlet.class
Relative path: WEB-INF/classes/tservlets
Size: 9621
Date: 2/15/02 6:05 PM

Figure 3-79 Adding additional class files for the Web module

8. In the Add files window, click the **Browse** button to locate the **OrderEntryWar.jar** file in the wsws directory. Select all the files from the ShopData package and click **Add**. Use the same technique to add all the files from the Support and tservlets package. Click **OK** to complete the settings.

9. Select **File-> Save** to save the work. Now we have finished the tasks for the Web module. A new file called *OrderEntryServlet.war* is created in the wsws directory.

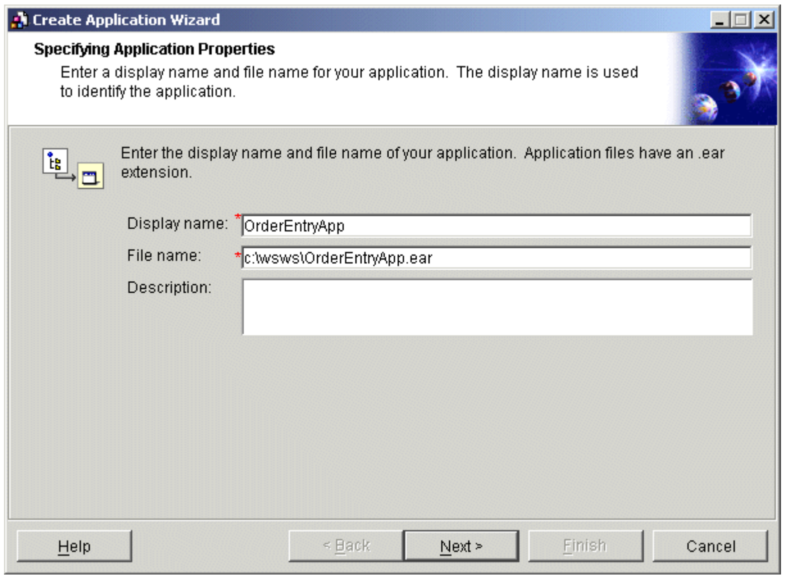
Creating an enterprise application for the OrderEntryApp

Now we have the following three modules:

- Deployed_OrderEntryBeans.jar for EJBs
- MyOrderEntryClient.jar for application client
- OrderEntryServlet.war for servlets

Based on these files, we create the enterprise application using AAT:

1. In AAT, select **File-> Wizards-> Create Application Wizard**. In the Create Application Wizard initial page (Figure 3-80), enter `OrderEntryApp` for Display name and `x:\wsws\OrderEntryApp.ear` for File Name. Replace *x* with the workstation drive letter.



Create Application Wizard

Specifying Application Properties

Enter a display name and file name for your application. The display name is used to identify the application.

Enter the display name and file name of your application. Application files have an .ear extension.

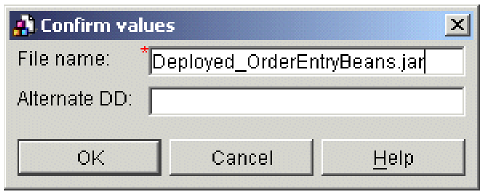
Display name: * OrderEntryApp

File name: * c:\wsws\OrderEntryApp.ear

Description:

Figure 3-80 Creating OrderEntryApp enterprise application

2. Keep clicking **Next** until the Adding EJB Modules window appears. Click **Add** to add the **Deployed_OrderEntryBeans.jar** file from the wsws directory. When the Confirm values dialog (Figure 3-81) appears, leave Alternate DD blank and click **OK**.



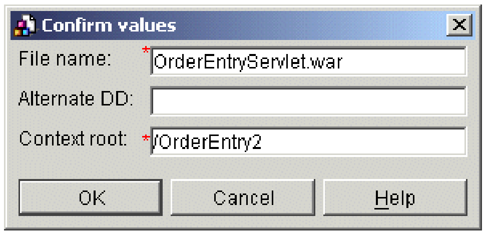
Confirm values

File name: * Deployed_OrderEntryBeans.jar

Alternate DD:

Figure 3-81 Confirming the values for adding EJB modules

3. Click **Next** and in the Adding Web Modules window. Click **Add** to add the **OrderEntryServlet.war** file. In the Confirm values window, as shown in Figure 3-82, leave Alternative DD blank, enter `/OrderEntry2` for Context root, and click **OK**.


Confirm values

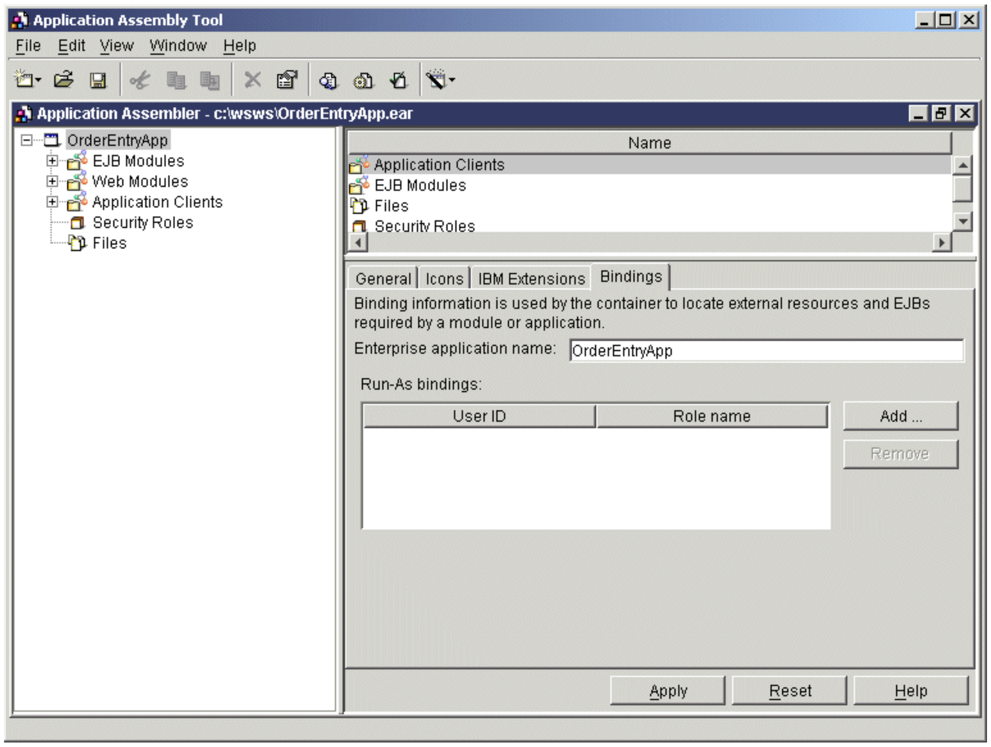
File name: OrderEntryServlet.war

Alternate DD:

Context root: /OrderEntry2

Figure 3-82 Confirming the values for adding Web modules

4. Click **Next**. In the Adding Application Clients Modules window, click **Add** to add the **MyOrderEntryClient.jar** file. In the confirm value window, leave Alternate DD blank and click **OK**.
5. Click **Next** and then click **Finish** to complete the settings.
6. In the AAT main window, click the **OrderEntryApp** application in left pane and click the **Bindings** tab in the right pane. Fill in the Enterprise application name with `OrderEntryApp`, as shown in Figure 3-83. Click **Apply** to save the changes.



Binding information is used by the container to locate external resources and EJBs required by a module or application.

Enterprise application name: OrderEntryApp

Run-As bindings:

User ID	Role name

Figure 3-83 Setting the bindings for OrderEntryApp

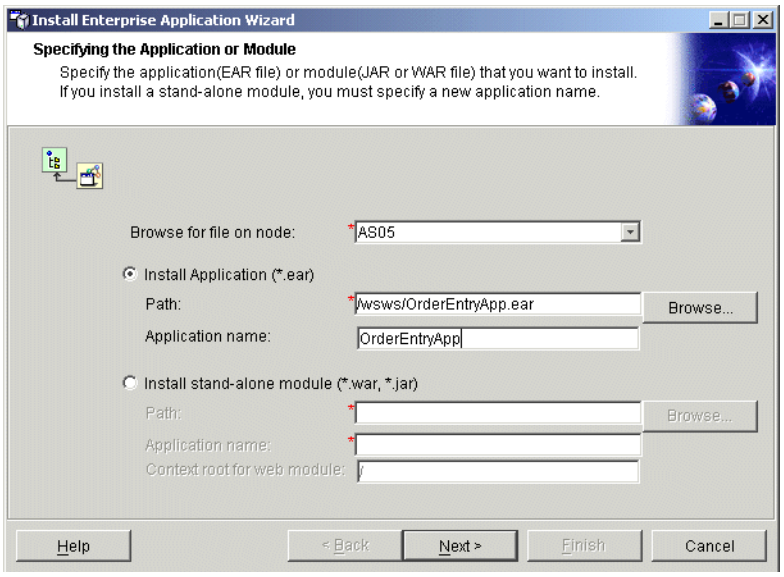
7. Select **File-> Save** to save the file. A new file named *OrderEntryApp.ear* is created in the wsws directory. This is the file where we can install on WebSphere Application Server 4.0.

3.3.15 Installing the OrderEntryApp application on Advanced Edition

In this section, we install the OrderEntryApp enterprise application on WebSphere Application Server Version 4.0 Advanced Edition with the Administrative Console.

1. Copy the **OrderEntryApp.ear** file from our local drive to the iSeries IFS wsws directory. Now, the Administrative Console can access it when creating enterprise applications.

2. In the Console, select the wizard icon and select **Install Enterprise Application**. The Specifying the Application or Module window (Figure 3-84) appears. Make sure that the **Install Application** radio button is selected. Click the **Browse** button next to Path to locate the **OrderEntryApp.ear** in the wsws directory. Enter `OrderEntryApp` for the Application name.



Specifying the Application or Module

Specify the application(EAR file) or module(JAR or WAR file) that you want to install.
If you install a stand-alone module, you must specify a new application name.

Browse for file on node: *AS05

(●) Install Application (*.ear)

Path: */wsws/OrderEntryApp.ear

Application name: OrderEntryApp

( ) Install stand-alone module (*.war, *.jar)

Path: *

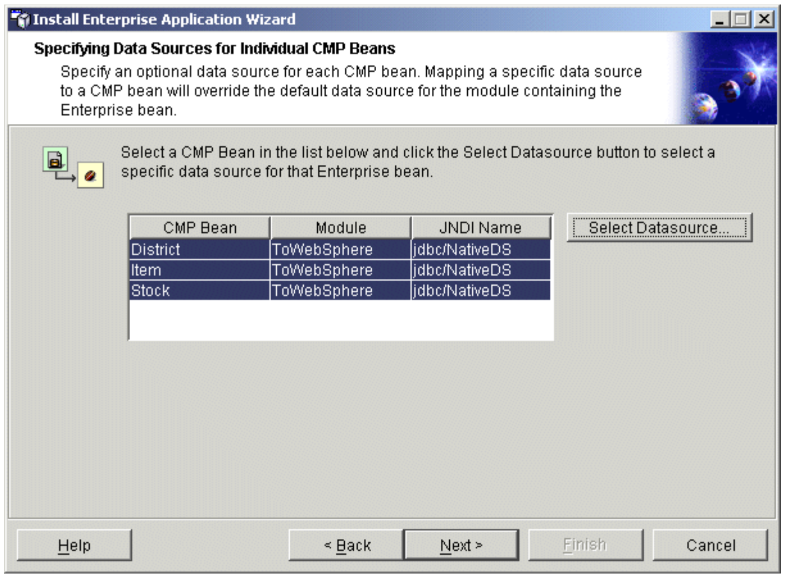
Application name: *

Context root for web module: /

Figure 3-84 Installing the application

3. Keep clicking **Next** until you reach the Specifying the Default Datasource for EJB Modules window. Click the **Select Datasource** button and select the **NativeDS** Datasource. Enter a user ID and password (twice) and click **OK**.
4. Click **Next**. In the Specifying Data Sources for individual CMP beans window, select all three of the CMP beans. Click the **Select Datasource** button. Then select the **NativeDS** Datasource. Enter a user ID and password (twice) and click **OK**. Now we have a Data Source for each CMP bean as shown in Figure 3-85.

Note: We use the NativeDS DataSource. See Chapter 3 in the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815, for information on how to create a DataSource.



Specifying Data Sources for Individual CMP Beans

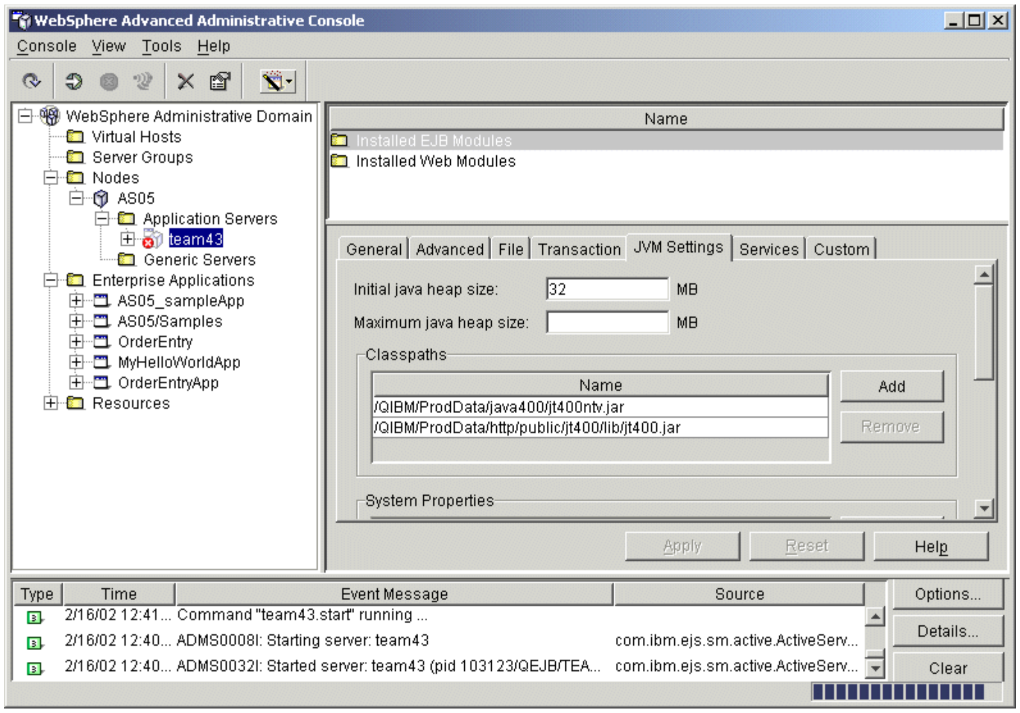
Specify an optional data source for each CMP bean. Mapping a specific data source to a CMP bean will override the default data source for the module containing the Enterprise bean.

Select a CMP Bean in the list below and click the Select Datasource button to select a specific data source for that Enterprise bean.

CMP Bean	Module	JNDI Name
District	ToWebSphere	jdbc/NativeDS
Item	ToWebSphere	jdbc/NativeDS
Stock	ToWebSphere	jdbc/NativeDS

Figure 3-85 Specifying data sources for CMP beans

5. Keep clicking **Next** until you reach the Completing the Application Installation window. Click **Finish** to install the application. When the Regenerate the application dialog appears, click **No**.
6. Now we have successfully installed the OrderEntryApp enterprise application on WebSphere Application Server Version 4.0 Advanced Edition. We need to stop the server. Before we restart it, we set up the classpath for this application. The application server needs to find the classes in the IBM Toolbox for Java. As shown in Figure 3-86, select the application server and click the **JVM Settings** tab in the right pane. Add the following files to the Classpaths settings and click **Apply**.
   - /QIBM/ProdData/Java400/jt400ntv.jar
   - /QIBM/ProdData/http/public/jt400/lib/jt400.jar



Initial java heap size: 32 MB
Maximum java heap size: MB

Classpaths

Name
/QIBM/ProdData/java400/jt400ntv.jar
/QIBM/ProdData/http/public/jt400/lib/jt400.jar

System Properties

Type	Time	Event Message	Source
	2/16/02 12:41...	Command "team43.start" running ...	
	2/16/02 12:40...	ADMS0008I: Starting server: team43	com.ibm.ejs.sm.active.ActiveServ...
	2/16/02 12:40...	ADMS0032I: Started server: team43 (pid 103123/QEJB/TEA...	com.ibm.ejs.sm.active.ActiveServ...

Figure 3-86 Setting the classpath

Restart the server to make the new application available. For an external HTTP server, we need to regenerate the Web server plug-ins.

3.3.16 Testing the OrderEntryApp application

Now we have successfully installed the OrderEntryApp application on WebSphere Application Server Advanced Edition. The next step is to test it.

Since we have two kinds of EJB clients – application clients and servlets – we test both of them.

Testing the application client

To test the application client, follow these steps:

1. Open a workstation command prompt session and change the directory to the `\<WebSphere install>\AppServer\bin` directory. Enter the following command:

   ```
   launchclient x:\wsws\orderentryapp.ear port -CCBootstrapHost=sysname
   -CCBootstrapPort=port
   ```

   Here *x* is the drive where the wsws directory is stored, *sysname* is the name of iSeries server, and *port* is the administrative server bootstrap port.

2. Once the client application window (Figure 3-87) appears, select **Connect-> Connect**. Enter the iSeries server name, user ID, and password in the signon dialog, and click **OK**.

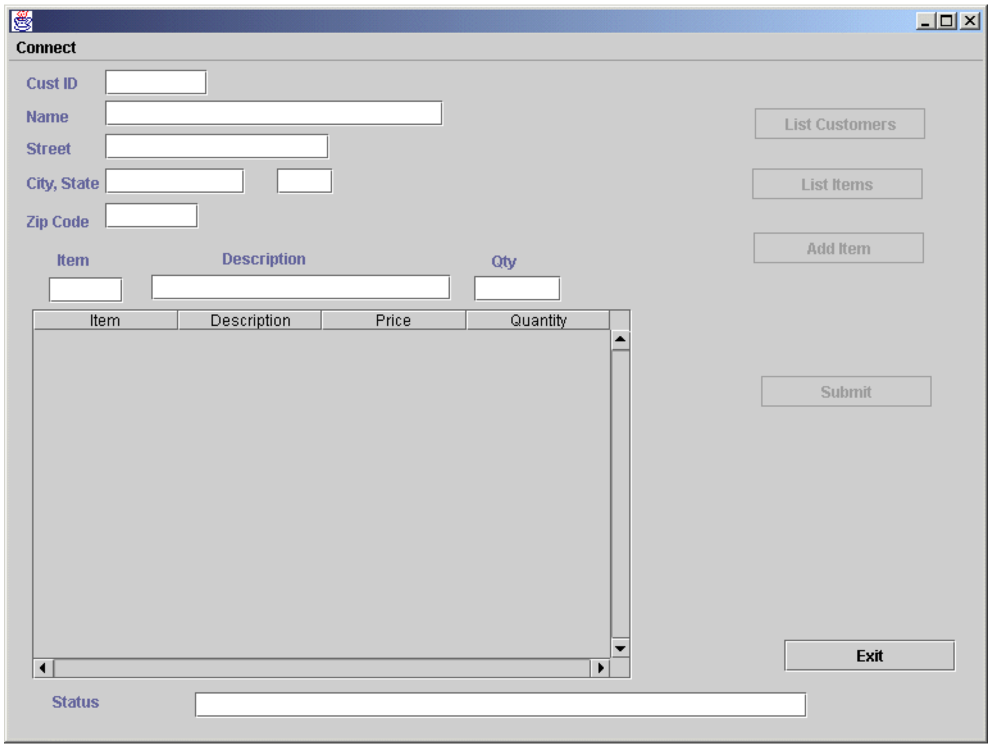
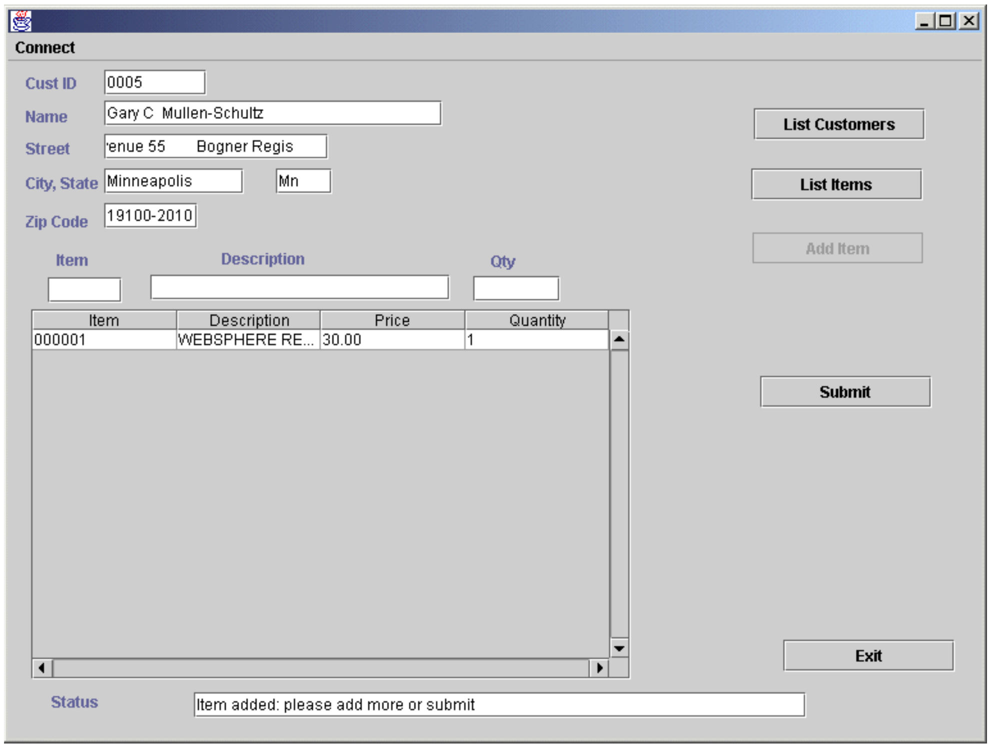


Figure 3-87 Running the client application

3. Once you successfully sign on (a status message indicates this), click the **List Customers** button, select one customer, and click **OK**.
4. Click the **List Items** button, select an item, and click **OK**. Dismiss the List Items window. Return to the main window, enter a quantity for the selected item, and click the **Add Item** button. As shown in Figure 3-88, this item is added to the list. You can keep adding new items.



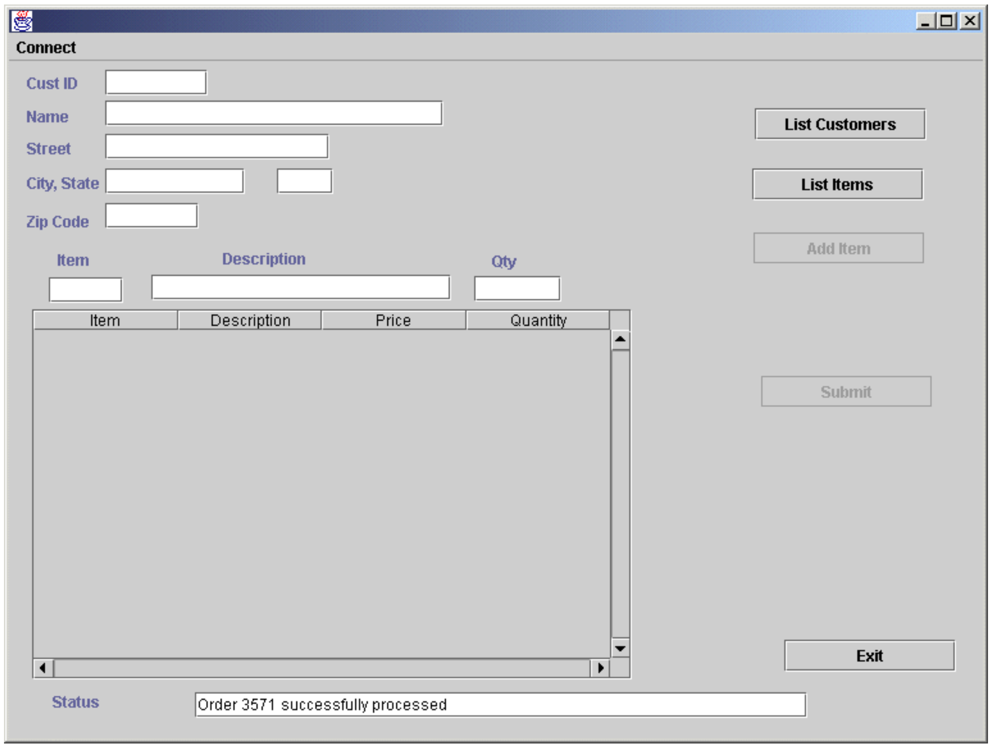
Cust ID	0005
Name	Gary C Mullen-Schultz
Street	'enue 55 Bogner Regis
City, State	Minneapolis Mn
Zip Code	19100-2010

Item	Description	Price	Quantity
000001	WEBSPHERE RE...	30.00	1

Status: Item added: please add more or submit

Figure 3-88 Adding an item to the list

5. Click the **Submit** button to place an order. As shown in Figure 3-89, if everything works correctly, an order number is returned to the Status field.



Status: Order 3571 successfully processed

Figure 3-89 A successful order placement

Testing the servlet

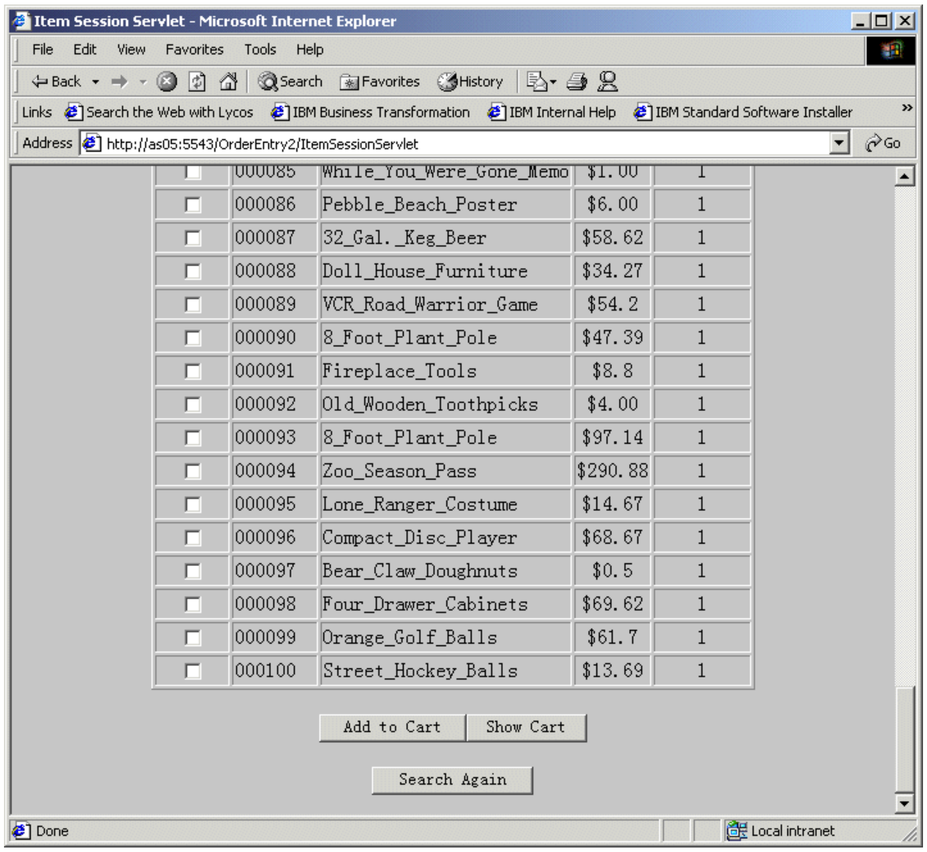
To test the servlet, follow these steps:

1. Open a browser to access the servlet by entering the URL:

   `http://`*`sysname`*`:`*`port`*`/OrderEntry2/ItemSessionServlet`

   Here *sysname* is the iSeries server name, and *port* is the external (or internal) HTTP server port.

   If everything works properly, the item list shown in Figure 3-90 appears.

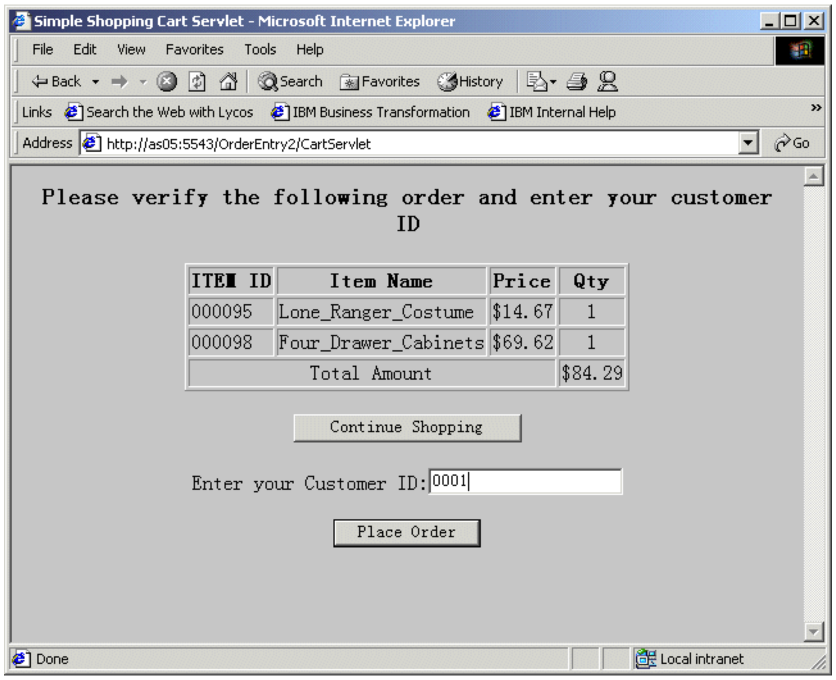


Item Session Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://as05:5543/OrderEntry2/ItemSessionServlet
Go
Done
Local intranet

☐	000085	While_You_Were_Gone_Memo	$1.00	1
☐	000086	Pebble_Beach_Poster	$6.00	1
☐	000087	32_Gal._Keg_Beer	$58.62	1
☐	000088	Doll_House_Furniture	$34.27	1
☐	000089	VCR_Road_Warrior_Game	$54.2	1
☐	000090	8_Foot_Plant_Pole	$47.39	1
☐	000091	Fireplace_Tools	$8.8	1
☐	000092	Old_Wooden_Toothpicks	$4.00	1
☐	000093	8_Foot_Plant_Pole	$97.14	1
☐	000094	Zoo_Season_Pass	$290.88	1
☐	000095	Lone_Ranger_Costume	$14.67	1
☐	000096	Compact_Disc_Player	$68.67	1
☐	000097	Bear_Claw_Doughnuts	$0.5	1
☐	000098	Four_Drawer_Cabinets	$69.62	1
☐	000099	Orange_Golf_Balls	$61.7	1
☐	000100	Street_Hockey_Balls	$13.69	1

Figure 3-90 Testing the servlet

2. Select some items and click the **Add to Cart** button to add them to the shopping cart.
3. After viewing the shopping cart, click the **Check Out** button. As shown in Figure 3-91, enter a customer number (0001 to 0010) and click the **Place Order** button.


Simple Shopping Cart Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:5543/OrderEntry2/CartServlet
Go
Continue Shopping
Place Order
Done
Local intranet

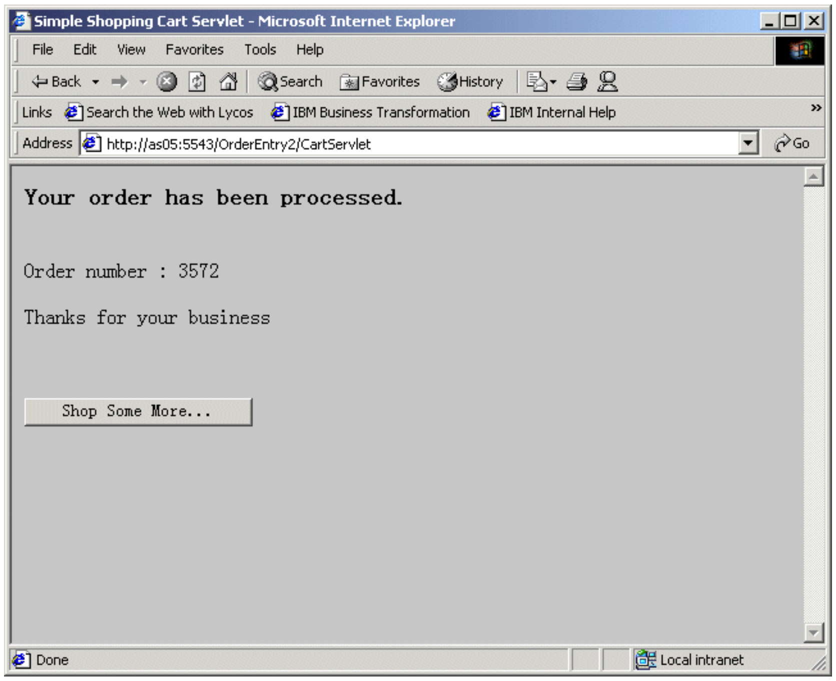
Please verify the following order and enter your customer ID

ITEM ID	Item Name	Price	Qty
000095	Lone_Ranger_Costume	$14.67	1
000098	Four_Drawer_Cabinets	$69.62	1
Total Amount			$84.29

Enter your Customer ID: 0001

Figure 3-91 Placing an order

If everything works successfully, we see a confirmation message as shown in Figure 3-92.


Simple Shopping Cart Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://as05:5543/OrderEntry2/CartServlet
Go
Shop Some More...
Done
Local intranet

Your order has been processed.

Order number : 3572

Thanks for your business

Figure 3-92 A successful order

We have successfully run the OrderEntryApp transaction application in WebSphere Application Server Version 4.0 Advanced Edition.

4

Introduction to WebSphere Studio Application Developer

This chapter provides an introduction to WebSphere Studio Application Developer. It is a follow-on product to VisualAge for Java and WebSphere Studio. It provides many of the key VisualAge for Java and WebSphere Studio capabilities, plus it adds many new capabilities. It helps you build and test J2EE compliant applications. We also refer to it as *Application Developer*.

The purpose of this chapter is to get you started with WebSphere Studio Application Developer. We walk you through some simple examples to show you how to navigate in Application Developer and how to customize your workspace. We show you how to do more complex examples – such as building, testing, and deploying servlets, JavaServer Pages, and Enterprise JavaBeans – in other chapters of this redbook.

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4.1 WebSphere Studio Application Developer overview

WebSphere Studio Application Developer is the follow-on technology for WebSphere Studio, Professional and Advanced Editions and VisualAge for Java Enterprise Edition. These new tools support the end-to-end development, testing, and deployment of e-business applications.

The new WebSphere Studio products are designed from the ground up to meet the requirements for all new types of applications. These requirements include:

- Open standards
- Java
- XML
- Web Services
- Testing
- Varying levels of integration with other components and ISV products
- Pluggability
- Expandability
- Role-based development
- Increased usability for all users
- Enhanced team support
- Increased speed to market

Application Developer provides integrated development tools for all e-business development roles. These roles include Web developers, Java developers, business analysts, application architects, and enterprise application programmers.

Application Developer brings together the most popular features of WebSphere Studio "Classic", and VisualAge for Java and combines them with the advantages of the latest technology, providing open standards, tool integration, more flexibility, and the ability to tie in existing applications.

Figure 4-1 shows all the tasks you can manage with Application Developer.

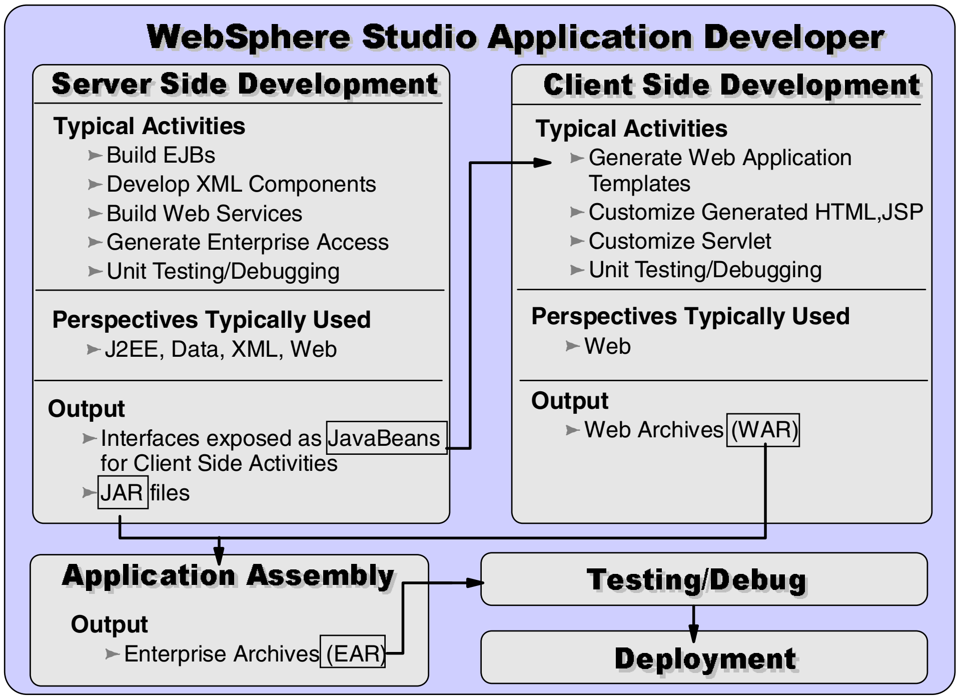


Figure 4-1 Building a J2EE Application with Application Developer

Java features

- Ships with JDK 1.3
- Pluggable runtime JDK support per project
  - Specify JRE and rt.jar for running/building/debugging
- Incremental saves
- Java code snippet support (scrapbook)
- Task Sheet (All Problems Page)
- Code Assist
- JDI-based debugger
  - One debugger for local/remote debugging
- Run code with errors
- Refactoring support
  - Rename/move support for method/class/packages
  - Fixes all dependencies for renamed element
  - Method extraction

J2EE features

- Full J2EE 1.2 Support
- WAR/EAR deployment support
- All metadata exposed as XMI
- Enhanced Unit Test Environment for J2EE
  - IBM WebSphere Application Server or Apache Tomcat
  - Create multiple projects with different Unit Test configurations/instances
    - Version Unit Test Environment
    - Share Unit Test Environment configuration across developers

- Object-oriented mapping for EJBs
  - Top-down/bottom-up/meet-in-the-middle
- Updated EJB Test Client
  - HTML-based
  - J2EE Programming model
  - Built-in JNDI Registry Browser
- Enterprise Connectors (separate plug-in offering)
  - JCA Connector based
- Built-in J2EE perspective provides the useful views for the EJB/J2EE developer

Web features

- HTML/JSP editing
  - WYSIWYG page design, source editing, page preview
- WAR import/export
- Links View (Relations)
  - View HTML/JSP and all links referenced in HTML/JSP
- Parsing/link management
  - Automatically fix links when resources are moved/renamed
- Built-in servlet, database, JavaBean wizards
  - Quick generation of HTML/Servlet/JSP
- Built-in JSP debugger
- Site-style and template support
- Built-in Web perspective provides the useful views for HTML/JSP developer

XML features

- Built-in XML tooling provides integrated tools/perspectives to create XML-based components:
  - DTD Editor
    - Visual tool for working with DTDs
    - Create DTDs from existing documents
    - Generate an XML Schema from a DTD
    - Generate JavaBeans for creating/manipulating XML documents
    - Generate an HTML form from a DTD
  - XML Schema Editor
    - Visual tool (Design/Source) for working with an XML Schema
    - Generate DTDs from an XML Schema
    - Generate JavaBeans for creating/manipulating XML documents
  - XML Source Editor
    - DTD/Schema validation
    - Code Assist for building XML documents
- Additional XML Tools:
  - XML Mapping Editor
    - Generate XSL to map XML between DTDs/schemas

  - XSL Trace Editor
    - Trace XSL transformation
    - Examine relationships between the result node, the template rule, and the source node
  - XML to/from relational databases
    - Generate XML, XSL, XSD from an SQL query
  - RDB/XML Mapping Editor
    - Map columns in a table to elements and attributes in an XML document
    - Generate a Database Access Definition (DAD) script to compose/decompose XML documents to/from a database
    - DAD is used with DB2 XML Extender
- Built-in XML perspective provides the useful views for the XML developer

Web Services features

- Easily consume/construct Web Services:
  - Discover
    - Browse UDDI registry to locate existing Web Services
    - Generate JavaBean Proxy for existing Web Services
  - Create/transform new Web Services from JavaBeans, databases, and so on
  - Deploy Web Service to WebSphere or Tomcat for testing
  - Test (via a built-in test client) immediately local/remote Web Services
  - Publish Web Services to UDDI registry

Relational Database features

- Relational Schema Center
  - Provides views geared for database administrators (DBAs) to:
    - Create Databases
    - Create Tables/Views/Indexes/Keys
    - Generate DDL
  - Online and offline support for working with databases
    - Metadata generated as XMI
- SQL Query Builder
  - Visually construct SQL statements
    - Insert, update, delete, select supported
  - Metadata generated as XMI
  - SQL/XML mapping
- Built-in Data perspective provides the useful views for DBAs

4.2 Getting started with Application Developer

Next we help you get started with Application Developer. We provide step-by-step instructions to show how to perform some general tasks with WebSphere Studio Application Developer. These tasks are:

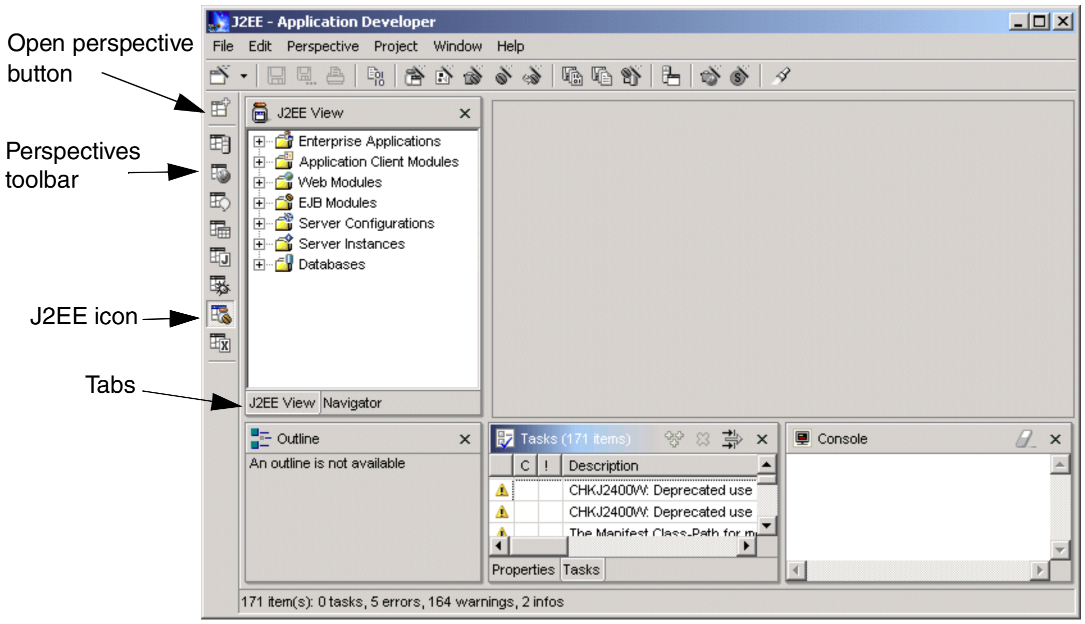
- Navigating in Application Developer
- Importing resources
- Customizing Application Developer

4.2.1 Navigating in Application Developer

In Application Developer, there are several ways to see your project. You must choose one method or the other, depending of the role you are playing at the time. These views are called *perspectives*. To work with perspectives, follow these steps:

1. Start Application Developer by clicking **Start-> Programs-> IBM WebSphere Studio Application Developer-> IBM WebSphere Studio Application Developer**.

   Application Developer starts in the J2EE perspective (this is the default perspective) as shown in Figure 4-2.



An outline is not available

CHKJ2400W: Deprecated use

CHKJ2400W: Deprecated use

The Manifest Class-Path for m

171 item(s): 0 tasks, 5 errors, 164 warnings, 2 infos

Figure 4-2 J2EE perspective

2. Click the **Open perspective** button.
3. Look at the predefined selection of perspectives in the pop-up menu and select **Other**.
4. Select **Help** and click **OK** as shown in Figure 4-3.

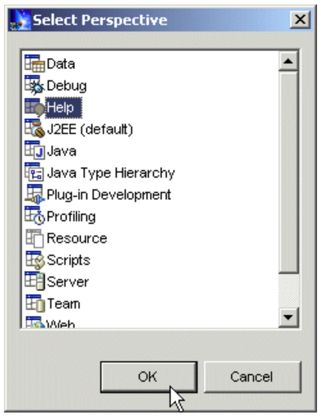


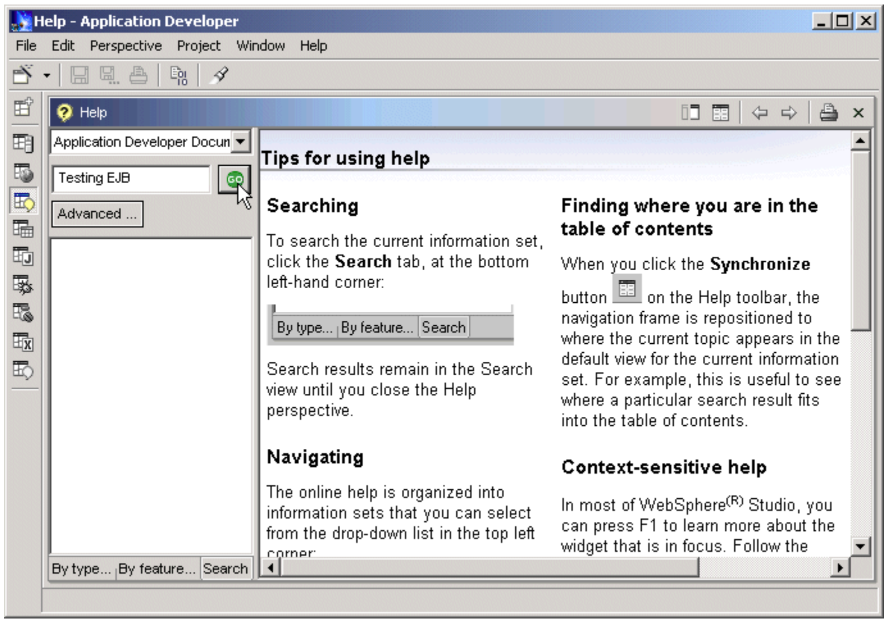
Figure 4-3 Select Perspective

The Help perspective contains the help information for the tool; you can explore any topic. Notice that the perspective has three tabs:

– By type...
– By feature...
– Search

The first two tabs have information ordered by those two references. The last one is for searching any topic that you want in the tool help information.

5. Click the **Search** tab. Enter `Testing EJB` in the search text field (you have to replace *Enter search string* in the search text field) as shown in Figure 4-4.


Help - Application Developer
File Edit Perspective Project Window Help
Help
Application Developer Docun
Testing EJB
GO
Advanced ...
By type... By feature... Search

Tips for using help

Searching

To search the current information set, click the **Search** tab, at the bottom left-hand corner:

By type... By feature... Search

Search results remain in the Search view until you close the Help perspective.

Navigating

The online help is organized into information sets that you can select from the drop-down list in the top left corner:

Finding where you are in the table of contents

When you click the **Synchronize** button on the Help toolbar, the navigation frame is repositioned to where the current topic appears in the default view for the current information set. For example, this is useful to see where a particular search result fits into the table of contents.

Context-sensitive help

In most of WebSphere(R) Studio, you can press F1 to learn more about the widget that is in focus. Follow the

Figure 4-4 Searching in the help perspective

Click **GO**.

6. After some time, you see all the topics that contain the string `Testing EJB`. You can browse through the search results. Notice that the search facility highlights the search string in the text. Click the **Advanced** button located under the search text field.
7. Select the **Search headings only** check box as shown in Figure 4-5.

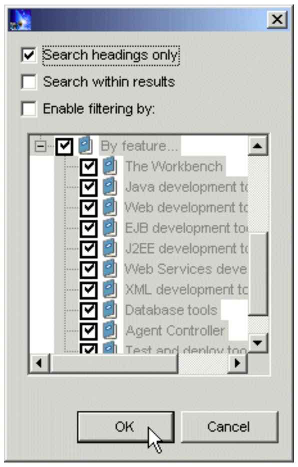


Figure 4-5 Advanced search

Click **OK** to set this option and close the window.

8. Click **GO** again.
9. Now you see only a subset of the references you had before. Observe the differences in the search results.

Next, we open the Java perspective by following these steps:

1. Select **Perspective-> Open-> Other** from the menu (Figure 4-6). Select **Java** from the list and click **OK**. This is an alternative method of opening a perspective.

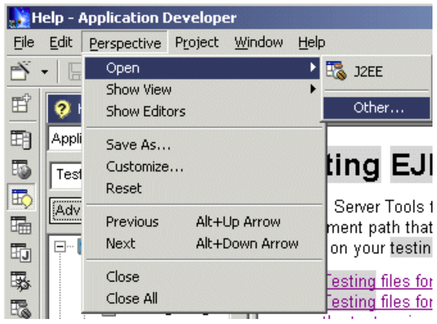


Figure 4-6 Opening Other perspective from the menu

Notice that now the Java icon is in the perspective toolbar. You can see all the icons when you select the perspective as shown in Figure 4-3.

2. In the Java perspective, you can develop Java code for your application, as we do later in this chapter.

   You can return to the help perspective by clicking the help icon in the perspective. You see that Application Developer remembers the last search you did.

3. Right-click the **Java perspective** button on the perspective toolbar. Select **Close**, as shown in Figure 4-7. This closes the Java perspective.

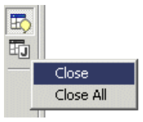


Figure 4-7 Closing the Java perspective

4.2.2 Importing resources

When working with Application Developer, you can import code from previous Java developments. You can import Java code or JAR files to an existing project. We explain how to do this in the following steps:

1. Switch to the J2EE perspective by clicking the **J2EE perspective** button in the perspective toolbar.
2. Create a Java project by selecting **File-> New-> Other** from the menu, as shown in Figure 4-8.

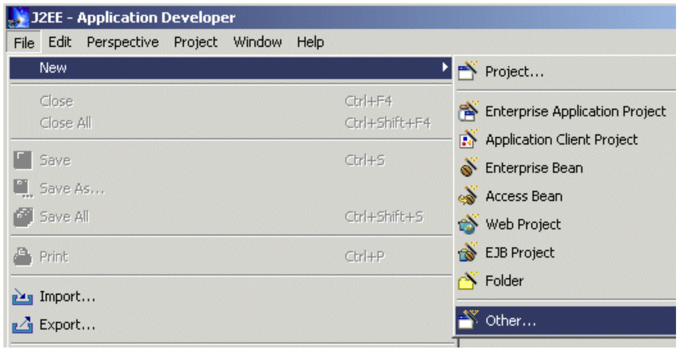


Figure 4-8 Creating a new Java project

3. Click **Java** in the left pane of the pop-up window and select **Java Project** in the right pane. There is also a button on the toolbar in the Java perspective to perform this task. Click **Next** as shown in Figure 4-9.

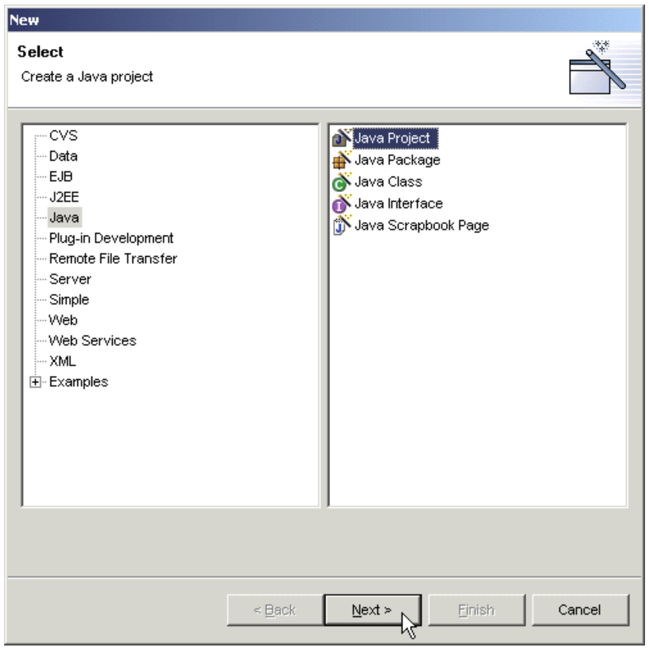


Figure 4-9 Selecting the Java project to create

4. Enter `JUnit` as the project name. Click **Finish** as shown in Figure 4-10.

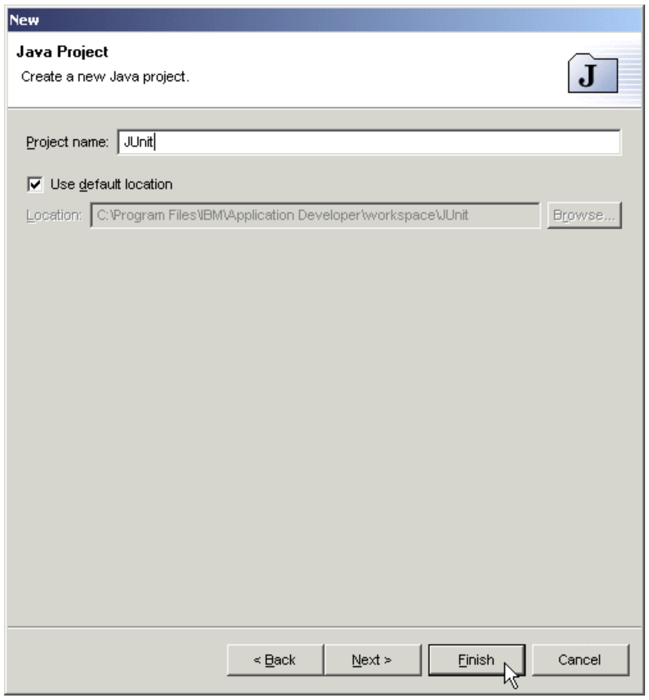

New
Java Project
Create a new Java project.
Project name: JUnit
Use default location
Location: C:\Program Files\IBM\Application Developer\workspace\JUnit
Browse...
< Back
Next >
Finish
Cancel

Figure 4-10 Clicking Finish to create the Java project

Application Developer switches to the Java perspective. Now we are going to import a JAR file:

1. Select **File-> Import** from the menu.
2. Select **Zip file** and click **Next** as shown in Figure 4-11.

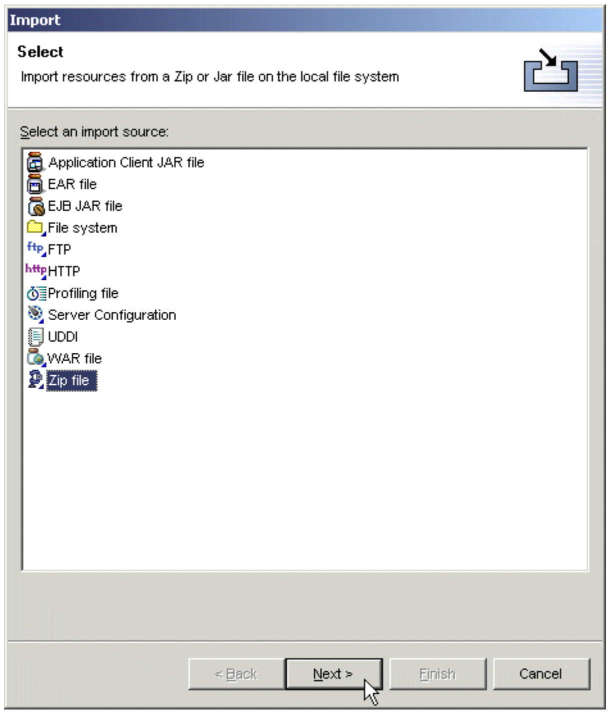


Figure 4-11 Importing a JAR file

3. Click **Browse** next to the Zip file field, and navigate to the zip file. We use the JAR file *junit37src.jar*.
4. Click **Open**.
5. Click **Browse** next to the Folder field. The JAR file is found in the <Application Developer install directory>\plugins\org.eclipse.jdt.ui.examples.projects\archive\junit\ directory.
6. Select **JUnit** and click **OK** as shown in Figure 4-12.

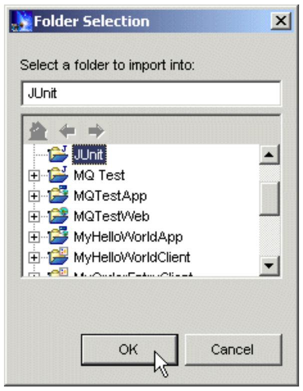


Figure 4-12 Selecting the folder for importing the JAR file

7. Click **Finish** as shown in Figure 4-13.

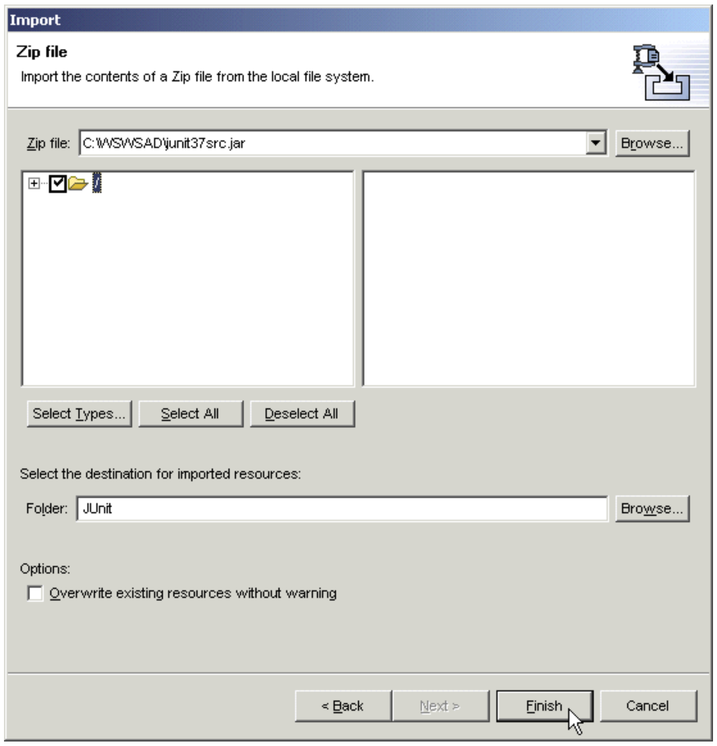
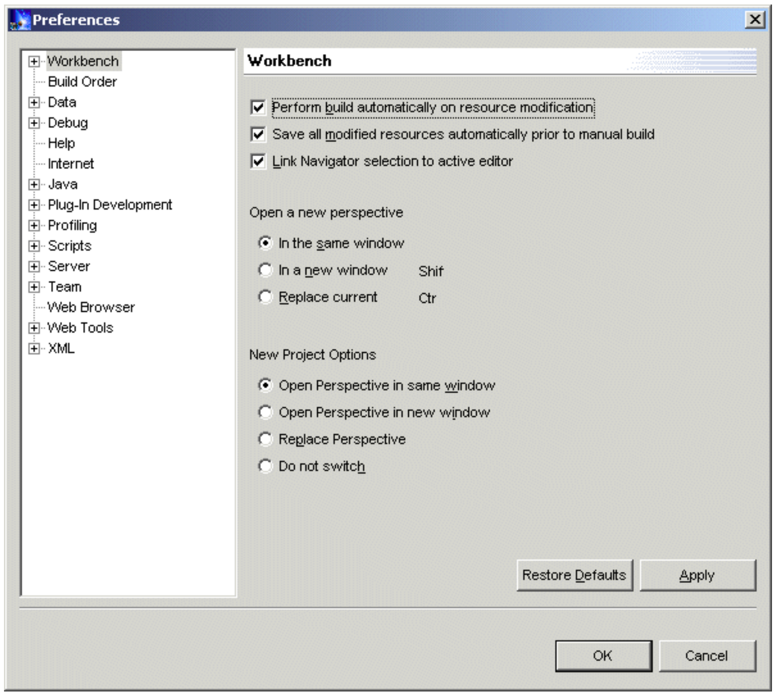

Import
Zip file
Import the contents of a Zip file from the local file system.
Zip file: C:\WSWSAD\junit37src.jar
Browse...
/
Select Types...
Select All
Deselect All
Select the destination for imported resources:
Folder: JUnit
Browse...
Options:
Overwrite existing resources without warning
< Back
Next >
Finish
Cancel

Figure 4-13 Clicking Finish to import the JAR file

4.2.3 Customizing Application Developer

Now we show you how to customize some of the options of Application Developer to make it more suitable to your personal preferences. Follow these steps:

1. Click **Window-> Preferences** to open the Preferences window as shown in Figure 4-14.



Workbench

- [✓] Perform build automatically on resource modification
- [✓] Save all modified resources automatically prior to manual build
- [✓] Link Navigator selection to active editor

Open a new perspective

- [✓ In the same window]
- In a new window Shif
- Replace current Ctr

New Project Options

- [✓ Open Perspective in same window]
- Open Perspective in new window
- Replace Perspective
- Do not switch

Figure 4-14 The Preferences window

2. One of the most interesting options is the automatic build. It is enabled by default. You can deselect **Perform build automatically on resource modification** to disable it. If you do this, you need to invoke the build/rebuild project option from the Application Developer menu every time you need to compile the code in your project.
3. Expand the **Workbench** tree. Select **Perspectives**. J2EE is the default perspective. You can select the perspective you want to be your default one. For example, select the Web perspective and click **Make Default** as shown in Figure 4-15.

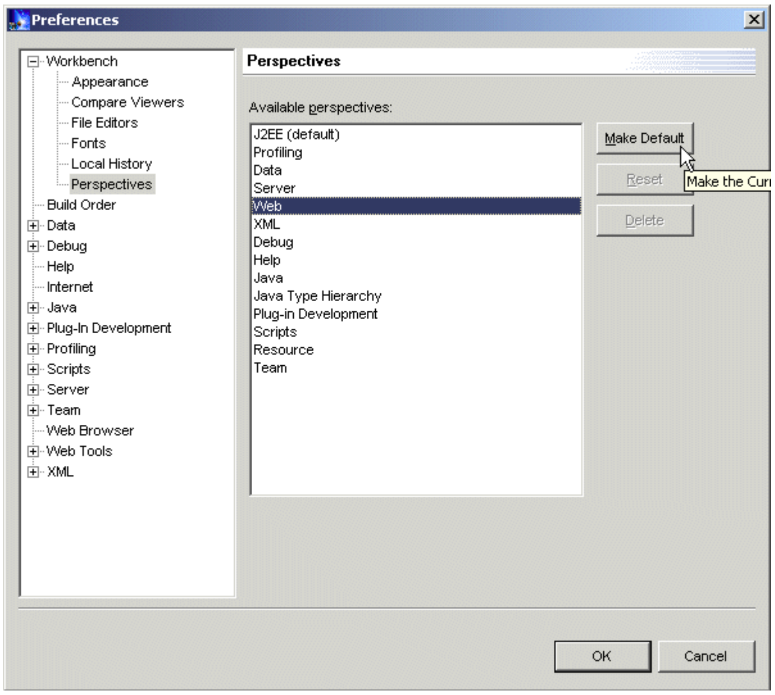


Figure 4-15 Changing the default perspective

4. Select **Fonts** from the workbench tree. You can change the default font as shown in Figure 4-16.

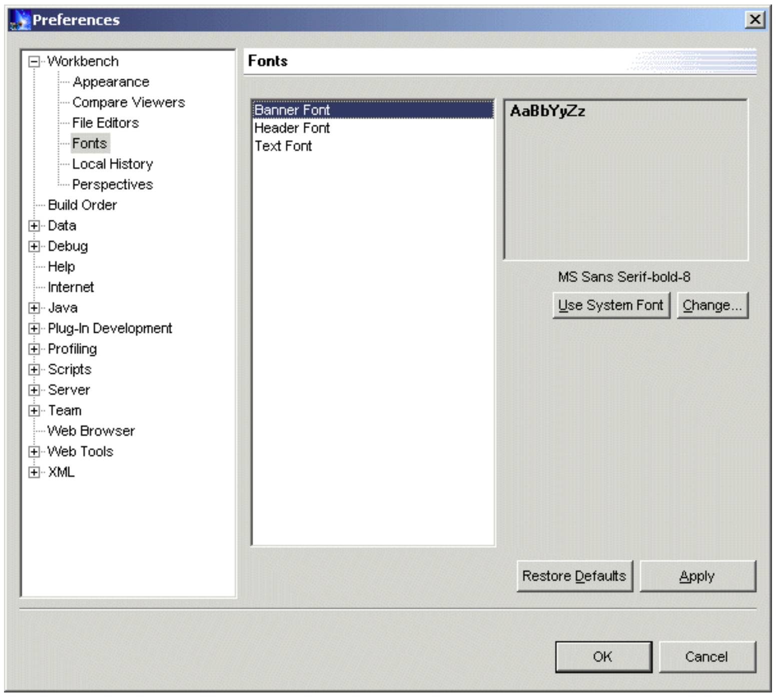
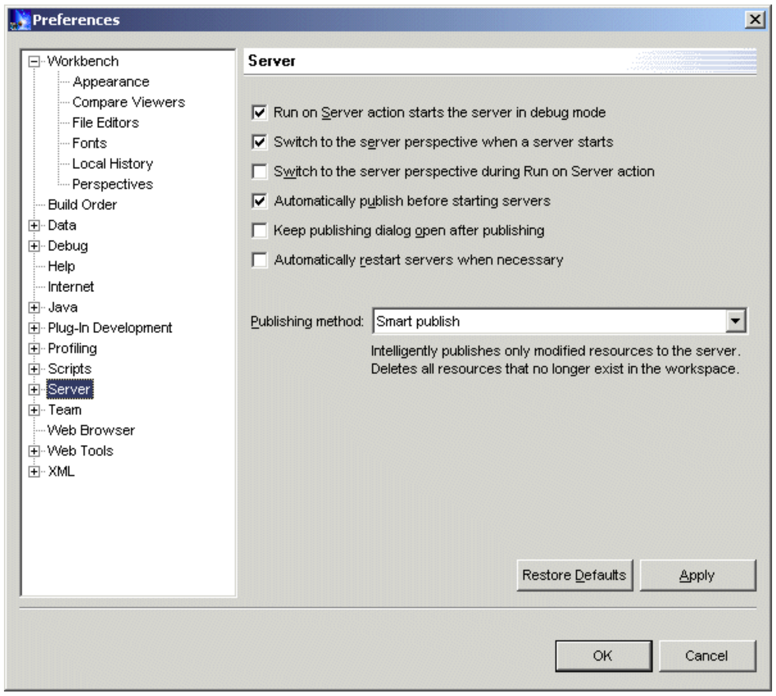


Figure 4-16 Default fonts

5. Click **Server**. On the Server Preferences panel, you can configure the behavior of Application Developer when you run your application on a server, as shown in Figure 4-17.



Server

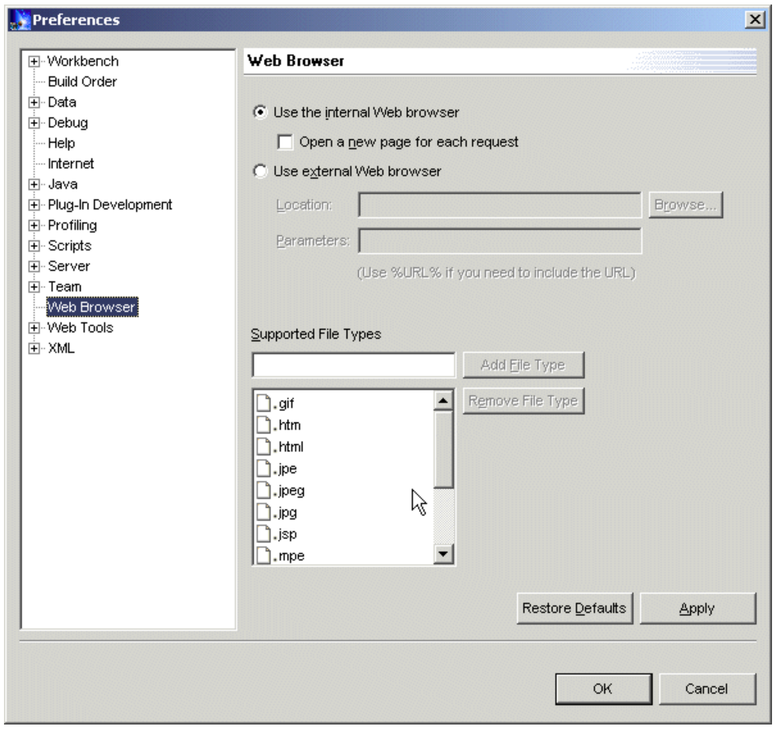
- [✓] Run on Server action starts the server in debug mode
- [✓] Switch to the server perspective when a server starts
- [ ] Switch to the server perspective during Run on Server action
- [✓] Automatically publish before starting servers
- [ ] Keep publishing dialog open after publishing
- [ ] Automatically restart servers when necessary

Publishing method: Smart publish

Intelligently publishes only modified resources to the server. Deletes all resources that no longer exist in the workspace.

Figure 4-17 Server preferences

6. Select **Web Browser**. Here you can choose the settings for the browser. You can choose the internal or another browser for testing as shown in Figure 4-18.



Web Browser

[✓] Use the internal Web browser

- [ ] Open a new page for each request

[ ] Use external Web browser

Location:

Parameters:

(Use %URL% if you need to include the URL)

Supported File Types

.gif
.htm
.html
.jpe
.jpeg
.jpg
.jsp
.mpe

Figure 4-18 Web Browser preferences

Click **OK**. Application Developer saves and applies your changes to the environment.

There are many more preferences that you can set.

Now we work some with the editors. Follow these steps:

1. Switch to the Java perspective if you are in a different one. You should see a window similar to the one shown in Figure 4-19.

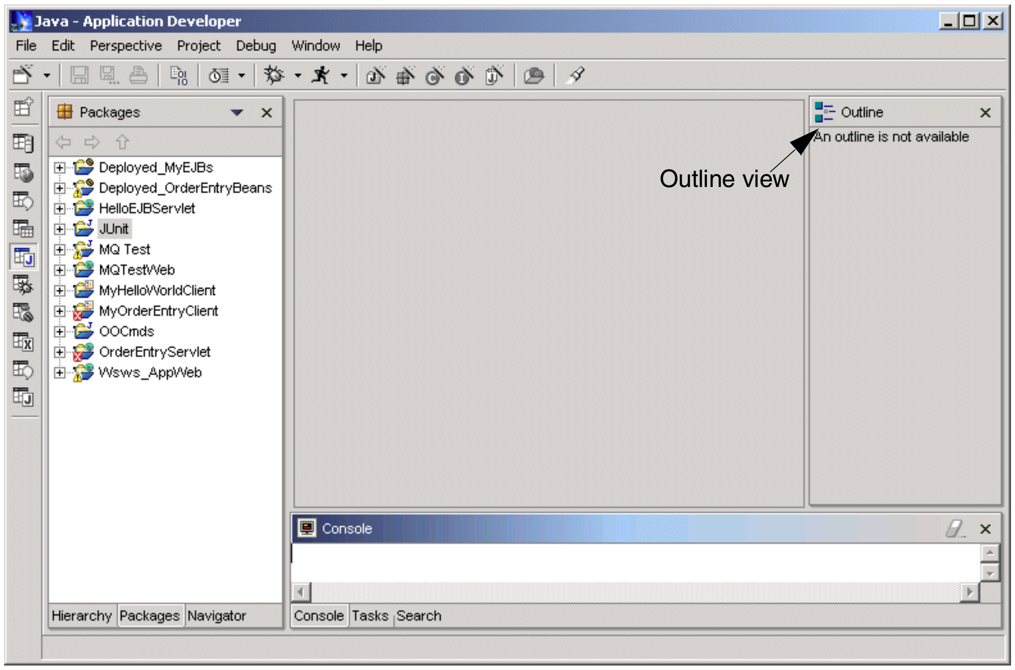


Figure 4-19 Java perspective

2. To create more space for your Java file editor, you can move the **Outline** view to a different location:

   a. Click the **Outline** title bar and drag it to the bottom of the Packages view. The cursor changes its shape as you drag the view through the different areas of the window.

   b. When the cursor changes its shape to an arrow, release the mouse button. You see a window similar to the one shown in Figure 4-20.

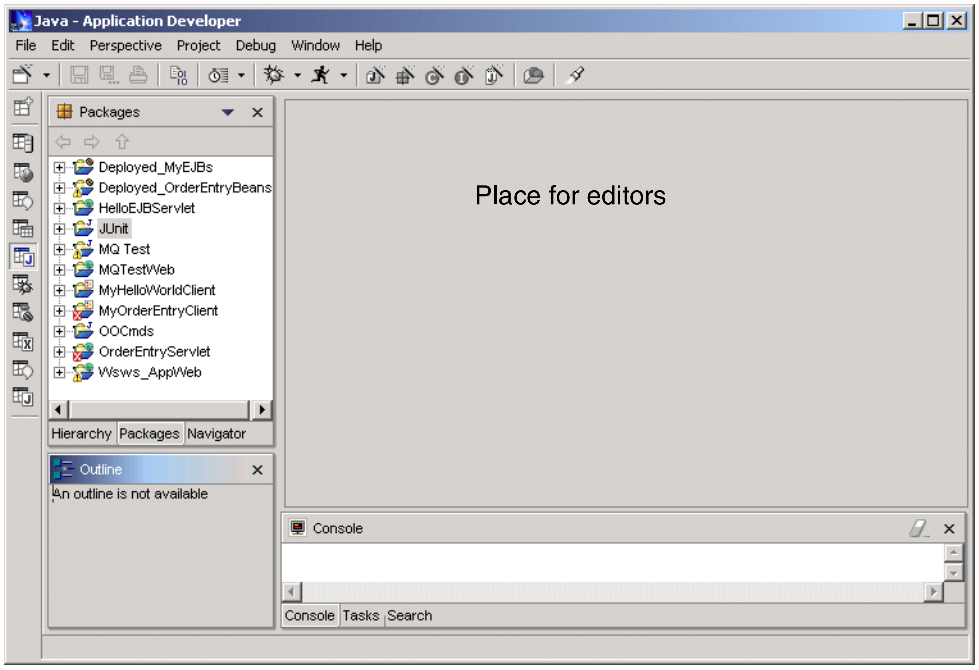


Figure 4-20 Moving the Outline view

When you move the views, you can obtain three different cursors as shown in Table 4-1.

Table 4-1 Different cursors

Cursor shape	Description
⬇	The view is added to the border that points the arrow.
⊞	The view is set where you release the cursor; you can resize it however you want. The view will be as a different window.
🗂	This is the stacked folders icon. The view is added to a pane with other views. Then, you can select any view with a tab.

Now we continue working with the Java perspective. Follow these steps:

1. In the Java perspective, select the **Packages** view, and then expand the **JUnit** tree.

   By default, Application Developer shows, in the tree, the library and JAR files that are part of the project build path.

2. To change this behavior, open the Packages view menu by clicking the down arrow on the title bar as shown in Figure 4-21.

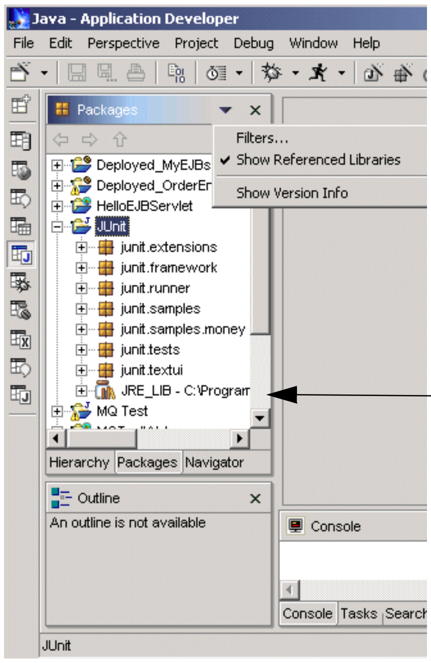


Figure 4-21 The Package view menu

3. There is a check mark next to Show Referenced Libraries. If you click **Show Referenced Libraries**, the referenced libraries are removed.

When you are programming, there are some places that you frequently go to. You can bookmark these places, so you can access them very quickly. Follow these steps to create a bookmark:

1. Open the Bookmarks view by clicking **Perspective-> Show View-> Other**.
2. Expand the **Basic** tree and select **Bookmarks**. Click **OK** as shown in Figure 4-22.

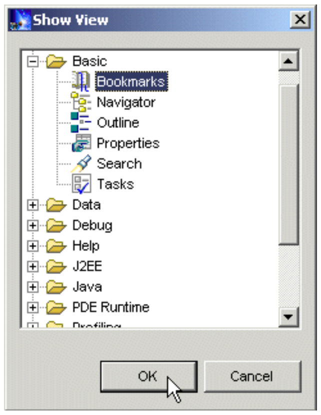


Figure 4-22 Opening the Bookmarks view

3. Now you see the bookmark view in the Java perspective. You can add this new view to the same set of views as Navigator by dragging it into the Navigator view and having the correct cursor as shown in Table 4-1. See Figure 4-23.

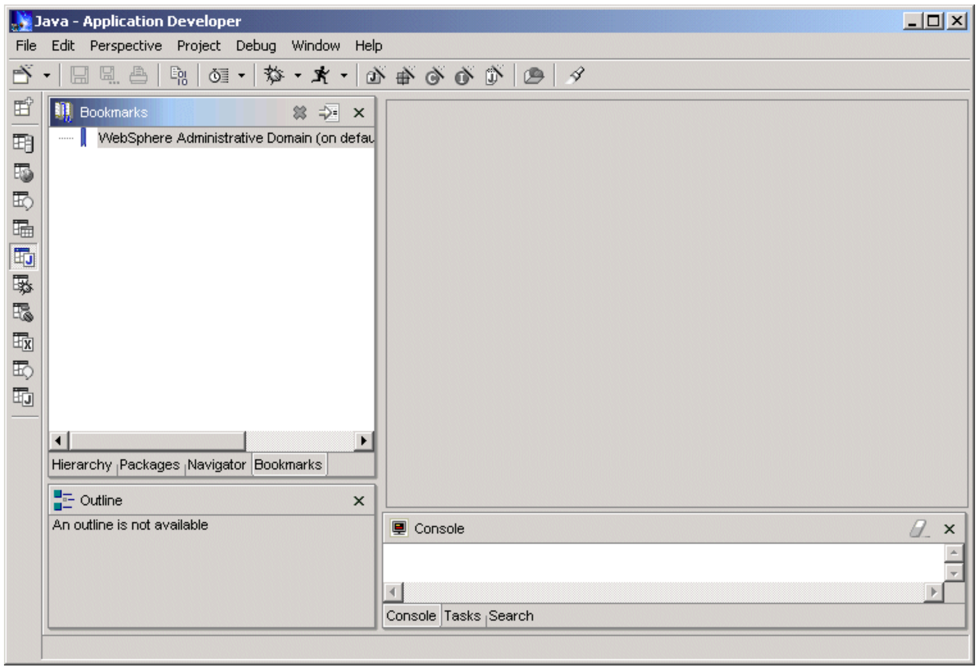

Java - Application Developer
File Edit Perspective Project Debug Window Help
Bookmarks
WebSphere Administrative Domain (on defau
Hierarchy Packages Navigator Bookmarks
Outline
An outline is not available
Console
Console Tasks Search

Figure 4-23 The Bookmarks view

4. Now we convert the bookmarks view to a fast view. Click the **Bookmarks** title bar and drag it to the perspective toolbar. As you move your cursor over the perspective toolbar, the cursor changes its shape to the stacked folders icon.

   Release the mouse button. You see a new icon on the toolbar as shown in Figure 4-24.

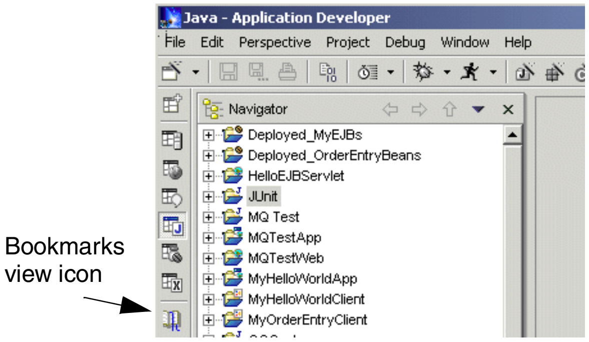
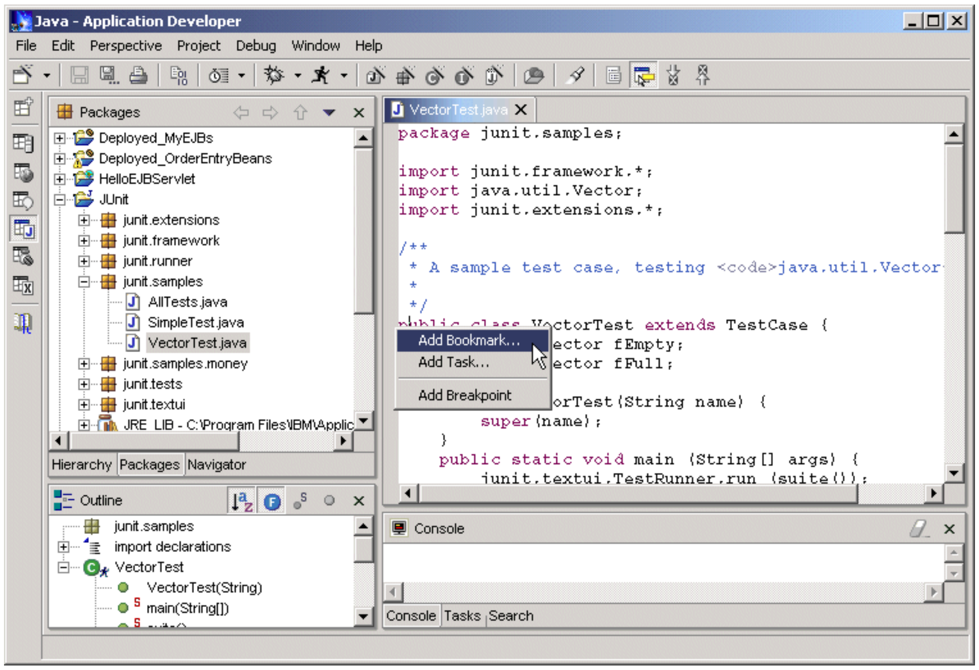


Figure 4-24 The Bookmarks view icon

Now we can add some bookmarks:

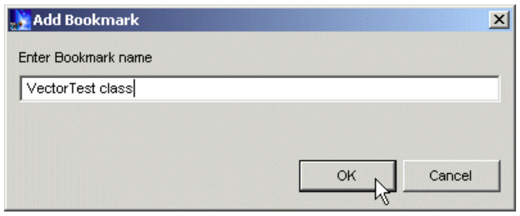
1. Expand the **junit.samples** package in the package view.
2. Open **VectorTest.java** by double-clicking the file in the tree. Application Developer opens the file in the Java editor view.
3. Place the cursor on any line in the file.
4. Right-click the marker bar, which is the gray left band before the line. Select **Add Bookmark** as shown in Figure 4-25.



```
package junit.samples;

import junit.framework.*;
import java.util.Vector;
import junit.extensions.*;

/**
 * A sample test case, testing <code>java.util.Vector
 *
 */
public class VectorTest extends TestCase {
                    ector fEmpty;
                    ector fFull;

                    orTest(String name) {
        super(name);
    }
    public static void main (String[] args) {
        junit.textui.TestRunner.run (suite());
```

Figure 4-25 Adding a bookmark

5. Enter a name in the pop-up window. As an alternative, you can highlight any text in the file and then right-click and select **Add Bookmark**. In this case, the highlighted text is the bookmark name.
6. Click **OK** as shown in Figure 4-26.

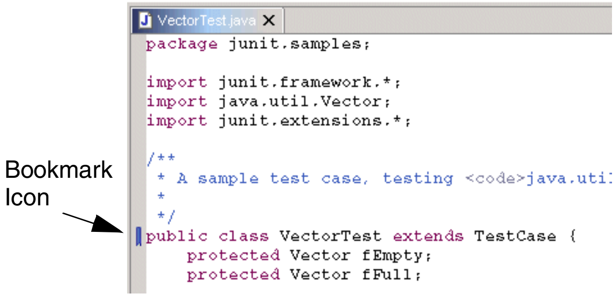


Enter Bookmark name

VectorTest class

Figure 4-26 Setting the bookmark name

A bookmark icon is added to the marker bar as shown in Figure 4-27.

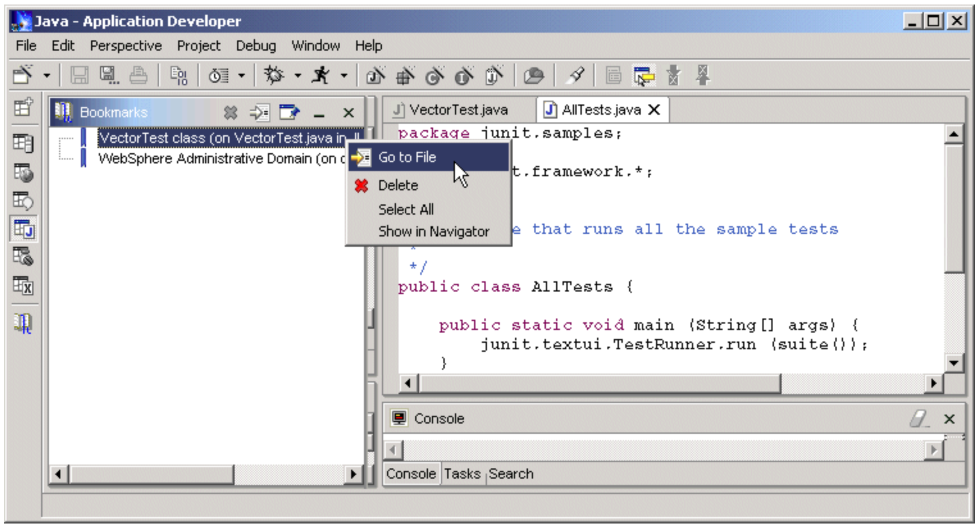


```
package junit.samples;

import junit.framework.*;
import java.util.Vector;
import junit.extensions.*;

/**
 * A sample test case, testing <code>java.uti
 *
 */
public class VectorTest extends TestCase {
    protected Vector fEmpty;
    protected Vector fFull;
```

Figure 4-27 The added bookmark icon

7. Open any other file from the JUnit project.
8. Click the **Bookmark view** icon on the perspective toolbar. This opens the Bookmark view.

9. Right-click the bookmark and select **Go to File** from the pop-up menu, as shown in Figure 4-28. The tool switches to the location of your bookmark.


Java - Application Developer
File Edit Perspective Project Debug Window Help
Bookmarks
VectorTest class (on VectorTest.java in
WebSphere Administrative Domain (on c
Go to File
Delete
Select All
Show in Navigator
VectorTest.java
AllTests.java
Console
Console Tasks Search

```
package junit.samples;
t.framework.*;
e that runs all the sample tests
 */
public class AllTests {

    public static void main (String[] args) {
        junit.textui.TestRunner.run (suite());
    }
```

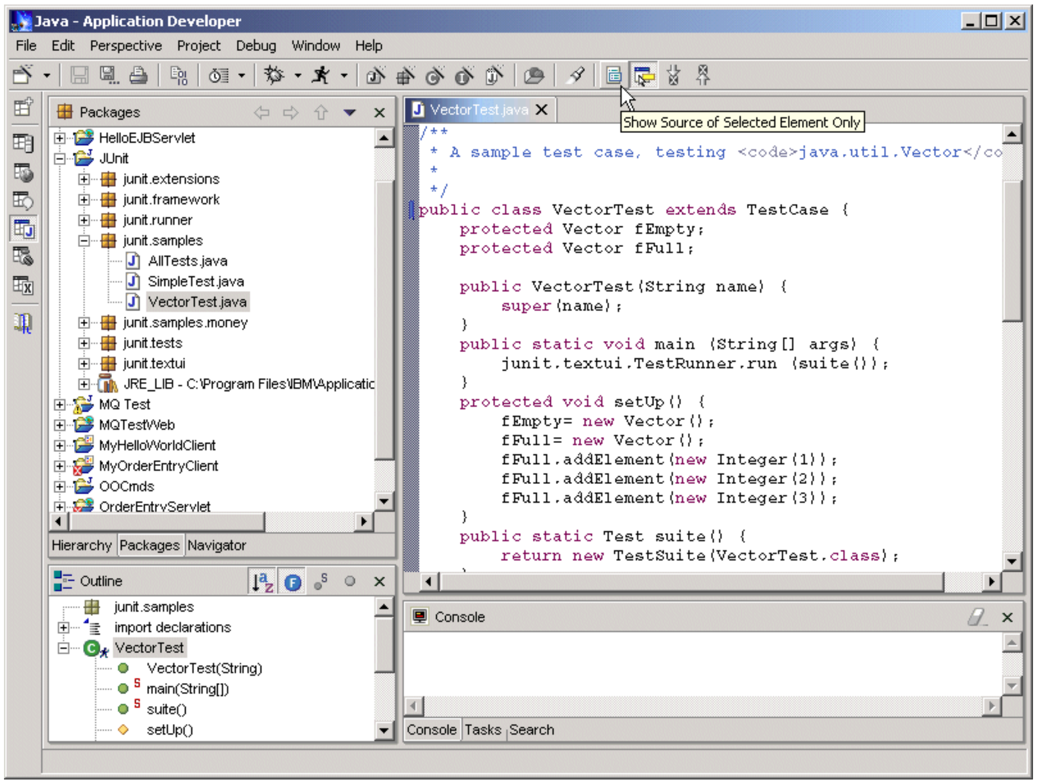
Figure 4-28 Going to a bookmark

10. To close the bookmark view, click outside of the view or click the underscore icon on the Bookmark title bar.

If you are used to developing Java applications with VisualAge for Java, you can get a VisualAge for Java behavior for displaying Java code. Follow these steps:

1. Open any Java file and click anywhere in the Java editor view.
2. Click the **Show Source of Selected Element Only** button as shown in Figure 4-29.
3. In the Outline view, select the element (method or variable) that you want to display.

   You see only the selected method or variable in the Java editor view, as with VisualAge for Java.



```
/**
 * A sample test case, testing <code>java.util.Vector</co
 *
 */
public class VectorTest extends TestCase {
    protected Vector fEmpty;
    protected Vector fFull;

    public VectorTest(String name) {
        super(name);
    }
    public static void main (String[] args) {
        junit.textui.TestRunner.run (suite());
    }
    protected void setUp() {
        fEmpty= new Vector();
        fFull= new Vector();
        fFull.addElement(new Integer(1));
        fFull.addElement(new Integer(2));
        fFull.addElement(new Integer(3));
    }
    public static Test suite() {
        return new TestSuite(VectorTest.class);
```

Figure 4-29 Show Source of Selected Element Only button

Now we add the Navigator view to the perspective. In this view, you see all the folders and objects of your application. This view is common for all perspectives. Follow these steps:

1. Click **Perspective-> Show View-> Other** in the main menu.
2. Expand **Basic**.
3. Select **Navigator**.
4. Click **OK** as shown in Figure 4-30.

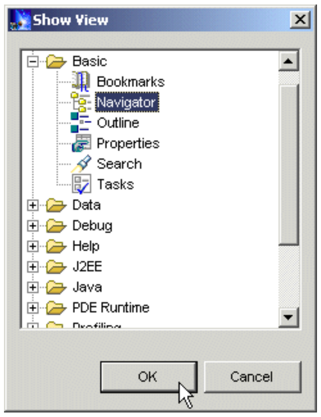


Figure 4-30 Opening the Navigator view

You see the Navigator view added to the bottom right part of the Application Developer window (Figure 4-31).

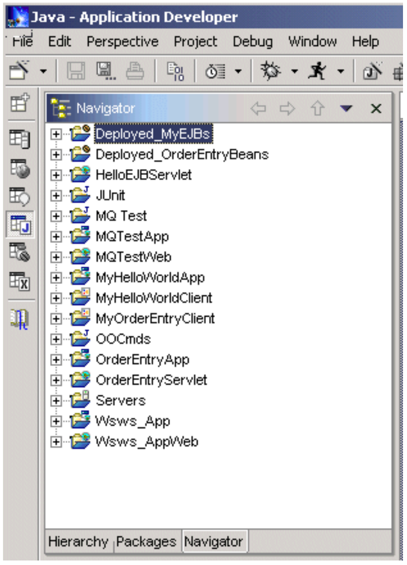
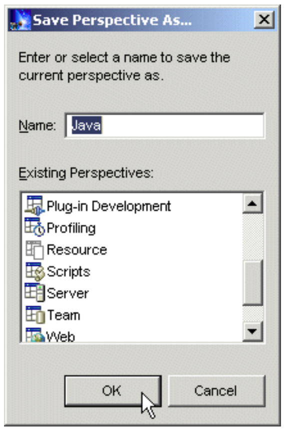


Figure 4-31 The Navigator view

You can browse all the folders from this view.

Now we save the Java perspective by following these steps:

1. From the main menu, select **Perspective-> Save As**.
2. Enter the new name or leave `Java`. Click **OK** as shown in Figure 4-32.


Save Perspective As...

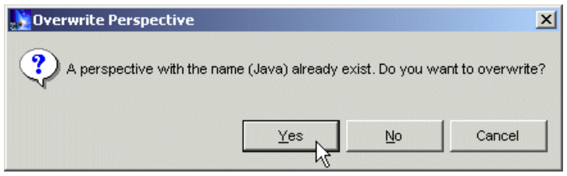
Enter or select a name to save the current perspective as.

Name: Java

Existing Perspectives:

Figure 4-32 Saving the customized perspective

3. If the perspective already exists, you are prompted with a confirmation window as shown in Figure 4-33. Click **Yes** if you want to overwrite it.


Overwrite Perspective

A perspective with the name (Java) already exist. Do you want to overwrite?

Figure 4-33 Confirmation window for overwriting a perspective

4.3 Working with Java code

With Application Developer, you can work with Java code as we explain in the previous topic. In this section, we learn more about some other basic actions on working with Java code. Of course, for working with the Java code, the best perspective is the Java perspective. We show you how you can:

- ► Add new methods, classes, packages
- ► Compile Java code
- ► Run code
- ► Export Java code

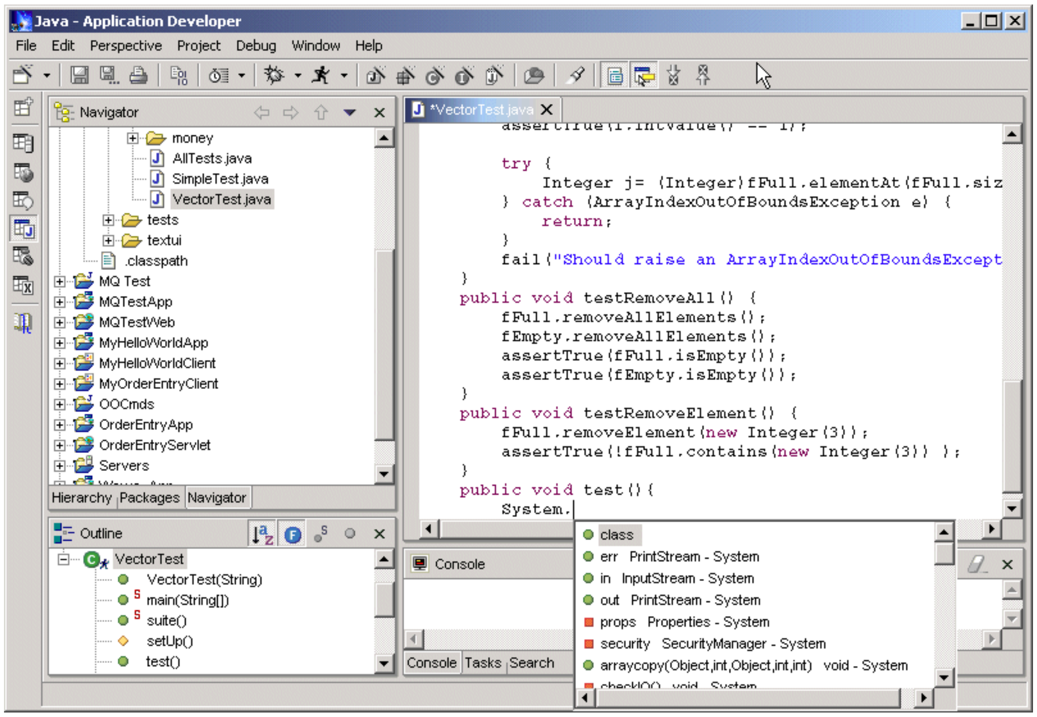
4.3.1 Adding new methods

To add a new method, follow these steps:

1. Open the **Java** perspective.
2. Expand the **JUnit** tree in the Packages view.
3. Expand the **junit.samples** package.
4. Open **VectorTest.java** by double-clicking the file name in the tree.
5. Scroll to the very bottom of the file in the editor view.
6. Add the following text just before the closing bracket:

   ```
   public void test() {
   ```

7. On the next line, start typing `System.`, and press Ctrl-spacebar to invoke the content assist tool, as shown in Figure 4-34.



```
            try {
                Integer j= (Integer)fFull.elementAt(fFull.siz
            } catch (ArrayIndexOutOfBoundsException e) {
                return;
            }
            fail("Should raise an ArrayIndexOutOfBoundsExcept
        }
        public void testRemoveAll() {
            fFull.removeAllElements();
            fEmpty.removeAllElements();
            assertTrue(fFull.isEmpty());
            assertTrue(fEmpty.isEmpty());
        }
        public void testRemoveElement() {
            fFull.removeElement(new Integer(3));
            assertTrue(!fFull.contains(new Integer(3)) );
        }
        public void test(){
            System.
```

```
class
err  PrintStream - System
in  InputStream - System
out  PrintStream - System
props  Properties - System
security  SecurityManager - System
arraycopy(Object,int,Object,int,int)  void - System
```

Figure 4-34   Using code assistant (Ctrl-spacebar)

8. Select **out** and press Enter.

9. You can perform the same step to select the **println(String)** method in the PrintStream class.

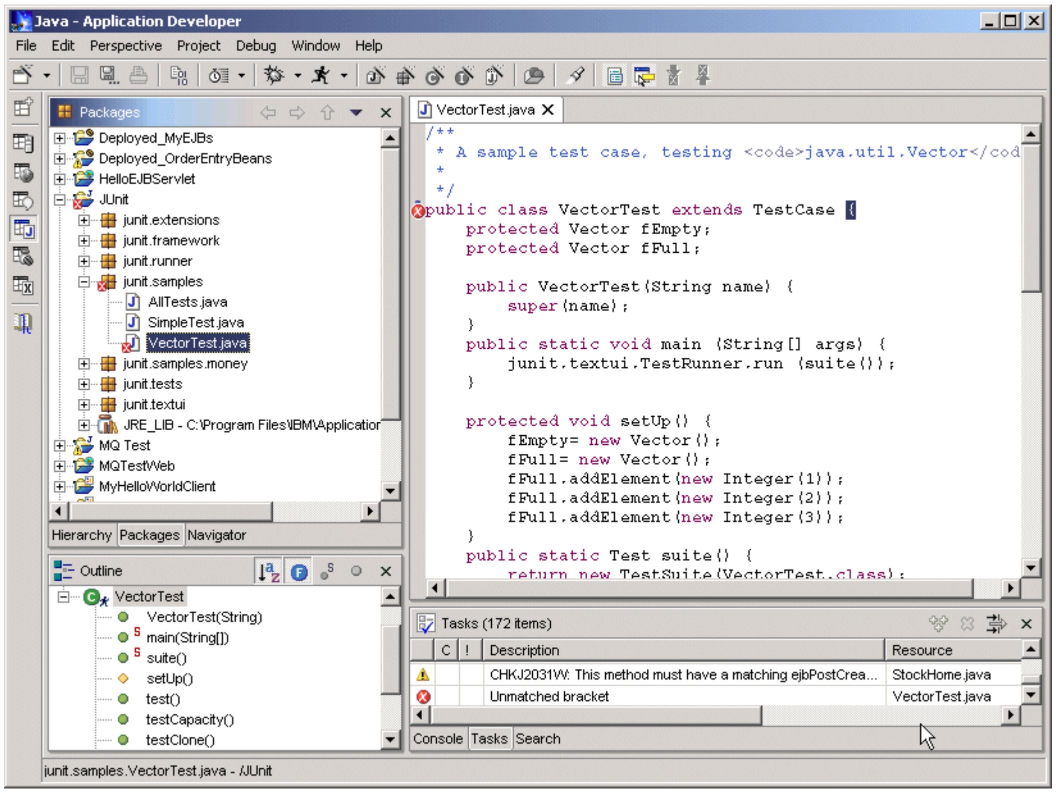
10. Enter `Java with Application Developer` as the parameter for the `println()` method.

11. Enter **;** at the end of the line. The text you enter should look like Example 4-1.

Example 4-1   The test method

```
public void test()
{
   System.out.print("Java with Application Developer");
```

12. Save the file by pressing Ctrl-S. You see one error in the Task view, as shown in Figure 4-35.



```
/**
 * A sample test case, testing <code>java.util.Vector</cod
 *
 */
public class VectorTest extends TestCase {
    protected Vector fEmpty;
    protected Vector fFull;

    public VectorTest(String name) {
        super(name);
    }
    public static void main (String[] args) {
        junit.textui.TestRunner.run (suite());
    }

    protected void setUp() {
        fEmpty= new Vector();
        fFull= new Vector();
        fFull.addElement(new Integer(1));
        fFull.addElement(new Integer(2));
        fFull.addElement(new Integer(3));
    }
    public static Test suite() {
        return new TestSuite(VectorTest.class);
```

	C	!	Description	Resource
⚠			CHKJ2031W: This method must have a matching ejbPostCrea...	StockHome.java
⊗			Unmatched bracket	VectorTest.java

Figure 4-35   The unmatched error task

13. Double-click the error in the Task view. Application Developer displays the line in error as shown in Figure 4-35.

14. Click **test()** in the Outline view (lower-left corner of the window).

15. Add a closing bracket for the `test()` method.

16. Save the file. The error is gone.

4.3.2 Compiling Java code

As you have noticed, Application Developer automatically performs the build as you save the file. This feature is controlled by the Perform build automatically on resource modification option in the Preferences window.

You can build the project at any time. Follow these steps:

1. Right-click **JUnit** in the Packages view.
2. Select **Build Project** as shown in Figure 4-36. The Rebuild Project option re-compiles all classes in the project.

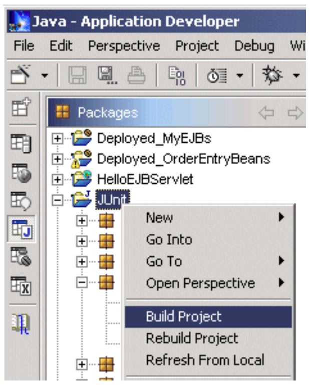


Figure 4-36 Building the Java project

4.3.3 Running the Java code

Next we run the Java program. Follow these steps:

1. Change the project's properties:
   a. Right-click **JUnit**. Select **Properties** as shown in Figure 4-37.

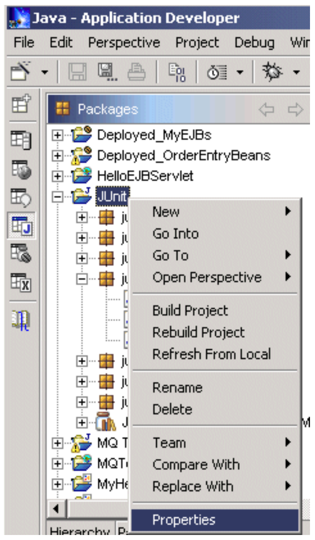
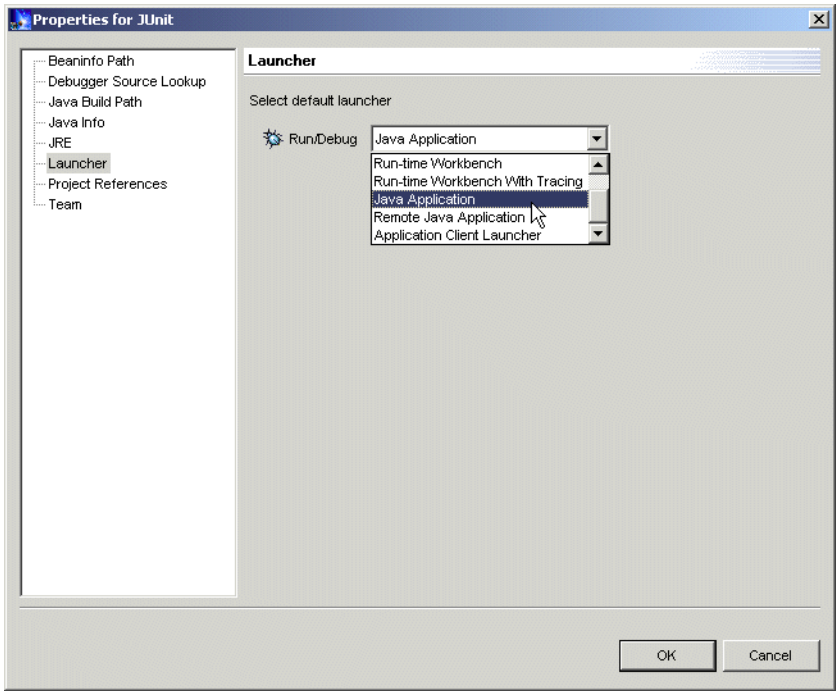


Figure 4-37 Opening the project properties

   b. Select **Launcher**.
   c. From the Run/Debug pull-down menu, select **Java Application** as shown in Figure 4-38.
   d. Click **OK**.



Launcher

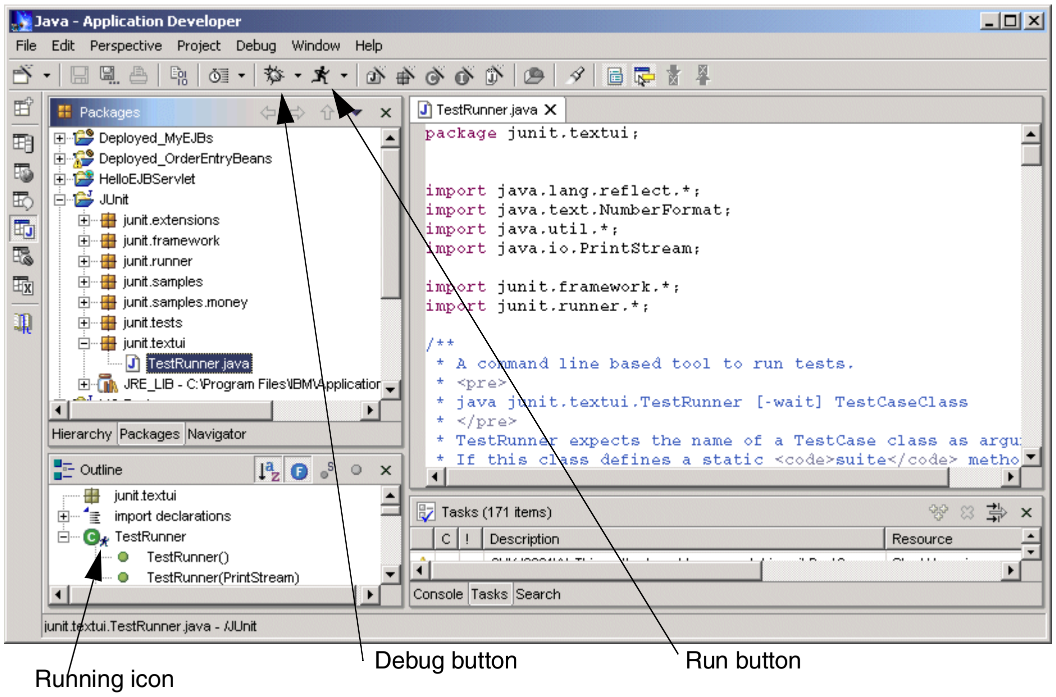
Select default launcher

Run/Debug: Java Application

Figure 4-38 Selecting Java Application as the default launcher

2. Expand the **junit.textui** package.
3. Double-click **TestRunner.java**.

   Notice the running icon next to the class name in the Outline view. This icon indicates that the class contains a `main()` method and can be run as shown in Figure 4-39.

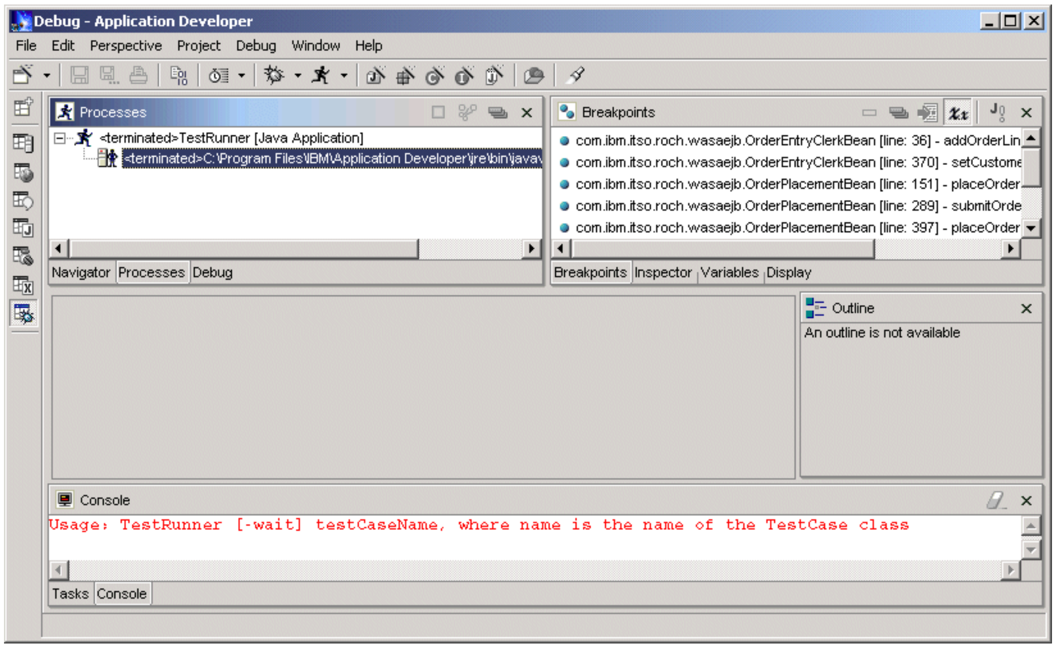


```
package junit.textui;


import java.lang.reflect.*;
import java.text.NumberFormat;
import java.util.*;
import java.io.PrintStream;

import junit.framework.*;
import junit.runner.*;

/**
 * A command line based tool to run tests.
 * <pre>
 * java junit.textui.TestRunner [-wait] TestCaseClass
 * </pre>
 * TestRunner expects the name of a TestCase class as argu
 * If this class defines a static <code>suite</code> metho
```

Figure 4-39 The TestRunner class

4. Click the **Run** button on the toolbar.

   Application Developer switches to the Debug perspective and reports an error (look for the error message in the Console view).


Debug - Application Developer
File Edit Perspective Project Debug Window Help
Processes
<terminated>TestRunner [Java Application]
<terminated>C:\Program Files\IBM\Application Developer\jre\bin\java\
Navigator Processes Debug
Breakpoints
com.ibm.itso.roch.wasaejb.OrderEntryClerkBean [line: 36] - addOrderLin
com.ibm.itso.roch.wasaejb.OrderEntryClerkBean [line: 370] - setCustome
com.ibm.itso.roch.wasaejb.OrderPlacementBean [line: 151] - placeOrder
com.ibm.itso.roch.wasaejb.OrderPlacementBean [line: 289] - submitOrde
com.ibm.itso.roch.wasaejb.OrderPlacementBean [line: 397] - placeOrder
Breakpoints Inspector Variables Display
Outline
An outline is not available
Console
Tasks Console

```
Usage: TestRunner [-wait] testCaseName, where name is the name of the TestCase class
```

Figure 4-40 The debug perspective

5. Switch to the Java perspective.
6. Right-click **TestRunner.java** in the Packages view.
7. Select **Properties**.
8. In the Program Arguments field on the Execution Arguments properties page, type `junit.samples.VectorTest` as shown in Figure 4-41. This argument indicates which class should be tested by TestRunner.java.

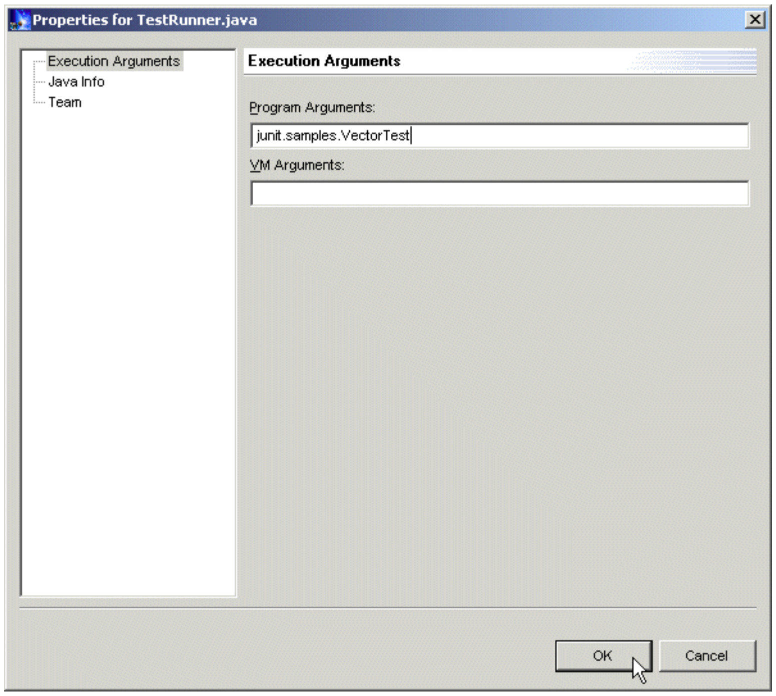
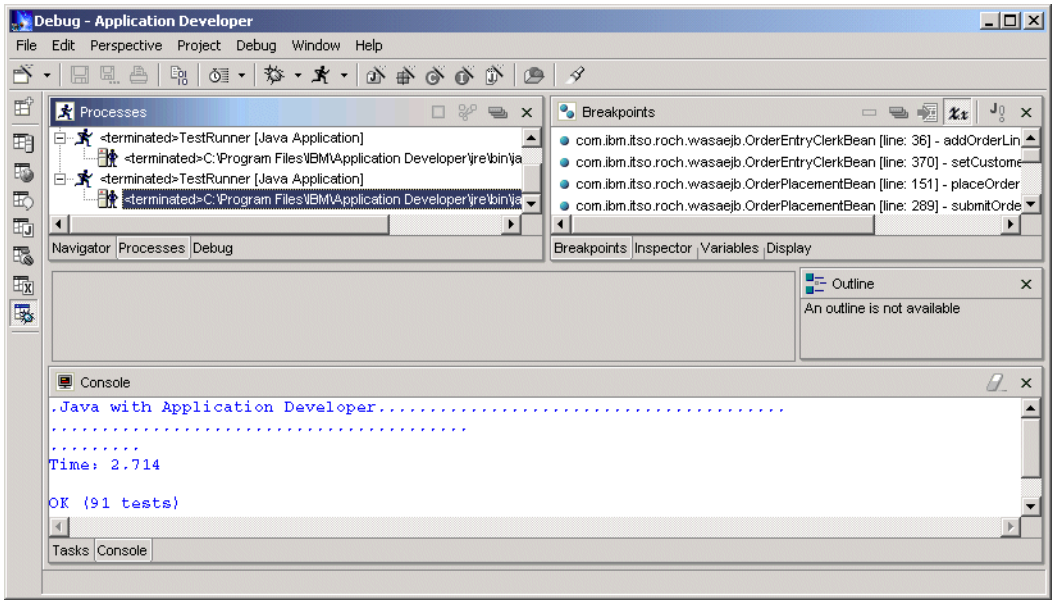


Figure 4-41 The Program Arguments window

9. Click **OK**.
10. Click the **Run** button again.

    Application Developer switches to the Debug view. This time the test runs with no errors.
11. Go back to the Java perspective and change the Execution Arguments property to `junit.samples.AllTests`.
12. Run TestRunner.java again.

Under Console, you see the line you added to the VectorTest class as shown in Figure 4-42.


Debug - Application Developer
File Edit Perspective Project Debug Window Help
Processes
<terminated>TestRunner [Java Application]
<terminated>C:\Program Files\IBM\Application Developer\jre\bin\ja
<terminated>TestRunner [Java Application]
<terminated>C:\Program Files\IBM\Application Developer\jre\bin\ja
Navigator Processes Debug
Breakpoints
com.ibm.itso.roch.wasaejb.OrderEntryClerkBean [line: 36] - addOrderLin
com.ibm.itso.roch.wasaejb.OrderEntryClerkBean [line: 370] - setCustome
com.ibm.itso.roch.wasaejb.OrderPlacementBean [line: 151] - placeOrder
com.ibm.itso.roch.wasaejb.OrderPlacementBean [line: 289] - submitOrde
Breakpoints Inspector Variables Display
Outline
An outline is not available
Console
Tasks Console

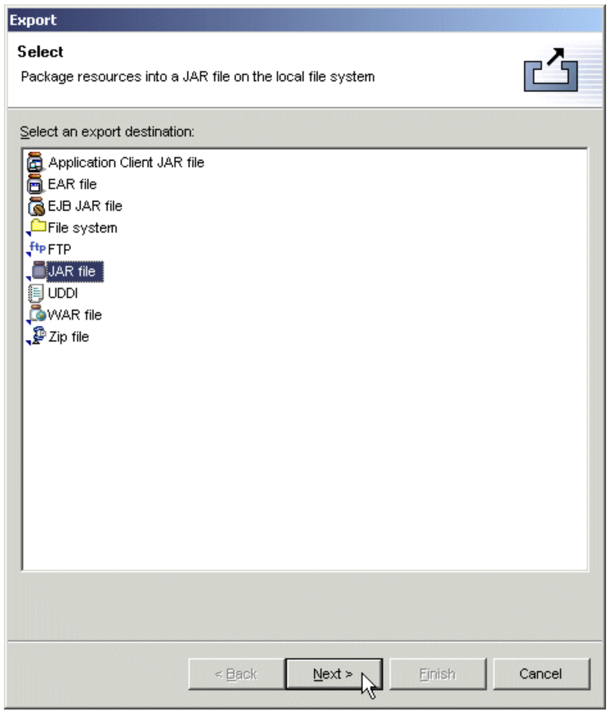
```
.Java with Application Developer.........................................
.........................................
.........
Time: 2.714

OK (91 tests)
```

Figure 4-42 The TestRunner output

4.3.4 Exporting the Java code

The last step is to export the JUnit project. Follow these steps:

1. Click **File-> Export** on the menu.
2. Select **JAR file** and click **Next** as shown in Figure 4-43.



Export

Select

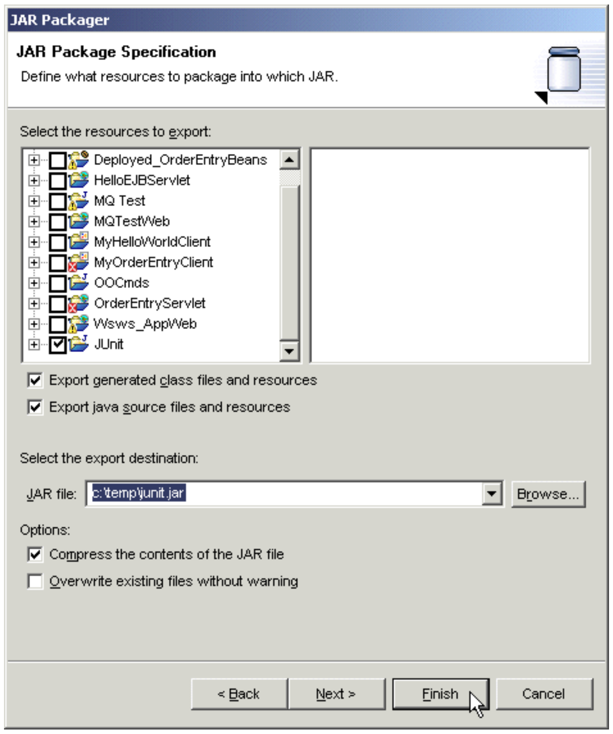
Package resources into a JAR file on the local file system

Select an export destination:

- Application Client JAR file
- EAR file
- EJB JAR file
- File system
- FTP
- JAR file
- UDDI
- WAR file
- Zip file

Figure 4-43 Exporting a JAR file

3. Select the check box next to the **JUnit** project.
4. Make sure that the **Export generated class files and resources** and **Export java source files and resources** check boxes are selected.
5. Enter `c:\temp\junit.jar` in the Select the export destination field.
6. Click **Finish** as shown in Figure 4-44.


JAR Packager

JAR Package Specification

Define what resources to package into which JAR.

Select the resources to export:

- [ ] Deployed_OrderEntryBeans
- [ ] HelloEJBServlet
- [ ] MQ Test
- [ ] MQTestWeb
- [ ] MyHelloWorldClient
- [ ] MyOrderEntryClient
- [ ] OOCmds
- [ ] OrderEntryServlet
- [ ] Wsws_AppWeb
- [✓] JUnit

[✓] Export generated class files and resources

[✓] Export java source files and resources

Select the export destination:

JAR file: c:\temp\junit.jar

Options:

[✓] Compress the contents of the JAR file

[ ] Overwrite existing files without warning

Figure 4-44 Finishing the export of the JAR file

4.4 Conclusion

WebSphere Studio Application Developer combines the functionality that was found in VisualAge for Java and the earlier WebSphere Studio product. However, many new features were added. It supports perspectives that allow you to work with your applications from different views.

For example, the J2EE perspective allows you work in an environment customized for building J2EE compliant applications. Application Developer allows you to export your applications directly into J2EE compliant formats, such as enterprise archive (EAR) files and Web archive (WAR) files. You can install these files as enterprise applications in WebSphere Application Server 4.0 without using the WebSphere Application Assembly Tool.

This chapter introduced you to Application Developer. We walked you through some simple examples to show you how to navigate in Application Developer and customize your workspace.

5

Building Java servlets and JSPs with WebSphere Studio Application Developer

WebSphere Studio Application Developer is an optimized J2EE application development platform. It is evolved from VisualAge for Java Enterprise Edition and WebSphere Studio Advanced Edition. It inherits some of the best features of VisualAge for Java and WebSphere Studio and adds many new features.

Many developers are still working on VisualAge for Java and WebSphere Studio. When they move to Application Developer, an important task is to smoothly migrate their code to this new environment.

In this chapter, we migrate the code developed with VisualAge for Java in Chapter 2, “Servlet and JSP development using VisualAge for Java” on page 21, to Application Developer. We also explain how to build new applications with Application Developer.

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5.1 Migrating code from VisualAge for Java

In Chapter 2, “Servlet and JSP development using VisualAge for Java” on page 21, we develop the Java code with VisualAge for Java. We export the code into JAR files that are used by the Application Assembly Tool.

In Chapter 3, “WebSphere V4.0 assembly and deployment tools” on page 75, we use the WebSphere Application Assembly Tool (AAT) to assemble the Java code, JSPs, and images into a WAR file. A WAR file can be deployed on WebSphere Application Server 4.0.

Application Developer can migrate code from either JAR files or WAR files, as shown in Figure 5-1. Since these two file formats have some differences, Application Developer treats them differently.

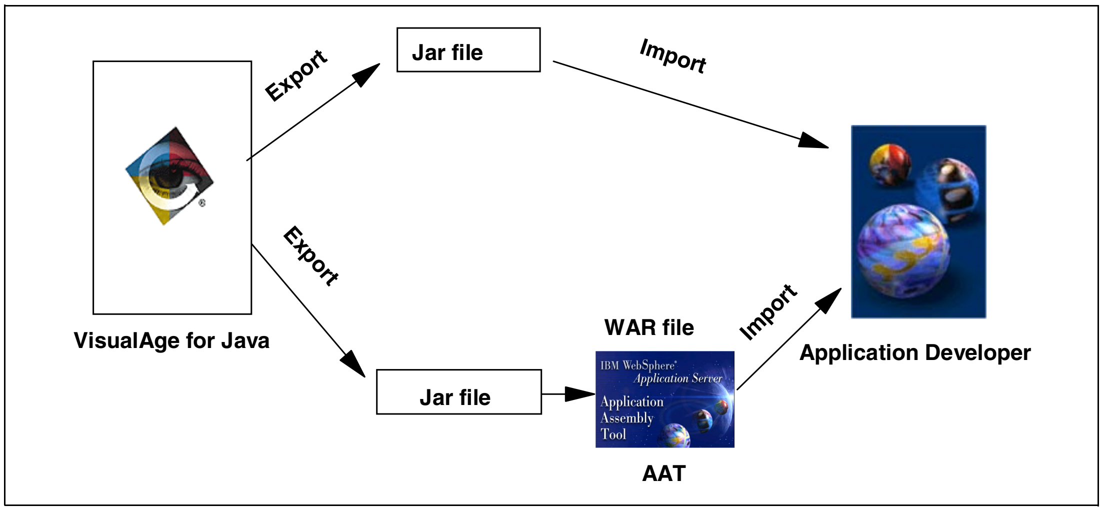


Figure 5-1 Migrating code from VisualAge for Java to Application Developer

Since a WAR file has gone through AAT, all the configuration tasks like servlet mappings, initial parameters, adding supporting classes, adding JSP pages, and so on have already been done. In fact, a WAR file is a ready-to-go Web application. When migrating WAR files into Application Developer, we simply import them. All the settings are already there, and the IBM extended configuration files for WebSphere (XML files) are ready. When you develop Web applications for WebSphere Application Server 4.0 with VisualAge for Java and want to migrate code into Application Developer, we recommend that you to generate a WAR file with AAT first. Then, import the WAR file into Application Developer.

If you develop Java applications for non-J2EE compliant servers, like Apache Tomcat or WebSphere 3.5, you may not use AAT. For this situation, just export the Java code into JAR files. Then import it into Application Developer. You have to configure the servlet mappings, parameters, JSPs, and so on in Application Developer.

Tip: The completed applications developed for this chapter are available for download from the ITSO Web site as explained in Appendix A, “Additional material” on page 425.

In this chapter, we import a WAR file named *Wsws_Appweb.war* into Application Developer. It contains the Java code developed in Chapter 2, “Servlet and JSP development using VisualAge for Java” on page 21.

5.2 Migrating the OrderEntry WAR file

Now we start to work on the OrderEntry application in Application Developer. Since we already wrote the code with VisualAge for Java and assembled it into WAR file with AAT, we can reuse this code in our new development environment.

5.2.1 Importing a WAR file

If you want to keep your application development environments separated in Application Developer, you can create a new workspace to store the application artifacts for each environment. To do this, follow these steps:

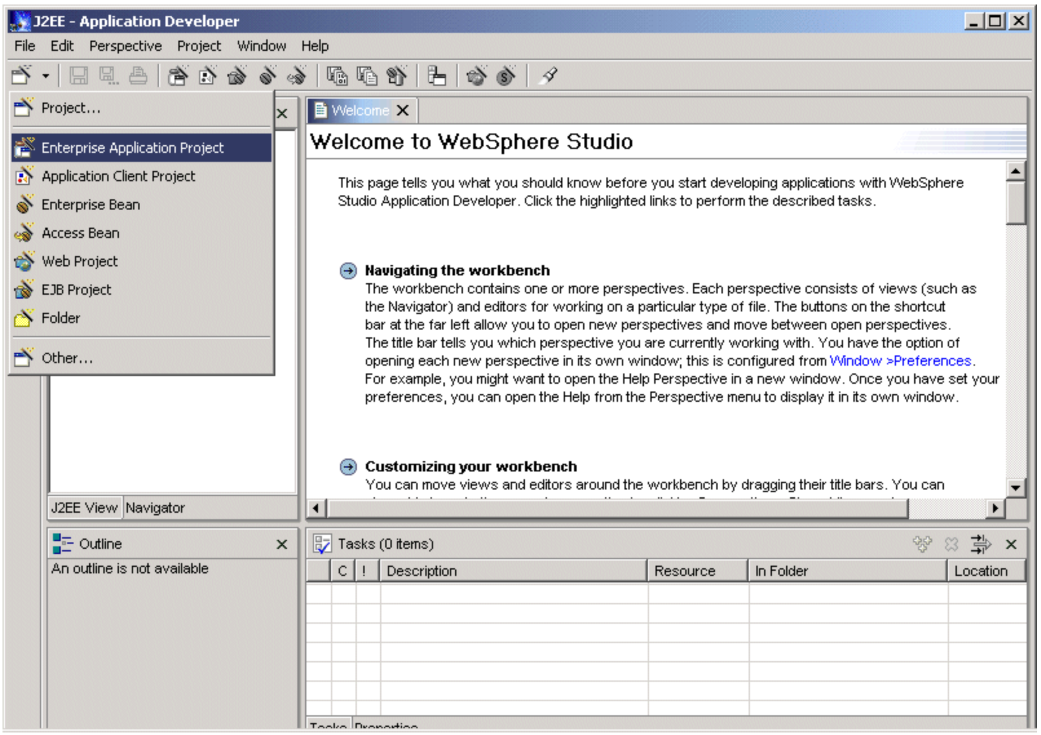
1. Create a new directory in the file system. Here we call the workspace directory *itsoad*. From a command line window, type:

   ```
   md x:\itsoad
   x:\<Application Developer install directory>\wsappdev -data x:\itsoad
   ```

   Here *x* is the drive letter and *<Application Developer install directory>* is the path where you installed Application Developer. By default, it is x:\Program Files\IBM\Application Developer.

   It may be worth creating a shortcut on your Windows desktop for launching the command in the future. The default parameters to launch Application Developer used by the start menu icon revert your settings back to the default workspace in the installation directory.

2. Once Application Developer is started, click the down arrow next to the **Open The New Wizard** button, as shown in Figure 5-2.


J2EE - Application Developer
File Edit Perspective Project Window Help
Project...
Enterprise Application Project
Application Client Project
Enterprise Bean
Access Bean
Web Project
EJB Project
Folder
Other...
Welcome
J2EE View Navigator
Outline
An outline is not available
Tasks (0 items)
C ! Description Resource In Folder Location

Welcome to WebSphere Studio

This page tells you what you should know before you start developing applications with WebSphere Studio Application Developer. Click the highlighted links to perform the described tasks.

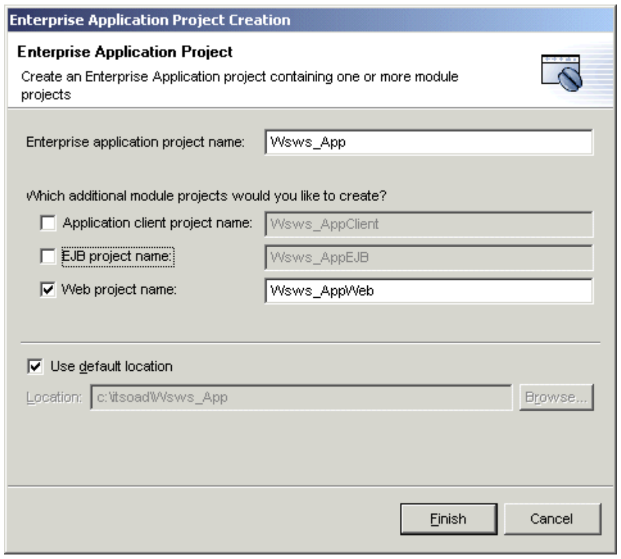
Navigating the workbench
The workbench contains one or more perspectives. Each perspective consists of views (such as the Navigator) and editors for working on a particular type of file. The buttons on the shortcut bar at the far left allow you to open new perspectives and move between open perspectives. The title bar tells you which perspective you are currently working with. You have the option of opening each new perspective in its own window; this is configured from Window >Preferences. For example, you might want to open the Help Perspective in a new window. Once you have set your preferences, you can open the Help from the Perspective menu to display it in its own window.

Customizing your workbench
You can move views and editors around the workbench by dragging their title bars. You can

Figure 5-2 Creating an enterprise application project

We select **Enterprise Application Project**. Another way to do this is to click **Other** and select **J2EE** in the left pane and **Enterprise Application Project** in the right pane of the pop-up window.

3. In the Enterprise Application Project Creation window, as shown in Figure 5-3, we enter `Wsws_App` as the name of the project. We deselect **Application Client project name** and **EJB project name** because we don't work on EJBs in this chapter. But we select **Web project name** and then click **Finish**.


Enterprise Application Project Creation

Enterprise Application Project

Create an Enterprise Application project containing one or more module projects

Enterprise application project name: Wsws_App

Which additional module projects would you like to create?

- [ ] Application client project name: Wsws_AppClient
- [ ] EJB project name: Wsws_AppEJB
- [x] Web project name: Wsws_AppWeb

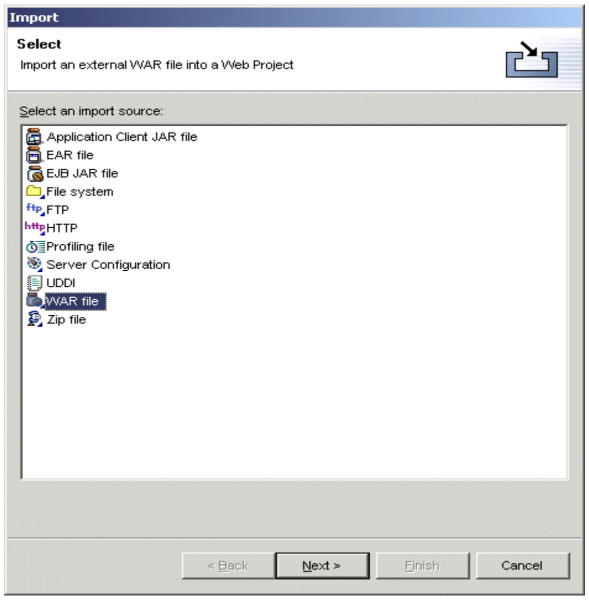
- [x] Use default location

Location: c:\itsoad\Wsws_App

Figure 5-3 Enterprise application project creation wizard

Once the project is created, Application Developer automatically switches to the J2EE perspective and shows the new project under Enterprise Applications.

4. We import the WAR file into the *Wsws_AppWeb* project. Click the **Navigator** tab and select the **Wsws_AppWeb** project. Click **File-> Import**, and the Import window appears as shown in Figure 5-4. Select **WAR file** from the available options and click **Next**.


Import

Select

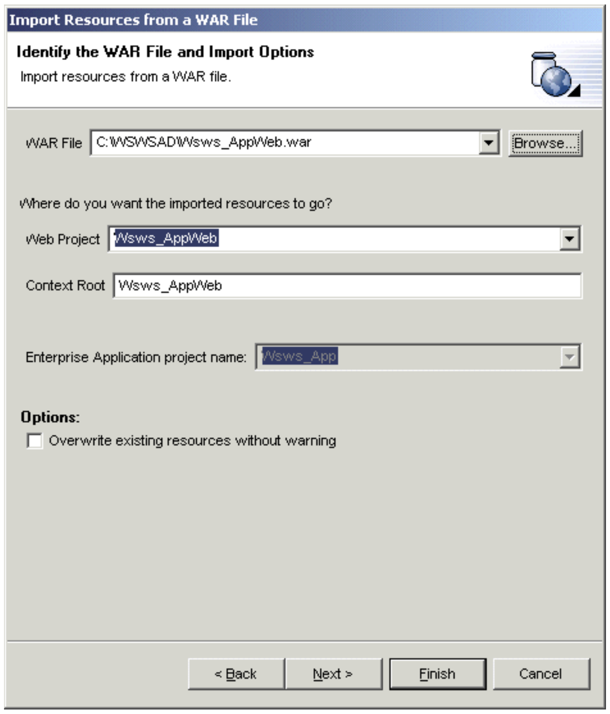
Import an external WAR file into a Web Project

Select an import source:

Figure 5-4 Importing a WAR file

5. In the Import Resources from a WAR File window (Figure 5-5), we click the **Browse** button next to the WAR file field and navigate to the WAR file. We select the **Overwrite existing resources without warning** check box; otherwise, Application Developer asks if you want

to overwrite one of the XML files it has created for the *Wsws_App* project. Finally, we click **Finish**.


Import Resources from a WAR File
Identify the WAR File and Import Options
Import resources from a WAR file.
Browse...
< Back
Next >
Finish
Cancel

WAR File C:\WSWSAD\Wsws_AppWeb.war

Where do you want the imported resources to go?

Web Project Wsws_AppWeb

Context Root Wsws_AppWeb

Enterprise Application project name: Wsws_App

Options:

☐ Overwrite existing resources without warning

Figure 5-5 Importing the wsws.war file

6. In the Application Developer main window, click the Navigator view and expand **Wsws_AppWeb-> webApplication-> WEB-INF-> lib**.
7. We select **Wsws_AppWeb_classes.jar**, if it exists, right-click it, and select **Delete**. This JAR file is deleted.

Note: Application Developer places all the original class files from the Web application in this JAR file. If we update the Web application and try to test the changes, we don't see the changes because Application Developer uses the original JAR file for testing.

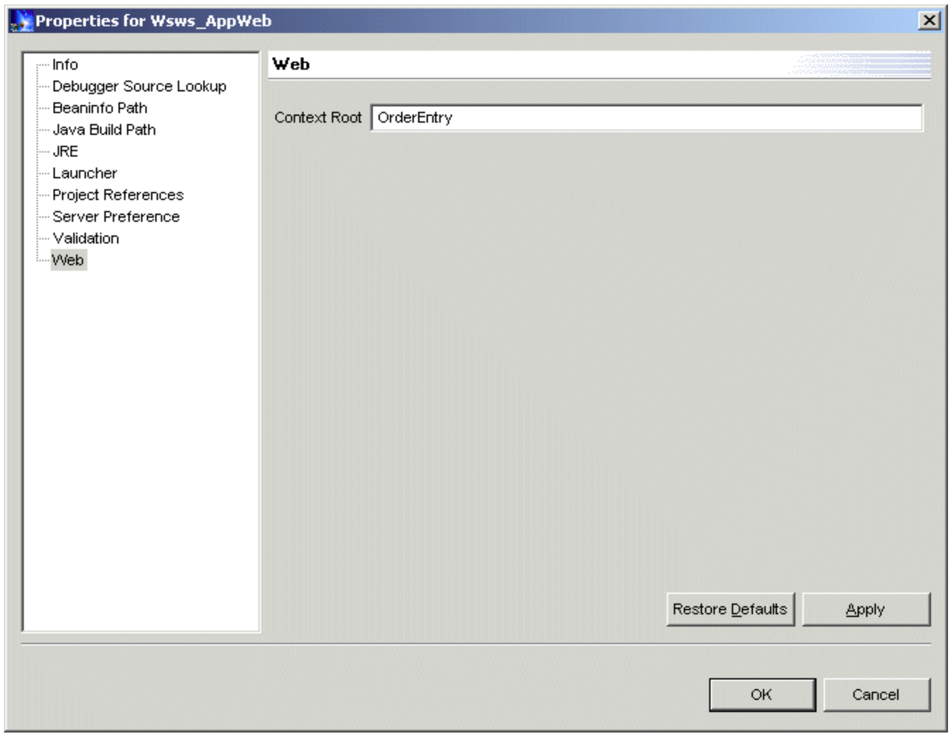
5.2.2 Building the project and modifying the project's properties

This section explains how to build the project and modify its properties. We follow these steps:

1. We set the application context root. The context root defines the logical root for all of the application's files. To invoke ItemServlet.html, in the browser, we enter:

   ```
   http://sysname:port/<context root>/ItemServlet.html
   ```

2. We right-click the **Wsws_AppWeb** project in the Navigator view and select **Properties**.
3. In the Properties window, shown as Figure 5-6, we click **Web** in the left pane and replace Wsws_AppWeb with `OrderEntry` as the context root. We click **OK** and then click **Yes** in the pop-up window asking whether we want to change links based on the new value for the context root.

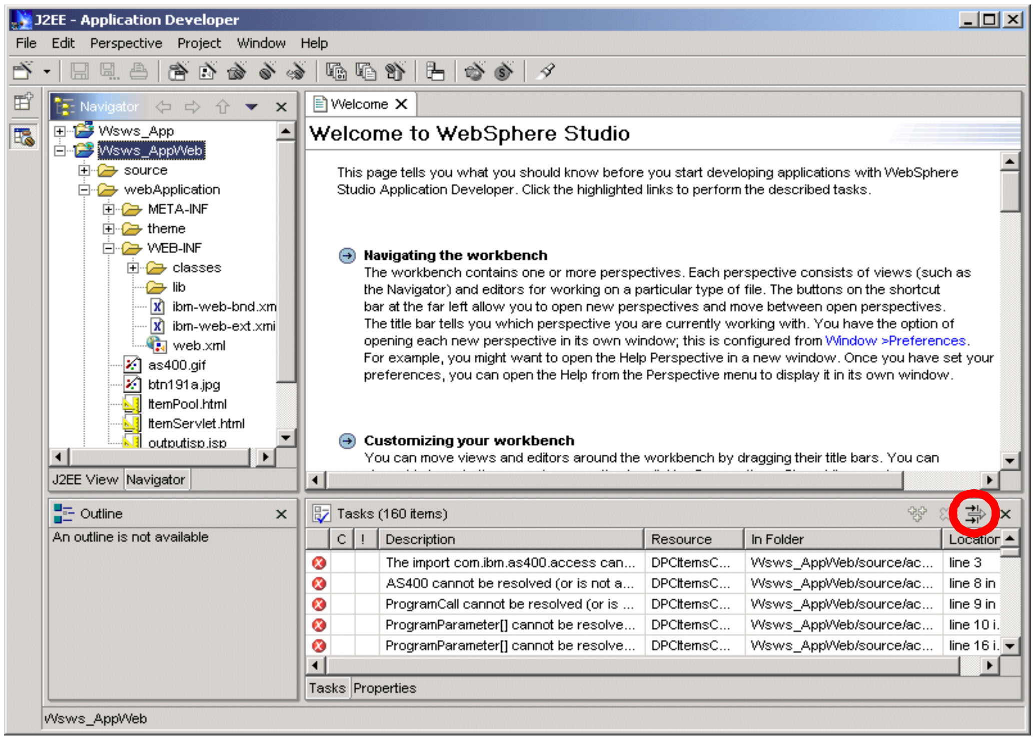


Context Root OrderEntry

Figure 5-6 Modifying the application context root

4. We delete the **Wsws_AppWeb_classes.jar** file and add the context root.
5. We compile the whole project. This may be an optional step if you left the **Perform build automatically on resource modification** option selected. We select **Wsws_AppWeb** in the Navigator view, right-click, and select **Rebuild Project**.

   Application Developer compiles and validates all files within the project. As a result of the build, we see many errors and warnings in the task view (bottom portion of the Application Developer window). If we double-click any error, Application Developer opens the file with the error. All errors are visible in the marker area of the editor window.
6. We can filter some unnecessary warnings. Click the **Filter** button in the task view's toolbar (circled in Figure 5-7).



Wsws_App
Wsws_AppWeb
source
webApplication
META-INF
theme
WEB-INF
classes
lib
ibm-web-bnd.xm
ibm-web-ext.xmi
web.xml
as400.gif
btn191a.jpg
ItemPool.html
ItemServlet.html
outputisp.jsp

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Customizing your workbench
You can move views and editors around the workbench by dragging their title bars. You can

An outline is not available

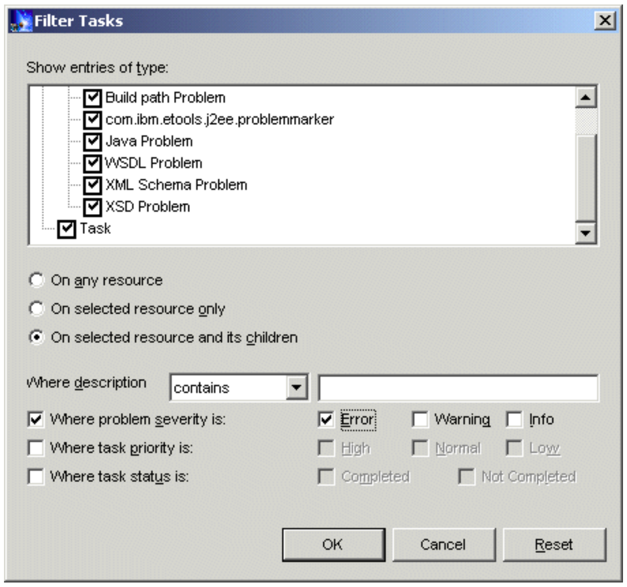
Tasks (160 items)

	C	!	Description	Resource	In Folder	Location
⊗			The import com.ibm.as400.access can...	DPCItemsC...	Wsws_AppWeb/source/ac...	line 3
⊗			AS400 cannot be resolved (or is not a...	DPCItemsC...	Wsws_AppWeb/source/ac...	line 8 in
⊗			ProgramCall cannot be resolved (or is ...	DPCItemsC...	Wsws_AppWeb/source/ac...	line 9 in
⊗			ProgramParameter[] cannot be resolve...	DPCItemsC...	Wsws_AppWeb/source/ac...	line 10 i.
⊗			ProgramParameter[] cannot be resolve...	DPCItemsC...	Wsws_AppWeb/source/ac...	line 16 i.

Wsws_AppWeb

Figure 5-7 Clicking the filter button

7. In the Filter Tasks windows, select the options that are shown in Figure 5-8 and click **OK**. The number of items shown in the Task view decreases.



Show entries of type:
- [✓] Build path Problem
- [✓] com.ibm.etools.j2ee.problemmarker
- [✓] Java Problem
- [✓] WSDL Problem
- [✓] XML Schema Problem
- [✓] XSD Problem
- [✓] Task

On any resource
On selected resource only
[✓ On selected resource and its children]

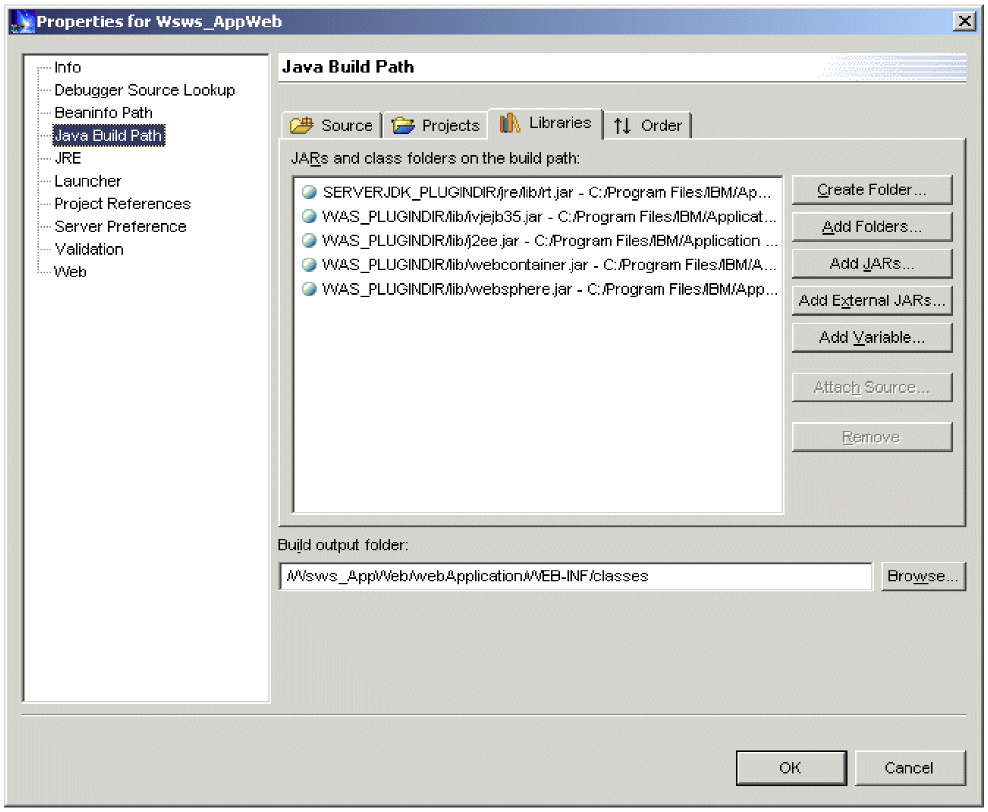
Where description: contains

[✓] Where problem severity is: [✓] Error [ ] Warning [ ] Info
[ ] Where task priority is: [ ] High [ ] Normal [ ] Low
[ ] Where task status is: [ ] Completed [ ] Not Completed

Figure 5-8 Selecting filter options

8. Most of the errors indicate that the Java compiler cannot resolve some packages and classes. All of them are part of the IBM Toolbox for Java. We need to add the IBM Toolbox for Java JAR file to the classpath.

We select the **Wsws_AppWeb** project in the Navigator view, right-click, and select **Properties**. In the Properties window, shown as Figure 5-9, we select **Java Build Path** and the tabbed window appears in the right pane. We click the **Libraries** tab and then click the **Add External JARs** button.



JARs and class folders on the build path:

SERVERJDK_PLUGINDIR/jre/lib/rt.jar - C:/Program Files/IBM/Ap...
WAS_PLUGINDIR/lib/ivjejb35.jar - C:/Program Files/IBM/Applicat...
WAS_PLUGINDIR/lib/j2ee.jar - C:/Program Files/IBM/Application ...
WAS_PLUGINDIR/lib/webcontainer.jar - C:/Program Files/IBM/A...
WAS_PLUGINDIR/lib/websphere.jar - C:/Program Files/IBM/App...

Build output folder: /Wsws_AppWeb/webApplication/WEB-INF/classes

Figure 5-9 Adding external JAR files into the classpath

In the JAR selection window, we navigate to the directory where jt400.jar is stored. In our example, we place it into the c:\jt400 directory. We select the **jt400.jar** file. Click **Open** to select it and then click **OK** in the Properties window.

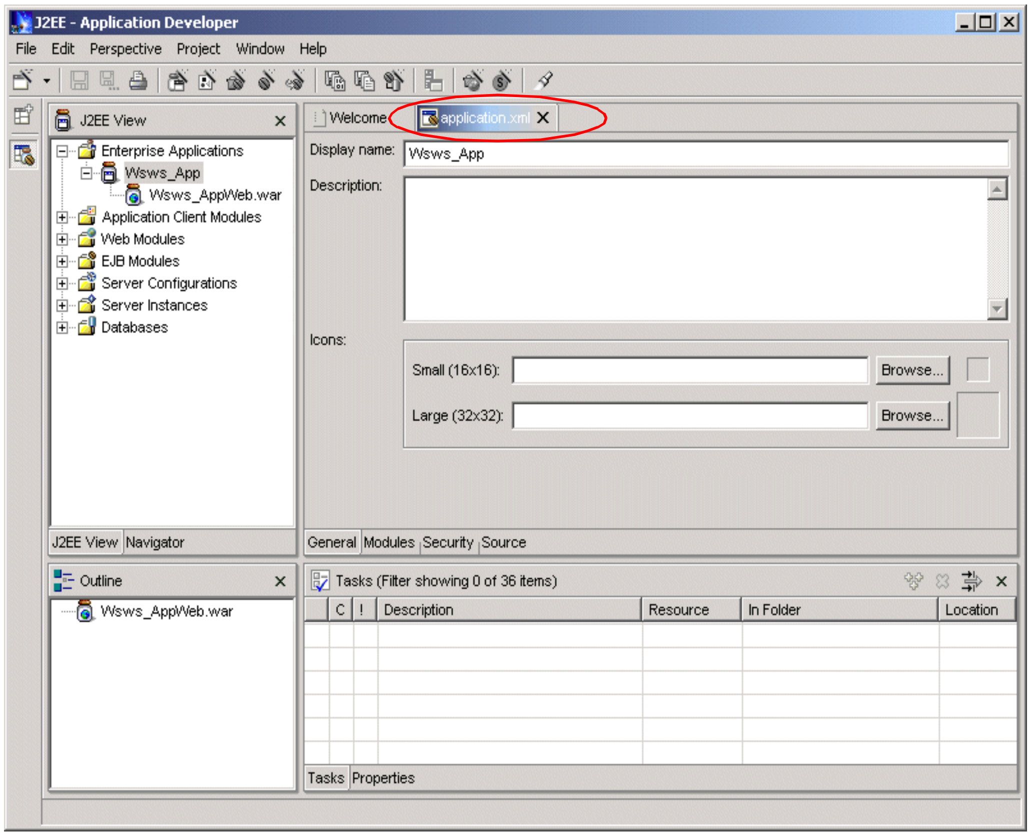
9. Now we can rebuild the project. If you left the **Perform build automatically on resource modification** option selected, it automatically rebuilds the project. All errors should disappear.

5.2.3 Exploring the enterprise application structure in Application Developer

Application Developer follows the J2EE specification in the way it handles enterprise projects. Any EJB jar or WAR file you import into Application Developer has to be part of an enterprise application project. Next, we explore the structure of an enterprise application in Application Developer:

1. We open the J2EE perspective and switch to the J2EE view. This view explores the Application Developer resources from the J2EE specification point of view.
2. We expand the **Enterprise Applications** tree. We see the **Wsws_App** application. Expand this application and all the modules that are part of the application (Web, EJB, or application client) are displayed. In this case, there is only one module – Wsws_AppWeb.war.

3. We right-click **Wsws_App** and select **Open With-> Application Editor**. Application Developer opens the application.xml file, which is the deployment descriptor (DD) for this application. This is shown in Figure 5-10.



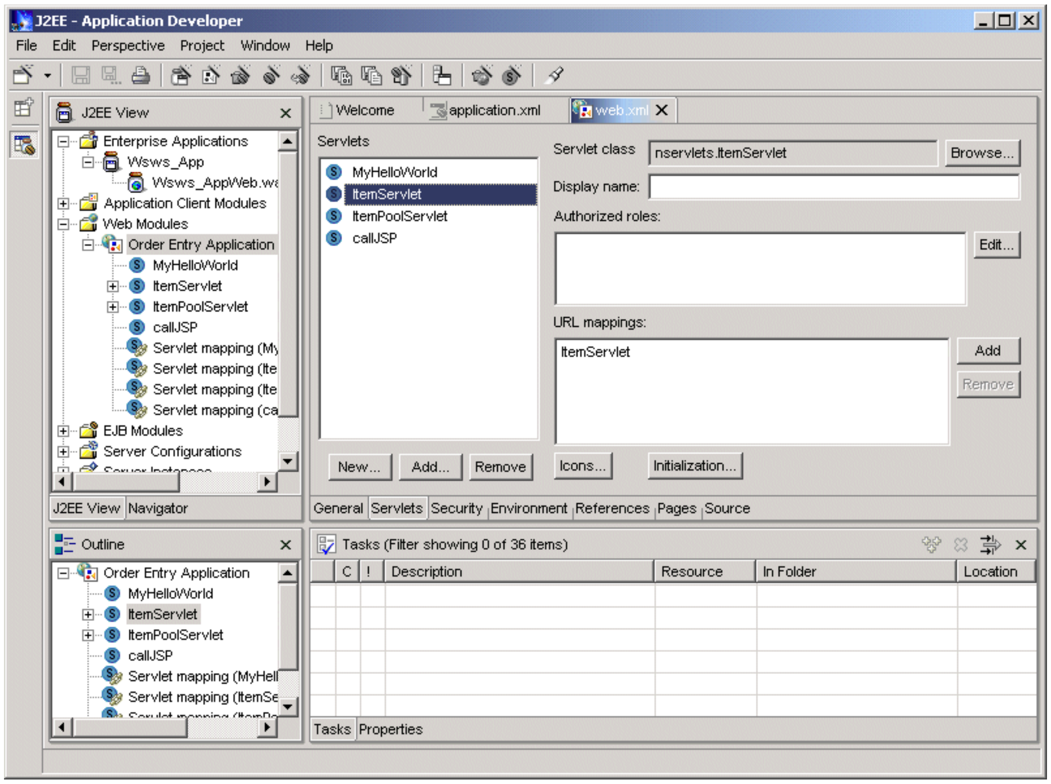
Display name: Wsws_App

Figure 5-10 Deployment descriptor for Wsws_App

4. In the left pane, we expand **Web Modules** and see the **Order Entry Application Module** This name is defined in AAT. We select this module, right-click and select **Open with-> Web.xml.editor**. Application Developer opens the Deployment Descriptor (DD) for the Web module (WAR file).
5. As shown in Figure 5-11, click the **Servlets** tab on the bottom portion of the Web.xml editor and select **ItemServlet** from the list. The editor displays the Java class that implements this servlet and the servlet's URL mapping.

Note: URL mapping is what you enter in the Web browser window as the servlet's name under the context root of the application. It is the same concept as servlet mappings in AAT. Consider this example:

```
http://sysname:port/OrderEntry/ItemServlet
```



Servlets: MyHelloWorld, ItemServlet, ItemPoolServlet, callJSP

Servlet class: nservlets.ItemServlet

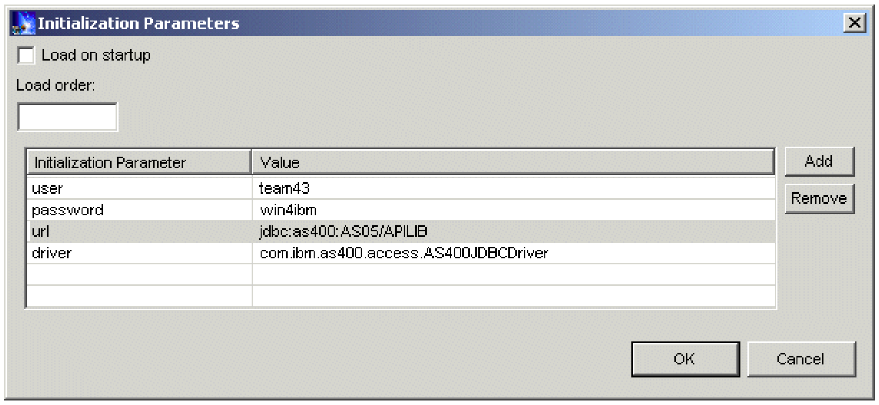
Display name:

Authorized roles:

URL mappings: ItemServlet

Figure 5-11 Deployment descriptor for a Web module

6. We click the **Initialization** button. The new pop-up window (Figure 5-12) lets us add or remove the initialization parameters for the servlet. In this case, these parameters include user name, password, URL of the database, and the JDBC driver class name. You can change the parameters to values appropriate for your system and click **OK**.



Load on startup

Load order:

Initialization Parameter	Value
user	team43
password	win4ibm
url	jdbc:as400:AS05/APILIB
driver	com.ibm.as400.access.AS400JDBCDriver

Figure 5-12 Initial parameters for ItemServlet

7. We repeat the steps for ItemPoolServlet to change the initial parameters. We can click the **Source** tab and view the XML source for the parameters we modified with the web.xml editor. If all the changes are correct, we press the Ctrl-S key combination to save the web.xml file. Now the servlets are ready for testing.

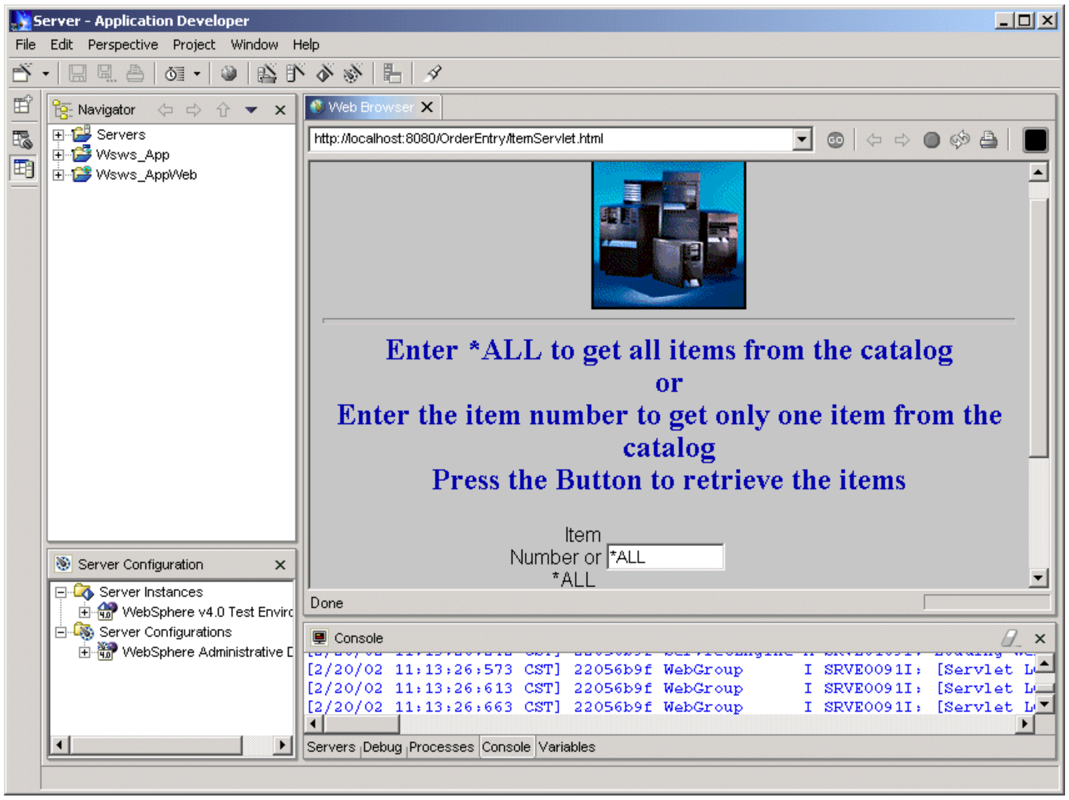
5.2.4 Testing the servlets

Now we can test the servlets. We close all the open files in Application Developer and save them if necessary.

ItemServlet testing

The ItemServlet application has an HTML page for data input. We need to run it instead of running the servlet itself:

1. In Application Developer, we open the J2EE perspective and select the Navigator view.
2. We expand **Wsws_AppWeb-> webApplication**, right-click **ItemServlet.html**, and select **Run on Server**. A new pop-up Publishing window appears showing the progress of the publishing task. Once it is finished, the WebSphere Test Environment Server automatically starts, and the perspective is switched to the Server perspective, as shown in Figure 5-13.


Server - Application Developer
File Edit Perspective Project Window Help
Navigator
Servers
Wsws_App
Wsws_AppWeb
Web Browser
Server Configuration
Server Instances
WebSphere v4.0 Test Envirc
Server Configurations
WebSphere Administrative D
Console
Servers Debug Processes Console Variables

http://localhost:8080/OrderEntry/ItemServlet.html

Enter *ALL to get all items from the catalog
or
Enter the item number to get only one item from the catalog
Press the Button to retrieve the items

Item Number or *ALL: *ALL

Done

```
[2/20/02 11:13:26:573 CST] 22056b9f WebGroup      I SRVE0091I: [Servlet L
[2/20/02 11:13:26:613 CST] 22056b9f WebGroup      I SRVE0091I: [Servlet L
[2/20/02 11:13:26:663 CST] 22056b9f WebGroup      I SRVE0091I: [Servlet L
```

Figure 5-13 The server view

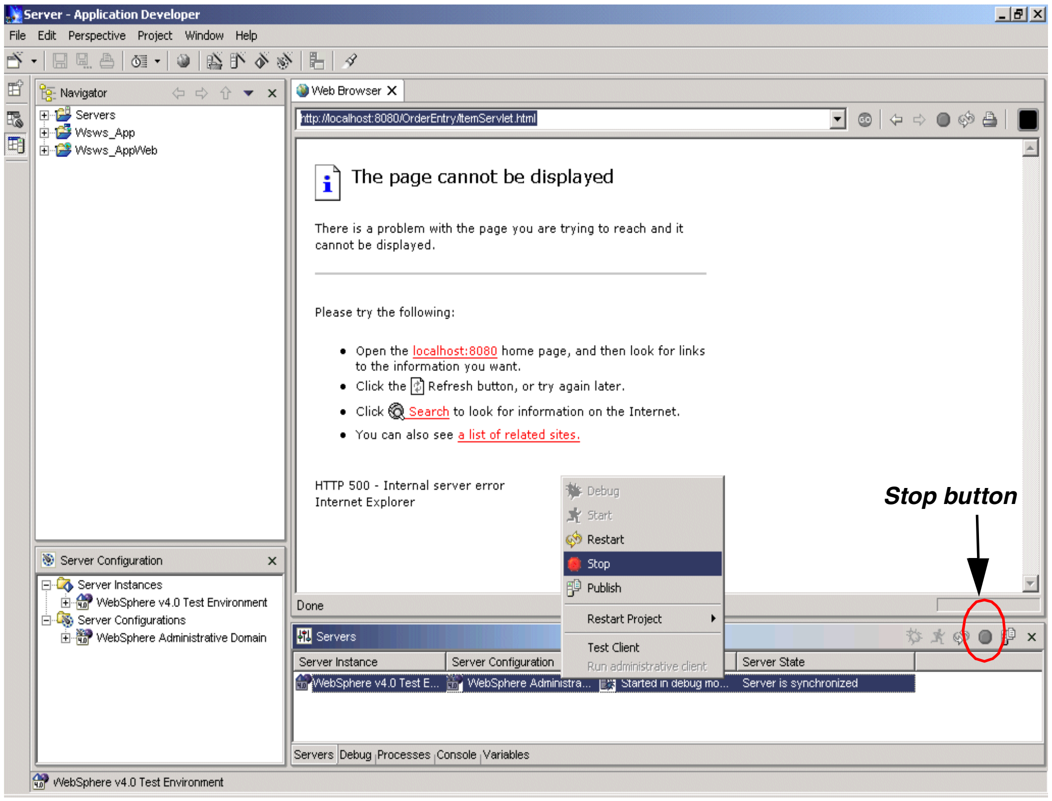
3. The embedded browser starts with the input HTML page displayed. We click the **Get Items Information** button in the browser. We see an error screen in the Web browser and the exception stack (Figure 5-14) in the Console view. The important line is highlighted.

```
[2/20/02 11:22:24:466 CST] 275feb9c SystemOut     U cannot register JDBC driver
java.lang.ClassNotFoundException: com.ibm.as400.access.AS400JDBCDriver
    at java.net.URLClassLoader.findClass(URLClassLoader.java:205)
    at java.lang.ClassLoader.loadClass(ClassLoader.java:325)
```

Figure 5-14 Exception stack in the Console view

4. The WebSphere Test Environment cannot find the JDBC driver class which is part of the jt400.jar file. We need to add it to the server classpath.

   a. We select the **Servers** view from one of the tabs in the lower portion of the Application Developer window. We right-click the server instance and select **Stop**. You can also click the **Stop** button on the Server view toolbar. This is shown in Figure 5-15.


Server - Application Developer
File Edit Perspective Project Window Help
Navigator
Servers
Wsws_App
Wsws_AppWeb
Web Browser
http://localhost:8080/OrderEntry/ItemServlet.html
Server Configuration
Server Instances
WebSphere v4.0 Test Environment
Server Configurations
WebSphere Administrative Domain
Debug
Start
Restart
Stop
Publish
Restart Project
Test Client
Run administrative client
Stop button
Done
Servers
Server Instance
Server Configuration
Server State
Servers Debug Processes Console Variables
WebSphere v4.0 Test Environment

The page cannot be displayed

There is a problem with the page you are trying to reach and it cannot be displayed.

Please try the following:

- Open the localhost:8080 home page, and then look for links to the information you want.
- Click the Refresh button, or try again later.
- Click Search to look for information on the Internet.
- You can also see a list of related sites.

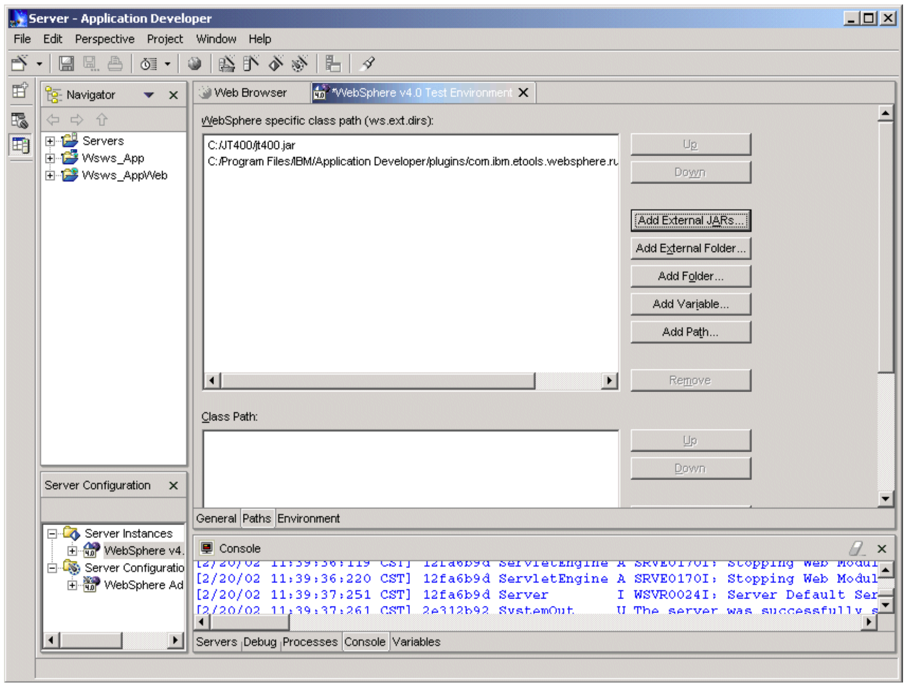
HTTP 500 - Internal server error
Internet Explorer

Server Instance	Server Configuration		Server State
WebSphere v4.0 Test E...	WebSphere Administra...	Started in debug mo...	Server is synchronized

Figure 5-15 Stopping the WebSphere test server in Application Developer

   b. After this server stops, we expand the **Server Instances** tree in the Server Configuration view (lower-left portion of the Application Developer window). We double-click **WebSphere v4.0 Test Environment** and select the **Paths** tab in the editor window.

   c. As shown in Figure 5-16, we click the **Add External JARs** button and navigate to the directory where the **jt400.jar** file is stored. We select it and click **Open**. We use the same technique to add the j2ee.jar file as an external JAR file. It is found in the \Program Files\IBM\Application Developer\plugins\com.ibm.etools.websphere.runtime\lib directory. We close the file in the editor window and click **Yes** on the pop-up window to save the changes.



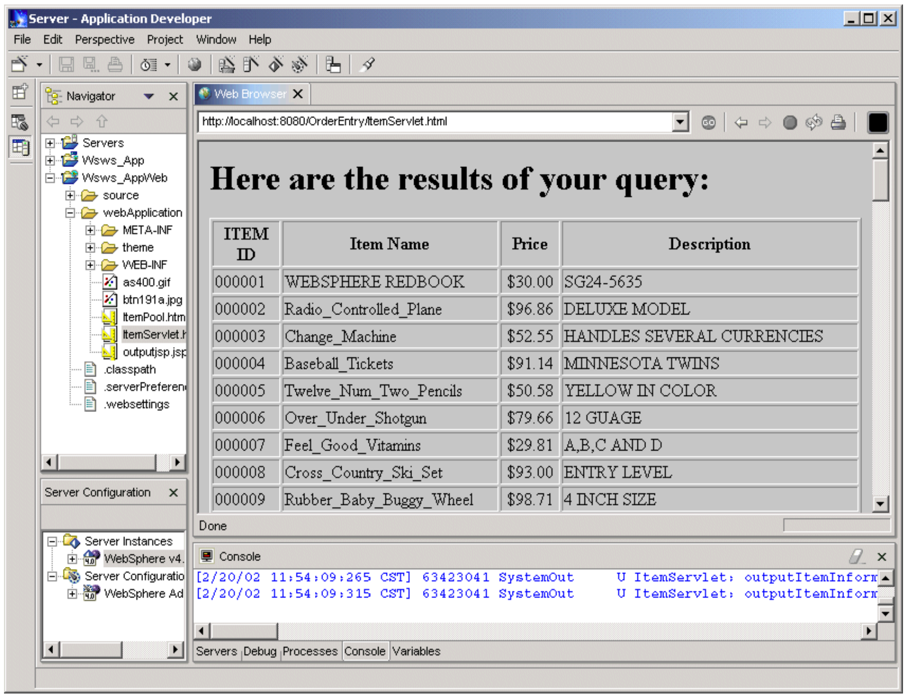
WebSphere specific class path (ws.ext.dirs):

```
C:/JT400/jt400.jar
C:/Program Files/IBM/Application Developer/plugins/com.ibm.etools.websphere.ru
```

```
[2/20/02 11:39:36:220 CST] 12fa6b9d ServletEngine A SRVE0170I: Stopping Web Modul
[2/20/02 11:39:37:251 CST] 12fa6b9d Server        I WSVR0024I: Server Default Ser
[2/20/02 11:39:37:261 CST] 2e312b92 SystemOut     U The server was successfully s
```

Figure 5-16 Adding external JAR files into the classpath

5. Now we can restart the server by clicking the **Start the Server** button on the title bar of the Server view. When the server is ready, we see the `Server Default Server open for e-business` line in the Console view.
6. We expand **Wsws-AppWeb-> webApplication**, right-click **ItemServlet.html**, and select **Run on Server**. When the input HTML page appears, we click the **Get Items Information** button. We see the list of items from the iSeries database table as shown in Figure 5-17.



http://localhost:8080/OrderEntry/ItemServlet.html

Here are the results of your query:

ITEM ID	Item Name	Price	Description
000001	WEBSPHERE REDBOOK	$30.00	SG24-5635
000002	Radio_Controlled_Plane	$96.86	DELUXE MODEL
000003	Change_Machine	$52.55	HANDLES SEVERAL CURRENCIES
000004	Baseball_Tickets	$91.14	MINNESOTA TWINS
000005	Twelve_Num_Two_Pencils	$50.58	YELLOW IN COLOR
000006	Over_Under_Shotgun	$79.66	12 GUAGE
000007	Feel_Good_Vitamins	$29.81	A,B,C AND D
000008	Cross_Country_Ski_Set	$93.00	ENTRY LEVEL
000009	Rubber_Baby_Buggy_Wheel	$98.71	4 INCH SIZE

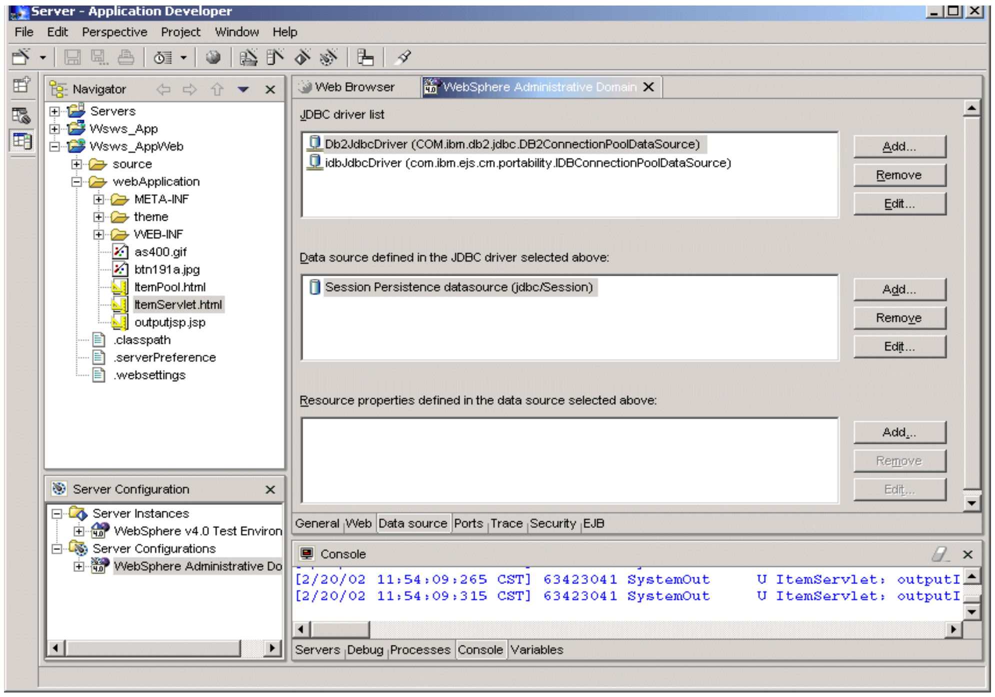
```
[2/20/02 11:54:09:265 CST] 63423041 SystemOut     U ItemServlet: outputItemInform
[2/20/02 11:54:09:315 CST] 63423041 SystemOut     U ItemServlet: outputItemInform
```

Figure 5-17 ItemServlet result page

ItemPoolServlet testing

To test the ItemPoolServlet class, we need to create a DataSource in the WebSphere Test Environment:

1. We open the Server perspective, expand the **Server Configuration** tree in the Server Configuration view, and double-click **WebSphere Administrative Domain**. Application Developer opens the server configuration file in the editor view as shown in Figure 5-18.


Server - Application Developer
File Edit Perspective Project Window Help
Navigator
Servers
Wsws_App
Wsws_AppWeb
source
webApplication
META-INF
theme
WEB-INF
as400.gif
btn191a.jpg
ItemPool.html
ItemServlet.html
outputjsp.jsp
.classpath
.serverPreference
.websettings
Server Configuration
Server Instances
WebSphere v4.0 Test Environ
Server Configurations
WebSphere Administrative Do
Web Browser
WebSphere Administrative Domain
JDBC driver list
Add...
Remove
Edit...
Data source defined in the JDBC driver selected above:
Resource properties defined in the data source selected above:
General Web Data source Ports Trace Security EJB
Console
Servers Debug Processes Console Variables

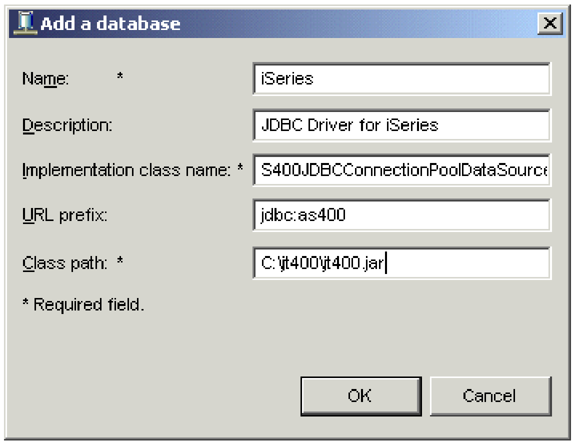
Db2JdbcDriver (COM.ibm.db2.jdbc.DB2ConnectionPoolDataSource)
idbJdbcDriver (com.ibm.ejs.cm.portability.IDBConnectionPoolDataSource)

Session Persistence datasource (jdbc/Session)

```
[2/20/02 11:54:09:265 CST] 63423041 SystemOut     U ItemServlet: outputI
[2/20/02 11:54:09:315 CST] 63423041 SystemOut     U ItemServlet: outputI
```

Figure 5-18 WebSphere Administration Domain configuration

2. We select the **Data source** tab in the editor view. We click **Add** next to the JDBC driver list box and enter the parameters as shown in Figure 5-19, where the full name for the Implementation class name field is `com.ibm.as400.access.AS400JDBCConnectionPoolDataSource`. Then we click **OK**.

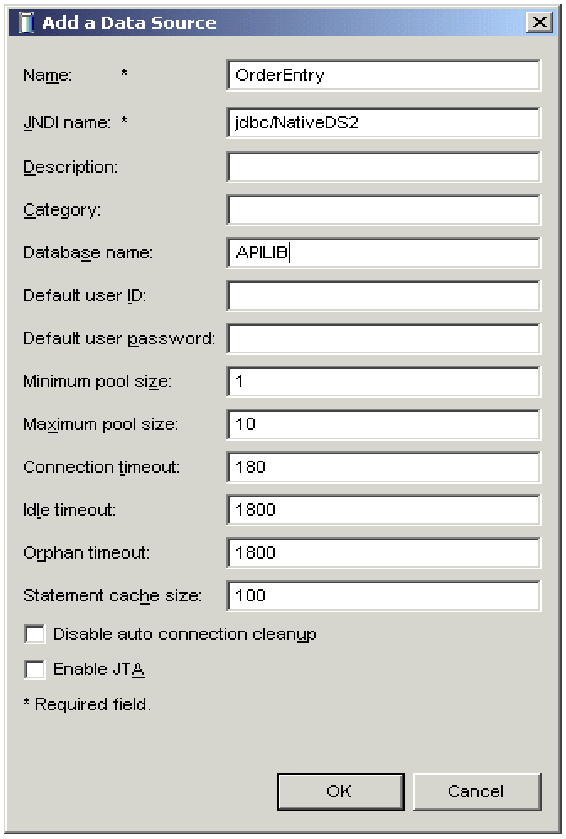


Name: *	iSeries
Description:	JDBC Driver for iSeries
Implementation class name: *	S400JDBCConnectionPoolDataSourc
URL prefix:	jdbc:as400
Class path: *	C:\jt400\jt400.jar

* Required field.

Figure 5-19 JDBC driver parameters

3. The IBM Toolbox for Java JDBC driver has been added and highlighted. We click the **Add** button next to the Data Source defined in the JDBC driver selected above box. We fill in the fields as shown in Figure 5-20 and then click **OK**.



Name: *	OrderEntry
JNDI name: *	jdbc/NativeDS2
Description:	
Category:	
Database name:	APILIB
Default user ID:	
Default user password:	
Minimum pool size:	1
Maximum pool size:	10
Connection timeout:	180
Idle timeout:	1800
Orphan timeout:	1800
Statement cache size:	100

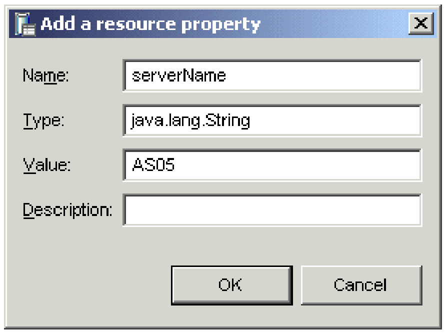
☐ Disable auto connection cleanup

☐ Enable JTA

* Required field.

Figure 5-20 Data Source parameters

4. Finally, we specify the target system where the database tables are located. We click **Add** next to the Resource properties defined in the data source selected above box. We fill in the parameters as shown in Figure 5-21. We make sure the system name, in the Value field, is correct and click **OK**.



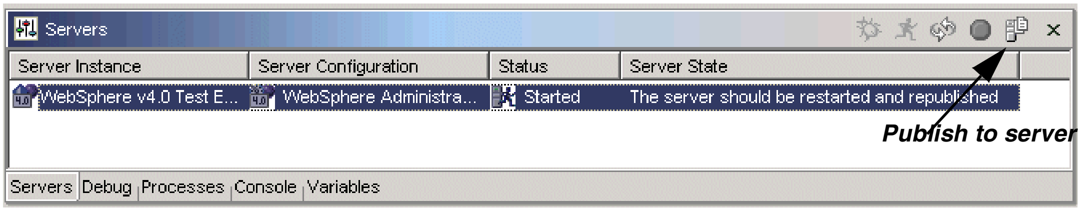
Name:	serverName
Type:	java.lang.String
Value:	AS05
Description:	

Figure 5-21 Data source property dialog box

5. We use the same technique to add a resource property named *libraries*. We set the value to the name of the iSeries library that holds the tables, apilib.

6. We save the file by pressing the Ctrl-S key combination. The ItemPoolServlet is ready for testing. We select the Server view by clicking the **Server** tab in the lower right part of the

Application Developer window. It informs you that you have made some changes and you have to republish your project (see Figure 5-22).



Server Instance	Server Configuration	Status	Server State
WebSphere v4.0 Test E...	WebSphere Administra...	Started	The server should be restarted and republished

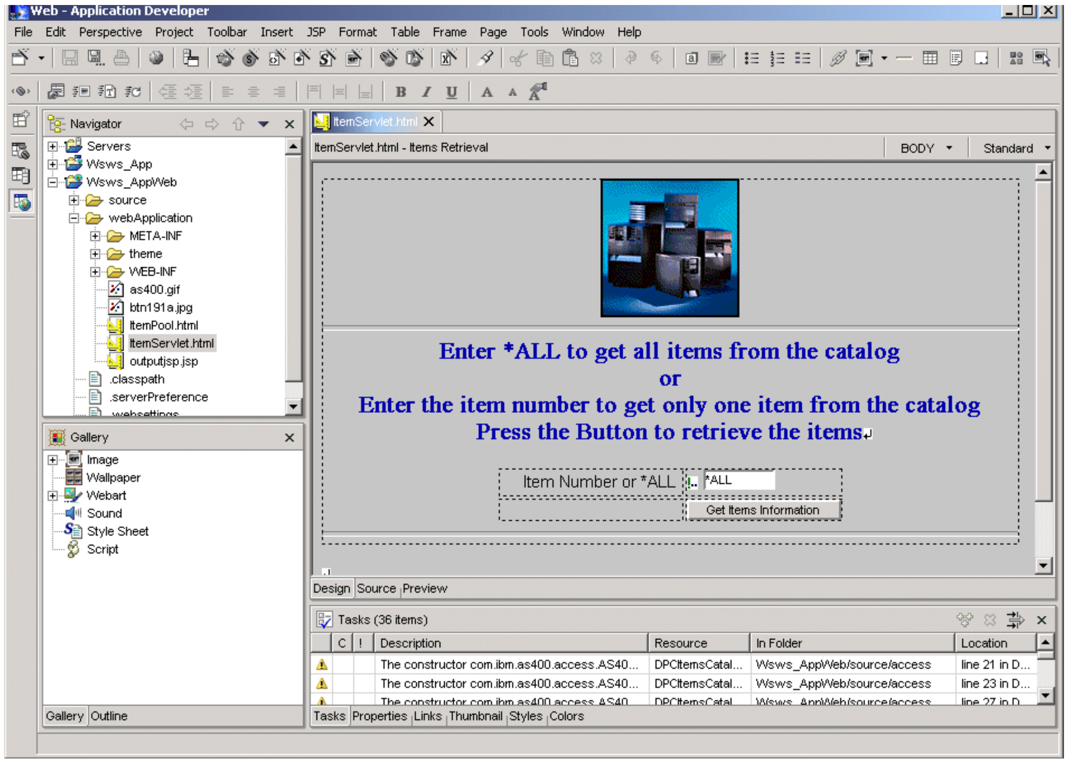
Figure 5-22 The Server view

7. We click the **Publish to the server** button and then click **Finish**. We click **OK** in the Publishing pop-up window.
8. Now we can start the server by clicking the **Start the server** button.
9. When the server is ready, we expand **Wsws_AppWeb -> webApplication**, right-click **ItemPool.html**, and select **Run on Server**.
10. We see the input HTML page. Then we click the **Get Items Information** button and retrieve the data.

Working with HTML files in Application Developer

Since Application Developer is evolved from VisualAge for Java Enterprise Edition and WebSphere Studio Advanced Edition, it inherits the page designing capabilities, which makes it an integrated Web application development environment. Next we work with Page Designer in Application Developer:

1. In Application Developer, we switch to the Web perspective and expand **Wsws_AppWeb-> webApplication**. We double-click **ItemServlet.html**. Then Page Designer is invoked with the HTML page shown in Figure 5-23.



Enter *ALL to get all items from the catalog
or
Enter the item number to get only one item from the catalog
Press the Button to retrieve the items.

C	!	Description	Resource	In Folder	Location
	⚠	The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 21 in D...
	⚠	The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 23 in D...
	⚠	The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 27 in D...

Figure 5-23 ItemServlet.html in Page Designer

2. In the Page Designer view, we place the cursor just below the line that reads: `Press the Button to retrieve the items`. We select **Insert-> Form and Input Fields-> Submit Button** from the menu.
3. In the pop-up window, as shown in Figure 5-24, we enter `Submit` in the Name box and `Get All Items` in the Label box.

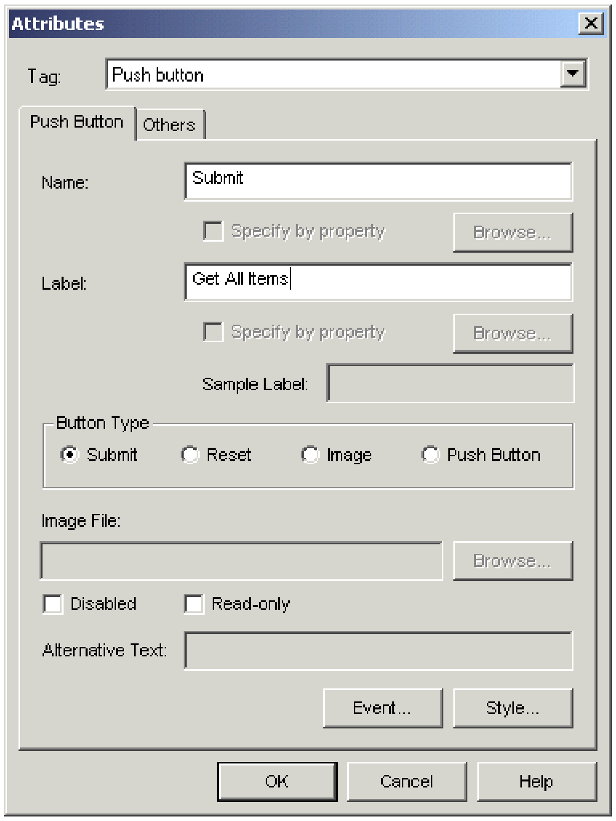
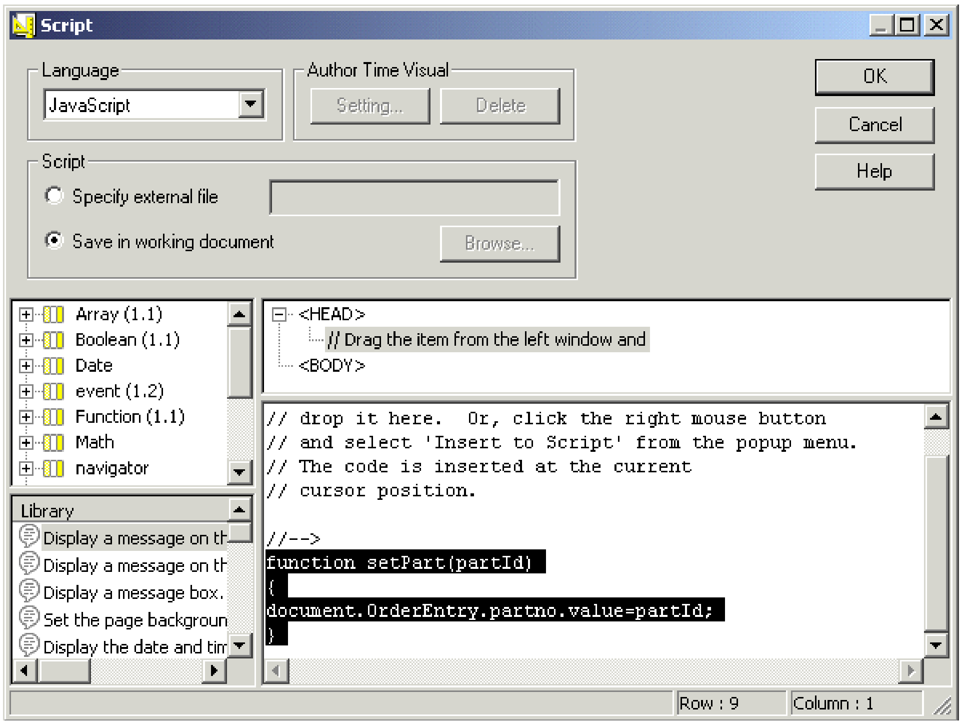


Figure 5-24 Adding a Submit button

4. Now we have a Submit button that invokes the ItemServlet servlet and retrieves all the data. We have to pass the part number as a parameter. We use JavaScript to do this.
   a. We click the **Event** button. In the pop-up Edit Event window, we select **OnClick** from the Event list. We click the **Script** button.
   b. The new pop-up Script window allows us to create a custom Java script. We enter the body of the setPart function as shown in Figure 5-25 and click **OK**.



Language: JavaScript

Script: [ ] Specify external file [✓ Save in working document]

- Array (1.1)
- Boolean (1.1)
- Date
- event (1.2)
- Function (1.1)
- Math
- navigator

Library:
- Display a message on th
- Display a message on th
- Display a message box.
- Set the page backgroun
- Display the date and tir

```
<HEAD>
  // Drag the item from the left window and
<BODY>
```

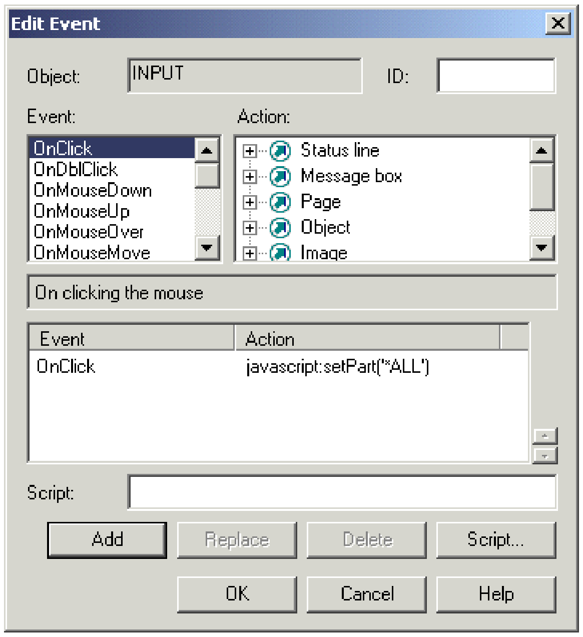
```
// drop it here.  Or, click the right mouse button
// and select 'Insert to Script' from the popup menu.
// The code is inserted at the current
// cursor position.

//-->
function setPart(partId)
{
document.OrderEntry.partno.value=partId;
}
```

Figure 5-25 JavaScript function

c. In the Script box of the Edit Event window, we enter the following code that calls the setPart JavaScript function when we click the **Submit** button:

```
javascript:setPart('*ALL')
```

d. We click the **Add** button. The Edit Event window looks like the example in Figure 5-26. We click **OK**.



Object: INPUT ID:

Event:
- OnClick
- OnDblClick
- OnMouseDown
- OnMouseUp
- OnMouseOver
- OnMouseMove

Action:
- Status line
- Message box
- Page
- Object
- Image

On clicking the mouse

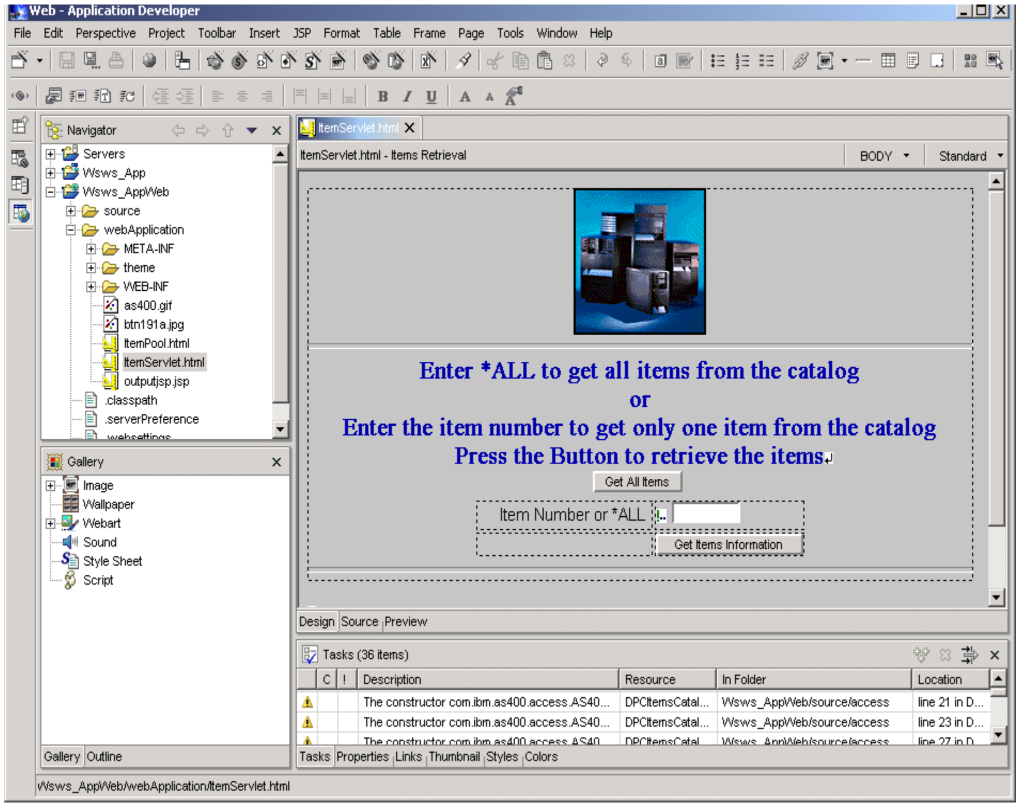
Event	Action
OnClick	javascript:setPart('*ALL')

Script:

Figure 5-26 The Edit Event window

e. We click **OK** in the Attribute window to add the new button to the page.

f. Since this new button retrieves all items from the database table, we can remove the default value `*ALL` for the Part Number field. We double-click the Part Number text field (where you see *ALL) in the Page Designer view. Then we delete ***ALL** from the initial value box and click **OK**. We press Ctrl-S to save the file. Now the page looks like the example in Figure 5-27.



Enter *ALL to get all items from the catalog
or
Enter the item number to get only one item from the catalog
Press the Button to retrieve the items.

Get All Items

Item Number or *ALL

Get Items Information

Tasks (36 items)

C	!	Description	Resource	In Folder	Location
⚠		The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 21 in D...
⚠		The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 23 in D...
⚠		The constructor com.ibm.as400.access.AS40...	DPCItemsCatal...	Wsws_AppWeb/source/access	line 27 in D...

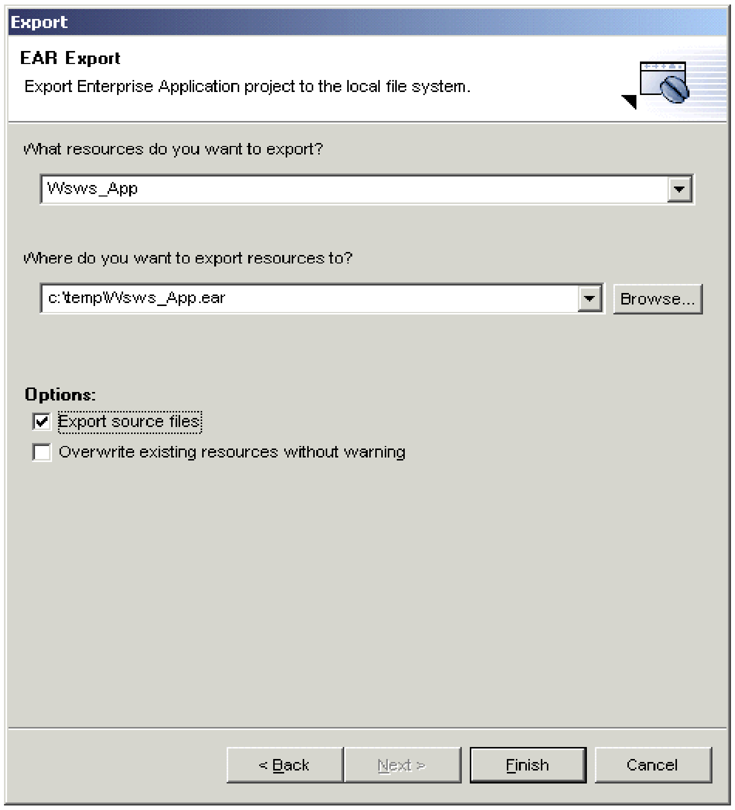
Figure 5-27 Modified ItemPool.html page

5. We can test the new HTML page using the same steps as those outlined in “ItemServlet testing” on page 185. To retrieve all the item data, we click the new **Get All Items** button. We can also retrieve information for a single item using the Get Items Information button. Valid values are in the range 000001 - 000100.

Exporting an EAR file

After the modification of the OrderEntry application, we can deploy it on WebSphere Application Server 4.0. Application Developer is capable of generating J2EE standard enterprise applications, so we don’t need to go through the Application Assembly Tool.

1. In Application Developer, we select **File-> Export** from the menu.
2. In the pop-up Export window, we select **EAR file** and click **Next**.
3. In the EAR Export window, as shown in Figure 5-28, we select **Wsws_App** from the What resources do you want to export? pull-down list. We enter `x:\temp\Wsws_App.ear` in the Where do you want to export resources to? input field. We select the **Export source file** check box and click **Finish**.


Export

EAR Export

Export Enterprise Application project to the local file system.

What resources do you want to export?

Wsws_App

Where do you want to export resources to?

c:\temp\Wsws_App.ear

Options:

- [x] Export source files
- [ ] Overwrite existing resources without warning

Figure 5-28 Exporting an EAR file

The Wsws_App.ear file is placed in the temp directory. It is ready for deployment on WebSphere Application Server 4.0.

5.3 Developing a new application with Application Developer

In 5.2, “Migrating the OrderEntry WAR file” on page 177, we imported the OrderEntry WAR file into Application Developer. The application was originally developed using VisualAge for Java. This is a convenient way to migrate from VisualAge for Java to Application Developer.

In this section, we use Application Developer to develop a new application. The new application is a Web-based version of the RPG OrderEntry application described in 7.1, “The ABC Company” on page 232.

You may have already noticed that, in the ItemSessionServlet example shown in 2.7.3, “ItemSessionServlet example” on page 64, we hard code all the output pages in the servlet. If you want to change anything about the presentation, such as font size, images and so on, you have to change the code of the servlet. The reason for this is that VisualAge for Java does not have the capability of building JSP pages with What You See Is What You Get (WYSIWYG) tools. We either have to hard code the page in the servlet, or integrate VisualAge for Java with WebSphere Studio to build the JSP pages. This makes the example more complicated.

A popular Web application model is to use a logical three-tier model. The first tier is a presentation tier that typically consists of a graphical user interface shown in a browser. The middle tier is business tier where we build the business logic. The third tier is the data tier that contains the application data.

This architecture takes advantage of each Web component. We use JSPs for the presentation layer. We use servlets and EJBs to control the application flow and to implement the business logic. This is known as *Model-View-Controller architecture*. Figure 5-29 shows the application design.

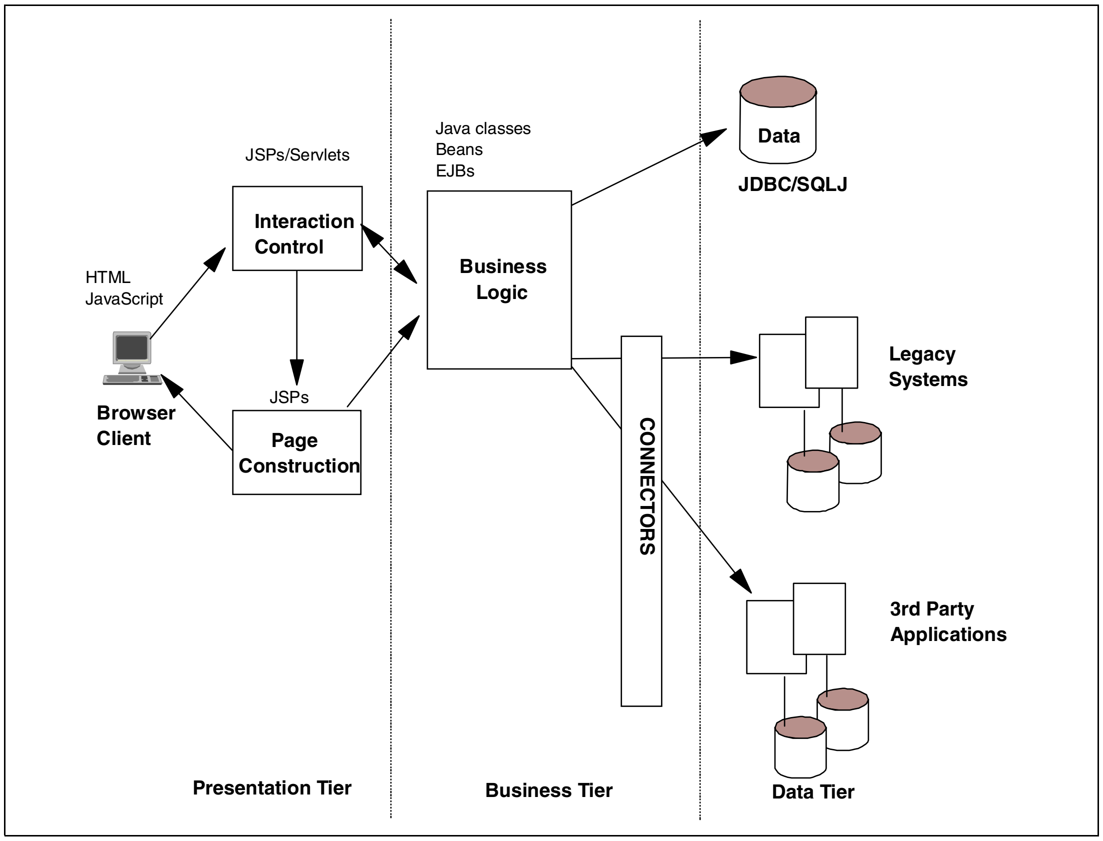


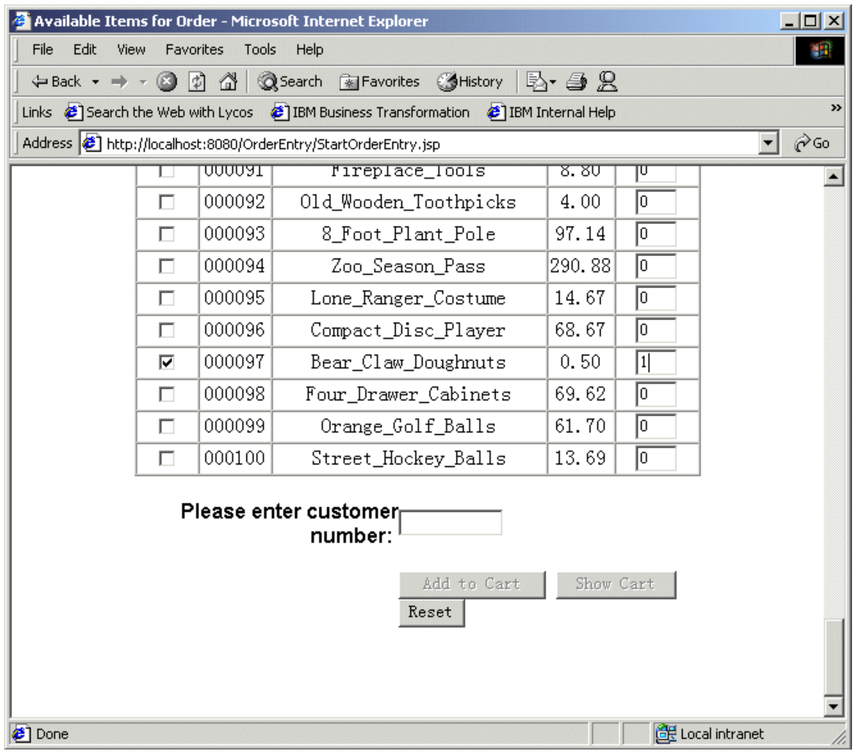
Figure 5-29 Web application 3-tier architecture

We build the new OrderEntry application using JSPs, servlets, and JavaBeans. We do not use Enterprise JavaBeans. For an example that uses JSPs, servlets, and EJBs, see Chapter 10, “Building Java applications with Enterprise JavaBeans” on page 315. Since Application Developer has an integrated environment for all these Web components, all the tasks like designing, testing, and exporting can be done within it.

5.3.1 New OrderEntry application logic

The application logic is similar with the ItemSessionServlet example in 2.7.3, “ItemSessionServlet example” on page 64, but we use JSPs for presentation of the information. We also add the ability to actually place an order.

When we call the servlet, it uses a JavaBean to retrieve all the available items from the Item table. It passes the result to a JSP page through a session object. The JSP page is responsible for showing the items in a browser. This is shown in Figure 5-30.


Available Items for Order - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/OrderEntry/StartOrderEntry.jsp
Go
Done
Local intranet

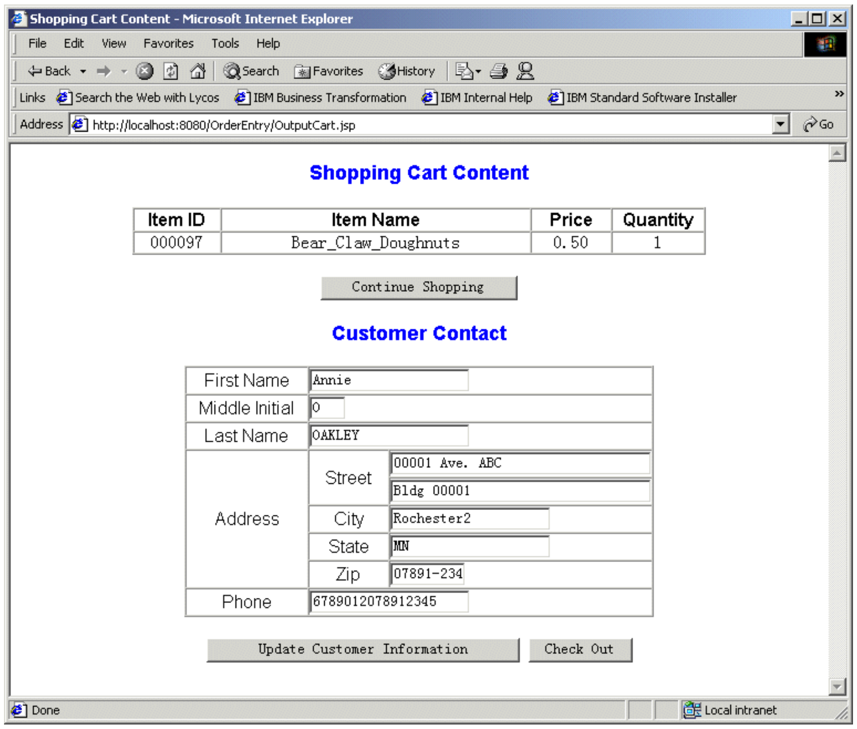
☐	000091	Fireplace_Tools	8.80	0
☐	000092	Old_Wooden_Toothpicks	4.00	0
☐	000093	8_Foot_Plant_Pole	97.14	0
☐	000094	Zoo_Season_Pass	290.88	0
☐	000095	Lone_Ranger_Costume	14.67	0
☐	000096	Compact_Disc_Player	68.67	0
✓	000097	Bear_Claw_Doughnuts	0.50	1
☐	000098	Four_Drawer_Cabinets	69.62	0
☐	000099	Orange_Golf_Balls	61.70	0
☐	000100	Street_Hockey_Balls	13.69	0

Please enter customer number:

Add to Cart | Show Cart | Reset

Figure 5-30 Item JSP page

Once we select some items, enter numbers in the quantity field, and enter the customer number, the Add to Cart button and Show Cart button are enabled. Clicking these buttons, invokes a controller servlet. It sends the shopping data and customer data to another JSP page for display as shown in Figure 5-31.


Shopping Cart Content - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://localhost:8080/OrderEntry/OutputCart.jsp
Go
Done
Local intranet

Shopping Cart Content

Item ID	Item Name	Price	Quantity
000097	Bear_Claw_Doughnuts	0.50	1

Continue Shopping

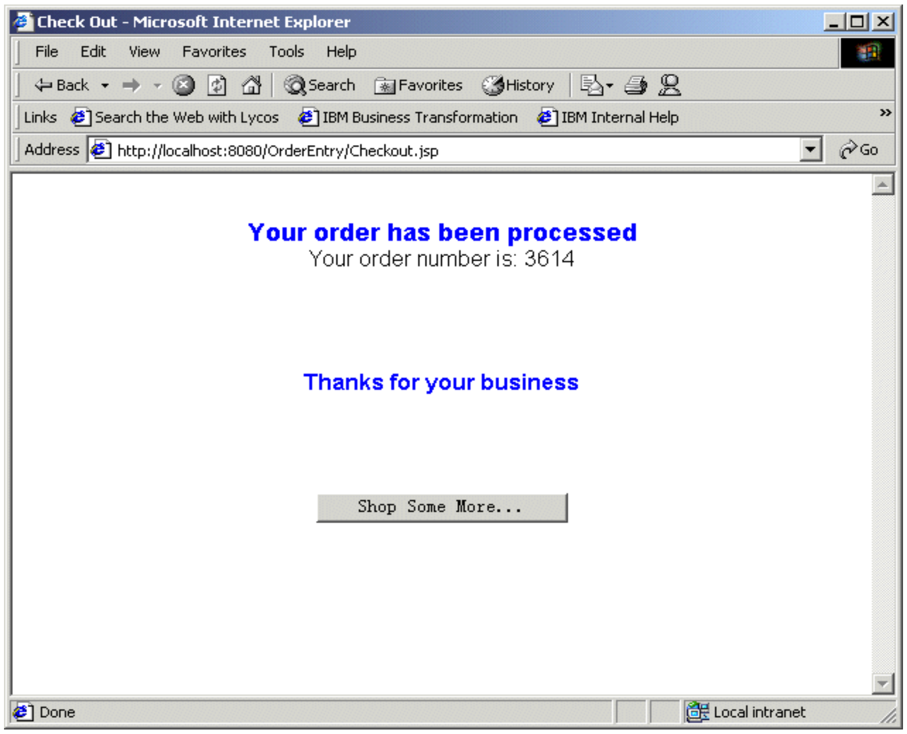
Customer Contact

First Name		Annie
Middle Initial		0
Last Name		OAKLEY
Address	Street	00001 Ave. ABC
		Bldg 00001
	City	Rochester2
	State	MN
	Zip	07891-234
Phone		6789012078912345

Update Customer Information | Check Out

Figure 5-31 Shopping cart JSP

We can either click the **Continue Shopping** button to go back the item JSP page or update the customer information by clicking the related button. Once we are ready to check out, we click the **Check Out** button. This invokes the controller servlet again. The controller servlet calls the JavaBeans to perform order processing and shows the transaction result on a JSP page as shown in Figure 5-32.


Check Out - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help
Address http://localhost:8080/OrderEntry/Checkout.jsp
Go
Shop Some More...
Done
Local intranet

Your order has been processed
Your order number is: 3614

Thanks for your business

Figure 5-32 Transaction result page

5.3.2 Building the application

We build three new JSPs for presentation:

- *StartOrderEntry.jsp* to show all the items you can add to the shopping cart
- *OutputCart.jsp* to show the shopping cart content and customer information
- *Checkout.jsp* to show the transaction result

We build two new servlets for logic control:

- *StartOrderEntryServlet* to create new a session object and retrieve the available items from the Items table
- *OrderEntryControllerServlet* to control all the actions from the JSP pages

We build four new JavaBeans for the business process:

- *Customer* to contain the customer information
- *JDBCPoolCustomer* to retrieve customer information from the Customer table and return the Customer bean
- *OrderDetail* to contain the order detail information
- *OrderProcess* to handle the order placement process

We reuse some existing beans in the access, shopData, and support packages:

- *Items*, which contains the item detail
- *CartItem*, which contains the item detail in the shopping cart

- *ShoppingCart*, which represents shopping cart data
- *JDBCPoolCatalog*, which retrieves all items from the database

Note: The Customer and OrderDetail beans already exist in the Support package. Since our new Customer and OrderDetail beans are different, we create new beans instead of using the old ones. We create them in the access package.

The architecture for our new application is shown in Figure 5-33. The StartOrderEntryServlet is used to retrieve item data and pass it to StartOrderEntry.jsp. All the action control is done by the OrderEntryControllerServlet, which passes different data beans back and forth through a session object.

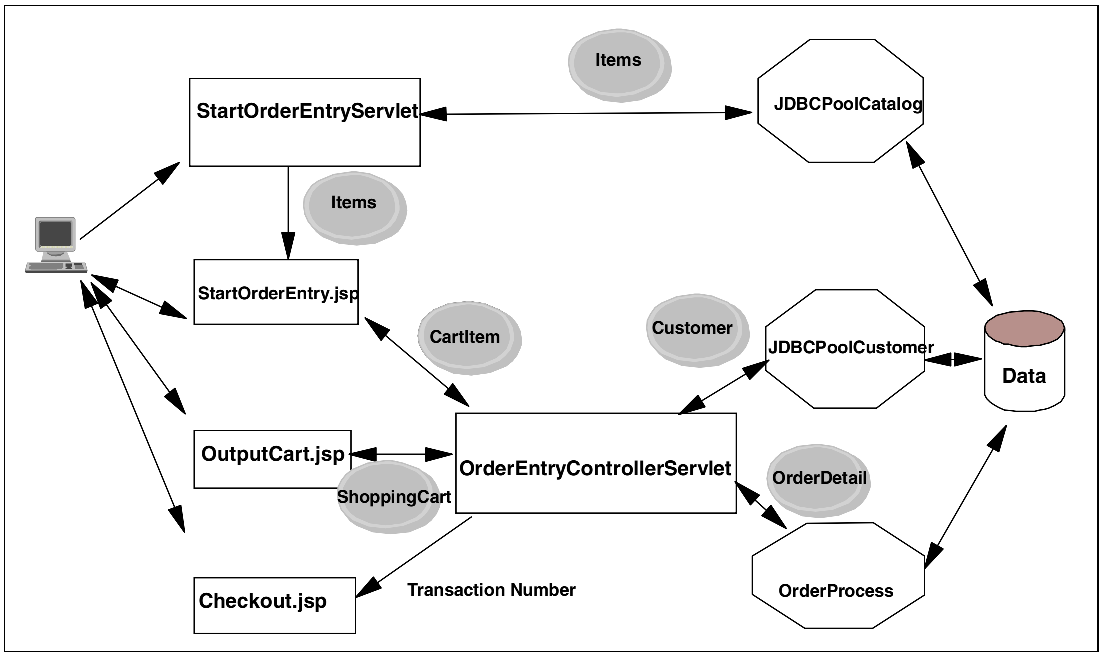


Figure 5-33 New shopping cart application architecture

The new project is based on the project we created in 5.2, “Migrating the OrderEntry WAR file” on page 177. We add the JavaBeans, JSPs, and servlets to the project.

5.3.3 Building the OrderEntry application with Application Developer

We switch to the Java perspective. By default, Application Developer shows the library and JAR files that are part of the project build path. To change this behavior, we open the **Packages** view menu by clicking the down arrow on the title bar. As shown in Figure 5-34, we deselect **Show Referenced Libraries**.

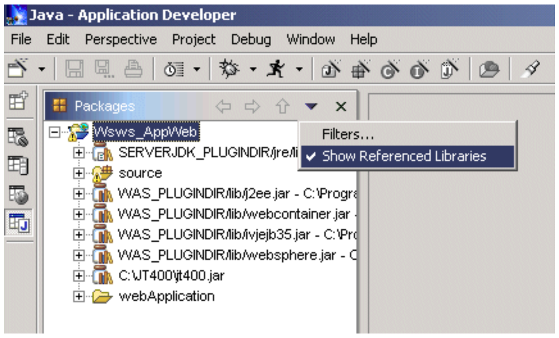
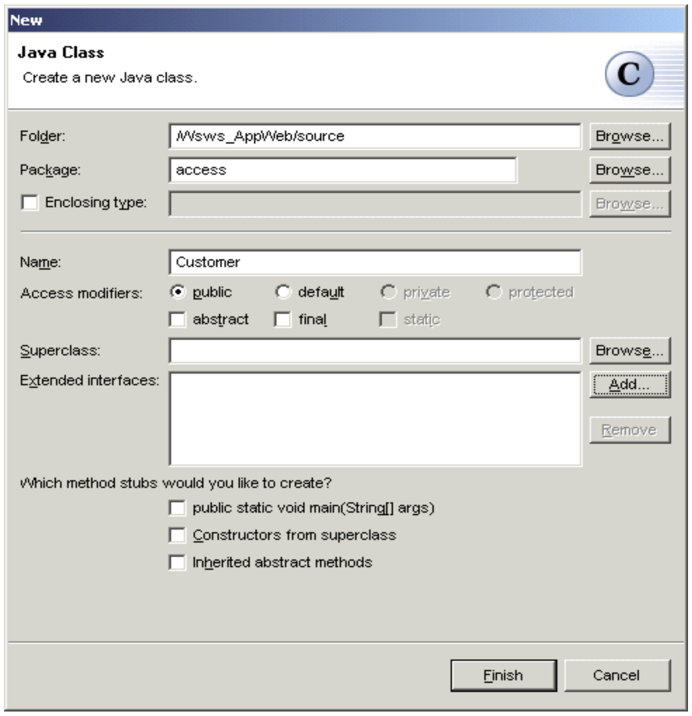

Java - Application Developer
File Edit Perspective Project Debug Window Help
Packages
Filters...
✓ Show Referenced Libraries
Wsws_AppWeb
SERVERJDK_PLUGINDIR/jre/li
source
WAS_PLUGINDIR/lib/j2ee.jar - C:\Progra
WAS_PLUGINDIR/lib/webcontainer.jar
WAS_PLUGINDIR/lib/ivjejb35.jar - C:\Pro
WAS_PLUGINDIR/lib/websphere.jar - C
C:\JT400\jt400.jar
webApplication

Figure 5-34 The Package view menu

Customer bean

We follow these steps:

1. We add the JavaBeans to the project. We expand the **source** folder in the left pane, right-click the **access** package, and select **New-> Class**.
2. In the Java Class window, shown in Figure 5-35, we enter `Customer` for Name, remove **java.lang.Object** from Superclass, and click the **Add** button next to the Extended interfaces field.



New

Java Class

Create a new Java class.

Folder: /Wsws_AppWeb/source

Package: access

Enclosing type:

Name: Customer

Access modifiers: [✓ public] default private protected

abstract final static

Superclass:

Extended interfaces:

Which method stubs would you like to create?

public static void main(String[] args)

Constructors from superclass

Inherited abstract methods

Figure 5-35 Creating the Customer class

3. In the Extended Interfaces Selection window, shown in Figure 5-36, we select **Serializable** as the interface name and **java.io** as the package name. We click **OK** and the interface is added into the Extended Interface input field. We click **Finish**.

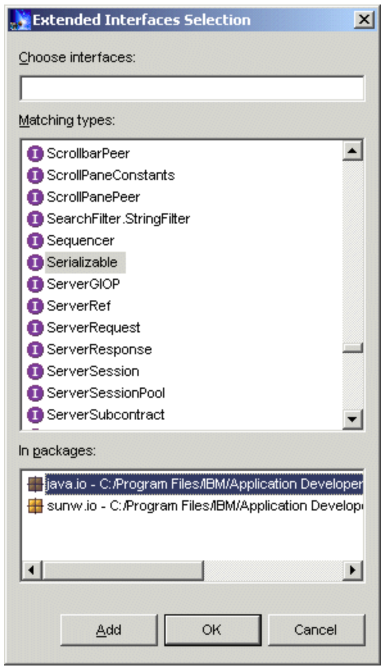


Figure 5-36 Adding an interface

4. The Customer object is created in the access package and the source is opened automatically. In the source window, we add the following line of code just below package access:

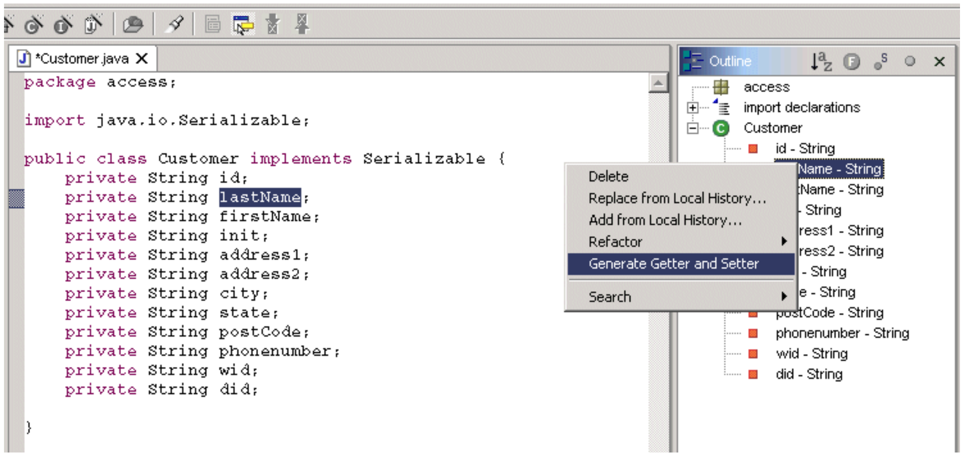
```
import java.math.*;
```

5. We define the private variables that represent customer information. Example 5-1 shows the private variables that we add.

Example 5-1 Variable definition for Customer class

```
    private String id;
    private String lastName;
    private String firstName;
    private String init;
    private String address1;
    private String address2;
    private String city;
    private String state;
    private String postCode;
    private String phonenumber;
    private String wid;
    private String did;
```

6. For all the variables defined, we want to define setter and getter methods. Application Developer provides a function to do this. In the Outline window shown in Figure 5-37, we right-click in each field and select **Generate Getter and Setter**.



```
package access;

import java.io.Serializable;

public class Customer implements Serializable {
      private String id;
      private String lastName;
      private String firstName;
      private String init;
      private String address1;
      private String address2;
      private String city;
      private String state;
      private String postCode;
      private String phonenumber;
      private String wid;
      private String did;

}
```

Figure 5-37 Generating Getter and Setter methods

7. Setter and getter methods are created for each private variable. We need to modify one getter method, `getDid()`. The *Did* variable is defined as numeric in the database. When we call `getDid()` from other classes, we want to an `int` returned. The method is changed as shown in Example 5-2.

Example 5-2 getDid() method

```
public int getDid() {
   return Integer.parseInt(did);
}
```

8. We also need to build a constructor for this class. We pass the constructor a String array. It interprets the array and moves the data to the corresponding private variables. Example 5-3 shows the constructor code.

Example 5-3 Constructor for Customer class

```
public Customer(String[] custInfo) {
   id = custInfo[0];
   lastName = custInfo[1];
   firstName = custInfo[2];
   init = custInfo[3];
   address1 = custInfo[4];
   address2 = custInfo[5];
   city = custInfo[6];
   state = custInfo[7];
   postCode = custInfo[8];
   phonenumber=custInfo[9];
   wid=custInfo[10];
   did=custInfo[11];
```

OrderDetail bean

We use the same technique to build the OrderDetail class. Since the steps are very similar, we do not go through it in detail. Example 5-4 shows the code for the OrderDetail class.

Example 5-4 OrderDetail class

```
package access;
import java.math.*;
import java.io.*;

public class OrderDetail implements Serializable {
   String itemID = null;
   float itemAmount = 0;
   int itemQty = 0;
   int lineNumber = 0;
   public OrderDetail(){
      super();
   }
   public OrderDetail (String itemID, float itemAmount, int itemQty) {
   this.itemID = itemID;
   this.itemAmount = itemAmount;
   this.itemQty = itemQty;
   }

   public float getItemAmount() { return itemAmount;}
   public String getItemID() { return itemID; }
   public int getItemQty() { return itemQty; }
   public int getLineNumber() { return lineNumber; }
   public void setLineNumber(int ln) {lineNumber = ln;}
}
```

The Customer and OrderDetail beans represent customer and order detail information. They are passed back and forth by the servlets and JSPs. Once you select items and click the Check Out button, the OrderDetail bean is filled in by the controller servlet. For the customer bean, customer information is retrieved from the Customer table. We build an access bean, JDBCPoolCustomer, which connects to the database table and retrieves the data for the Customer bean.

JDBCPoolCustomer class

For the JDBCPoolCustomer class, we use JDBCCatalogSupport as the super class because we want to reuse some of its functions. We add three methods to the class:

- `connectToDB(datasource, userid, password)` looks up the data source name using JNDI APIs.
- `getCustomerByID(id)` retrieves Customer data from the Customer table using a Customer ID key and returns a Customer bean.
- `setCustomer(String[])` updates the Customer table with new customer information.

The `connectToDB` method functions are similar to the functions we described in 2.5.1, “DataSource version” on page 41. The `getCustomerbyID(id)` and `setCustomer(String[])` methods use the data source retrieved in the `connectToDB()` method to connect to the database table. Example 5-5 shows part of the code of the `getCustomerbyID(id)` method.

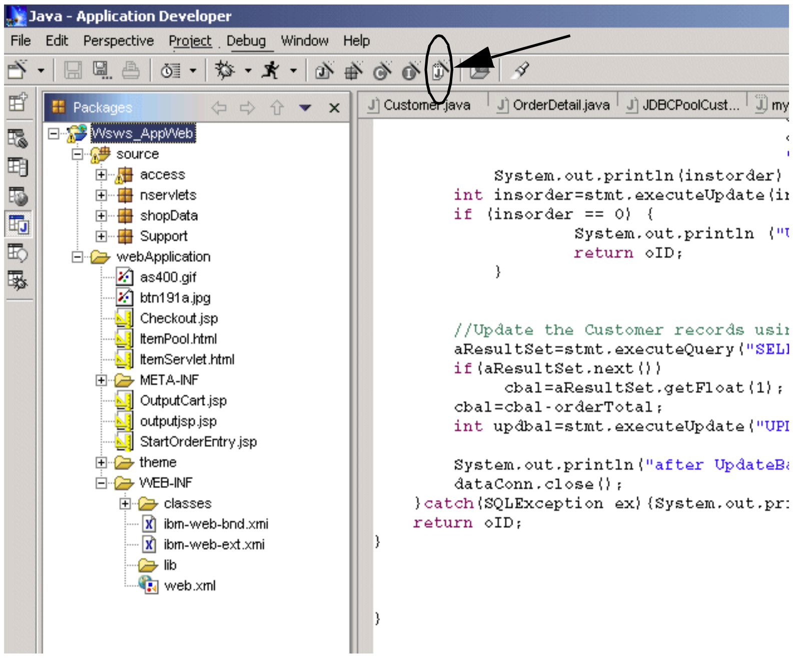
Example 5-5 getCustomerbyID() method

```
try {
   dataConn1 = getConnection(v3DS, connUserId, connUserPassword);
   } catch (Exception e) {
   System.out.println("JDBCPoolCustomer: “+ e.getMessage());
      e.printStackTrace();
      }
      try {
      psSingleRecord = dataConn1.prepareStatement("SELECT CLAST, CFIRST, CINIT,
       CADDR1, CADDR2, CCITY, CSTATE, CZIP, CPHONE, CWID, CDID  FROM CSTMR WHERE CID = ?");
      psSingleRecord.setString(1, customerID);
      aResultSet = psSingleRecord.executeQuery();
      if (aResultSet.next()){
         String[] acustomerData = new String[12];
         acustomerData[0]=customerID;
         for (int i=1; i<=11;i++)
            acustomerData[i]=aResultSet.getString(i);
         customer=new access.Customer(acustomerData);
      }
      dataConn1.close();
   } catch (SQLException ex) {
      ex.printStackTrace();
   }

   return customer;
```

Now, the Customer, OrderDetail, Item beans, JDBCPoolCustomer, and JDBCPoolCatalog access classes are complete. We are ready to test them. Since we haven't created the servlets and JSPs to invoke these classes yet, we use the Application Developer Scrapbook to test the Customer bean.

Testing the Customer bean in the scrapbook

We click the **Create a Scrapbook Page** icon as shown in Figure 5-38. In the pop-up window, we select the access package, enter `mytest` as the File name, and click **Finish**.



```
            System.out.println(instorder)
        int insorder=stmt.executeUpdate(i
        if (insorder == 0) {
                    System.out.println ("
                    return oID;
            }

        //Update the Customer records usi
        aResultSet=stmt.executeQuery("SEL
        if(aResultSet.next())
              cbal=aResultSet.getFloat(1);
        cbal=cbal-orderTotal;
        int updbal=stmt.executeUpdate("UP

        System.out.println("after UpdateB
        dataConn.close();
    }catch(SQLException ex){System.out.pr
    return oID;
}

}
```

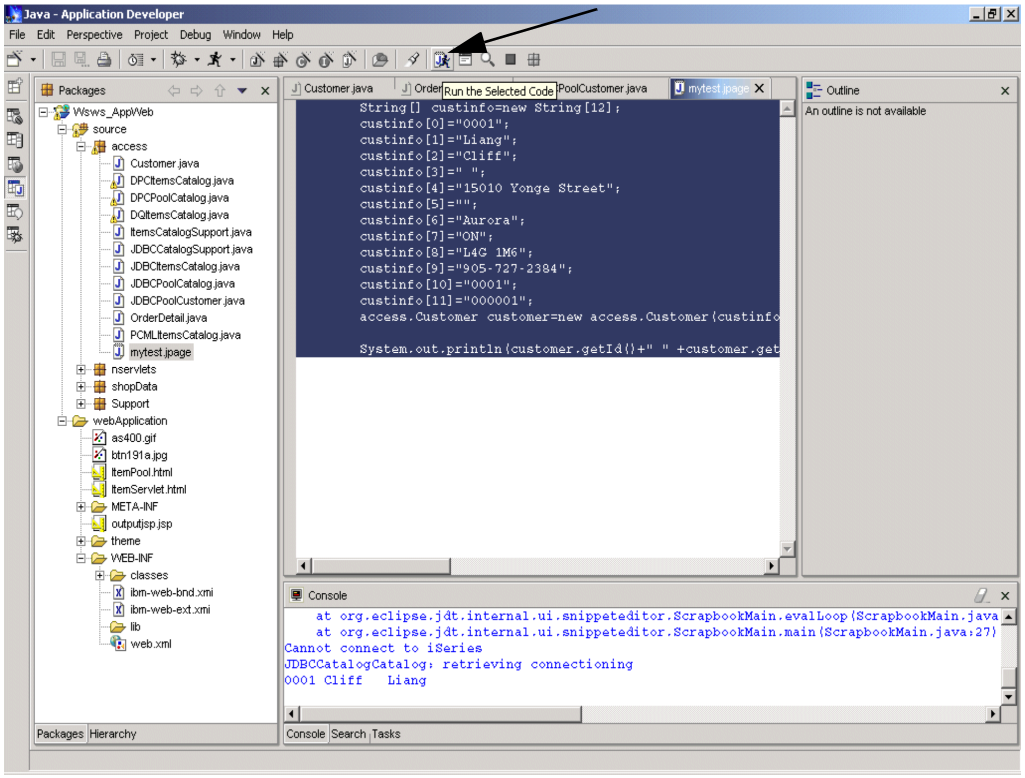
Figure 5-38 Creating a scrapbook page

A new scrapbook page, named *mytest.jpage*, is created in the access package. We double-click this file. In the source code area, we enter the code shown in Figure 5-39.

```
String[] custinfo=new String[12];
custinfo[0]="0001";
custinfo[1]="Liang";
custinfo[2]="Cliff";
custinfo[3]=" ";
custinfo[4]="15010 Yonge Street";
custinfo[5]="";
custinfo[6]="Aurora";
custinfo[7]="ON";
custinfo[8]="L4G 1M6";
custinfo[9]="905-727-2384";
custinfo[10]="0001";
custinfo[11]="000001";
access.Customer customer=new access.Customer(custinfo);

System.out.println(customer.getId()+" " +customer.getFirstName()
      +" "+customer.getInit() +" "+customer.getLastName());
```

Figure 5-39 Code in the scrapbook page

We select all the code in the scrapbook and click the **Run the Selected Code** button as shown in Figure 5-40. The result is displayed on the console.



```
String[] custinfo=new String[12];
custinfo[0]="0001";
custinfo[1]="Liang";
custinfo[2]="Cliff";
custinfo[3]=" ";
custinfo[4]="15010 Yonge Street";
custinfo[5]="";
custinfo[6]="Aurora";
custinfo[7]="ON";
custinfo[8]="L4G 1M6";
custinfo[9]="905-727-2384";
custinfo[10]="0001";
custinfo[11]="000001";
access.Customer customer=new access.Customer(custinfo

System.out.println(customer.getId()+" " +customer.get
```

```
    at org.eclipse.jdt.internal.ui.snippeteditor.ScrapbookMain.evalLoop(ScrapbookMain.java
    at org.eclipse.jdt.internal.ui.snippeteditor.ScrapbookMain.main(ScrapbookMain.java:27)
Cannot connect to iSeries
JDBCCatalogCatalog: retrieving connectioning
0001 Cliff   Liang
```

Figure 5-40 Running code in the scrapbook

OrderProcess class

The OrderProcess class is very similar to the JDBCPoolCustomer class. This class encapsulates the order placement process. The logic to place an order is to:

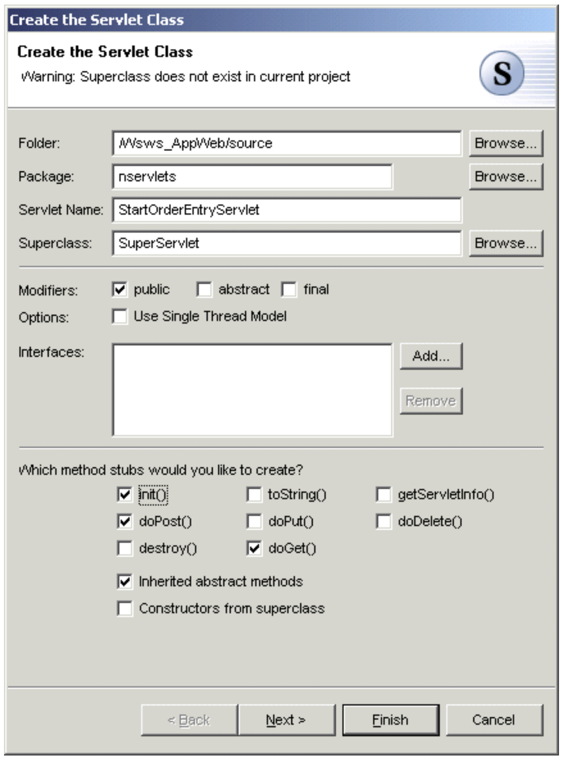
1. Access the District table to retrieve the next order number.
2. Increase the next order number by one and write it back to the District table.
3. Retrieve the shopping cart from the session object. For each item in the cart, retrieve the item ID, item quantity, and item amount. Deduct the quantity from the quantity in stock field of the Stock table.
4. Insert a new record into the Order Line table with the order details.
5. Insert a order summary into the Orders table.
6. Update the customer balance in the Customer table.

This logic is placed in the `placeOrder()` method. We do not go through this in detail.

StartOrderEntryServlet servlet

The StartOrderEntryServlet servlet is the entry point of this application. It accepts a request from the browser, retrieves all the items from the Item table, creates a new session object, and puts the list of items in it. Finally, it forwards the request to the StartOrderEntry JSP. After this, all the flow control is done by another servlet, OrderEntryControllerServlet.

1. In Application Developer, we switch to the Web perspective.
2. We right-click the **nservlets** package and select **New-> Servlet**.
3. In the Create the Servlet Class window, shown in Figure 5-41, we enter `StartOrderEntryServlet` as the servlet Name. We replace javax.servlet.http.HttpServlet with `SuperServlet` in the Superclass field because we want to use some functions defined in nservlets.SuperClass. We select the **init()**, **doPost()**, and **doGet()** methods in the Which method stubs would you like to create? option and click **Next**.


Create the Servlet Class

Create the Servlet Class

Warning: Superclass does not exist in current project

Folder: /Wsws_AppWeb/source

Package: nservlets

Servlet Name: StartOrderEntryServlet

Superclass: SuperServlet

Modifiers: [✓ public] abstract final

Options: Use Single Thread Model

Interfaces:

Which method stubs would you like to create?

[✓ init()] toString() getServletInfo()

[✓ doPost()] doPut() doDelete()

destroy() [✓ doGet()]

[✓ Inherited abstract methods]

Constructors from superclass

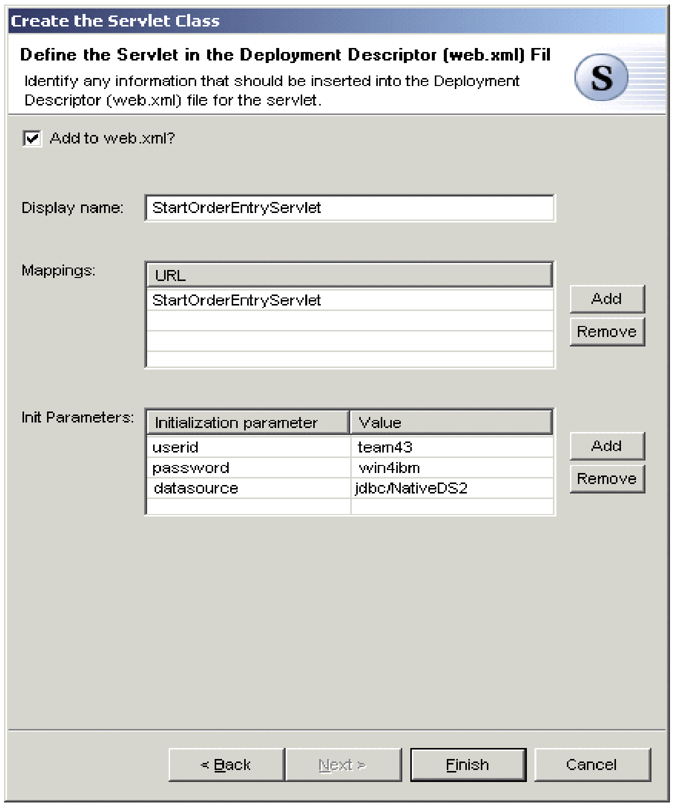
Figure 5-41 Creating StartOrderEntryServlet

4. The next window, Define the Servlet in the Deployment Descriptor File, allows you to define the servlet initial parameter settings (see Figure 5-42). We select the **Add to web.xml** option and leave the values in Display name and Mappings fields untouched. We click the **Add** button next to Init Parameters and add the name/value pairs listed in Table 5-1.

Table 5-1 StartorderEntryServlet initialization parameters

Name	Value
userid	A valid iSeries user ID
password	A valid iSeries password
datasource	jdbc/NativeDS2

The StartOrderEntryServlet servlet is created in the nservlets package and the source code window is automatically opened.


Create the Servlet Class

Define the Servlet in the Deployment Descriptor (web.xml) Fil

Identify any information that should be inserted into the Deployment Descriptor (web.xml) file for the servlet.

☑ Add to web.xml?

Display name: StartOrderEntryServlet

Mappings:

URL
StartOrderEntryServlet

Init Parameters:

Initialization parameter	Value
userid	team43
password	win4ibm
datasource	jdbc/NativeDS2

Figure 5-42 Defining the servlet in the deployment descriptor file

5. We add the following import statements to the servlet:

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
import java.util.*;
```

6. In the `init()` method of this servlet, we instantiate a JDBCPoolCatalog object that is used to connect to the database. We retrieve the initial parameters and invoke the `connectToDB()` method, which looks up the JDBC data source. Example 5-6 shows part of the code of the `init()` method.

Example 5-6 init() method of StartOrderEntryServlet

```
super.init(config, SuperServlet.SYSTEM);
aJDBCPoolCatalog=new access.JDBCPoolCatalog();
String datasource = getInitParameter("datasource");
String userid = getInitParameter("userid");
String password = getInitParameter("password");
flexLog("DataSource: " + datasource);
flexLog("UserID: " + userid);
flexLog("Password: " + password);
if ((datasource == null)||(userid == null)||(password == null))  {
   flexLog("StartOrderEntryServlet: .....");
   throw new ServletException("Could not retrieve ....");
}
String returnValue = aJDBCPoolCatalog.connectToDB(datasource, userid, password);
if (!returnValue.equals("connection successful")) {
   throw (new ServletException("Unable to connect to DB"));
} else {
   flexLog("StartOrderEntryServlet: return ....");
}
return;
```

7. In the `doGet()` method, we pass control to the `doPost` method. This way we only need to add logic to the `doPost()` method.
8. In the `doPost()` method, we create the session object and invoke the `getAllV()` method of JDBCPoolCatalog to retrieve the items from database. We put the data into the session object and forward the request to the StartOrderEntry JSP. Example 5-7 shows part of the code of the `doPost()` method.

Example 5-7 doPost() method of StartOrderEntryServlet

```
    HttpSession session = request.getSession(false);
    if (session != null)
        session.invalidate();
   session = request.getSession(true);
   response.setContentType("text/html");
   response.setHeader("Pragma", "no-cache");
   PrintWriter out = response.getWriter();
   if (null == session) {... }
   try {
       Vector items = null;
      try {
            items = aJDBCPoolCatalog.getAllV();
      } catch (Exception e) {
            System.out.println("...... ");
      }
  session.setAttribute("sessionlist.items", items);
  response.sendRedirect(response.encodeRedirectURL("StartOrderEntry.jsp"));
```

StartOrderEntry.jsp

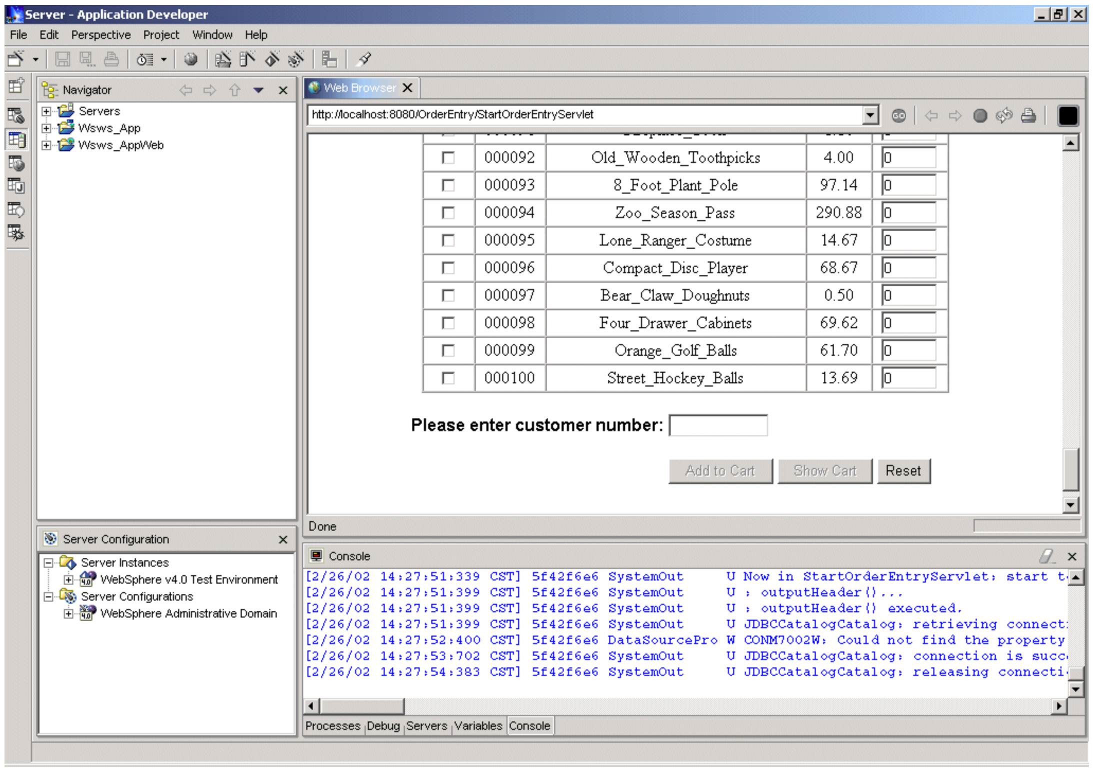
Since the StartOrderEntryServlet forwards the request to the StartOrderEntry JSP, we need to build the JSP page:

1. Still in the Web perspective, we right-click **webApplication** in the left pane and select **New-> JSP File**. In the pop-up window, we enter `StartOrderEntry` for File Name and click **Finish**. The StartOrderEntry.jsp file is created under the webApplication folder.
2. We do not go through how to design JSP pages in this section. We just simply click the **Source** tab for the JSP and input the code there. The JSP code checks the session object and picks up the item data from the session. It then creates a table to show all the data in the browser. It displays an input field for customer ID and three buttons for the tasks of adding items to the shopping cart, showing the shopping cart and resetting the values. Each action we invoke in the JSP page is routed to the OrderEntryControllerServlet servlet. Example 5-8 shows some of the code of the StartOrderEntry JSP.

Example 5-8 Code of StartOrderEntry.jsp

```
<%@ page import="java.util.* "%>
<%
   HttpSession mySession = request.getSession(false);
   Vector itemVector = (Vector)(mySession.getAttribute("sessionlist.items"));
   String custID = (String)(mySession.getAttribute("customerID"));
%>
<html><head>
....

<form method="POST" name="orderEntryForm" action="/OrderEntry/OrderEntryControllerServlet">
<INPUT TYPE="hidden" NAME="action" VALUE="default">
<CENTER>
<table border="1" width="72%" cellspacing="0" cellpadding="0">
...

<% if (itemVector != null)  { %>
   <% for (int i = 0; i < itemVector.size(); i ++) { %>
   <% String[] aPart = ((String[]) itemVector.elementAt(i)); %>
   <tr>
    <td width="8%" valign="middle" align="center"><CENTER><INPUT TYPE=checkbox
      name=index value="<%= i %>" onclick="incrementNumChecked()"></CENTER></td>
   </table><br>
...
```

3. Now we can run StartOrderEntryServlet in Application Developer. We right-click the servlet and select **Run On Server**. Application Developer automatically starts the WebSphere 4.0 Test server and shows the result in the embedded browser. Figure 5-43 shows the output of the JSP.


Server - Application Developer
File Edit Perspective Project Window Help
Navigator
Servers
Wsws_App
Wsws_AppWeb
Web Browser
http://localhost:8080/OrderEntry/StartOrderEntryServlet
Server Configuration
Server Instances
WebSphere v4.0 Test Environment
Server Configurations
WebSphere Administrative Domain
Done
Console
Processes Debug Servers Variables Console

☐	000092	Old_Wooden_Toothpicks	4.00	0
☐	000093	8_Foot_Plant_Pole	97.14	0
☐	000094	Zoo_Season_Pass	290.88	0
☐	000095	Lone_Ranger_Costume	14.67	0
☐	000096	Compact_Disc_Player	68.67	0
☐	000097	Bear_Claw_Doughnuts	0.50	0
☐	000098	Four_Drawer_Cabinets	69.62	0
☐	000099	Orange_Golf_Balls	61.70	0
☐	000100	Street_Hockey_Balls	13.69	0

Please enter customer number:

Add to Cart | Show Cart | Reset

```
[2/26/02 14:27:51:339 CST] 5f42f6e6 SystemOut     U Now in StartOrderEntryServlet: start t
[2/26/02 14:27:51:399 CST] 5f42f6e6 SystemOut     U : outputHeader()...
[2/26/02 14:27:51:399 CST] 5f42f6e6 SystemOut     U : outputHeader() executed.
[2/26/02 14:27:51:399 CST] 5f42f6e6 SystemOut     U JDBCCatalogCatalog: retrieving connect:
[2/26/02 14:27:52:400 CST] 5f42f6e6 DataSourcePro W CONM7002W: Could not find the property
[2/26/02 14:27:53:702 CST] 5f42f6e6 SystemOut     U JDBCCatalogCatalog: connection is succ
[2/26/02 14:27:54:383 CST] 5f42f6e6 SystemOut     U JDBCCatalogCatalog: releasing connecti
```

Figure 5-43   Running StartOrderEntryServlet in the WebSphere Test Environment

OrderEntryControllerServlet servlet

The OrderEntryControllerServlet servlet is a very important part of our application. It acts as the gateway and control center. All the requests from the JSPs come into this servlet. It decides which function should be called. All the data coming from the access classes is sent to this servlet, which forwards the data to the JSPs through the session object.

Creating OrderEntryControllerServlet is similar with creating StartOrderEntryServlet. It also needs initial parameters such as userid, password, and data source. It extends SuperServlet instead of extending HttpServlet directly.

The action control part is in the `doPost()` method. It calls different functions based on the action value returned from the JSP page. Example 5-9 shows part of the code of the `doPost()` method.

Example 5-9 doPost() method for OrderEntryControllerServlet

```
if (action.equals("AddToCart")) {
        addToCart(session, request, response, customerID);
    } else
        if (action.equals("ShowCart")) {
            displayCart(customerID, response, session);
        } else
            if (action.equals("CheckOut")) {
                placeOrder(session, response);
                response.sendRedirect(response.encodeRedirectURL("Checkout.jsp"));
            } else
                if (action.equals("UpdateCustomerInformation")) {
                    session.setAttribute("custUpdateFlag", "false");
                    updateCustomer(request, response, session);
                } else
                    if (action.equals("ContinueShopping")) {
                        response.sendRedirect
                          (response.encodeRedirectURL("StartOrderEntry.jsp"));
                    } else
                        if (action.equals("ShopSomeMore")) {
                             Vector itemVector =
                                    (Vector) (session.getAttribute("sessionlist.items"));
                             String custID = (String) (session.getAttribute("customerID"));
                            if (session != null)
                                session.invalidate();

                            session = request.getSession(true);
                           session.setAttribute("sessionlist.items", itemVector);
                           session.setAttribute("customerID", custID);
                          response.sendRedirect(response.
                             encodeRedirectURL("StartOrderEntry.jsp"));
```

If we click the *Add to Cart button* or the *Show Cart button* in the StartOrderEntry JSP, the controller servlet calls the `addToCart()` method and the `displayCart()` methods respectively. We add these methods.

The `addToCart()` method is used to add the items you select into the shopping cart and to put the shopping cart into the session object. It first retrieves the selected items from the session object. It moves them into the CartItem bean and puts it into the session object. Example 5-10 shows the key part of the `addToCart()` method.

Example 5-10 Code of addToCart() method

```
Vector parts = (Vector) session.getAttribute("sessionlist.items");
   String[] value = request.getParameterValues("index");
   String[] quantity = request.getParameterValues("quantity");
   if  (value != null) {
      int j = 0;
      for (int i = 0; i < value.length; i++) {
         j = Integer.parseInt(value[i]);
         String[] data = (String[]) parts.elementAt(j);
         Integer qty = new Integer (quantity[j]);
         CartItem aCartItem = new CartItem(data[0], data[1], data[2], data[3], qty);
         cart.getItems().addElement(aCartItem);
      }
      session.setAttribute("shopcart.selected", cart);
      displayCart(customerID, response, session);
```

The `displayCart()` method is used to assemble the shopping cart data and customer information together and forward them to a JSP page. Recall that in the StartOrderEntry page, you need to input customer ID. The customer detail is retrieved based on this ID. Since the shopping cart is already in the session object, we only need to retrieve customer data from the database. The method then puts the customer information into the session object and forwards the request to OutputCart JSP. This JSP page is responsible for retrieving data from the session object and presenting it in the browser. Example 5-11 shows some of the code in the `displayCart()` method.

Example 5-11 Code in displayCart() method

```
   aJDBCPoolCustomer = new access.JDBCPoolCustomer();
   access.Customer customer=null;
   String returnValue = aJDBCPoolCustomer.connectToDB(..);
   ....
   customer = aJDBCPoolCustomer.getCustomerByID(newCustID);
   session.setAttribute("customerObj", customer);
   session.setAttribute("cFirstName", customer.getFirstName());
   session.setAttribute("cMiddleInitials", customer.getInit());
   session.setAttribute("cLastName", customer.getLastName());
   session.setAttribute("cAddressLine1", customer.getAddress1());
   session.setAttribute("cAddressLine2", customer.getAddress2());
   session.setAttribute("cCity", customer.getCity());
   session.setAttribute("cState", customer.getState());
   session.setAttribute("cZip", customer.getPostCode());
   session.setAttribute("cPhone", customer.getPhonenumber());
      wid=customer.getWid();
      did=customer.getDid();
   try {
      response.sendRedirect(response.encodeRedirectURL("OutputCart.jsp"));
   }
   catch (Exception ex){
      System.out.println(ex.getMessage());
   }
```

There are two other key methods – `placeOrder()` and `updateCustomer()`. The `placeOrder()` method invokes the function to create an order transaction. The `updateCustomer()` method calls the `setCustomer()` method of `JDBCPoolCustomer` to update the customer information.

Now the OrderEntryControllerServlet servlet is complete. We add OutputCart.jsp and Checkout.jsp into the Web application using the same technique as in “StartOrderEntry.jsp” on page 209. We do not go through these JSP pages in detail. They are basically used to present the results of the shopping cart, customer information, and transactions.

Exporting to an EAR file

After completing the OrderEntry application, we can deploy it on WebSphere Application Server 4.0. Application Developer is capable of generating J2EE standard enterprise applications, so we don’t need to go through the Application Assembly Tool. The steps are exactly same as “Exporting an EAR file” on page 194.

5.4 Conclusion

In this chapter, we used Application Developer to build J2EE compliant applications. We migrated the examples created in Chapter 2, “Servlet and JSP development using VisualAge for Java” on page 21, to Application Developer. We also created a new application using Application Developer. Application Developer allows you to export directly to war and ear formats. You do not need to use the Application Assembly Tool.

6

Introduction to Enterprise JavaBeans

JavaBeans have become widely accepted in the Java programming community as the way to create the client side for applications. JavaBeans allow application programmers to create reusable components and build applications with those components. The flexibility and ease-of-use associated with the component model, and the tools that use JavaBeans, have helped application developers greatly. Extending this concept to the server side, business components add considerable complexity. Developers must address the following items:

- Persisting the component data in a data source
- Distributing the components across a network
- Managing transactions
- Building the necessary security required by business applications

The Enterprise JavaBeans (EJB) technology provides a logical extension to the JavaBeans concept. It is targeted at server-tier business logic development. It provides interfaces that insulate the programmer from the complexities and dependencies that are unique to a platform.

EJB technology is critical for the development of robust, Java-based business applications on the iSeries server. This chapter discusses the basics of EJB technology, what it offers application developers, its key features, and how EJB technology fits into the iSeries environment.

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6.1 The Enterprise JavaBeans specification

Business applications that support a wide variety of users within or across business domains are usually very complex. The complexity of the domain requires application developers to understand the underlying domain technology and the business domain sufficiently to design and implement applications. Advancements in technology have increased the capabilities that can be integrated into business applications. At the same time, the new technology has increased the complexity of application development.

The EJB specification was defined by Sun Microsystems Inc. to address the issues concerned with developing applications. The mission of the EJB specification is to define an architecture for application development, which accomplishes the following goals:

- **Make it easier to write business applications**: By separating the business application from system services, the application developer can focus on the needs of the business application. This includes the business logic and the representation of business data.
- **Increase manageability of the systems environment**: By keeping the business logic and business data in a server environment, the application code is centrally managed. Administration of the application environment is simplified, which allows easier distribution of enhancements, fixes, and extensions to the business application.
- **Promote reuse**: By defining business objects as components, an application developer can create new components, reuse existing components, or purchase components. By using existing components or purchasing components, the application developer assembles the application rather than developing and testing new code.

Version 1.1 of the EJB specification defines the fundamental mission and concepts for creating enterprise server applications. Subsequent versions of the EJB specification will expand and fine tune the specification to define all aspects of the EJB environment.

6.2 Enterprise JavaBeans architecture definition

The Enterprise JavaBeans architecture defines the fundamental concepts for Java server-based business applications. The architecture defined in the EJB specification, version 1.1, is available from Sun Microsystems on the Internet at:
`http://www.java.sun.com/products/ejb/`

The EJB architecture is a component-based architecture for the development and deployment of server-based business applications. It allows the separation of business applications from the underlying system services. The following list breaks these statements down to help unravel the definition of the EJB architecture:

- **Component based**: The EJB architecture uses the concept of components to represent business objects, business logic, or business tasks within the application.
- **Architecture**: The EJB architecture provides the structure for developing Java-based, object-oriented business applications. It is not a tool for building these business applications. However, it is an architecture for defining the application components.
- **Development and deployment**: The EJB architecture is Java-based, which allows many existing Integrated Development Environments (IDE) to support creating and testing of the components. The application developer selects from a variety of tools that support the EJB specification and provides the services needed by the application. The details of deployment are separated from the business components. Therefore, deployment considerations are customized to the needs of the business environment without affecting the business components.

- **Server-based business application**: In recent years, there has been a movement toward client/server computing-based environments, with increasing portions of the application residing on the client. The server is given the role of a data repository. By returning the application to the server, the ability to manage the application is simplified. The EJB specification allows you to distribute the application components across multiple servers to meet scalability and business structure needs.
- **Separation of the business application from the underlying system services**: With the EJB architecture, the application server environment manages and supports the system services. This removes the requirement for the business application to deal with low-level application programming interfaces (APIs) to perform its functions. However, these low-level APIs are still available, and the application can use them.

Since the beginning of Java, EJB architecture has mainly been used for client-side processing and Internet-based applications. It is being accepted as the standard for building object-oriented business applications in Java. Many server vendors are using this specification to define server environments, which is making the EJB specification a reality. Many businesses are now using Java and the EJB technology for building and deploying business applications on servers.

6.3 How EJB technology fits into the Java architecture

EJB technology complements and extends the existing Java architecture. This technology extends the promise of Java by providing an application server environment that handles system services that would otherwise be handled by the application code. This allows EJB technology to extend the ease-of-use of Java by allowing the application developer to focus on business applications and let the application server focus on system services.

The JavaBeans and Enterprise JavaBeans technology may seem to be on a collision course, but they actually complement each other. JavaBeans technology defines a component model with conventions that enable development tools to examine a JavaBean’s components to determine its capabilities. The development tools expose the properties and capabilities of a JavaBean to application developers. The application developer sets bean properties or connects the beans methods to other JavaBeans. Many JavaBeans components that exist today are used in graphical interface development.

EJB technology does not implement the same interfaces as JavaBean technology, nor does it follow the JavaBean event model. This technology has its own component model with distinct interfaces and conventions. It supports representing business logic and business data within an application environment. EJB components are intended for the server side of business applications, while JavaBeans components fit nicely with the client-side of the application. To be complete, the EJB component model includes an application server environment that provides the necessary services to secure the application, provide transactions, and persist business data.

EJB technology allows business applications to take advantage of the Internet, intranet, and extranet by making it easier to extend existing business applications. EJB technology provides extensions to the Java language that are needed before business application developers take Java seriously.

6.4 Why EJB is important

EJB technology is important to both application providers and the businesses that use their applications. The Java language allows application providers to develop applications that are platform independent. This is valuable to application users because it allows them to select the software they need, independent of the hardware platform, that fits their business environment. If a user has a mixture of hardware, they can still run the same application in these different environments. At the same time, the application developer does not need multiple versions of the same application, with each version tuned to the specific platform.

This allows the application developers to focus on the business problem they are trying to solve and let the EJB server handle system services. EJB technology allows the developer to define the deployment environment at installation time, rather than when the application is designed. This allows the developer to customize the application to the business domain, instead of to both the business domain and the specific hardware platform system.

Keeping the business logic and data on the server ensures that every user is working with the same master data and the same business logic. This also provides the application user better protection of intellectual assets that have been incorporated within the application. Servers, especially the iSeries server, have better security packages than many client systems. When a business is connected to the Internet, ensuring that corporate data and intelligence is safe from unauthorized access is important.

The Java language, as the application development language of choice, is the stated direction of IBM. The IBM Server division is moving forward to make Java its language of choice. Many computer industry leaders have committed to making Java the language of electronic business, the Internet, and business applications. By moving to Java and EJB technology, application providers position themselves for the future.

6.5 Leveraging Java and EJB technology

Java increases the productivity of developers who write applications and simplifies maintenance. The very nature of object-oriented technologies provides the basis for this statement. As a language, Java has taken the best of other object-oriented languages and applied various safeguards to minimize the problems programmers have experienced in the past. EJB technology makes developing applications with Java measurably easier. It hides all the system services details that are present when dealing with Java directly.

The EJB component model defines the infrastructure for creating an environment that separates system services from application business logic. The EJB server and EJB container deal with all the system service infrastructure included in the following list:

- Transactions
- Persistence
- Resources
- Security

This allows applications access to all of these services without dealing with their complexity. The application development activity is made easier, so the developer can focus on business logic application development.

The EJB component model represents business logic and business data as components. Business data is reused within the same domain in various aspects of the business. For example, assume the customer information is used in the following ways:

- In an OrderEntry application when a customer places or updates an order
- In accounting for creating invoices
- In marketing for target advertising campaigns

By creating the customer as a component, the applications that support these different organizations use the same customer component, which minimizes development and testing. As the development team identifies and creates a repository of business object components, they begin to assemble applications to satisfy different end-user requirements.

EJB technology also leverages existing applications currently running business environments. It allows the extension of existing applications to provide new and additional functions for the business. The EJB specification identifies Common Object Request Broker Architecture (CORBA) as the means to provide inter-operability between different programming languages. This allows applications written in different languages, possibly running on different platforms, to interact with each other.

Even without CORBA, EJB objects can be used to wrapper existing application logic. For example, you can wrapper Component Object Model (COM) objects as EJB components and use them as part of a Java application.

6.6 EJB architectural overview

The EJB specification consists of these two major units:

- Components
  - Entity beans
  - Session beans
- Services
  - EJB container
  - EJB server

Figure 6-1 shows the relationship between entity beans and session beans.

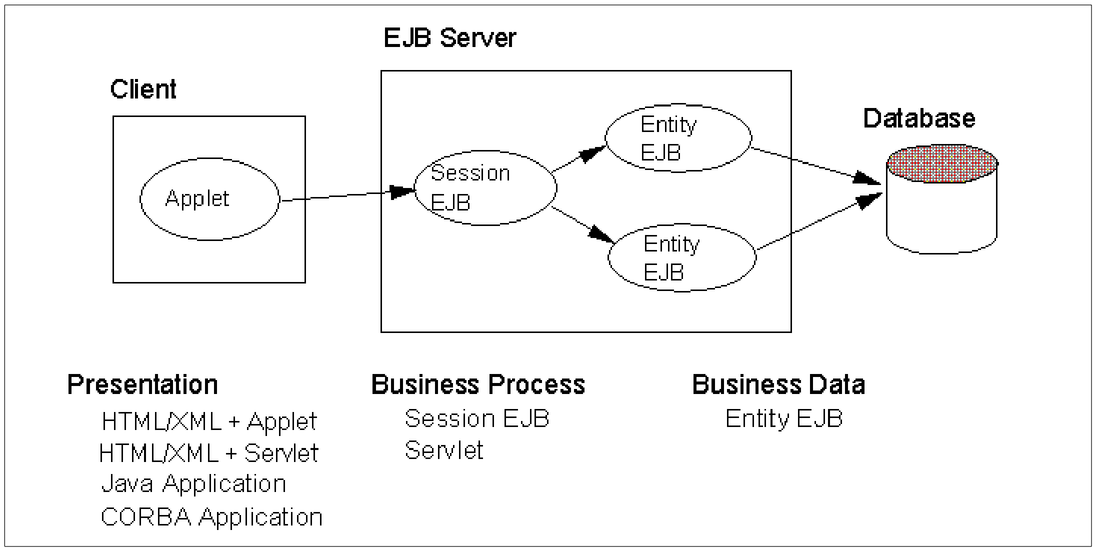


Figure 6-1 EJB architecture overview

Entity and session beans are explained here:

- **Entity beans**: These components represent business objects and contain business data. Because an entity bean contains business data, its contents are persisted for later use. Entity beans often reflect a row within an application database. An entity bean has methods to manage its data (get and set methods) and can support business logic pertaining to its business data.
- **Session beans**: These objects perform business processes or tasks within a business process. A client uses a session bean to complete a particular task. Session beans are transient (their data is not persisted) and only exist for the life of the transaction. Session beans usually perform such activities as obtaining or storing business data by using the entity beans or performing business logic that is maintained separately from the business data.

6.6.1 The EJB server

In the EJB architecture, system services can be broken down into two distinct areas, which are often linked: the enterprise bean server and the enterprise bean container.

Figure 6-2 shows the relationship between the EJB container and the EJB server.

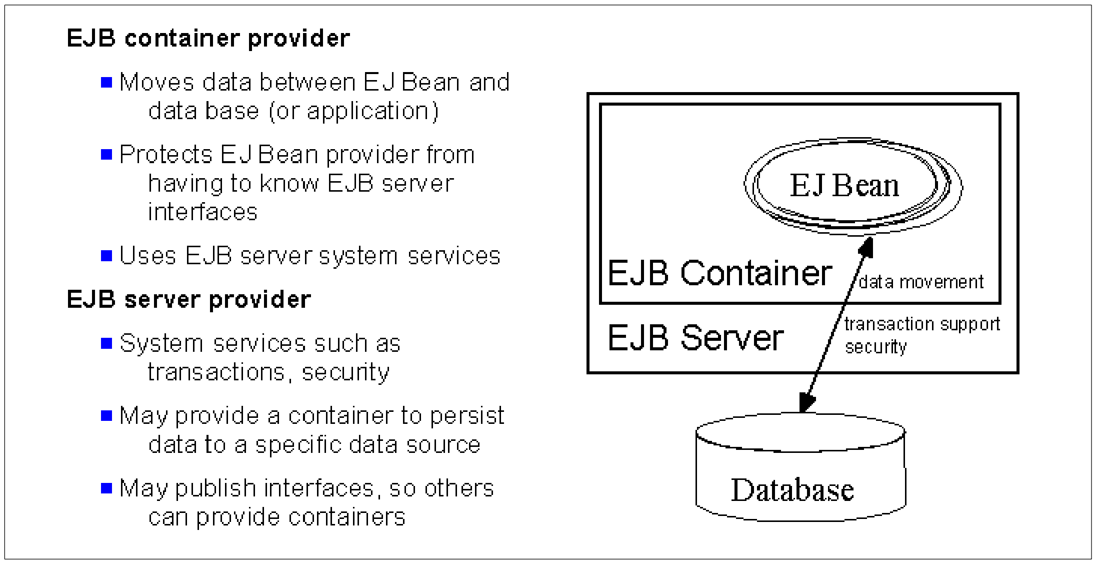

EJB container provider
Moves data between EJ Bean and data base (or application)
Protects EJ Bean provider from having to know EJB server interfaces
Uses EJB server system services
EJB server provider
System services such as transactions, security
May provide a container to persist data to a specific data source
May publish interfaces, so others can provide containers
EJ Bean
EJB Container
data movement
EJB Server
transaction support
security
Database

Figure 6-2 EJB system services providers

EJB container

EJB containers serve as the means to insulate the enterprise bean developer from the specifics of the EJB server services such as transaction management, security, and object distribution. It provides a simple interface for the enterprise bean and accesses the system services for it. This interface is referred to as the *component contract* for the Enterprise JavaBean.

The container is defined as a separate mechanism from the EJB server. The clarity of this separation is at the discretion of the tool vendor. The container manages Enterprise JavaBean objects. It manages the life cycle of the object (creation, maintenance, and deletion), implements the security for the object, and coordinates distributed transactions involving the object. By performing these activities, the container eliminates the need for bean developers to concern themselves with these issues.

EJB server

The EJB server allows the application developer to obtain the system services required by the application without directly dealing with lower level APIs. Figure 6-3 shows the architecture of the EJB server.

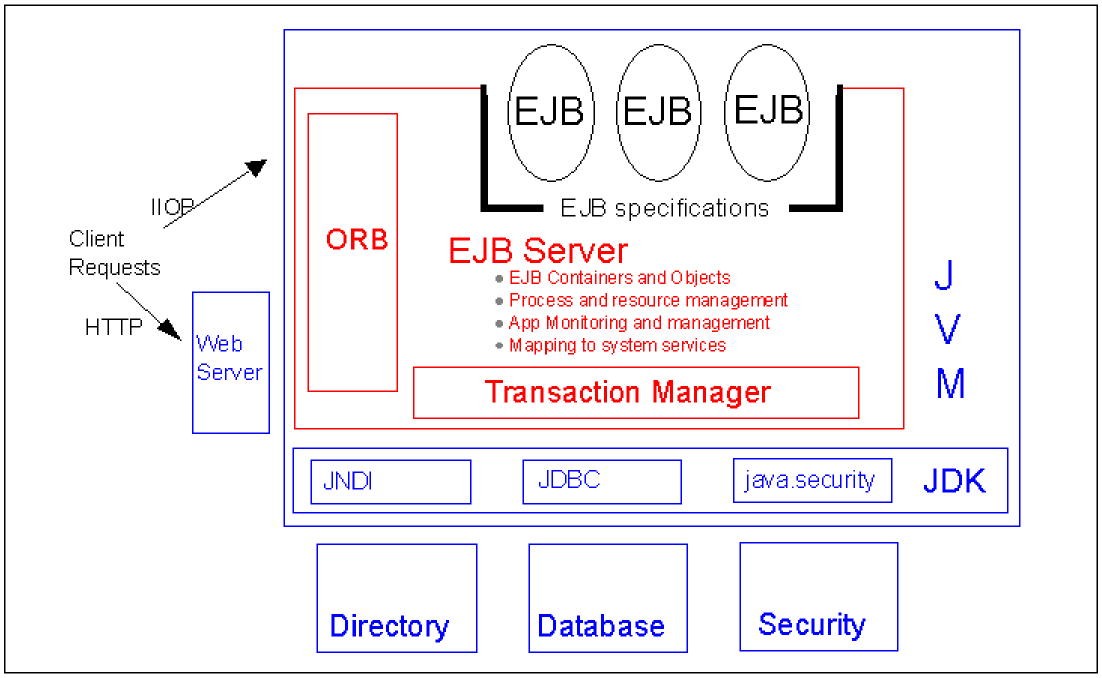


Figure 6-3 The EJB server

The EJB server carries the majority of the burden of dealing with the system environment by managing and coordinating the allocation of resources to the application. The following list describes the key system services (APIs) that the application server supports:

- **Security**: In the EJB component model, security is both granular and flexible. It is granular because it is configured at the component level or at the method level. It is flexible because it is configured outside the application code by using utilities provided by the application server provider.
- **Transactions**: In the EJB component model, transactions take two basic forms, which are explained in the following list. It is important to notice that the EJB specification does not specifically distinguish between these two forms. This breakdown is to simplify the explanation.
  - *Database transactions*: Database transactions are granular and are configured by settings in the component. Database transactions reflect state changes in the component that are reflected in the database.
  - *Business transactions*: Business transactions represent business processes or tasks that can involve a variety of components and business logic. Business transactions often encapsulate changes to many of the components involved in the transaction.
- **Persistence**: The EJB architecture eliminates the need for the components to deal with the persistence mechanism. Using JDBC as the database management technology, the application server interacts with a wide variety of data stores on the market today.

The EJB server supports these capabilities and manages many of the resources that are common within a Java application. These resources include thread pools and the caching of objects. It is important to notice that many of the low-level APIs associated with Java programming are hidden from the application developer.

The EJB server provider is typically a company that produces middleware or a company that produces operating systems, such as IBM. Currently, there is no standard for the interface between a container and an EJB server. This may be introduced in a later release of the EJB specification. The EJB server provider often provides a container as well. EJB server support is currently available on the iSeries server with WebSphere Application Server Advanced Edition, BEA WebLogic Application Server, BlueStone Software's Sapphire/Web, and Novera's jBusiness.

6.6.2 Types of components

The components (entity beans and session beans) break down into more discrete groupings:

Note: Entity beans are either *container managed* or *bean managed*. Session beans are *stateful* or *stateless*.

- **Container-managed entity beans**: Delegate the reading and writing of bean attributes to the persistent datastore to the container that holds them. This allows the bean provider to set up a mapping schema from the bean attributes to the database columns outside of the entity bean itself. It also allows the entity bean developer to keep the persistence details separate from the business object (entity bean). Greater flexibility is achieved because the persistence information may be modified without affecting the entity bean. This makes the bean more reusable and portable.
- **Bean-managed entity beans**: Support the situation where the bean developer needs to have more control over persisting a bean. Bean-managed entity beans allow the bean provider to control the reading and writing of the bean attributes to the database. This gives the bean provider greater flexibility in providing their own persistence strategy. This can include persisting to a variety of databases or file types or providing nested database transactions. All the code necessary to map the beans attributes to the database are part of the bean itself.

Session beans are transient objects and perform operations on behalf of the client, such as accessing the database through the entity bean or performing business logic. Session beans can be involved in a transaction. However, they may not be recoverable in the case of a system crash. A session bean is stateless or stateful:

- **Stateless session beans**: Perform activities for the client, but do not maintain any data. They can perform business logic and calculations. However, no instance variables are defined within the bean.
- **Stateful session beans**: Have data and maintain that data for the life of a transaction. If this data must be persisted, it must be forwarded to entity beans. Stateful session beans minimize the amount of interaction between the client and the server, making the application more efficient. However, it is imperative that any data that needs preserving is captured and forwarded.

Entity beans and session beans provide the heart of the business application by representing both the business objects (data) and the business logic (processes and tasks).

6.6.3 Component content

A *component* consists of interfaces, the class, any required utility classes, and a deployment descriptor. Previous discussion of the components focused on the class itself. However, in a distributed environment, a component is accessed through its interfaces. As defined in the following list, each component has two interfaces:

- **Home interface**: Contains the methods for creating, deleting, and locating (finding) a particular instance of a bean.
- **Remote interface**: Contains the business methods that may be performed on a bean. The client interacts with the remote interface for the entity or session bean.

One of the key advantages of using EJBs is how easy it is to customize a bean component. The deployment descriptor provides the means to make this possible. Figure 6-4 shows how deployment descriptors are used.

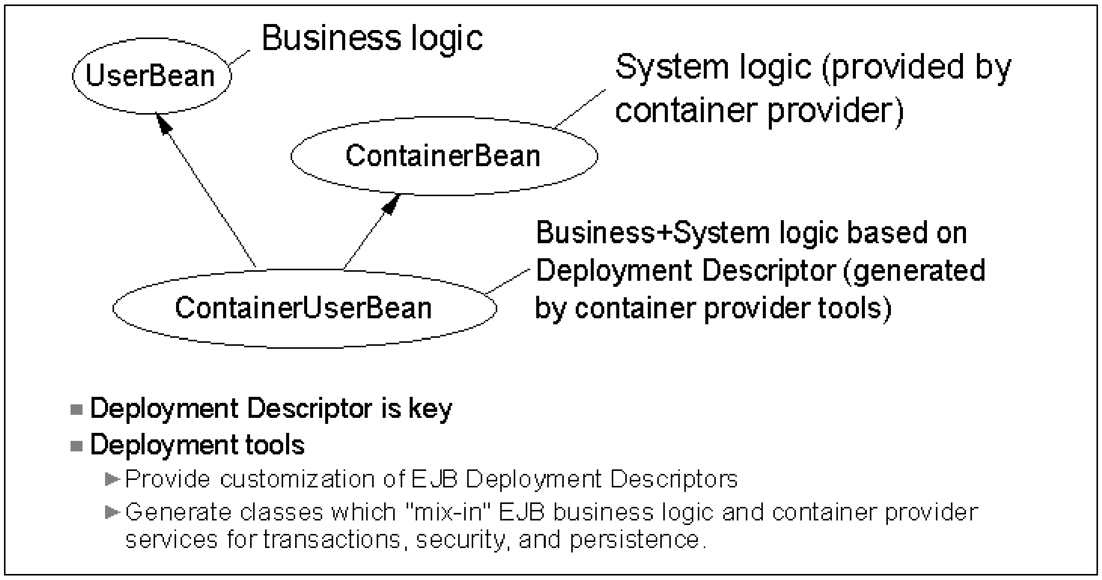

Business logic
UserBean
System logic (provided by container provider)
ContainerBean
Business+System logic based on Deployment Descriptor (generated by container provider tools)
ContainerUserBean
Deployment Descriptor is key
Deployment tools
Provide customization of EJB Deployment Descriptors
Generate classes which "mix-in" EJB business logic and container provider services for transactions, security, and persistence.

Figure 6-4 EJB deployment descriptors

Each Enterprise JavaBean class requires a *deployment descriptor*. The deployment descriptors are used to establish the runtime service settings for an enterprise bean. These settings tell the EJB container how to manage and control the enterprise bean. The settings can be set at application assembly or application deployment time.

The deployment descriptor specifies how to create and maintain an Enterprise Bean object. It defines, among other things, the enterprise bean class name, the JNDI name space that represents the container, the Home interface name, the Remote interface name, and the Environment Properties object name. It also specifies transaction semantics and security rules that should be applied to the Enterprise Bean. These settings are described in the following list:

- Bean JNDI Name
- Enterprise Bean Class Name
- Home Interface Class Name
- Remote Interface Class Name
- Environment Properties
- Reentrancy
- Control Descriptor (per bean or per method)
  - Run As Mode (Client, System, Specified Identity)
  - Isolation Level (Read committed, Read uncommitted, Repeatable read, Serializable)
  - Transaction Attribute (Bean Managed, Mandatory, Not Supported, Required, Requires New, Supports)

- Access Control Entry (per bean or per method)
  - Method name
  - Identities
- (Entity Only)
  - Container Managed Fields
  - Primary Key Class Name
- (Session Only)
  - Session Time-out
  - State Management Type (Stateful or Stateless)

These are the key settings found within the deployment descriptor. They provide flexible use of a component by customizing the component at runtime.

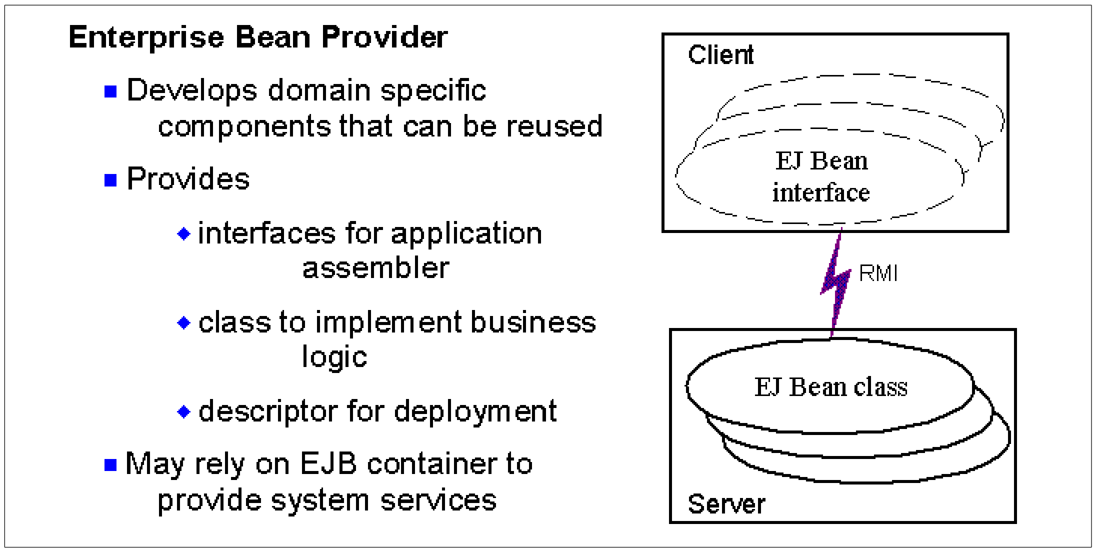
6.7 EJB roles

The EJB specification identifies various application development and deployment roles. Both tool vendors and application providers have a variety of opportunities to take advantage of EJB technology and play an active part in providing applications using the technology. The EJB specification in the following list identifies these major roles:

- Enterprise JavaBean provider
- Application assembler
- Application deployer
- Server provider
- Container provider

6.7.1 Enterprise JavaBean provider

As shown in Figure 6-5, the *Enterprise JavaBean provider* provides the components for building business applications. Domain expertise is a critical characteristic of these providers. The objective is to create business components that are usable in a variety of business applications. The components implement a business process or a business object. EJB technology allows the provider to focus on business needs so they can develop components, without needing extensive knowledge of the system services.



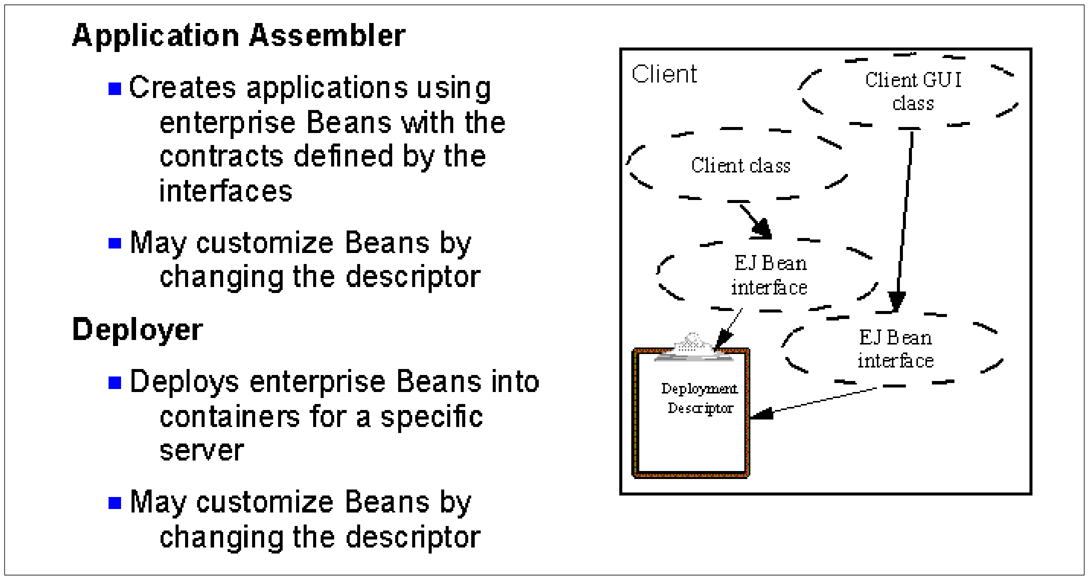
Enterprise Bean Provider

- Develops domain specific components that can be reused
- Provides
  - interfaces for application assembler
  - class to implement business logic
  - descriptor for deployment
- May rely on EJB container to provide system services

Figure 6-5 EJB provider

6.7.2 Application assembler

As shown in Figure 6-6, the *application assembler*, who is also an expert in the business domain, constructs the application. They are typically responsible for building the user interfaces for the application and providing the additional classes needed to complete the application. The assembler can customize Enterprise JavaBeans by changing the deployment information contained in the deployment descriptor.



Application Assembler

- Creates applications using enterprise Beans with the contracts defined by the interfaces
- May customize Beans by changing the descriptor

Deployer

- Deploys enterprise Beans into containers for a specific server
- May customize Beans by changing the descriptor

Figure 6-6 EJB assembler and deployer

6.7.3 Application deployer

The *application deployer* is responsible for deploying the application in a specific system environment. The deployer is usually an expert on the function and features of the platform, as well as the supporting technologies. The deployer maps the application to the platform environment and can make adjustments for items, such as security and the data store. The deployer can customize the Enterprise JavaBeans by changing the deployment information.

6.7.4 Server provider

The EJB specification divides the server functions into two components: the server and the container. The EJB *server provider* produces the middleware (server) that communicates between the platforms operating system environment and the container or bean managed beans. The middleware, created by the server provider, provides the management system services shown in the following list:

- Distributed transactions
- Object distribution
- Security
- Data persistence

The server provider can elect to include the container as part of their product.

6.7.5 Container provider

The *container provider* produces the EJB container that insulates the Enterprise JavaBean developer from the specifics of the EJB server services, such as transaction management, security, and persistence. The container provider ensures that the container provides a simple interface to the Enterprise JavaBean. The container accesses system services for the EJB.

6.8 Using EJB technology on the iSeries server

The Java programming language provides numerous advantages as an application development language. For the iSeries server, the main focus of Java application development has been client/server oriented. Because the iSeries server does not have a native graphical user interface, it is not optimized for the display of client windows and graphics. In the client/server environment, the iSeries server normally plays the role of a server. The Java programs run on the client and access the iSeries database using the iSeries host server programs.

Starting with OS/400 V4R2, Java programs can run on the iSeries server. The main disadvantage in using Java for developing business applications is the extra programming required to manage the services required for the runtime environment.

EJB technology provides the means to make Java a viable language for iSeries business application development. It focuses on server-side Java. EJB technology returns the focus of the application developer to the business application. The developer does not deal with system-level services. The iSeries server provides a secure and scalable environment for running Java applications, while EJB application servers provide server and container support.

6.8.1 Overview of Java for the iSeries server

The Java environment for the iSeries server is Java-compatible, which means it conforms to the Sun standard and can run 100% pure Java code without modification or re-compilation. The Java Virtual Machine (JVM) is implemented in the iSeries machine interface (MI), providing a high degree of integration with the underlying system. The integrated JVM includes an advanced garbage collection algorithm that improves Java performance and scalability. In addition to the integrated, compatible runtime, the iSeries Developer Kit for Java provides the additional commands, tools, and classes needed for Java development on the iSeries server.

Like other Java environments, Java source code files on the iSeries server are ASCII text files stored in the integrated file system. These are compiled into platform-independent class files (also stored in the IFS) that are interpreted by the JVM at runtime. The Java environment for iSeries also includes a Java *transforme*r that further optimizes Java class files and is used to create permanent, optimized 64-bit iSeries program objects.

The Qshell Interpreter is also required for Java development on the iSeries server. Qshell is a command interpreter, based on POSIX and X/Open standards. It provides the Java development tools that are typically required for program development. With a few exceptions, the Java tools support the syntax and options available on most Java platforms.

Figure 6-7 shows the different pieces that comprise the Java environment on the iSeries server.

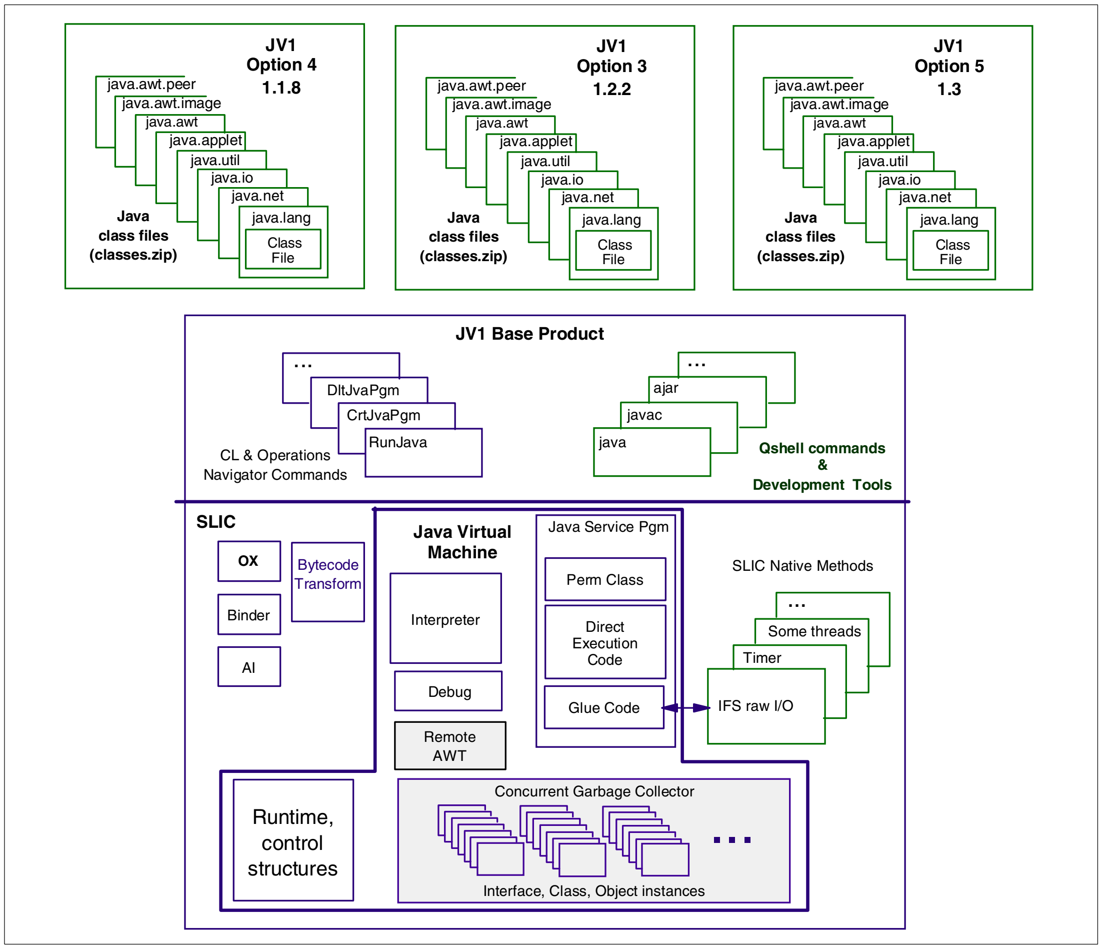


Figure 6-7 Java environment on the iSeries server

The integrated JVM is part of the System Licensed Internal Code (SLIC) on the iSeries server that is installed on every system. The iSeries Developer Kit for Java is packaged as a separate, no-charge Licensed Program Product (LPP) that must be installed on the iSeries server. The Qshell Interpreter is an OS/400 option that must be installed.

6.8.2 EJB technology on the iSeries server

An EJB server runs as an application above OS/400 on the iSeries server. For the most part, current EJB servers are written in Java and require the iSeries Developer Kit for Java on the system. The iSeries strategy is to support application servers that deliver back-end systems integration and business-to-business e-commerce opportunities.

6.9 EJB interoperability with other distributed architectures

The EJB architecture supports distribution using the standard Java remote method invocation (RMI). Every enterprise bean has a home interface and a remote interface that declare the methods a client can indirectly invoke on the enterprise bean. The objects that implement these interfaces are Java RMI remote objects provided by the container. At runtime, the client receives a reference to the home or remote object, and invokes methods on that reference. The EJB container intercepts the method request and provides services before passing the request on to the enterprise bean. The communication between the references (or stubs) on the client and the objects on the server is defined by the Java RMI specification.

6.9.1 CORBA

In addition to distributed object support using RMI, the EJB architecture also provides for EJB servers based on the Common Object Request Broker Architecture. Through standard EJB to CORBA mapping, an Interface Definition Language (IDL) interface can be generated from the remote interface. This mapping can be implicit when RMI over IIOP is used.

In addition to *on-the-wire* interoperability, CORBA-based EJB servers are required to use the OMG COS Naming Service for publishing and resolving the EJB home interface objects. The OMG Object Transaction Service is also required for transaction support in a CORBA-based EJB server.

These requirements allow a non-Java CORBA client to access enterprise beans using a CORBA-based EJB server. The client can use both CORBA and EJB objects within a transaction, and the transaction can span multiple CORBA-based EJB servers. WebSphere Application Server Version 4.0 Advanced Edition does not support CORBA clients.

6.9.2 Component Object Model (COM)

The EJB architecture provides no specific support for Microsoft's Component Object Model. However, it is possible to wrap the client interface to an enterprise bean with a COM object to make it accessible from Visual Basic or Visual C++. Conversely, it is possible to wrap a COM object to make it accessible from Java.

There are a number of products available that provide COM to Java interface support. WebSphere Enterprise Edition 4.0 and Linar's J-Integra such products. They provide COM-Java bridging tools. You can access ActiveX components as if they were Java objects. You can also access pure Java objects as if they were ActiveX components.

For more information about J-Integra, see: `http://www.linar.com/`

6.9.3 IBM WebSphere Business Components

IBM WebSphere Business Components are easy-to-use software implementation packages. These components support these features:

- Provide a coherent set of functions
- Can be independently developed and delivered
- Can be composed from other components
- Have explicit and well-specified interfaces for the component services they provide and require

IBM has developed WebSphere Business Components to help you reduce development time, create applications that operate across diverse infrastructures, and deliver value to your company faster with a whole project solution.

6.10 Conclusion

The Enterprise JavaBean architecture provides a component model for server applications. With EJBs, you have rapid application development and the rich graphical interfaces of a client, without sacrificing the thin client manageability and the security of a server. EJBs accomplish this by making it easy to partition an application into a user interface and the business logic. The user interface can be specified in a client application (written in Java, Visual Basic, PowerBuilder, and so on) or in HTML using a Java servlet. The server-side business logic is packaged as Enterprise JavaBean components. Enterprise JavaBeans are easily deployed anywhere on the network, reused within other business applications running on disparate platforms, and easily managed from a remote console.

Enterprise JavaBean technology is not a tool to build applications. Rather, it is the architecture for defining components that can be used with a variety of tools. A stated goal of the EJB specification is to be the standard component architecture for building distributed object-oriented business applications in the Java programming language. Enterprise JavaBeans make it possible to build distributed applications by combining components developed using tools from different vendors.

7

Overview of the OrderEntry application

This chapter explains the RPG OrderEntry application example. This application is representative of a commercial application. However, it does not include all of the necessary error handling that a business application requires.

This chapter also introduces the application and specifies the database layout. In Chapter 10, “Building Java applications with Enterprise JavaBeans” on page 315, the RPG OrderEntry application is converted to a Web-enabled application. The goal is to use the existing RPG application to service both the Web application and the host 5250 application.

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7.1 The ABC Company

The ABC Company is a wholesale supplier with one warehouse and 10 sales districts. Each district serves 3,000 customers (30,000 total customers for the company). The warehouse maintains stock for the 100,000 items sold by the Company.

Figure 7-1 illustrates the company structure (warehouse, district, and customer).

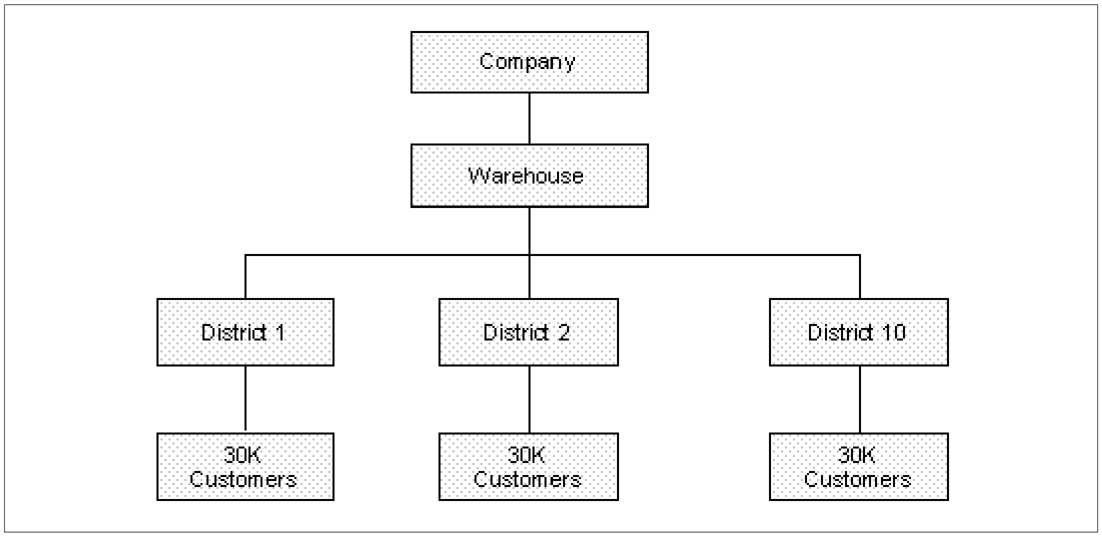


Figure 7-1 The company structure

7.2 The ABC Company database

The company runs its business with a database. This database is used in a mission-critical, online transaction processing (OLTP) environment. The database includes tables with the following data:

- District information (next available order number, tax rate, and so on)
- Customer information (name, address, telephone number, and so on)
- Order information (date, time, shipper, and so on)
- Order line information (quantity, delivery date, and so on)
- Item information (name, price, item ID, and so on)
- Stock information (quantity in stock, warehouse ID, and so on)

7.3 A customer transaction

A customer transaction occurs based on the following series of events:

1. Customers telephone one of the 10 district centers to place an order.
2. The district customer service representative answers the telephone, obtains the following information, and enters it into the application:
   - Customer number
   - Item numbers of the items the customer wants to order
   - The quantity required for each item
3. The customer service representative may prompt for a list of customers or a list of parts.
4. The application then performs the following actions:

   a. Reads the customer last name, customer discount rate, and customer credit status from the Customer Table (CSTMR).
   b. Reads the District Table for the next available district order number. The next available district order number increases by one and is updated.
   c. Reads the item names, item prices, and item data for each item ordered by the customer from the Item Table (ITEM).
   d. Checks if the quantity of ordered items is in stock by reading the quantity in the Stock Table (STOCK).
5. When the order is accepted, the following actions occur:
   a. A new row is inserted into the Order Table to reflect the creation of the new order (ORDERS).
   b. A new row is inserted into the Order Line Table to reflect each item in the order.
   c. The quantity is reduced by the quantity ordered.
   d. A message is written to a data queue to initiate order printing.

7.4 Application flow

Note: To download the sample code used in this redbook, please refer to Appendix A, “Additional material” on page 425, for more information.

The RPG OrderEntry application consists of the following components:

- **ORDENTD (Parts Order Entry)**: Display File
- **ORDENTR (Parts Order Entry)**: Main RPG processing program
- **PRTORDERP (Parts Order Entry)**: Print File
- **PRTORDERR (Print Orders)**: RPG server job
- **SLTCUSTD (Select Customer)**: Display file
- **SLTCUSTR (Select Customer)**: RPG SQL stored procedure
- **SLTPARTD (Select Part)**: Display file
- **SLTPARTR (Select Part)**: RPG stored procedure

Figure 7-2 show the RPG application flow. ORDENTR is the main RPG program. It is responsible for the main line processing. It calls two supporting RPG programs that are used to prompt for and select end-user input. They are SLTCUSTR, which handles selecting a customer, and SLTPARTR, which handles selecting part numbers. PRTODERR is an RPG program that handles printing customer orders. It reads order records that were placed in a data queue and prints them in a background job.

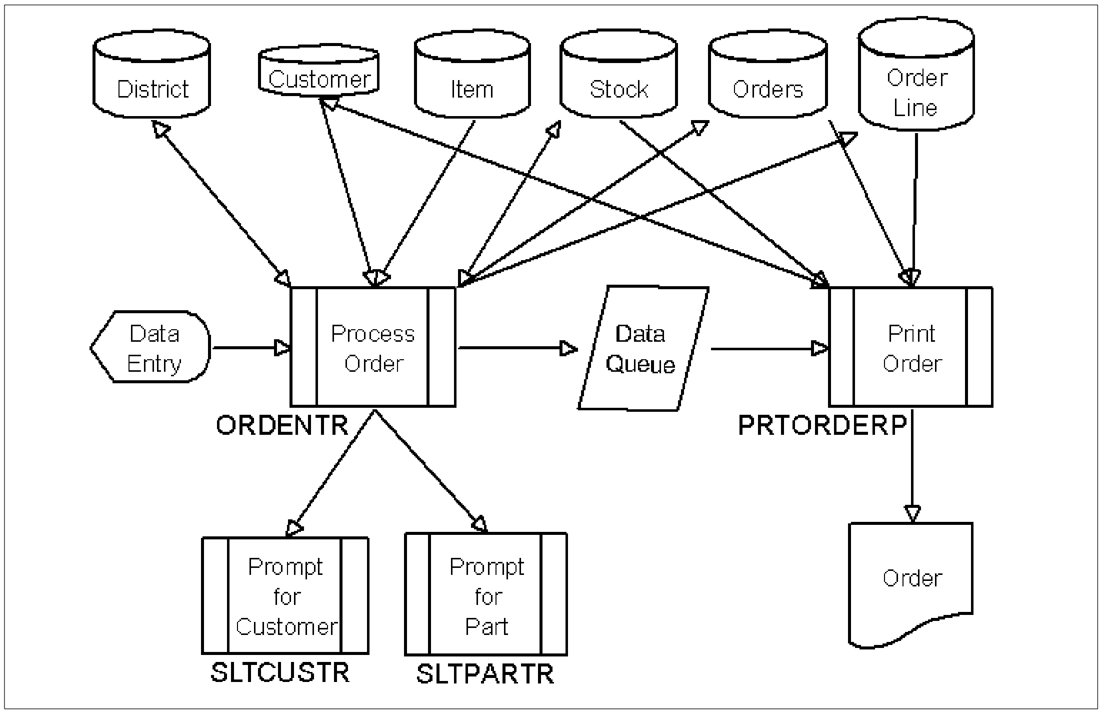


Figure 7-2 RPG application flow

7.5 Customer transaction flow

The following scenario walks through a customer transaction and shows the application flow. By understanding the flow of the iSeries application, you can understand the changes made to this application to support a graphical client.

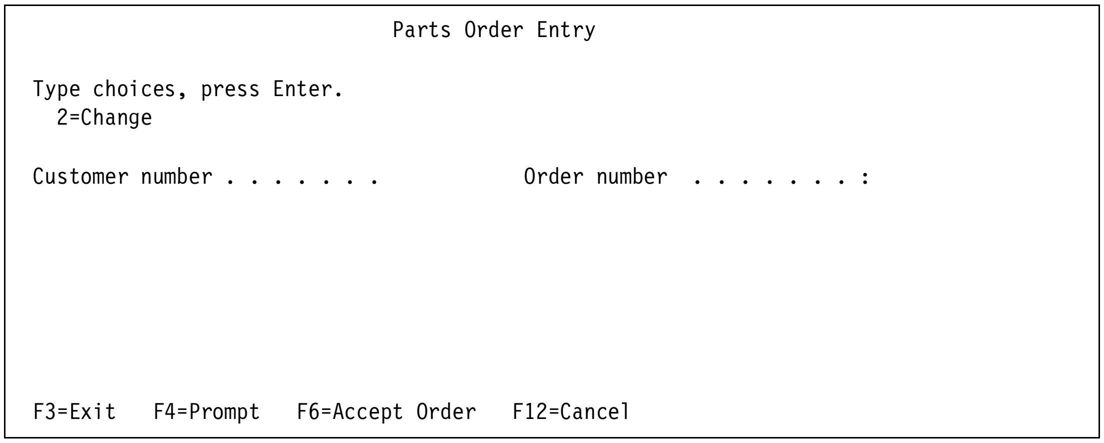
Starting the application

To start the application, the customer follows this series of steps:

1. The customer calls the main program from an OS/400 command line:

   ```
   CALL ORDENTR
   ```

   When the OrderEntry application is started, the Parts Order Entry display (Figure 7-3) appears.

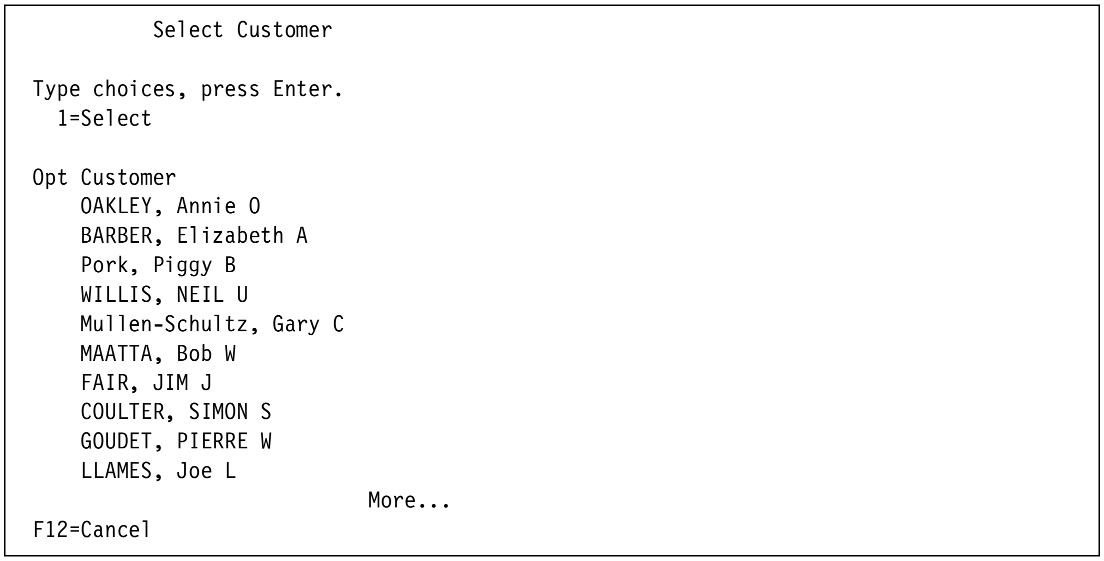


```
                                Parts Order Entry

 Type choices, press Enter.
   2=Change

 Customer number . . . . . . .           Order number  . . . . . . . :







 F3=Exit   F4=Prompt   F6=Accept Order   F12=Cancel
```

Figure 7-3   Parts Order Entry display

2. When the Parts Order Entry display appears, the user has two options:
   – Type a customer number and press the Enter key
   – End the program by pressing either F3 or F12.

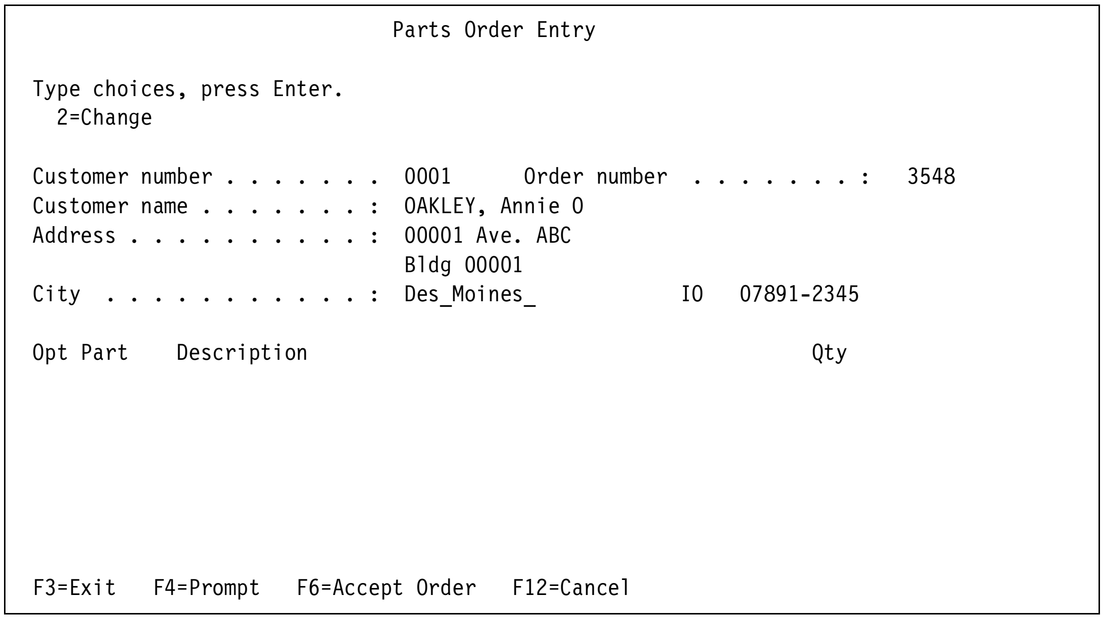
   If they do not know their customer number, the user can press F4 to view a window containing a list of available customers.



```
           Select Customer

 Type choices, press Enter.
   1=Select

 Opt Customer
     OAKLEY, Annie O
     BARBER, Elizabeth A
     Pork, Piggy B
     WILLIS, NEIL U
     Mullen-Schultz, Gary C
     MAATTA, Bob W
     FAIR, JIM J
     COULTER, SIMON S
     GOUDET, PIERRE W
     LLAMES, Joe L
                             More...
 F12=Cancel
```

Figure 7-4   Select Customer display

3. The user presses F12 to remove the window and return to the initial panel, or scrolls through the items in the list until they find the customer they want. They indicate their choice by typing a `1` in the option field and pressing the Enter key. The selected customer is then returned to the initial panel (Figure 7-5).

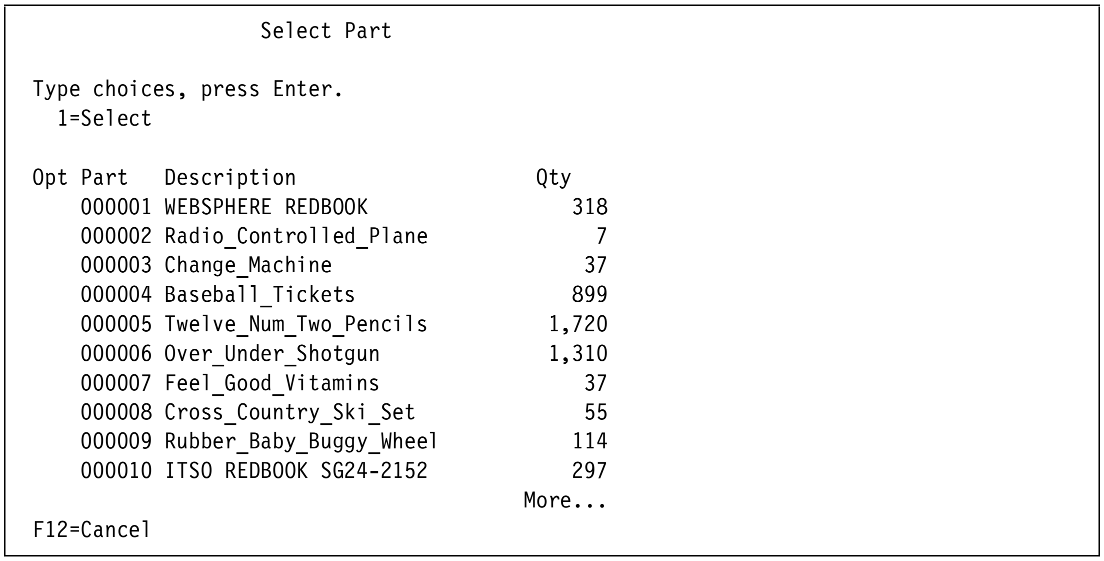


```
                                Parts Order Entry

Type choices, press Enter.
  2=Change

Customer number . . . . . . .  0001      Order number  . . . . . . . :   3548
Customer name . . . . . . . :  OAKLEY, Annie O
Address . . . . . . . . . . :  00001 Ave. ABC
                               Bldg 00001
City  . . . . . . . . . . . :  Des_Moines_           IO   07891-2345

Opt Part    Description                                     Qty







F3=Exit   F4=Prompt   F6=Accept Order   F12=Cancel
```

Figure 7-5 Parts Order Entry display

4. After selecting a customer from the list, or typing a valid customer number and pressing the Enter key, the customer details are shown and an order number is assigned. An additional prompt is displayed, which allows the user to type a part number and quantity.

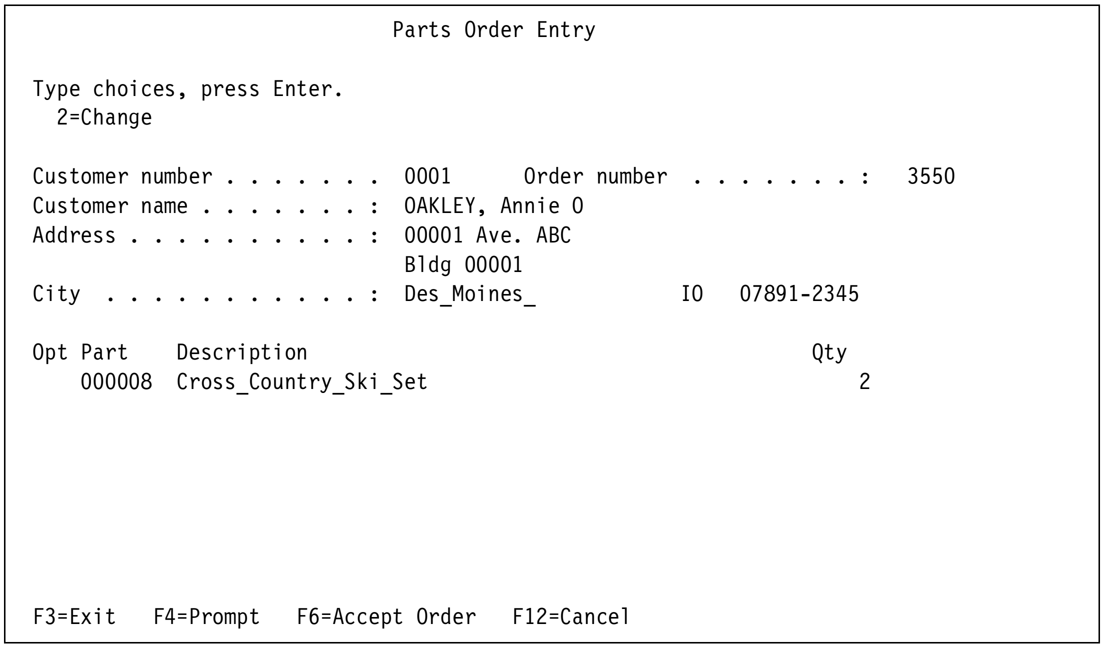
   If the user does not know the part number, they can press F4 to view a window containing a list of available parts (Figure 7-6).



```
                     Select Part

Type choices, press Enter.
  1=Select

Opt Part   Description                   Qty
    000001 WEBSPHERE REDBOOK                318
    000002 Radio_Controlled_Plane             7
    000003 Change_Machine                    37
    000004 Baseball_Tickets                 899
    000005 Twelve_Num_Two_Pencils         1,720
    000006 Over_Under_Shotgun             1,310
    000007 Feel_Good_Vitamins                37
    000008 Cross_Country_Ski_Set             55
    000009 Rubber_Baby_Buggy_Wheel          114
    000010 ITSO REDBOOK SG24-2152           297
                                        More...
F12=Cancel
```

Figure 7-6 Select Part display

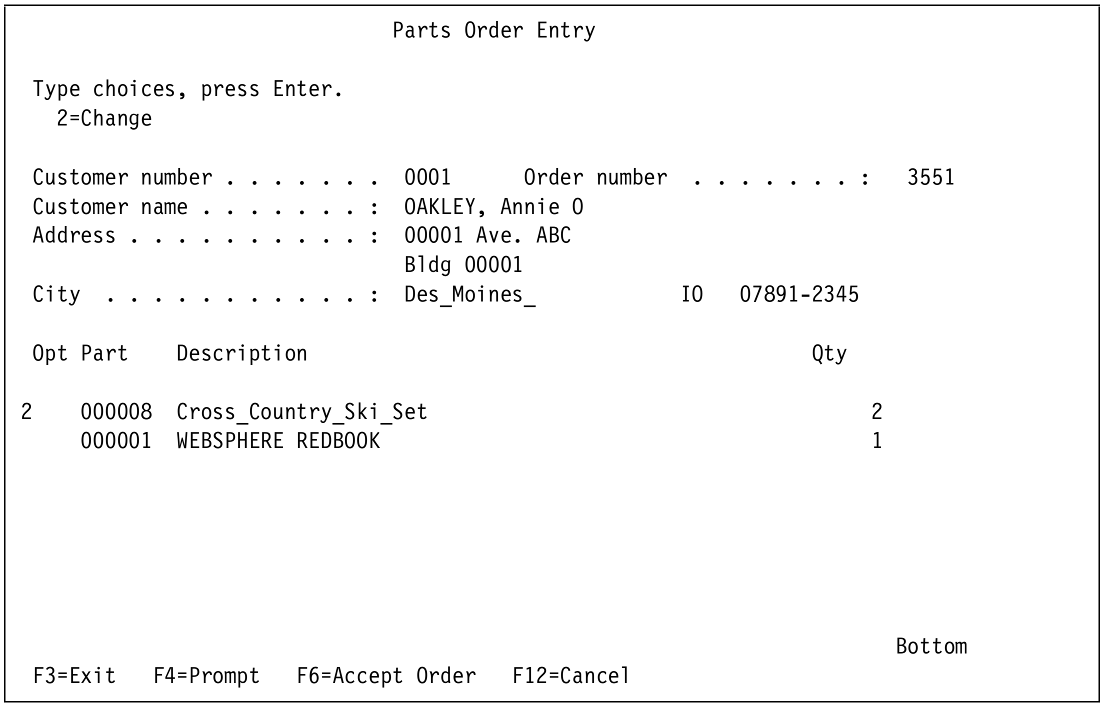
5. The user presses F12 to remove the window and return to the initial panel, or scrolls through the items in the list until they find the part they want. They type a 1 in the option field and press the Enter key to indicate their choice. The selected part is returned to the initial panel (Figure 7-7).



```
                                Parts Order Entry

 Type choices, press Enter.
   2=Change

 Customer number . . . . . . .  0001      Order number  . . . . . . . :   3550
 Customer name . . . . . . . :  OAKLEY, Annie O
 Address . . . . . . . . . . :  00001 Ave. ABC
                                Bldg 00001
 City  . . . . . . . . . . . :  Des_Moines_           IO   07891-2345

 Opt Part    Description                                      Qty
     000008  Cross_Country_Ski_Set                                2







 F3=Exit   F4=Prompt   F6=Accept Order   F12=Cancel
```

Figure 7-7   Parts Order Entry

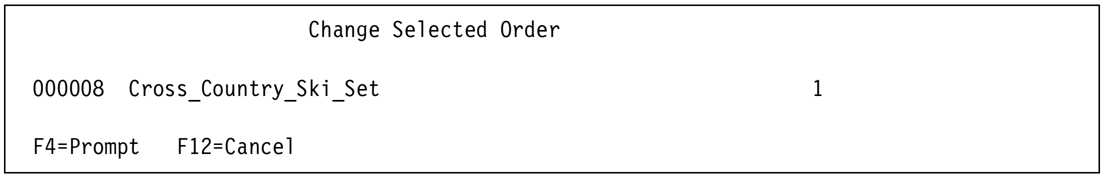
6. They select a customer from the list, or type a valid customer number and press the Enter key. Then the part and quantity ordered are added to the list section below the part entry fields (Figure 7-8).



```
                                Parts Order Entry

 Type choices, press Enter.
   2=Change

 Customer number . . . . . . .  0001      Order number  . . . . . . . :   3551
 Customer name . . . . . . . :  OAKLEY, Annie O
 Address . . . . . . . . . . :  00001 Ave. ABC
                                Bldg 00001
 City  . . . . . . . . . . . :  Des_Moines_           IO   07891-2345

 Opt Part    Description                                      Qty

2    000008  Cross_Country_Ski_Set                                 2
     000001  WEBSPHERE REDBOOK                                     1







                                                                      Bottom
 F3=Exit   F4=Prompt   F6=Accept Order   F12=Cancel
```

Figure 7-8   Part Order Entry display

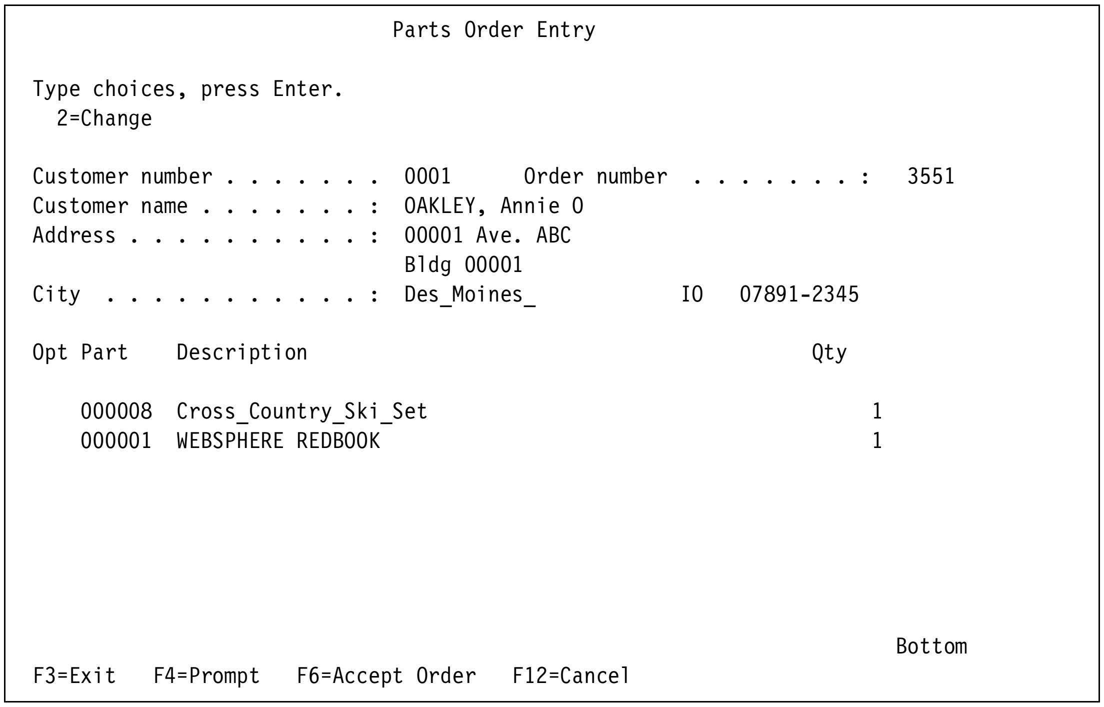
7. The user may type 2 beside an entry in the list to change the order. When the user presses the Enter key, a window appears that allows the order line to be changed (Figure 7-9).



```
                         Change Selected Order

 000008  Cross_Country_Ski_Set                                    1

 F4=Prompt   F12=Cancel
```

Figure 7-9 Changing the order quantity

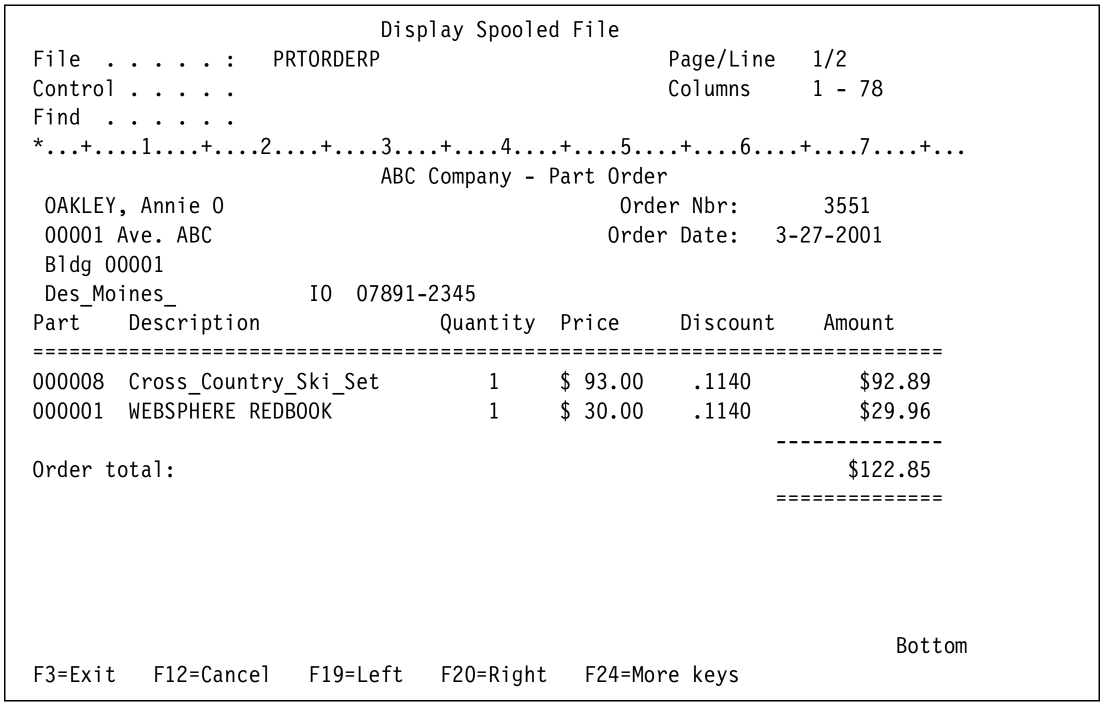
8. The user can choose to press F12 to cancel the change, press F4 to list the parts, or type a new part identifier or different quantity. Pressing the Enter key validates the part identifier and quantity. If they are valid, the order line is changed in the list, and the window is closed. The completed order is shown Figure 7-10.



```
                                Parts Order Entry

 Type choices, press Enter.
   2=Change

 Customer number . . . . . . .  0001      Order number  . . . . . . . :   3551
 Customer name . . . . . . . :  OAKLEY, Annie O
 Address . . . . . . . . . . :  00001 Ave. ABC
                                Bldg 00001
 City  . . . . . . . . . . . :  Des_Moines_           IO   07891-2345

 Opt Part    Description                                     Qty

     000008  Cross_Country_Ski_Set                               1
     000001  WEBSPHERE REDBOOK                                   1






                                                                    Bottom
 F3=Exit   F4=Prompt   F6=Accept Order   F12=Cancel
```

Figure 7-10 Completed order

9. Figure 7-11 shows you the quantity for Cross Country Ski Set is changed to 1. When the order is complete, the user presses F6 to update the database. Then, an order is placed in the data queue for printing.



```
                              Display Spooled File
File  . . . . . :   PRTORDERP                        Page/Line   1/2
Control . . . . .                                    Columns     1 - 78
Find  . . . . . .
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+...
                              ABC Company - Part Order
 OAKLEY, Annie O                                 Order Nbr:       3551
 00001 Ave. ABC                                 Order Date:   3-27-2001
 Bldg 00001
 Des_Moines_          IO  07891-2345
Part    Description               Quantity  Price     Discount    Amount
============================================================================
000008  Cross_Country_Ski_Set         1     $ 93.00    .1140        $92.89
000001  WEBSPHERE REDBOOK             1     $ 30.00    .1140        $29.96
                                                              --------------
Order total:                                                       $122.85
                                                              ==============




                                                                          Bottom
F3=Exit   F12=Cancel   F19=Left   F20=Right   F24=More keys
```

Figure 7-11   Printed order

The printed order (Figure 7-11) is created by a batch process. It shows the customer details and the items, quantities, and cost of the order.

7.6 Database table structure

The ABC Company database has eight tables:

- District
- Customer
- Order
- Order Line
- Item
- Stock
- Warehouse
- History

The relationship among these tables is shown in Figure 7-12.

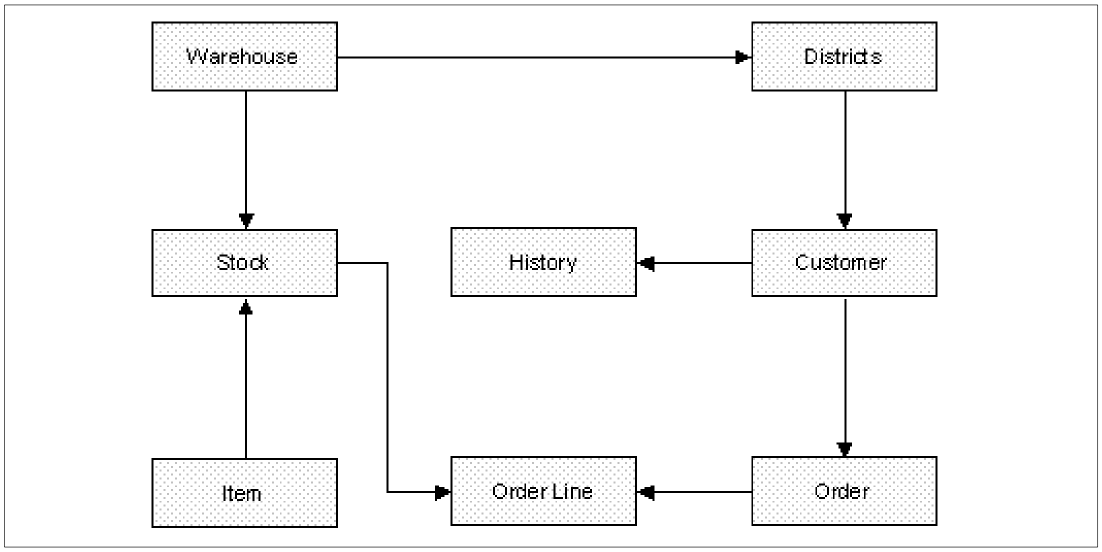


Figure 7-12 Table relationships

7.7 OrderEntry application database layout

The sample application uses the following tables of the database:

- District
- Customer
- Order
- Order line
- Stock
- Item (catalog)

The following tables describe, in detail, the layout of the database.

Table 7-1 District Table Layout (Dstrct)

Field name	Real name	Type	Length
DID	District ID	Decimal	3
DWID	Warehouse ID	Character	4
DNAME	District Name	Character	10
DADDR1	Address Line 1	Character	20
DADDR2	Address Line 2	Character	20
DCITY	City	Character	20
DSTATE	State	Character	2
DZIP	Zip Code	Character	10
DTAX	Tax	Decimal	5
DYTD	Year to Date Balance	Decimal	13
DNXTOR	Next Order Number	Decimal	9
Primary Key: DID and DWID			

Table 7-2 Customer Table Layout (CSTMR)

Field name	Real name	Type	Length
CID	Customer ID	Character	4
CDID	District ID	Decimal	3
CWID	Warehouse ID	Character	4
CFIRST	First Name	Character	16
CINIT	Middle Initials	Character	2
CLAST	Last Name	Character	16
CADDR1	Address Line 1	Character	20
CCREDT	Credit Status	Character	2
CADDR2	Address Line 2	Character	20
CDCT	Discount	Decimal	5
CCITY	City	Character	20
CSTATE	State	Character	2
CZIP	Zip Code	Character	10
CPHONE	Phone Number	Character	16
CBAL	Balance	Decimal	7
CCRDLM	Credit Limit	Decimal	7
CYTD	Year to Date	Decimal	13

Field name	Real name	Type	Length
CPAYCNT	Payment	Decimal	5
CDELCNT	Delivery Qty	Decimal	5
CLTIME	Time of Last Order	Numeric	6
CDATA	Customer Information	Character	500
Primary Key: CID, CDID, and CWID			

Table 7-3 Order Table Layout (ORDERS)

Field name	Real name	Type	Length
OWID	Warehouse ID	Character	4
ODID	District ID	Decimal	3
OCID	Customer ID	Character	4
OID	Order ID	Decimal	9
OENTDT	Order Date	Numeric	8
OENTTM	Order Time	Numeric	6
OCARID	Carrier Number	Character	2
OLINES	Number of Order Lines	Decimal	3
OLOCAL	Local	Decimal	1
Primary Key: OWID, ODID, and OID			

Table 7-4 Order Line Table Layout (ORDLIN)

Field name	Real name	Type	Length
OID	Order ID	Decimal	9
ODID	District ID	Decimal	3
OWID	Warehouse ID	Character	4
OLNBR	Order Line Number	Decimal	3
OLSPWH	Supply Warehouse	Character	4
OLIID	Item ID	Character	6
OLQTY	Quantity Ordered	Numeric	3
OLAMNT	Amount	Numeric	7
OLDLVD	Delivery Date	Numeric	6
OLDSTI	District Information	Character	24
Primary Key: OLWID, OLDID, OLOID, and OLNBR			

Table 7-5 Item Table Layout (ITEM)

Field name	Real name	Type	Length
IID	Item ID	Character	6
INAME	Item Name	Character	24
IPRICE	Price	Decimal	5
IDATA	Item Information	Character	50
Primary Key: IID			

Table 7-6 Stock Table Layout (Stock)

Field name	Real name	Type	Length
STWID	Warehouse ID	Character	4
STIID	Item ID	Character	6
STQTY	Quantity in Stock	Decimal	5
STDI01	District Information	Character	24
STDI02	District Information	Character	24
STDI03	District Information	Character	24
STDI04	District Information	Character	24
STDI05	District Information	Character	24
STDI06	District Information	Character	24
STDI07	District Information	Character	24
STDI08	District Information	Character	24
STDI09	District Information	Character	24
STDI10	District Information	Character	24
STYTD	Year to Date	Decimal	9
STORDERS	Number of orders	Decimal	5
STREMORD	Number of remote orders	Decimal	5
STDATA	Item Information	Character	50
Primary Key: STWID and STIID			

7.8 Database terminology

This redbook concentrates on the use of the iSeries server as a database server in a client/server environment. In some cases, we use SQL to access the iSeries database. In other cases, we use native database access.

The terminology used for the database access is different in both cases. In Table 7-7, you find the correspondence between the different terms.

Table 7-7 Database terminology

iSeries native	SQL
Library	Collection, schema
Physical file	Table
Field	Column
Record	Row
Logical file	View or index

8

iSeries EJB application development scenario

This chapter discusses how the example RPG application discussed in Chapter 7, “Overview of the OrderEntry application” on page 231, can be implemented using EJB components. The application architecture is detailed by identifying the objects, using Unified Modeling Language (UML) diagrams. These objects are identified as entity and session beans. This chapter discusses the reasons behind these selections, the implementation details of these choices, and how these EJB components are used to create various types of applications.

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8.1 OrderEntry application architecture with objects

This architecture example assumes that the database tables already exist and that an object architecture is built surrounding them. Initially, it is important to name the identifiable objects in the application. A variety of methods exist for creating an object-oriented application. One common way is to describe the process and highlight the nouns, as a starting point for identifying the objects.

In our example, a *customer* resides in a particular *district*. The customer contacts an order entry clerk to place an *order* for one or more *items*. Each item appears as an *order detail* line in the order. Before the order can be placed, the order entry clerk checks to see if there is enough of the item in *stock*.

This list of objects corresponds to the tables identified in Chapter 7, "Overview of the OrderEntry application" on page 231, which also identify the fields contained in the tables. An object diagram corresponding to these tables is shown in Figure 8-1.

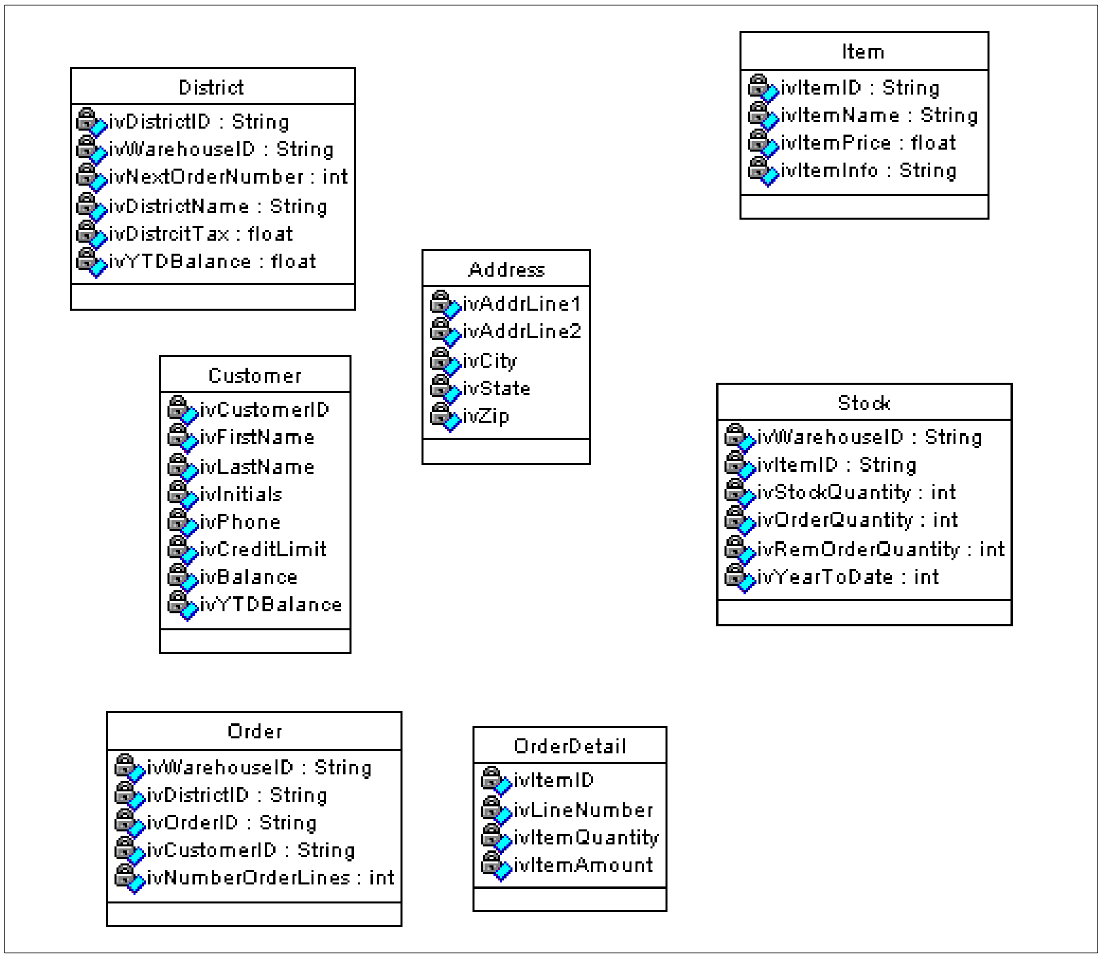


Figure 8-1 Application object diagram

In Figure 8-1, we make one further refinement. We separated out an address object to hold the common address information that is required by the customer and the district.

This list of objects represents all of the tables. However, the description includes another noun – the *order entry clerk* (OrderEntryClerk). This object becomes important in the next step of identifying objects, which is to identify the relationships between the objects. The OrderEntryClerk is an object with the primary purpose of acting on other objects. The relationships between the identified objects are either containment or use relationships. Figure 8-2 shows all of the objects that were previously identified and the relationships between them.

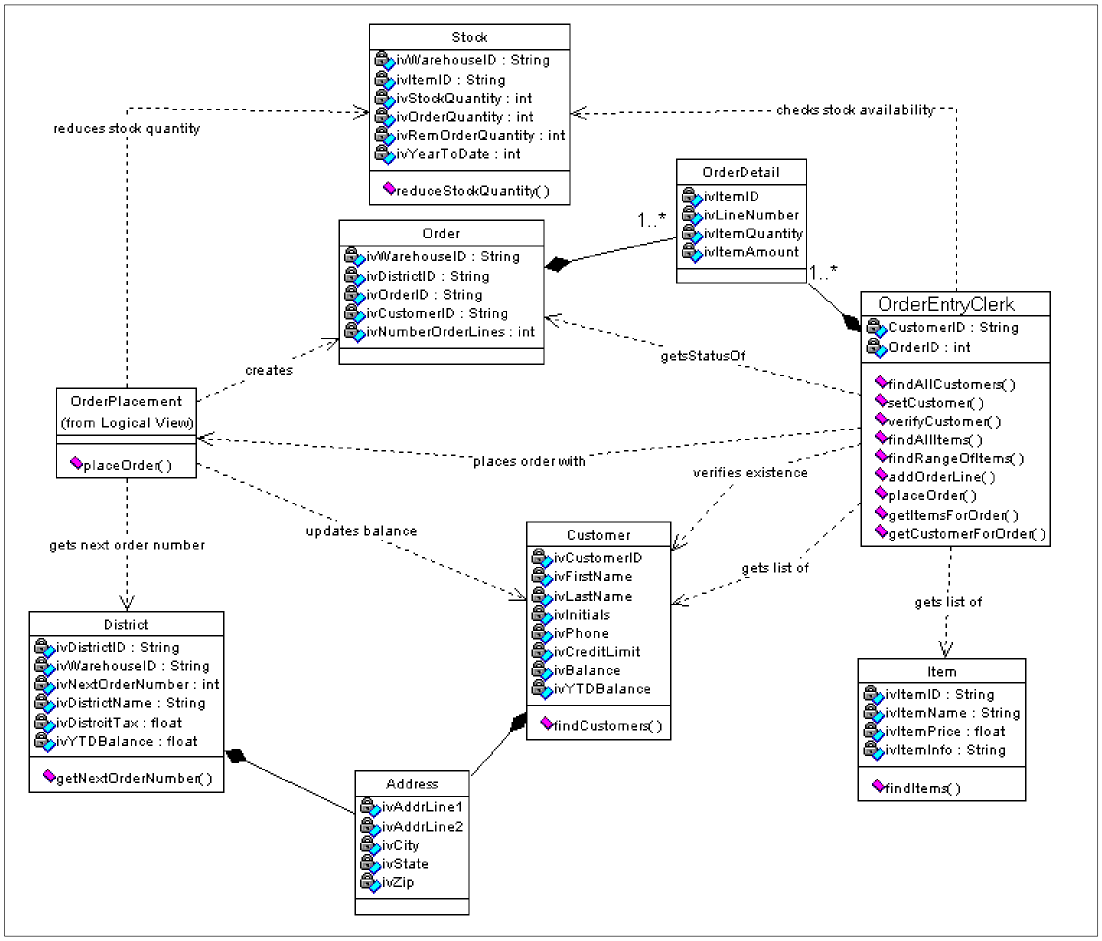


Figure 8-2 Object relationships

Both the customer and the district class contain an address. This provides reuse, one of the key benefits of object-oriented programming. As shown later in this chapter, reuse, as a goal, may need to be overlooked to gain other advantages, such as using some of the programming facilities. The order contains a collection of order details. Because the order entry clerk initially takes down the order information, it also needs to contain a collection of order details (OrderDetails). This collection of order details is used as a parameter when calling the method necessary to create a new order.

The use relationships primarily involve the OrderEntryClerk, as well. The OrderEntryClerk acts on several different objects. It retrieves a list of customers when the order is initiated. Later, when an order is placed, it verifies the existence of a specific customer. It also retrieves a list of items to be ordered. As requests for creating order details are received by the OrderEntryClerk, it checks the stock availability of the item being ordered. After all of the order details are created, the order is placed through the OrderEntryClerk.

To this point, all of the actions that have been described reflect only as reads of the database tables. Placing the order is the activity that involves writing to the tables represented by the objects. Because this is a complex task and represents a business transaction, OrderPlacement is represented as a separate object. The OrderPlacement object also acts on several different objects. It creates a new order object. Because it receives a collection of order details as a parameter, it merely passes them on to the order for them to be created. The OrderPlacement object also retrieves the next order number from the district, updates the customer balances, and reduces the stock quantity. All of these updates are completed as a single unit of activity and, therefore, are encapsulated in a transaction, as shown later in this chapter.

The objects described in this section serve one of two purposes. They either represent data that is maintained in a table, or they represent actions on the data or business tasks. These two types of objects correspond to entity and session beans, respectively.

8.2 Business data: Entity Enterprise JavaBeans

This section discusses the entity enterprise beans we developed for our example application. It also highlights some of the key topics we address in writing them.

Entity beans are persistent objects that represent data stored in some persistent fashion, such as a database or an existing legacy application. When you modify the variables for the bean, you modify the data in the database. In our case, the persistent store is the relational database on the iSeries server.

Our analysis identified the following five entity beans:

- Stock
- Item
- Customer
- Order
- District

8.2.1 Database access: Using a connection pool

In our example application, we use connection pools to optimize performance. Connection pools are commonly used because creating a new JDBC connection is time consuming and uses system resources. With a pool, WebSphere Application Server creates connection objects when the server starts. When a bean needs a connection to the database, it gets one from the pool. When the bean is done with the connection, it returns it to the pool.

The way you return a WebSphere Application Server connection to the pool is to call the connection `close` method, for example, `con.close()`. This works because a connection is actually a class that wrappers a JDBC connection.

Using WebSphere connection pools

To optimize performance in the enterprise bean data access methods, the developer should not use the `java.sql DriverManager getConnection(String url)` method to get a JDBC connection to the database. The developer should take advantage of the WebSphere Application Server connection pools defined in the DataSource Configuration object. For information about creating data sources, see Chapter 3 in the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815. The code in Example 8-1 shows this technique.

Example 8-1 Using a DataSource

```
import javax.naming.*;
import javax.sql.*;
import java.sql.*;
........
DataSource ds;
try {
   InitialContext initCtx = new InitialContext();
   String dataSourceName = (String)initCtx.lookup(“java:comp/env/dataSourceName”);
   ds = (DataSource) initCtx.lookup("jdbc/” + dataSourceName);
   }
..........
Connection con = ds.getConnection();
Statement stmt = con.createStatement();
.........
ds.close()
```

DataSources can be found by looking them up in the WebSphere Application Server JNDI naming space. To use a DataSource, you must:

1. Get an instance of the local iSeries javax.naming.InitialContext object.
2. Use its `lookup()` method, specifying `jdbc/<data source name>` as a parameter, to get an instance of DataSourceBean in a variable of type javax.sql.DataSource.

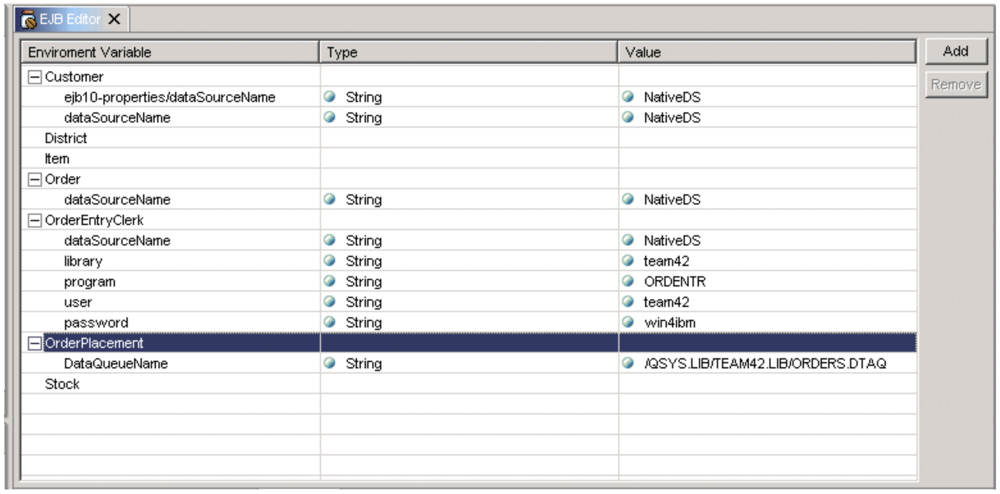
   Note: If you are working on WebSphere Application Server Advanced Edition 3.5, the DataSource is a variable of type com.ibm.ejs.dbm.jdbcext.javax.sql.DataSource.

3. Use the DataSourceBean `getConnection()` method to get a JDBC connection out of the DataSource connection pool.
4. When you are done with the connection, use the `java.sql.Connection close()` method to put the connection back in the pool.

The name of the DataSource should be externalized, because it is not likely that you will know it during bean development. A good technique is to place the DataSource name in an environment variable of the bean deployment descriptor. It can be changed at deployment time.

Figure 8-3 shows how to set the environment variable in Application Developer:

1. Right-click the project and select **Open with-> EJB Editor**.
2. Select the **Environment** tab.
3. Select the bean and click **Add** to add the environment variables.



Enviroment Variable	Type	Value
⊟ Customer		
ejb10-properties/dataSourceName	String	NativeDS
dataSourceName	String	NativeDS
District		
Item		
⊟ Order		
dataSourceName	String	NativeDS
⊟ OrderEntryClerk		
dataSourceName	String	NativeDS
library	String	team42
program	String	ORDENTR
user	String	team42
password	String	win4ibm
⊟ OrderPlacement		
DataQueueName	String	/QSYS.LIB/TEAM42.LIB/ORDERS.DTAQ
Stock		

Figure 8-3 Setting environment variables in Application Developer

8.2.2 Persistence: Container or bean managed

After you identify your entity beans, you must decide whether to use container-managed persistence (CMP) or bean-managed persistence (BMP). Use CMP, unless you want to do something it does not support, because CMP is much simpler to implement.

The common reasons for using BMP are:

- Performance
- Complex entity/database mapping

In our example, we use BMP in the Order bean to achieve maximum performance. The underlying data is stored in two tables: order (ORDERS) and order line (ORDLIN). It may also be used many times during the placement of an order. For a complete description of the applications tables, see 7.6, “Database table structure” on page 239.

Another reason to reject CMP is that the bean data is stored in a legacy application rather than in a database.

In our example, we also use BMP for the Customer bean because the Customer bean contains an Address object, which contains fields that need persisting.

Note: As a bean developer, you must choose which form of persistence to use. It is not possible to write an entity bean that can be switched from BMP to CMP at deployment time. Changing from one form of persistence to the other requires changes in your source code for the bean.

8.2.3 Container-managed persistence

In our example, the Stock, Item, and District beans use container-managed persistence (CMP). This means that we rely on WebSphere Application Server to update the Stock, Item, and District database tables any time we change the data in our entity bean. In Chapter 9, “Developing EJBs with Application Developer” on page 265, we use the Stock bean to describe how to implement CMP.

8.2.4 Bean-managed persistence

When you create an entity bean that uses bean-managed persistence, you take responsibility for the code that inserts, selects, updates, and deletes data from the underlying database or other persistent storage mechanism by implementing four life-cycle methods (listed below).

In the simplest case where a bean instance represents one row in a database table, the responsibilities of the methods are summarized in the following list:

- **ejbCreate**: Uses the client-supplied arguments to perform the following tasks:
  - Insert a new record in the database.
  - Set the instance variables for the bean.
  - Return an instance of the primary key for the bean.
- **ejbLoad**: Uses the primary key associated with the instance to perform the following tasks:
  - Retrieve the record from the database.
  - Update the bean instance variables from the database.
- **ejbStore**: Updates the database record using the values in the instance variables of the bean.
- **ejbRemove**: Deletes the database record.

The container is responsible for calling these methods at the appropriate time to maintain the synchronization between the bean and the underlying database.

In addition to the life-cycle methods, you must implement the `ejbFindByPrimaryKey` method and any other finder methods that you want to define. The container calls this method when the client calls `findByPrimaryKey` on the home interface.

When you use bean-managed persistence, you are not limited to storing a bean as a single row in a table. For example, the Order bean in our example application gets its data from two tables and several rows. You are not even limited to storing your data in a database. Regardless of the how the data is stored, the basic function of the four methods remains the same.

8.3 Business processes: Session Enterprise JavaBeans

This section discusses the session enterprise beans that we develop for our example application. It also highlights some of the key topics addressed in writing them. Session beans are non-persistent objects that run on the server and implement business logic.

Our example uses two session beans:

- OrderEntryClerk
- OrderPlacement

8.3.1 Three-tier versus two-tier architecture

Session beans allow you to easily implement a three-tier architecture. The traditional client/server architecture is a two-tiered architecture in which there are many clients and a single database. The clients often implement the business logic as well as the user interface. In a three-tiered architecture, business logic is moved out of the many clients and into a session bean running in an EJB server. The clients talk to the session bean and the bean talks to the databases.

This architecture makes the client code smaller and easier to maintain. You can change the business logic without redistributing any client code. More importantly, this architecture lets you share business logic across different types of clients. If you implement your business logic in a bean, you can use that same bean in a Java application, an applet, a servlet, or a non-Java application as shown in Figure 8-4.

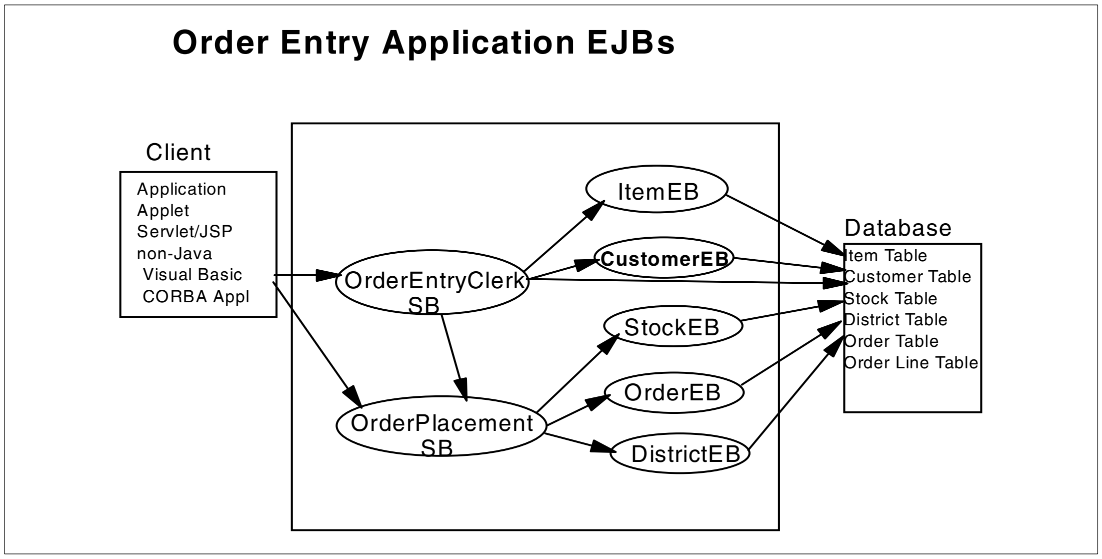


Figure 8-4 Three-tier architecture

8.3.2 Stateless or stateful beans

A *stateless session* bean allows you to write code that runs on the server and can be reused by many clients. However, the stateless session bean does not remember anything about the client between method invocations. In fact, if your client calls two methods of a stateless session bean, there is no guarantee that both methods are called on the same object in the server.

Conversely, a *stateful* session bean remembers information between method calls. To use a trivial example, a stateful session bean can have two methods – `setName` and `getName`. A client can pass a name to the bean using `setName` and retrieve that name in another call using `getName`.

8.3.3 Order Entry example

In our example application, the *OrderPlacement* bean is a stateless session bean, and the *OrderEntryClerk* bean is a stateful session bean. The OrderPlacement bean encapsulates the business logic to place an order. The OrderEntryClerk encapsulates the ordering process. The OrderEntryClerk bean is used by GUI programs such as Java applications or applets. The OrderPlacement bean is used by the OrderEntryClerk bean to actually place the order.

8.3.4 Stateless session bean: OrderPlacement

The OrderPlacement bean encapsulates the business logic to place an order in a method named `placeOrder()`.

The source code for the OrderPlacement bean consists of the following four components:

- **Deployment descriptor**: The ejb-jar.xml file that contains attribute and environment settings that define how the container invokes enterprise bean functions

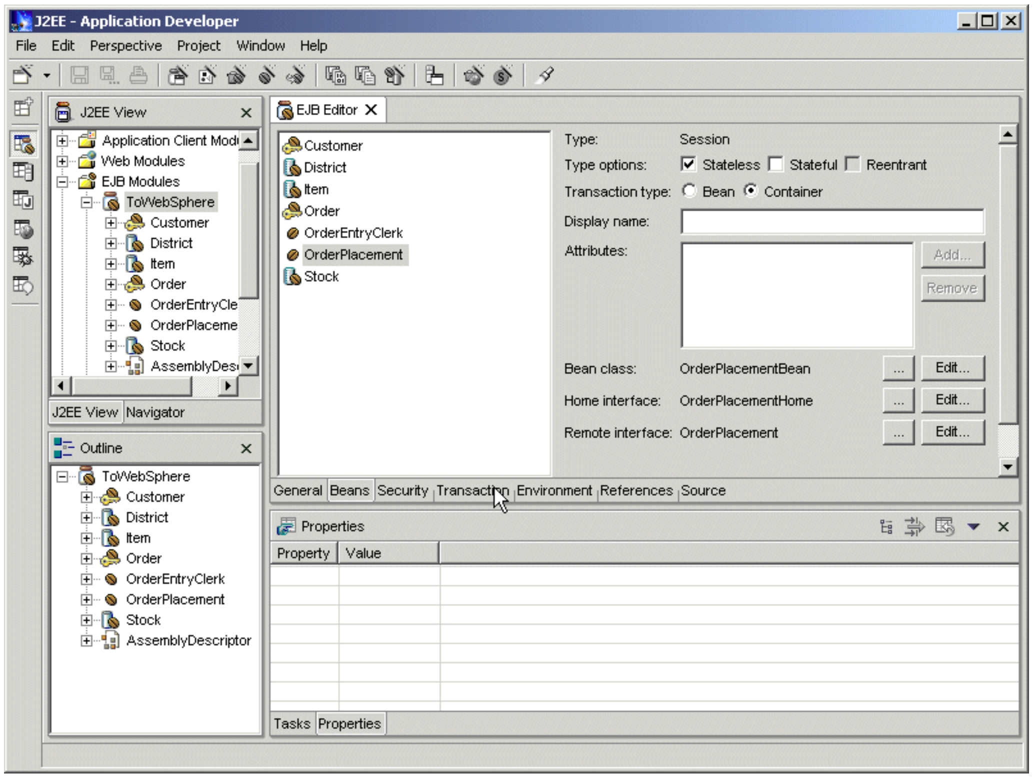
- **OrderPlacementHome**: The home interface for the bean
- **OrderPlacement**: The remote interface for the bean
- **OrderPlacementBean**: The implementation of the bean

Deployment descriptor

Every enterprise bean must have a deployment descriptor that contains settings for the bean attributes. There are two different types of attributes – bean-level and method-level.

A *bean-level attribute* is an attribute that applies to the entire bean, and it has a single value for the enterprise bean. A *method-level attribute* can be set on a single bean method. If a method-level value is specified, that value is used. If there is no method-level value, the bean-level value is used.

To see the deployment descriptor for the OrderPlacement bean, select the project **ToWebSphere** in the J2EE perspective. Right-click and select **Open With-> EJB Editor**. Select the **Beans** tab and click **OrderPlacement**. Figure 8-5 shows the settings used in our example beans.

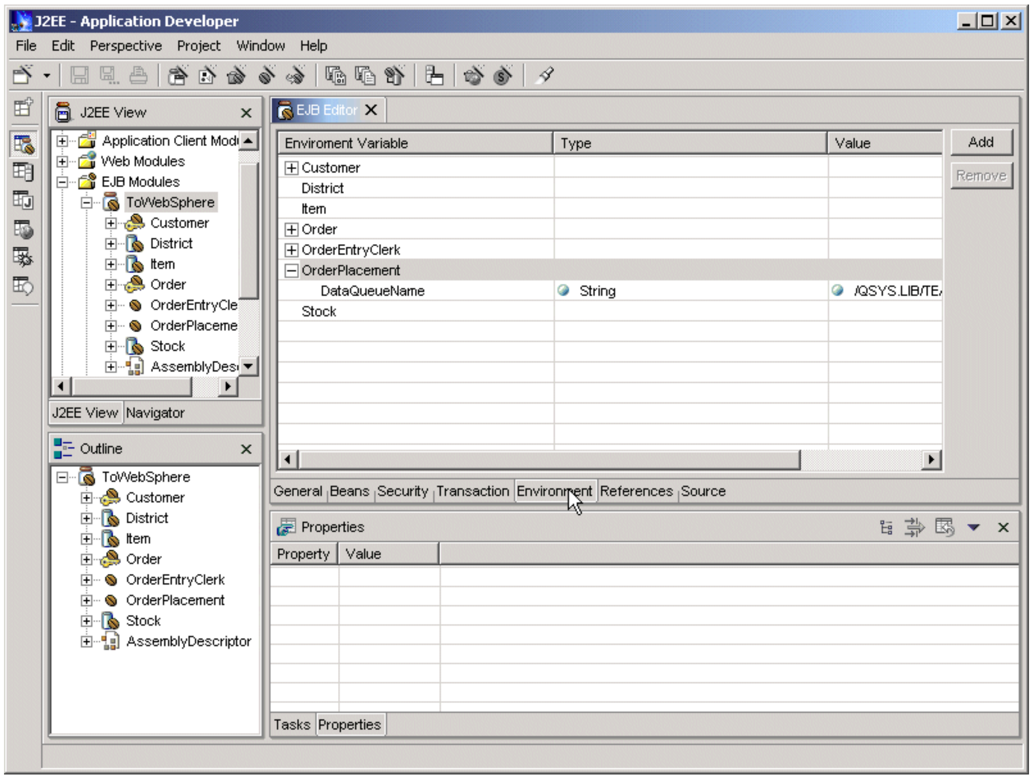


Type: Session
Type options: [✓ Stateless] Stateful Reentrant
Transaction type: Bean [✓ Container]
Display name:
Attributes:
Bean class: OrderPlacementBean
Home interface: OrderPlacementHome
Remote interface: OrderPlacement

Figure 8-5 OrderPlacementBean properties

We define the OrderPlacement bean as a stateless session bean using the *type option* value in the deployment descriptor as shown in Figure 8-5. This tells our container that it does not need to assign one instance of the OrderPlacement bean to each client. Instead, it can create a pool. For example, there may be one hundred clients connected to the server, but only five call *placeOrder* at any one time. In this case, the EJB container only creates five instances of the OrderPlacement bean.

The Environment tab of the deployment descriptor, shown in Figure 8-6, allows you to enter information that is specific to the bean. This is useful to externalize values that depend on the specific deployment environment. The `placeOrder` method of the OrderPlacementBean class uses a data queue to pass order information to other applications. We use the deployment descriptor to externalize the name of the data queue.

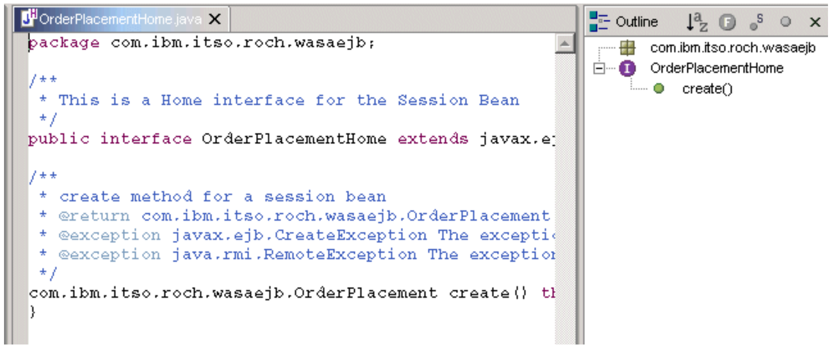


Enviroment Variable	Type	Value
Customer		
District		
Item		
Order		
OrderEntryClerk		
OrderPlacement		
DataQueueName	String	/QSYS.LIB/TE
Stock		

Figure 8-6 OrderPlacement bean properties environment tab

Home interface (OrderPlacementHome)

As shown in Figure 8-7, the home interface for a session bean does not have any finder methods. They don’t exist because a session bean does not represent an entity in a persistent datastore that you can locate.

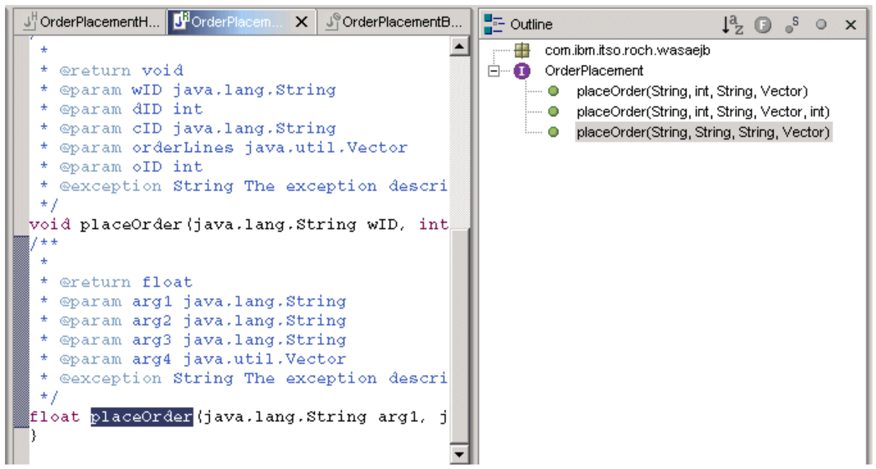


```
package com.ibm.itso.roch.wasaejb;

/**
 * This is a Home interface for the Session Bean
 */
public interface OrderPlacementHome extends javax.e

/**
 * create method for a session bean
 * @return com.ibm.itso.roch.wasaejb.OrderPlacement
 * @exception javax.ejb.CreateException The excepti
 * @exception java.rmi.RemoteException The exceptio
 */
com.ibm.itso.roch.wasaejb.OrderPlacement create() th
}
```

Figure 8-7 OrderPlacement home interface

Remote interface (OrderPlacement)

We define the business methods of the bean in the remote interface. In the case of the OrderPlacement bean, there is only the `placeOrder` method. As shown in Figure 8-8, three versions of the `placeOrder` method are available, depending on the parameters passed by the client.



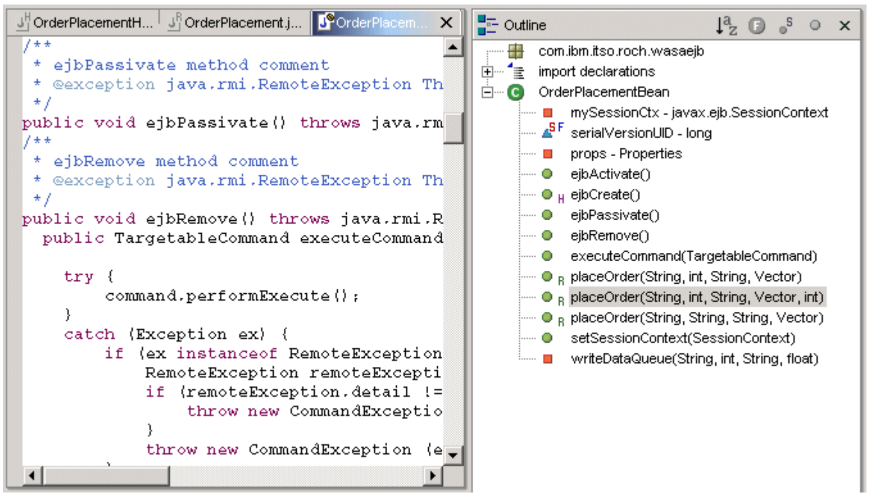
```
 *
 * @return void
 * @param wID java.lang.String
 * @param dID int
 * @param cID java.lang.String
 * @param orderLines java.util.Vector
 * @param oID int
 * @exception String The exception descri
 */
void placeOrder(java.lang.String wID, int
/**
 *
 * @return float
 * @param arg1 java.lang.String
 * @param arg2 java.lang.String
 * @param arg3 java.lang.String
 * @param arg4 java.util.Vector
 * @exception String The exception descri
 */
float placeOrder(java.lang.String arg1, j
}
```

```
com.ibm.itso.roch.wasaejb
OrderPlacement
    placeOrder(String, int, String, Vector)
    placeOrder(String, int, String, Vector, int)
    placeOrder(String, String, String, Vector)
```

Figure 8-8 OrderPlacement remote interface

Bean implementation (OrderPlacementBean)

We use the OrderPlacementBean class, shown in Figure 8-9, to implement the EJB SessionBean interface, the create method from the home interface, and the business logic.



```
/**
 * ejbPassivate method comment
 * @exception java.rmi.RemoteException Th
 */
public void ejbPassivate() throws java.rm
/**
 * ejbRemove method comment
 * @exception java.rmi.RemoteException Th
 */
public void ejbRemove() throws java.rmi.R
  public TargetableCommand executeCommand

    try {
        command.performExecute();
    }
    catch (Exception ex) {
        if (ex instanceof RemoteException
            RemoteException remoteExcepti
            if (remoteException.detail !=
                throw new CommandExceptio
            }
            throw new CommandException (e
```

```
com.ibm.itso.roch.wasaejb
import declarations
OrderPlacementBean
    mySessionCtx - javax.ejb.SessionContext
    serialVersionUID - long
    props - Properties
    ejbActivate()
    ejbCreate()
    ejbPassivate()
    ejbRemove()
    executeCommand(TargetableCommand)
    placeOrder(String, int, String, Vector)
    placeOrder(String, int, String, Vector, int)
    placeOrder(String, String, String, Vector)
    setSessionContext(SessionContext)
    writeDataQueue(String, int, String, float)
```

Figure 8-9 OrderPlacementBean

The SessionBean interface, together with the create method from the home interface, defines the bean instance life cycle. As you can see in Example 8-2, very little happens in these methods. In fact, the only work that is done is in the `setSessionContext` method.

Example 8-2 Session bean life-cycle methods

```
// private variables
private transient SessionContext ctx;
private transient Properties     props;
// Implementation of methods required by the SessionBean interface.
```

```
public void ejbActivate()  {
}

public void ejbRemove() {
}

public void ejbPassivate() {
}

// Implementation of create methods defined in home interface OrderPlacementHome
public void ejbCreate () {
}
```

The business logic is implemented in the `placeOrder` method. As shown in Example 8-3, `placeOrder` uses the District, Stock, Order, and Customer entity beans to perform much of its processing. It also uses the private method, `writeDataQueue`, to write the order to the data queue. We use an iSeries batch program to read the data queue entries and print order information.

Example 8-3 The placeOrder method processing

```
public float placeOrder(String wID, int dID, String cID, Vector orderLines) throws
javax.ejb.EJBException {
   float oID = 0;
   try {

   //The InitialContext will let us retrieve references to the entity beans we need.
      InitialContext initCtx = new InitialContext();
   //Get the Order Number from the District entity bean.
      DistrictHome dHome = (DistrictHome) initCtx.lookup("District");
      DistrictKey districtID = new DistrictKey(dID, wID);
      District district = (District) dHome.findByPrimaryKey(districtID);
      int oIDint;
      oIDint = district.getNextOrderId(true);
   //'true' tells the District to increment the order id.
      oID = oIDint;
   //Update the Stock level for each item in an order line using the Stock entity bean
      StockHome sHome = (StockHome) initCtx.lookup("Stock");
      Enumeration lines = orderLines.elements();
      float orderTotal = 0;
      while (lines.hasMoreElements()) {
         OrderDetail od = (OrderDetail) lines.nextElement();
         String itemID = od.getItemID();
         int itemQty = od.getItemQty();
         orderTotal += od.getItemAmount();
   //Calculate the order total while we are going through the orders.
         StockKey stockID = new StockKey(wID, itemID);
         //StockKey stockID = new StockKey(itemID, wID);
         Stock stock = (Stock) sHome.findByPrimaryKey(stockID);
         stock.decreaseStockQuantity(itemQty);
      }
      //Save the Order to the database by creating an Order entity bean
      OrderHome oHome = (OrderHome) initCtx.lookup("Order");
      oHome.create(wID, dID, cID, oID, orderLines);
      //Update the Customer records using the Customer entity bean
      CustomerHome cHome = (CustomerHome) initCtx.lookup("Customer");
      CustomerKey customerID = new CustomerKey(cID);
      Customer customer = (Customer) cHome.findByPrimaryKey(customerID);
      customer.updateBalance(orderTotal);
      //Write the order to the data queue.
      try {
         writeDataQueue(wID, dID, cID, oID);
      } catch (Exception e) {
         System.out.println("WriteDataQueue error: " + e.getMessage());
         throw new EJBException(e.getMessage());
      }       System.out.println("before the final catch");
   } catch (Exception e) {
      throw new EJBException(e.getMessage());
   }
           System.out.println("outside the main try block" + oID);
   return oID;
}
```

8.3.5 Stateful session bean: OrderEntryClerk

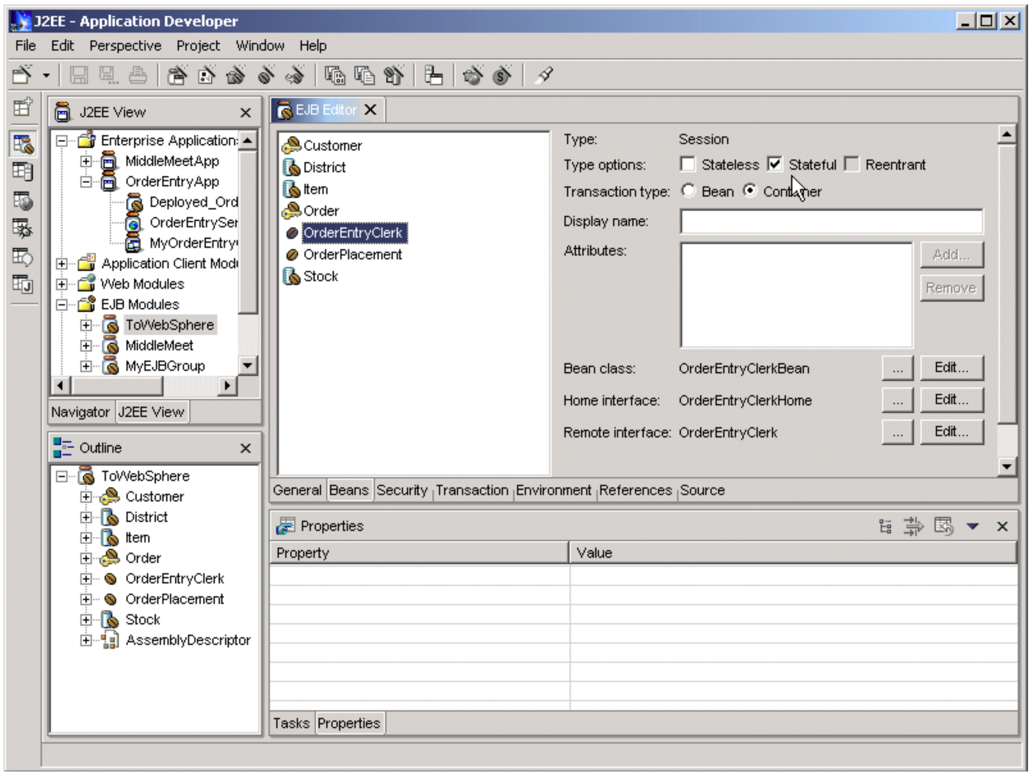
The OrderEntryClerk encapsulates the ordering process. We define the OrderEntryClerk bean as a stateful session bean to use it as an order clerk. This bean keeps a record of who the customer is and what items they want to order.

The source code for the OrderClerk bean consists of the following four components:

- **Deployment descriptor**: The ejb-jar.xml file that contains attribute and environment settings that define how the container invokes enterprise bean functions
- **OrderEntryClerkHome**: The interface for the bean
- **OrderEntryClerk**: The remote interface for the bean
- **OrderEntryClerkBean**: The implementation of the bean

Deployment descriptor

To see the deployment descriptor for the OrderEntryClerk bean, select the project **ToWebSphere** in the J2EE perspective. Right-click and select **Open With-> EJB Editor**. Select the **Beans** tab and click **OrderEntryClerk**. Figure 8-10 shows the settings used in our bean.

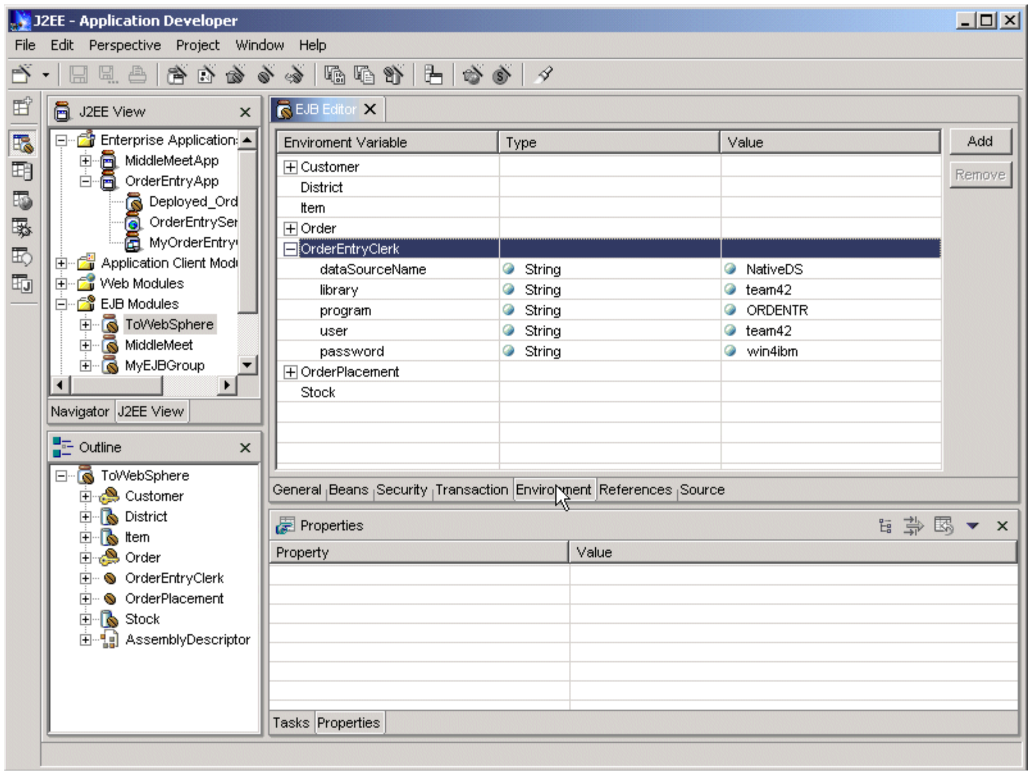


Type: Session
Type options: Stateless [✓ Stateful] Reentrant
Transaction type: Bean [✓ Container]
Display name:
Attributes:
Bean class: OrderEntryClerkBean
Home interface: OrderEntryClerkHome
Remote interface: OrderEntryClerk

Figure 8-10 OrderEntryClerkBean properties

We define the OrderEntryClerk bean as a stateful session bean using the *type option* value attribute value in the deployment descriptor as shown in Figure 8-10. This tells our container that it needs to assign an instance to each client and that it needs to store the non-transient variables of the bean across method calls.

The Environment tab of the deployment descriptor, shown in Figure 8-11, allows you to enter information specific to the bean. This is useful to externalize values that depend on the specific deployment environment. We use the deployment descriptor to externalize the name of the DataSource.

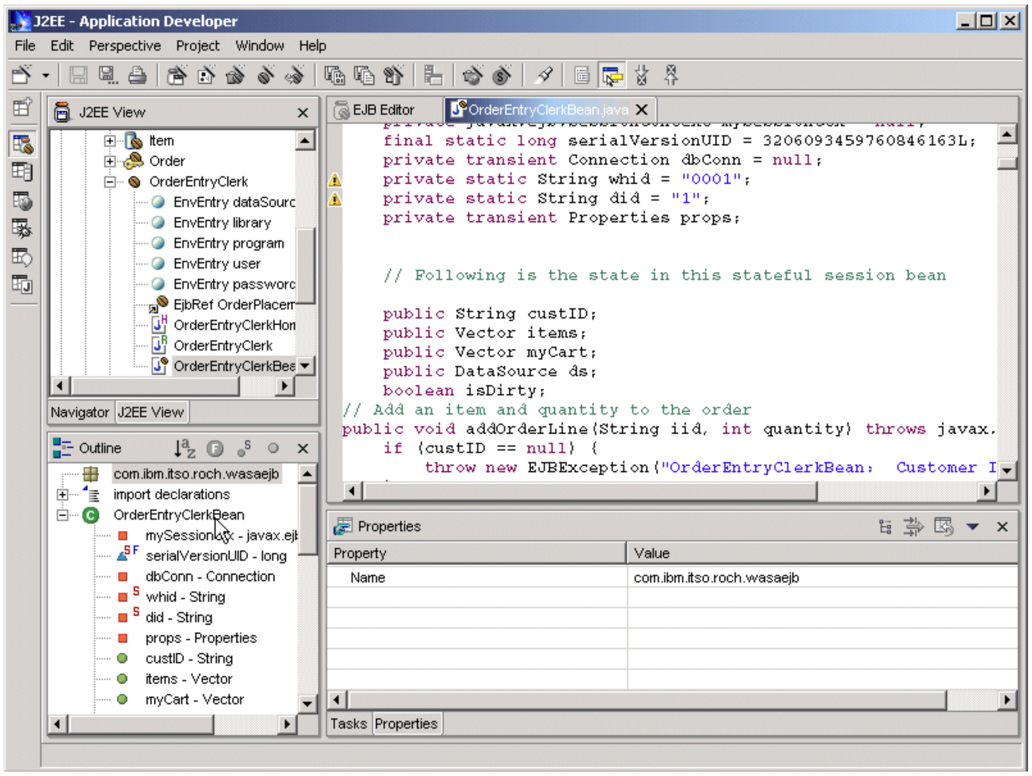


Enviroment Variable	Type	Value
Customer		
District		
Item		
Order		
OrderEntryClerk		
dataSourceName	String	NativeDS
library	String	team42
program	String	ORDENTR
user	String	team42
password	String	win4ibm
OrderPlacement		
Stock		

Figure 8-11 OrderEntryClerkBean properties environment tab

OrderEntryClerkBean

We use the OrderEntryClerkBean class, shown in Figure 8-12, to implement the EJB SessionBean interface, the create method from the home interface, and the business logic. The SessionBean interface, together with the create method from the home interface, defines the bean instance life cycle.



```
    final static long serialVersionUID = 3206093459760846163L;
    private transient Connection dbConn = null;
    private static String whid = "0001";
    private static String did = "1";
    private transient Properties props;


    // Following is the state in this stateful session bean

    public String custID;
    public Vector items;
    public Vector myCart;
    public DataSource ds;
    boolean isDirty;
// Add an item and quantity to the order
public void addOrderLine(String iid, int quantity) throws javax.
    if (custID == null) {
        throw new EJBException("OrderEntryClerkBean:  Customer I
```

Property	Value
Name	com.ibm.itso.roch.wasaejb

Figure 8-12 OrderEntryClerkBean

Implementing a state

As a bean developer, use the following steps to implement a state:

1. Define non-transient variables in your bean.
2. Initialize these variables in the `ejbCreate` methods.
3. Use these variables in the business logic.

The bean state consists of any variables we define that are not transient. As shown in Example 8-4, the OrderEntryClerk bean has two variables that maintain the bean's state.

Example 8-4 Defining state variables

```
// Following is the state in this stateful session bean
      public String custID;
      public Vector items;
```

As shown in Example 8-5, we initialize these variables in the `ejbCreate` method. In our example, `ejbCreate` does not take any arguments. If we write the example differently, where the client passes the customer ID in as an argument when creating the bean, we set custID to the provided argument.

Example 8-5 Initializing values

```
public void ejbCreate() throws javax.ejb.CreateException,java.rmi.RemoteException {
   try {
      InitialContext initCtx = new InitialContext();
      String dataSourceName = (String)initCtx.lookup("java:comp/env/dataSourceName");
      ds = (DataSource) initCtx.lookup("jdbc/" + dataSourceName);
   }
   catch (Exception e) {
      throw new RemoteException("Error in ejbCreate: " + e.getMessage());
   }
   items = new Vector();
   custID = null;
   isDirty = true;
}
```

We use these variables in the business methods. The three methods related to the bean state are:

- `setCustomer` (Example 8-6)
- `addOrderLine` (Example 8-7)
- `placeOrder` (Example 8-8)

In the `setCustomer` method, we set the value of custID.

Example 8-6 The setCustomer method

```
public void setCustomer(String cid) throws RemoteException
{
   if ( verifyCustomer(cid) )
      {
      custID = cid;
      }
   else
      {
      throw new CpwejbException("Customer id " + cid + " not valid");
      }
}
```

In the `addOrderLine` method as shown in Example 8-7, we add another OrderDetail object to the items vector. These are the items that we want to order.

Example 8-7 The addOrderLine method

```
public void addOrderLine(String iid, int quantity) throws RemoteException {
   if (custID == null) {
      throw new RemoteException("OrderEntryClerkBean:  Customer ID must be set first");
   }
   Item item = null;
   try {
      InitialContext initCtx = new InitialContext();
      Object homeObject = initCtx.lookup("Item");
      ItemHome home = (ItemHome)
      javax.rmi.PortableRemoteObject.narrow((org.omg.CORBA.Object) homeObject,
      com.ibm.itso.roch.wasaejb.ItemHome.class);
      ItemKey itemK = new ItemKey(iid);
      item = home.findByPrimaryKey(itemK);
   }
   catch (Exception e) {
      throw new RemoteException(e.getMessage());
   }
   OrderDetail ol = new OrderDetail(iid, item.getItemPrice() * quantity, quantity);
   items.addElement(ol);
}
```

The `placeOrder` method is responsible for placing an order. As shown in Example 8-8, it uses the OrderPlacement EJB's `placeOrder` method to actually place the order.

Example 8-8 The placeOrder method

```
public String placeOrder() throws RemoteException
{
   String orderNumber = null;
   if (custID == null) {
      throw new CpwejbException("OrderEntryClerkBean:  Hey buddy!
      Customer ID must be set first");
   }
   if (items.size() == 0) {
      throw new CpwejbException("OrderEntryClerkBean:
      What are you thinking!  No order lines!");
   }
   try {
      InitialContext initCtx = new InitialContext();
      OrderPlacementHome home = (OrderPlacementHome) initCtx.lookup("OrderPlacement");
      OrderPlacement placement = home.create();
      float number = placement.placeOrder(whid, did, custID, items);
      orderNumber = Float.toString(number);
      orderNumber = orderNumber.substring(0, orderNumber.length() - 2);
      // Clear out the state of the session bean at this point
      items = new Vector();
      custID = null;
   }
   catch (Exception e) {
      throw new RemoteException(e.getMessage());
   }
   return orderNumber;
}
```

The OrderEntryClerk bean also implements several methods that pertain to activities that a clerk performs, but does not use its state:

- The `findAllCustomers` method retrieves a list of customers from the server.
- The `findAllItems` method retrieves a list of items from the server.
- The `findRangeOfItems` method retrieves a subset of items from the server.
- The `verifyCustomer` method verifies that a customer number is valid.
- The `getCustomerForOrder` method retrieves the customer number for an order.
- The `getItemsForOrder` method retrieves the order lines for an order.

These methods are used by client applications. See Chapter 10, "Building Java applications with Enterprise JavaBeans" on page 315, for details about how we use these methods.

8.4 Conclusion

This chapter covered the architecture and design of the Enterprise JavaBeans that are used in this redbook.

Our analysis identified the following five entity beans:

- Stock
- Item
- Customer
- Order
- District

In this chapter, we designed the following two session beans:

- OrderEntryClerk
- OrderPlacement

We also covered the following design decisions:

- Whether to use container managed or bean-managed persistence for the entity beans
- Whether to use stateful or stateless session beans

We covered key code snippets and control file settings that we used in implementing our beans. The entire source of all the beans is available for download from our Web site as explained in Appendix A, “Additional material” on page 425.

Now that our Enterprise JavaBeans are designed and written, we are ready to use them in applications. These applications are demonstrated in Chapter 10, “Building Java applications with Enterprise JavaBeans” on page 315. This chapter demonstrates the power of using Enterprise JavaBeans. After they are written and deployed on a server, such as the iSeries server, client programmers can use them with very little knowledge of how the beans actually work.

The client programmer only has to know what methods the Enterprise JavaBeans support and how to call them. All the difficult work is done by the bean writer or the Java server. Another key advantage is that whether you are writing a Java application, a Java applet, a Java servlet, or even a Visual Basic program, it always works the same way. You only need to call the methods provided by the Enterprise JavaBeans to handle the application processing.

9

Developing EJBs with Application Developer

The objective of this chapter is to show you how to develop Enterprise JavaBeans using Application Developer. This chapter focuses on entity bean creation and testing.

Entity beans with container-managed persistence (CMP) fields must be mapped to database tables in order to persist the data that the bean represents. You map entity beans to database tables by creating a map. Maps are used to generate the SQL and other supporting code needed to make enterprise beans persistent. The EJB to RDB mapping wizard supports the following techniques for mapping enterprise beans to database tables:

- **Bottom-up mapping**: In this approach, the CMP enterprise bean and the mapping between the table and CMP fields are automatically generated.
- **Top-down mapping**: This approach assumes that you already have existing enterprise beans. The enterprise bean design determines the database design.
- **Meet-in-the-middle**: In this approach, it is assumed that you have existing enterprise beans and a database schema. You do a meet-in-the-middle mapping by matching fields in enterprise beans to fields in the database table.

For an introduction to Enterprise JavaBeans, refer to Chapter 6, “Introduction to Enterprise JavaBeans” on page 215.

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9.1 Bottom-up mapping

When application developers move to the Enterprise JavaBeans technology, it is most likely that they want to map any new entity beans to legacy data.

This section shows how Application Developer can automatically generate a Stock entity bean from the existing Stock database table. We use the Stock table from the RPG OrderEntry application discussed in Chapter 7, "Overview of the OrderEntry application" on page 231.

9.1.1 Creating an EJB project

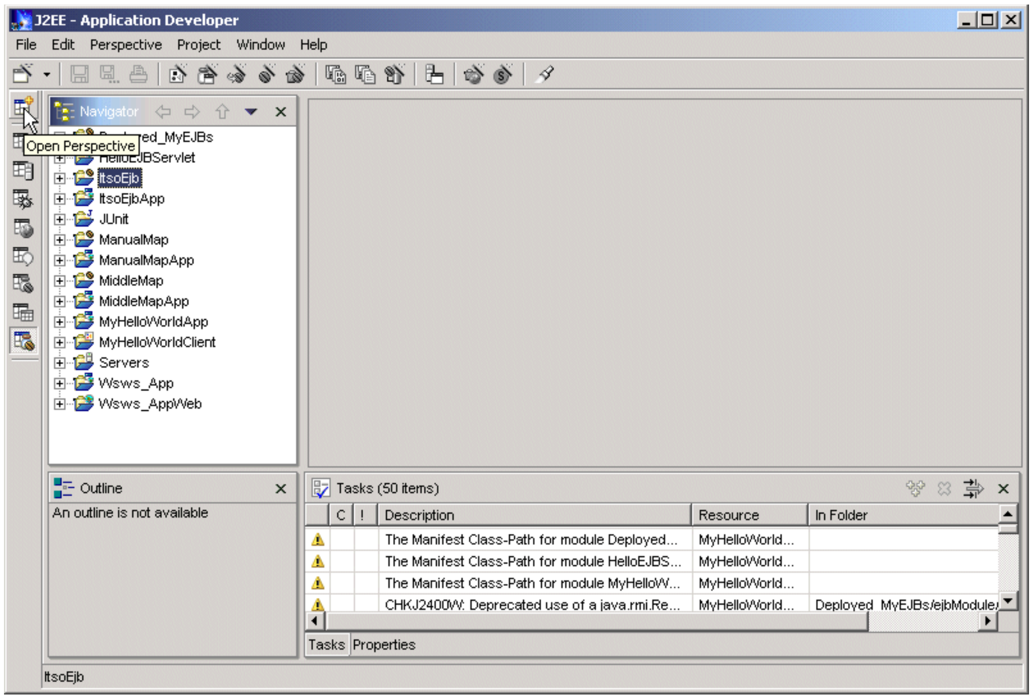
An EJB project is a logical module that allows you to manage your enterprise beans. To create an EJB project, follow these steps:

1. In the J2EE view of the J2EE perspective, select **File-> New-> EJB Project**.
2. Enter a project name.
3. Type or select the Enterprise Application project name to which this EJB project will be added. If the Enterprise Application does not exist, it is created.
4. Click **Next**. You can also click **Finish** at this point to create a default EJB project if you have no module dependencies or build settings to specify.

9.1.2 Importing a schema

The first step is to create a database schema that is used to create the Enterprise JavaBean. A schema is a representation of a database. On the iSeries server, we call it a library or collection. A *schema map* is a set of definitions for all the attributes that match all the columns for a database table, view, or SQL statement. You can create a schema based on an existing iSeries table. Follow these steps to create the Stock table schema:

1. Click the **Open Perspective** button on the perspective toolbar as shown in Figure 9-1.



C	!	Description	Resource	In Folder
	⚠	The Manifest Class-Path for module Deployed...	MyHelloWorld...	
	⚠	The Manifest Class-Path for module HelloEJBS...	MyHelloWorld...	
	⚠	The Manifest Class-Path for module MyHelloW...	MyHelloWorld...	
	⚠	CHKJ2400W: Deprecated use of a java.rmi.Re...	MyHelloWorld...	Deployed_MyEJBs/ejbModule/

Figure 9-1 Open perspective

2. Select the **Data** perspective. A window appears like the example in Figure 9-2.

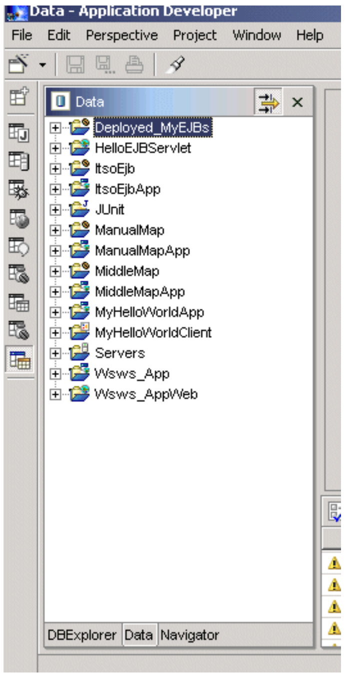
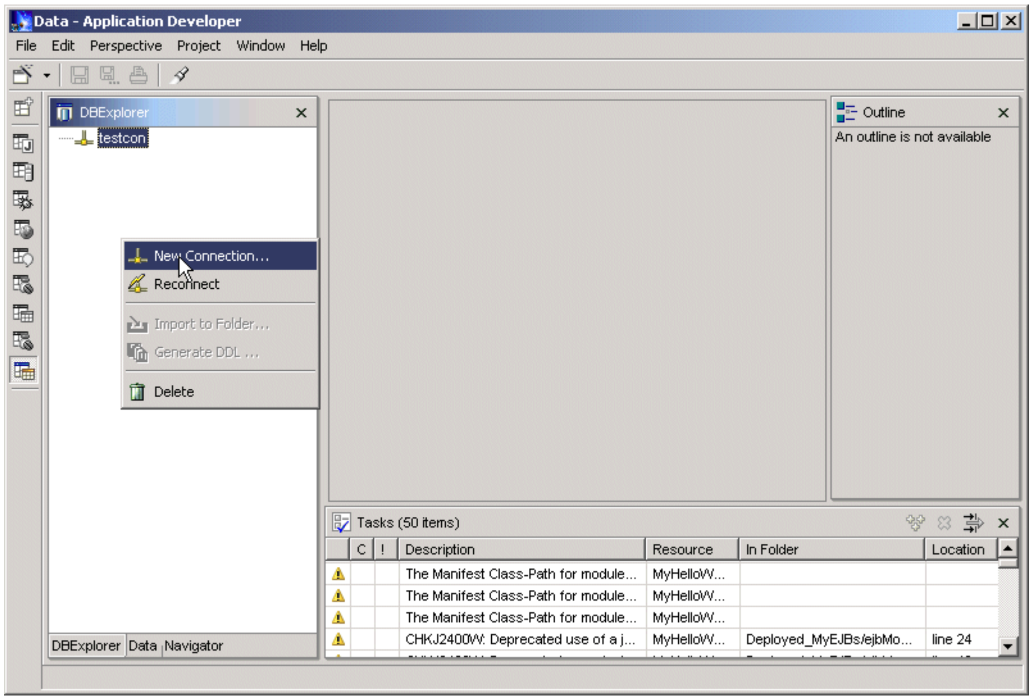


Figure 9-2 Data perspective

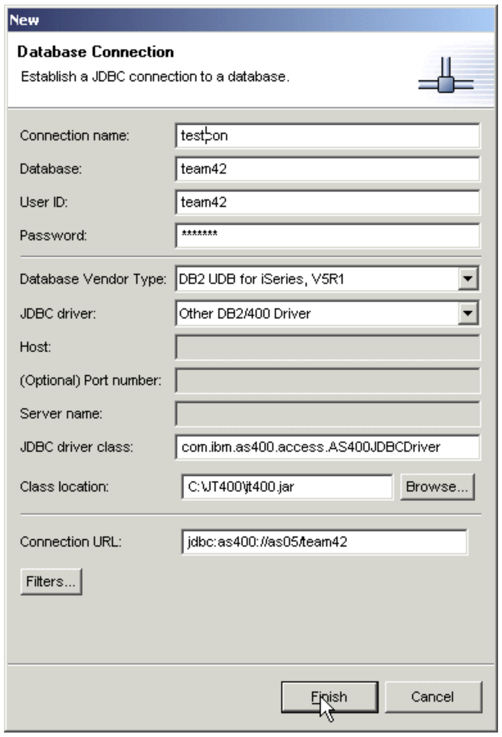
3. Ensure that the **DB Explorer** view is selected. Then right-click anywhere on this view and select **New Connection** as shown in Figure 9-3.


Data - Application Developer
File Edit Perspective Project Window Help
DBExplorer
testcon
New Connection...
Reconnect
Import to Folder...
Generate DDL ...
Delete
DBExplorer Data Navigator
Outline
An outline is not available
Tasks (50 items)

	C	!	Description	Resource	In Folder	Location
⚠			The Manifest Class-Path for module...	MyHelloW...		
⚠			The Manifest Class-Path for module...	MyHelloW...		
⚠			The Manifest Class-Path for module...	MyHelloW...		
⚠			CHKJ2400W: Deprecated use of a j...	MyHelloW...	Deployed_MyEJBs/ejbMo...	line 24

Figure 9-3 New Connection

4. Complete the Database connection dialog as shown in Figure 9-4.



Connection name:	testcon
Database:	team42
User ID:	team42
Password:	*******
Database Vendor Type:	DB2 UDB for iSeries, V5R1
JDBC driver:	Other DB2/400 Driver
Host:	
(Optional) Port number:	
Server name:	
JDBC driver class:	com.ibm.as400.access.AS400JDBCDriver
Class location:	C:\JT400\jt400.jar
Connection URL:	jdbc:as400://as05/team42

Figure 9-4 Database connection

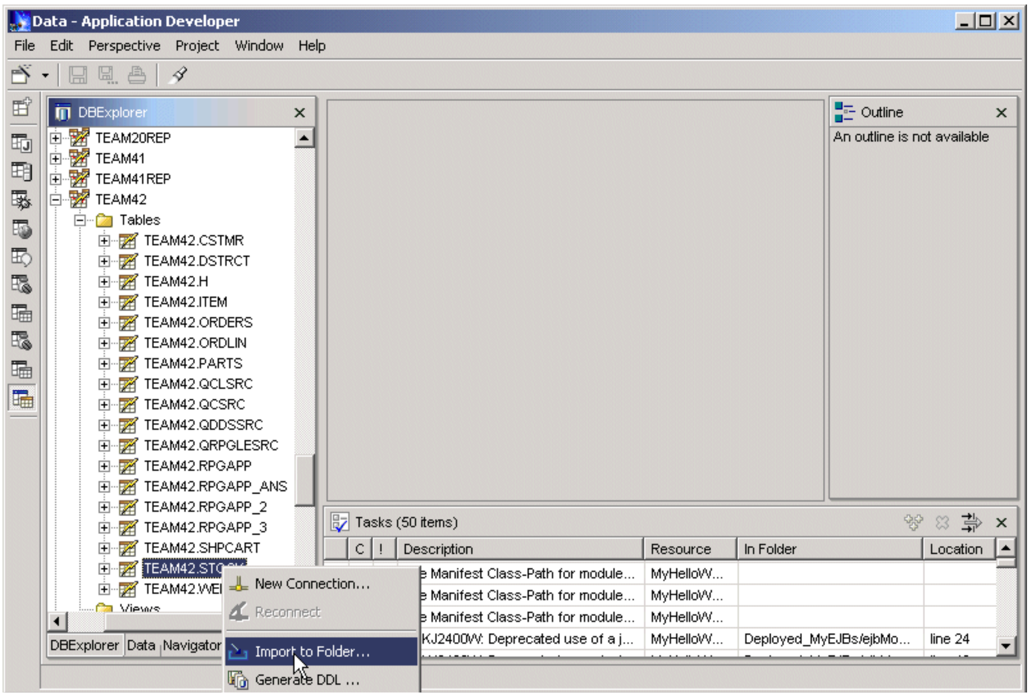
Enter the following parameters:

- **Connection name**: testcon or any other name
- **Database**: This is the datasource name that we use to connect to the iSeries server
- **userid**: A valid iSeries user ID
- **password**: A valid password
- **Database Vendor Type**: DB2 UDB for iSeries, V5R1 or V4R5 depending on your iSeries server
- **JDBC Driver**: Other DB2 UDB for iSeries driver
- **JDBC driver class**: com.ibm.as400.access.AS400JDBCDriver
- **Class location**: The location of the IBM Toolbox for Java jt400.jar file
- **Connection URL**: jdbc:as400://SystemName

5. Click the **Finish** button. The connection is established and the DB Explorer shows all the libraries on the server that you are authorized to.

> **Attention:** The DB Explorer view represents the physical schema inside the database, and no modification can be made.

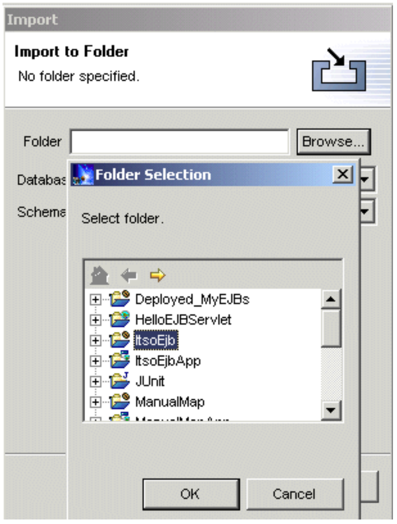
6. Locate the library that contains the tables. Select the **Stock** table. Right-click and select **Import to Folder** as shown in Figure 9-5.



	C	!	Description	Resource	In Folder	Location
			e Manifest Class-Path for module...	MyHelloW...		
			e Manifest Class-Path for module...	MyHelloW...		
			e Manifest Class-Path for module...	MyHelloW...		
			KJ2400W: Deprecated use of a j...	MyHelloW...	Deployed_MyEJBs/ejbMo...	line 24

Figure 9-5 Importing the Stock table schema

7. The Import to folder window appears. Click the **Browse** button next to the Folder as shown in Figure 9-6 and select your project. Then click **OK**.


Import

Import to Folder

No folder specified.

Folder

Database

Schema

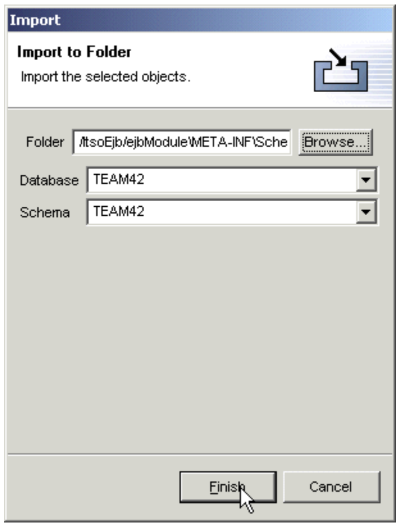
Folder Selection

Select folder.

- Deployed_MyEJBs
- HelloEJBServlet
- ItsoEjb
- ItsoEjbApp
- JUnit
- ManualMap

Figure 9-6 Import to the Folder

8. Select the Database and Schema from the drop-down list and click **Finish** as shown Figure 9-7. Click **Yes to All** to any dialog messages.


Import

Import to Folder

Import the selected objects.

Folder /ItsoEjb/ejbModule\META-INF\Sche

Database TEAM42

Schema TEAM42

Figure 9-7 Import to Folder

9. Go to the Navigator view. It's interesting to spend some time looking at the files generated in the project for the imported schema. This allows us to view how Application Developer has stored the metadata that represents the schema as shown in Figure 9-8.

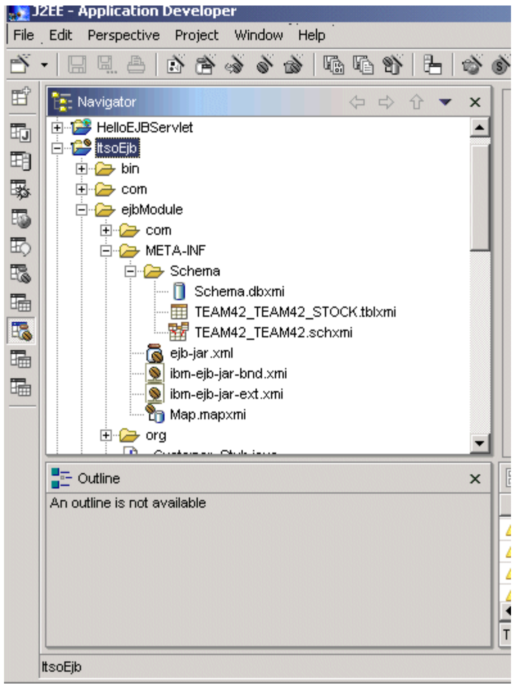


Figure 9-8 Imported database schema in a project

10. Application Developer creates a separate *xmi* file for each table in the schema with the file extension .tblxmi. It also creates an XML file for the schema with a .schxmi extension. Each of these files has its own editor. Double-click the file to open the editor. These files are also copied into the bin directory of the project for inclusion in the EJB JAR file.

11. Switch to the J2EE perspective. The database schema appears under Databases as shown in Figure 9-9.

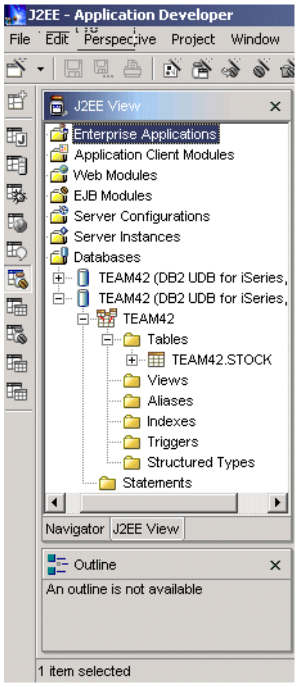
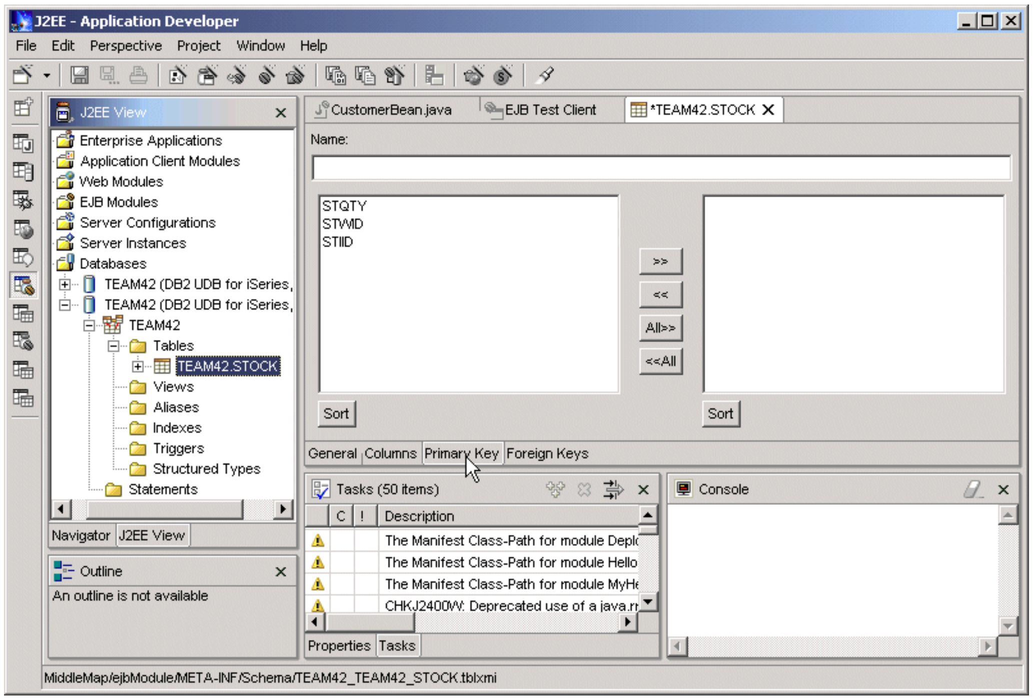


Figure 9-9 J2EE perspective for database schema

12. Double-click the Stock table schema and then select the **Primary Key** tab on the Stock table editor as shown in Figure 9-10.



The Manifest Class-Path for module Deplo
The Manifest Class-Path for module Hello
The Manifest Class-Path for module MyHe
CHKJ2400W: Deprecated use of a java.r
MiddleMap/ejbModule/META-INF/Schema/TEAM42_TEAM42_STOCK.tblxmi

Figure 9-10 Stock table schema browser

The schema browser could not find a primary key for the Stock table. The Application Developer wizard can generate a key descriptor only for files with primary key constraints. STOCK is a keyed physical file, but it does not have any primary key constraints.

13. To manually add the key descriptor for the Stock table, select the fields (**STWID** and **STIID**) and move them to the right pane using the **>>** button.

14. Close the schema browser and save the changes.

9.1.3 Creating the entity EJB from the imported schema

Now the schema is generated for the STOCK table and is imported to our working project. Follow these steps to create the Stock bean from the schema:

1. Under the EJB modules in the J2EE perspective, select the working project. In this case, we use **ItsoEjb** as our project. Right-click and select **Generate-> EJB to RDB Mapping** as shown in Figure 9-11.

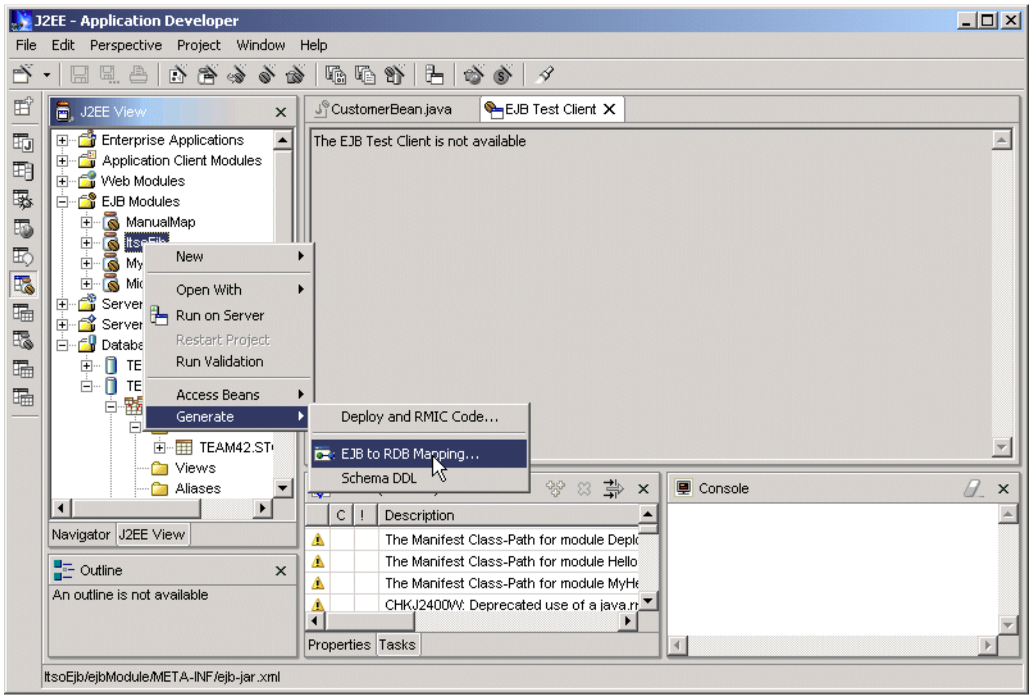

J2EE - Application Developer
File Edit Perspective Project Window Help
J2EE View
Enterprise Applications
Application Client Modules
Web Modules
EJB Modules
ManualMap
ItsoEjb
New
Open With
Run on Server
Restart Project
Run Validation
Access Beans
Generate
Deploy and RMIC Code...
EJB to RDB Mapping...
Schema DDL
TEAM42.ST
Views
Aliases
CustomerBean.java
EJB Test Client
The EJB Test Client is not available
Navigator J2EE View
Outline
An outline is not available
Description
The Manifest Class-Path for module Deplo
The Manifest Class-Path for module Hello
The Manifest Class-Path for module MyHe
CHKJ2400W: Deprecated use of a java.rm
Properties Tasks
Console
ItsoEjb/ejbModule/META-INF/ejb-jar.xml

Figure 9-11 Generating EJB to RDB Mapping

2. The mapping wizard opens as shown in Figure 9-12. Since no EJBs are currently defined in the project, only Bottom Up is enabled. Select the **Bottom Up** radio button and select the **Open mapping editor after completion** check box. Click **Next**.

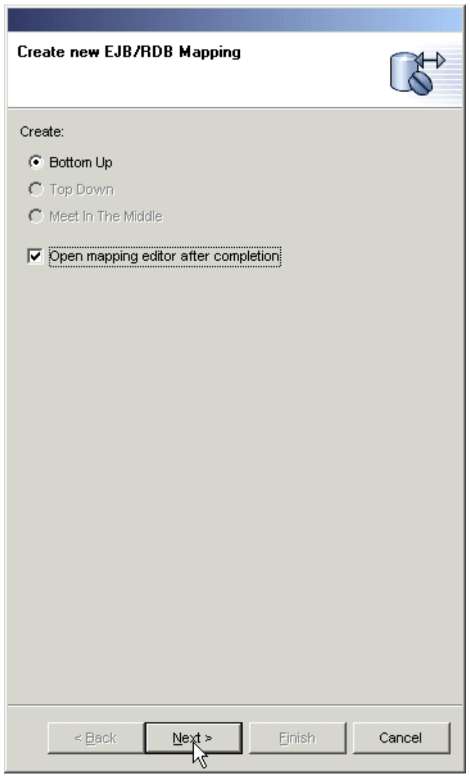
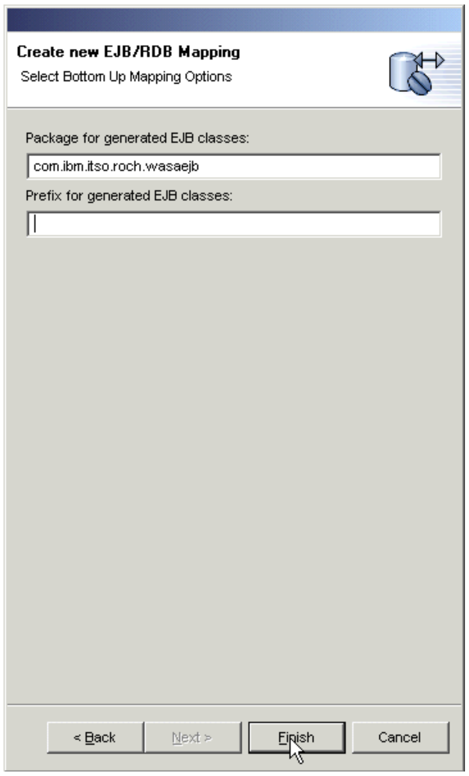


Figure 9-12 EJB to RDB mapping wizard

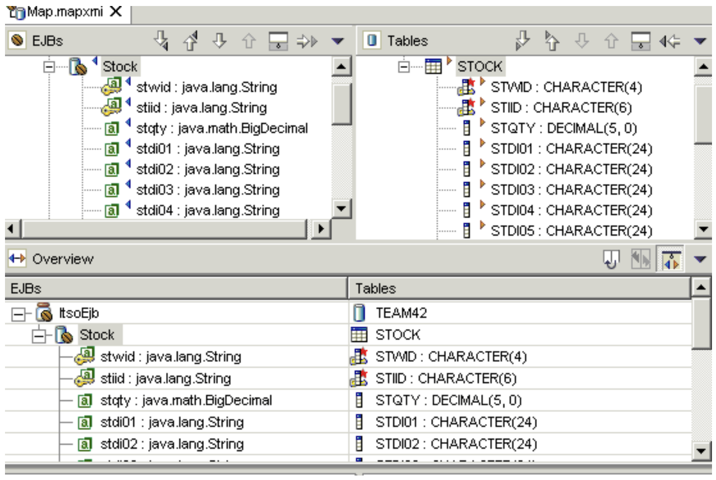
3. Leave the Prefix for generated EJB classes field blank as shown in Figure 9-13. In this case, we use `com.ibm.itso.roch.wasaejb` as the package name. By leaving the Prefix for generated EJB class field blank, the wizard uses the table names defined in the schema. Click the **Finish** button.


Create new EJB/RDB Mapping
Select Bottom Up Mapping Options

Package for generated EJB classes: com.ibm.itso.roch.wasaejb
Prefix for generated EJB classes:

Figure 9-13 Creating a new EJB/RDB mapping

When Application Developer completes the Create EJB to RDB mapping, the mapping file Map.mapxmi is opened in the J2EE perspective as shown in Figure 9-14.



EJBs	Tables
Stock	STOCK
stwid : java.lang.String	STWID : CHARACTER(4)
stiid : java.lang.String	STIID : CHARACTER(6)
stqty : java.math.BigDecimal	STQTY : DECIMAL(5, 0)
stdi01 : java.lang.String	STDI01 : CHARACTER(24)
stdi02 : java.lang.String	STDI02 : CHARACTER(24)
stdi03 : java.lang.String	STDI03 : CHARACTER(24)
stdi04 : java.lang.String	STDI04 : CHARACTER(24)
	STDI05 : CHARACTER(24)

EJBs	Tables
ItsoEjb	TEAM42
Stock	STOCK
stwid : java.lang.String	STWID : CHARACTER(4)
stiid : java.lang.String	STIID : CHARACTER(6)
stqty : java.math.BigDecimal	STQTY : DECIMAL(5, 0)
stdi01 : java.lang.String	STDI01 : CHARACTER(24)
stdi02 : java.lang.String	STDI02 : CHARACTER(24)

Figure 9-14 EJB to RDB editor

The top half of the editor shows the EJB and table definitions, and the bottom half shows how the contained fields and columns are mapped to each other. If you need to open this file again in the future, you must switch to the Navigator view and double-click the Map.mapxmi file.

Investigating the generated files

Again, it's worth spending some time navigating and reviewing the generated files from the Create EJB to RDB mapping wizard. The J2EE and Navigator views of the generated files in the project are shown in Figure 9-15.

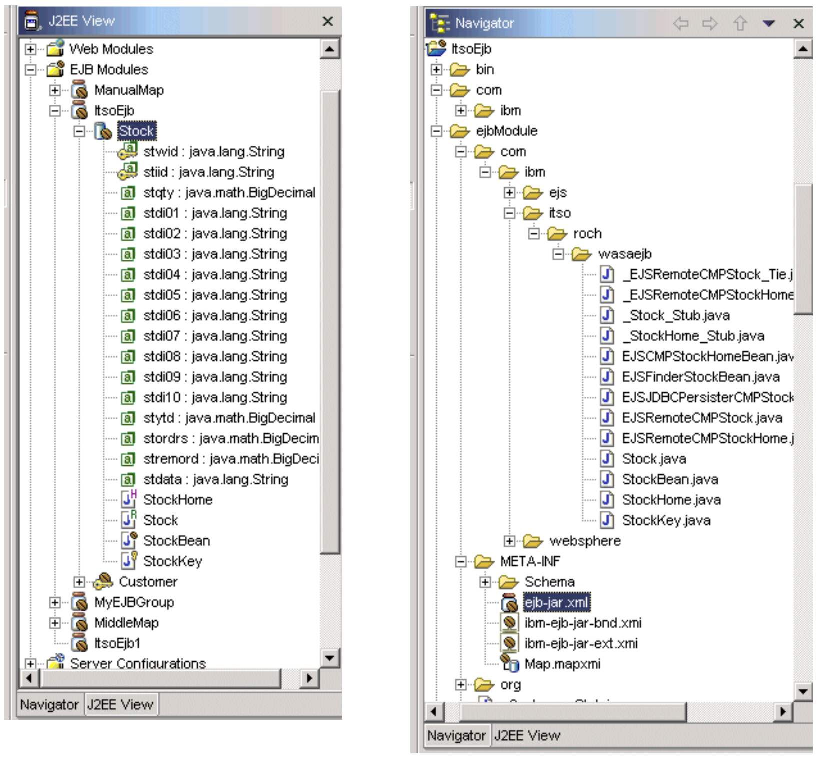


Figure 9-15 J2EE and Navigator perspectives

EJB classes review

You see four Java classes for the Stock EJB generated in the J2EE perspective:

- **StockHome**: The home interface. This is a factory that is used to create and find the instances of the Stock EJB.
- **Stock**: The remote interface. This class determines which methods can be remotely invoked.
- **StockBean**: The implementation class. This is where the logic is defined for the methods in the Stock EJB.
- **StockKey**: The key class. This is used to represent a unique key for the entity bean.

Each of these classes appears in the Navigator view as .java files in the package folder defined in the mapping wizard.

Generated EJB metadata

The Navigator view as shown in Figure 9-15 also shows the xmi files generated by the mapping wizard in the EJB project:

- **ejb-jar.xml**: The deployment descriptor for this EJB module
- **ibm-ejb-jar-bnd.xmi**: WebSphere bindings for the EJB module
- **ibm-ejb-jar-ext.xmi**: WebSphere extensions for the EJB module
- **Map.mapxmi**: The mappings between the EJB and the database schema

This is different from VisualAge for Java, where the metadata is stored internally inside the repository.

9.1.4 Defining getter methods as read-only

Application developer does not, by default, mark all getter methods in the EJB as read-only. This is an important step for obtaining reasonable performance from entity EJBs because it prevents the application server from writing the contents of the EJB back to the datastore after each get method is invoked. To set the getter methods as read-only, follow these steps:

1. Select the **ItsoEjb** project in the J2EE view of the J2EE perspective. Right-click and select **Open With-> EJB Extension Editor**.
2. Click the **Methods** tab and select the **Stock** bean. Click the **+** sign next to **Stock** to expand it and then expand **Remote methods** to view all the methods in the remote interface as shown in Figure 9-16.

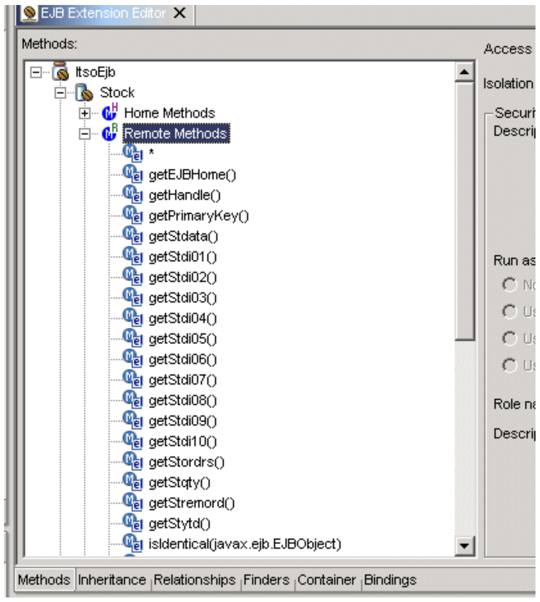
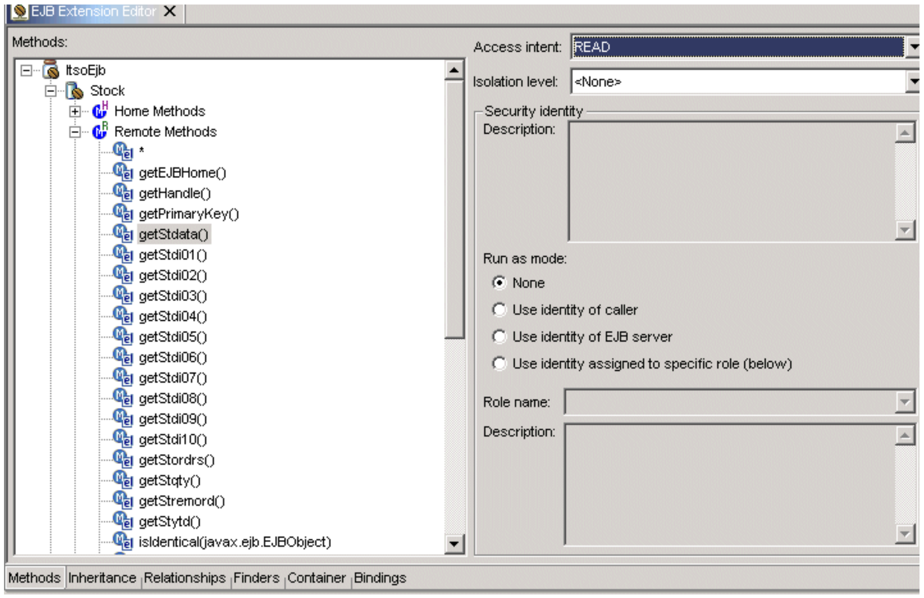


Figure 9-16 Setting EJB get methods to read only

3. Select the getter methods one by one and change the Access intent for each to **READ** from the drop-down list as shown in Figure 9-17.


EJB Extension Editor

Methods:

```
ItsoEjb
  Stock
    Home Methods
    Remote Methods
      *
      getEJBHome()
      getHandle()
      getPrimaryKey()
      getStdata()
      getStdi01()
      getStdi02()
      getStdi03()
      getStdi04()
      getStdi05()
      getStdi06()
      getStdi07()
      getStdi08()
      getStdi09()
      getStdi10()
      getStordrs()
      getStqty()
      getStremord()
      getStytd()
      isIdentical(javax.ejb.EJBObject)
```

Access intent: READ

Isolation level: <None>

Security identity

Description:

Run as mode:

- [✓ None]
- Use identity of caller
- Use identity of EJB server
- Use identity assigned to specific role (below)

Role name:

Description:

Figure 9-17 Setting the getter methods to read only

4. After you are done with all the methods, save and close the editor.

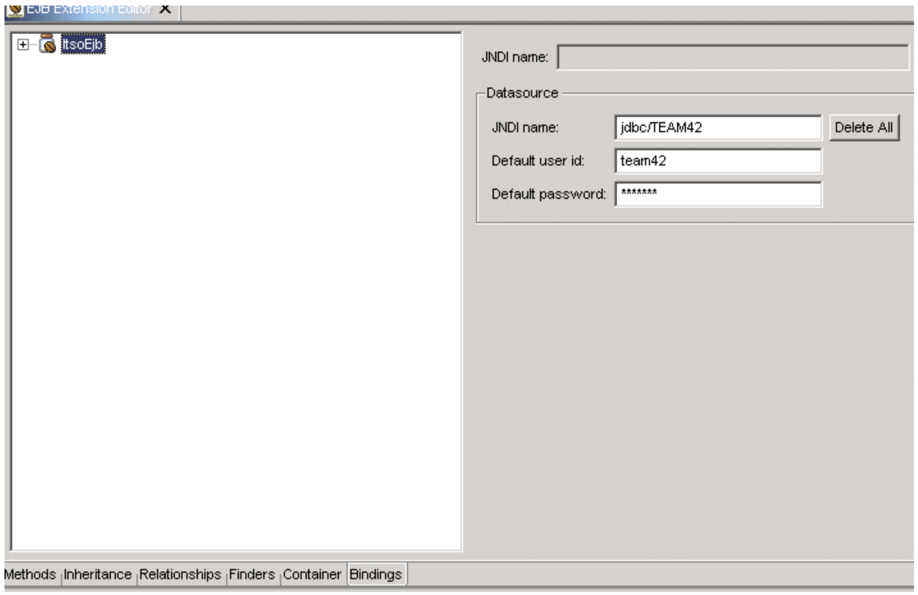
9.1.5 Deploying the Stock bean in the WebSphere Test Environment

In this section, we take you through the steps to define a JDBC data source for the EJB. We then validate and test the EJB.

Binding the Stock EJB to a JDBC data source

Each CMP EJB module must be assigned a JDBC data source reference in order for its CMP entities to persist correctly. Use the following steps to bind the data source:

1. Select the **ItsoEjb** project under the EJB module in the J2EE view of the J2EE perspective. Right-click and select **Open With-> EJB Extension Editor**.
2. Select the **Bindings** tab. Then click your project and complete the data source information for the ItsoEjb module. Enter the JNDI name for the data source name used while creating the schema. Also enter a valid user ID and password as shown in Figure 9-18.



JNDI name:

Datasource

JNDI name: jdbc/TEAM42

Default user id: team42

Default password: *******

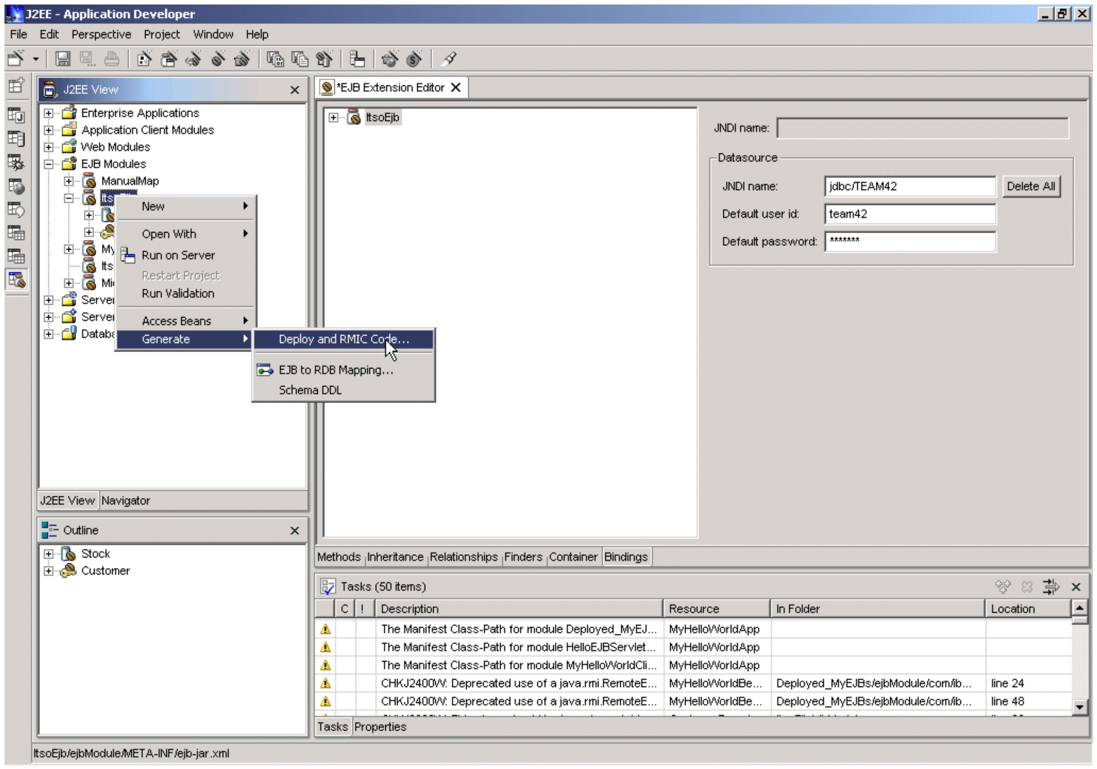
Figure 9-18 Defining a JDBC data source for an EJB module

3. Save the changes by selecting **File-> Save EJB Extension Editor**.

Generating the deployed code

In this section, we show you the steps to generate the deployed code to support execution under WebSphere Application Server:

1. Switch to the J2EE view in the J2EE perspective and select the EJB module.
2. Right-click the EJB module and select **Generate-> Deploy and RMIC code** from the menu as shown in Figure 9-19.



JNDI name:

Datasource

JNDI name: jdbc/TEAM42 Delete All

Default user id: team42

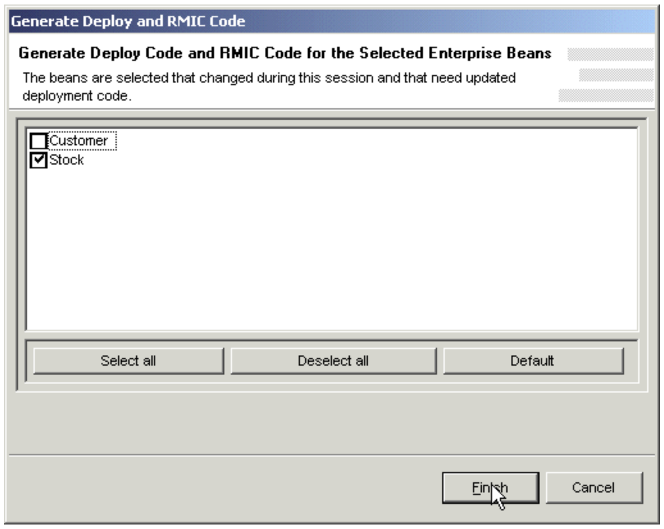
Default password: *******

Tasks (50 items)

	C	!	Description	Resource	In Folder	Location
⚠			The Manifest Class-Path for module Deployed_MyEJ...	MyHelloWorldApp		
⚠			The Manifest Class-Path for module HelloEJBServlet...	MyHelloWorldApp		
⚠			The Manifest Class-Path for module MyHelloWorldCli...	MyHelloWorldApp		
⚠			CHKJ2400W: Deprecated use of a java.rmi.RemoteE...	MyHelloWorldBe...	Deployed_MyEJBs/ejbModule/com/ib...	line 24
⚠			CHKJ2400W: Deprecated use of a java.rmi.RemoteE...	MyHelloWorldBe...	Deployed_MyEJBs/ejbModule/com/ib...	line 48

Figure 9-19 Generating the deployed code

3. Select the **Stock** check box and click **Finish** as shown in Figure 9-20.



Generate Deploy Code and RMIC Code for the Selected Enterprise Beans

The beans are selected that changed during this session and that need updated deployment code.

- [ ] Customer
- [x] Stock

Figure 9-20 Generating the deployed code for the Stock EJB

This option launches the command line ejbdeploy tool to generate the deployed code.

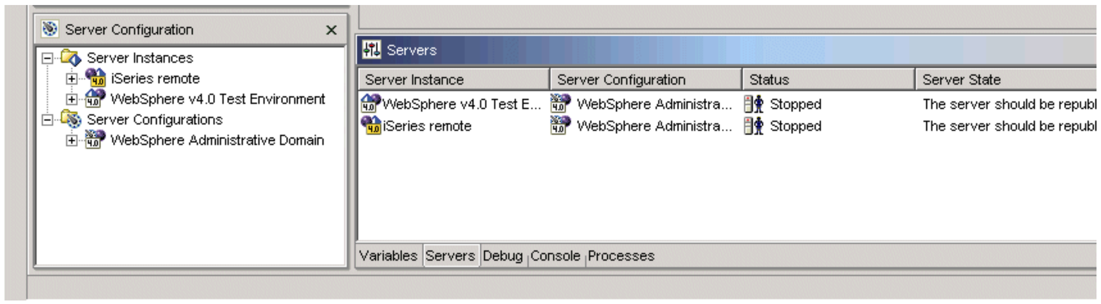
4. Switch back to the Navigator view in the J2EE perspective and open your project. Under the ejbModule folder, you can see the deployed code for the Stock EJB.

Testing the Stock entity EJB

Now that we have generated the deployed code for the Stock bean, we can test it. We test it in the Application Developer WebSphere Test Environment.

1. Switch to the Server perspective. If you do not have the icon on the toolbar, select the **Open perspective** button and select the **Server** perspective.

   Once the server perspective is open, the window looks like the example shown in Figure 9-21.



Server Instance	Server Configuration	Status	Server State
WebSphere v4.0 Test E...	WebSphere Administra...	Stopped	The server should be republ
iSeries remote	WebSphere Administra...	Stopped	The server should be republ

Figure 9-21 Server perspective

2. Right-click the **WebSphere Administrative Domain** under Server Configurations and select **Add Project**. Select the project as shown in Figure 9-22.

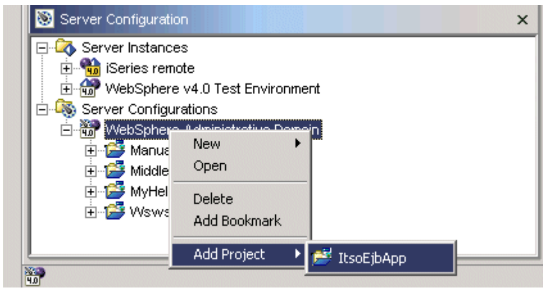
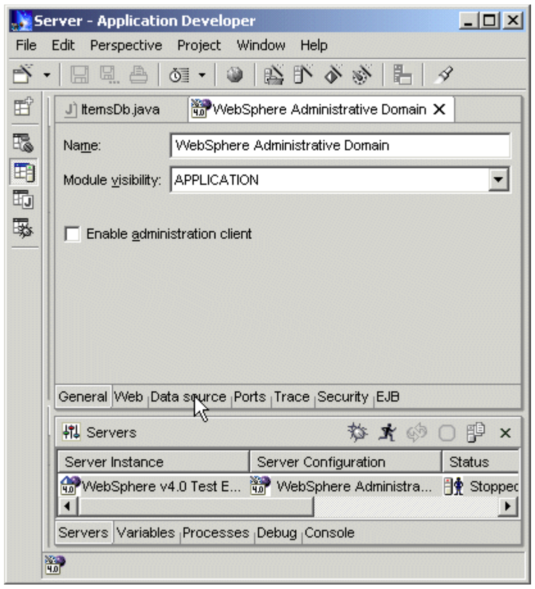


Figure 9-22 Adding the project to the server configuration

   You can now see the project listed under the WebSphere Administrative Domain.

3. Double-click **WebSphere Administrative Domain**. Application Developer opens the server configuration file in the editor view.
4. Select the **Data source** tab as shown in Figure 9-23.


Server - Application Developer
File Edit Perspective Project Window Help
ItemsDb.java
WebSphere Administrative Domain
General Web Data source Ports Trace Security EJB
Servers Variables Processes Debug Console

Name: WebSphere Administrative Domain

Module visibility: APPLICATION

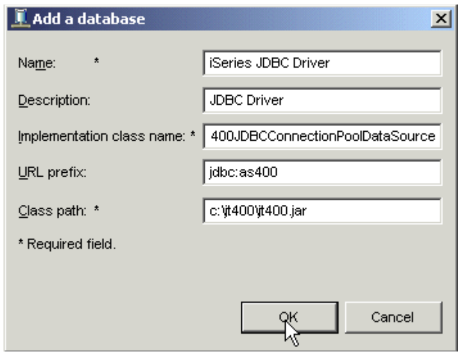
☐ Enable administration client

Servers

Server Instance	Server Configuration	Status
WebSphere v4.0 Test E...	WebSphere Administra...	Stopped

Figure 9-23 Data source tab in the server configuration

5. Click **Add** next to the **JDBC driver list** box.
6. Enter the parameters as shown in Figure 9-24, where the full name for the Implementation class name field is `com.ibm.as400.access.AS400JDBCConnectionPoolDataSource`.



Name: * iSeries JDBC Driver

Description: JDBC Driver

Implementation class name: * 400JDBCConnectionPoolDataSource

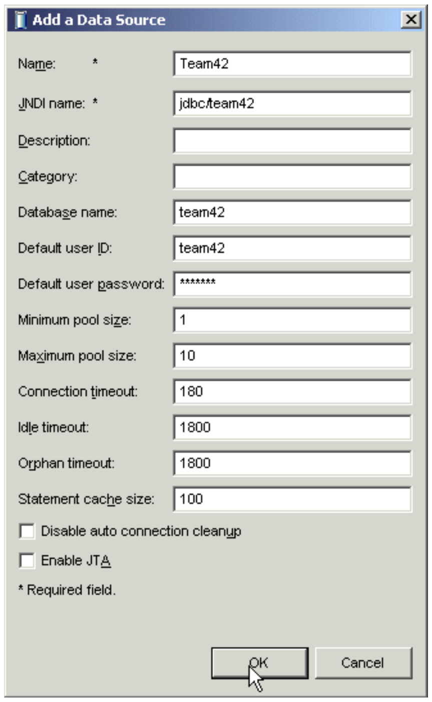
URL prefix: jdbc:as400

Class path: * c:\jt400\jt400.jar

* Required field.

Figure 9-24 JDBC driver parameters

7. Specify the folder where the IBM Toolbox for Java jt400.jar file is stored in the Class path field.
8. Click **OK**.
9. Click **Add** next to the Data Source defined in the JDBC driver selected above box.
10. Fill in the fields as shown in Figure 9-25. Make sure that the JNDI name is the same name as that defined in “Binding the Stock EJB to a JDBC data source” on page 277.



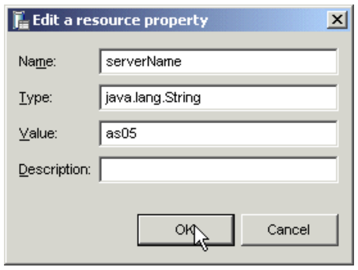
Name: *	Team42
JNDI name: *	jdbc/team42
Description:	
Category:	
Database name:	team42
Default user ID:	team42
Default user password:	*******
Minimum pool size:	1
Maximum pool size:	10
Connection timeout:	180
Idle timeout:	1800
Orphan timeout:	1800
Statement cache size:	100

- [ ] Disable auto connection cleanup
- [ ] Enable JTA

* Required field.

Figure 9-25 Datasource parameter window

11. Click **OK**.
12. We need to specify the target system where the database tables are located. Click **Add** nest to the Resource properties defined in the data source selected above box.
13. Fill in the parameters as shown in Figure 9-26. Replace the value field with your iSeries server name.



Name:	serverName
Type:	java.lang.String
Value:	as05
Description:	

Figure 9-26 Data source property dialog box

14. Click **OK**. Save changes by pressing Ctrl-S.

Note: In this example, we use the iSeries library specified in the user ID value of the data source. If you want to use a different library, you can specify a second resource property. The name of the property is *libraries*, and the value contains the library to use.

15. Start the server by selecting **WebSphere v4.0 Test Environment** in the Server Control Panel View and right-click. Select **Start** from the menu, or you can click the run icon as shown in Figure 9-27.

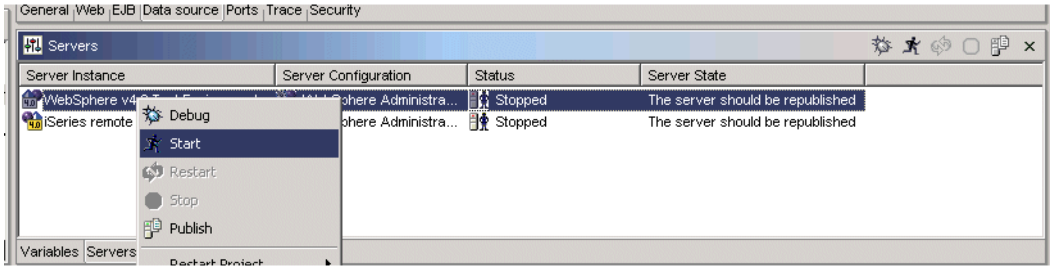
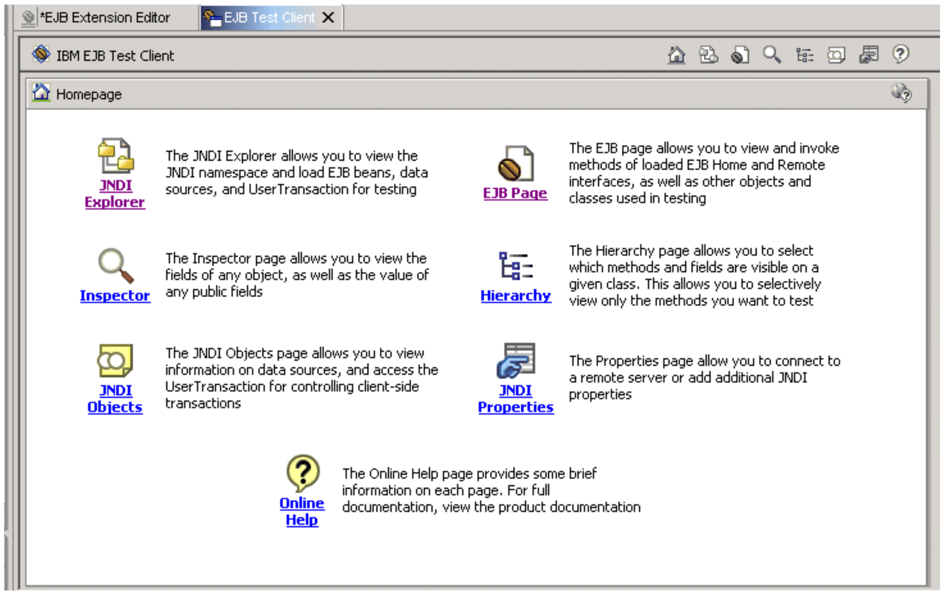


Figure 9-27 Starting the server

It takes some time to start so please be patient. Look for the `Server Default Server open for e-business` message in the console view or a started status in the server control panel view.

16. Switch back to the J2EE perspective and select the project under EJB modules. Right-click and select **Run on Server**.

17. The EJB Test Client opens. The first step is to see if the Stock bean has been added to the JNDI namespace. Click the **JNDI Explorer** link on the EJB Test Client as shown Figure 9-28.



The JNDI Explorer allows you to view the JNDI namespace and load EJB beans, data sources, and UserTransaction for testing

The EJB page allows you to view and invoke methods of loaded EJB Home and Remote interfaces, as well as other objects and classes used in testing

The Inspector page allows you to view the fields of any object, as well as the value of any public fields

The Hierarchy page allows you to select which methods and fields are visible on a given class. This allows you to selectively view only the methods you want to test

The JNDI Objects page allows you to view information on data sources, and access the UserTransaction for controlling client-side transactions

The Properties page allow you to connect to a remote server or add additional JNDI properties

The Online Help page provides some brief information on each page. For full documentation, view the product documentation

Figure 9-28 Home page for the EJB Test Client

In the EJB Test Client, you see the JNDI names as shown in Figure 9-29.

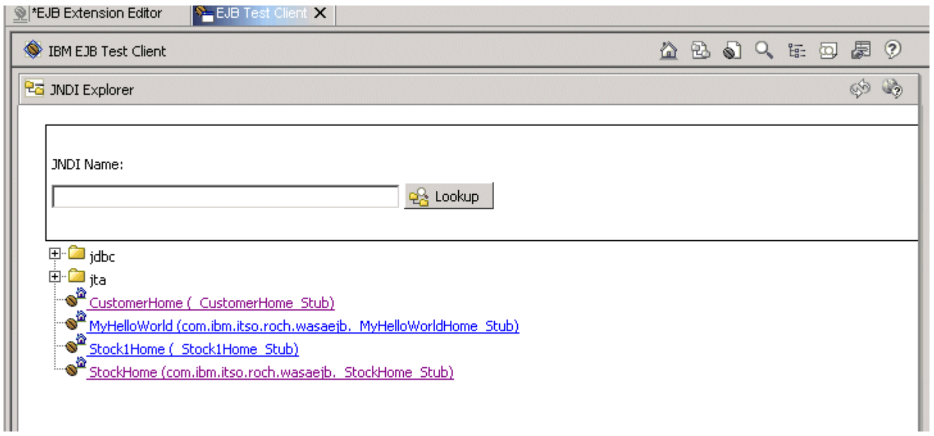

*EJB Extension Editor
EJB Test Client
IBM EJB Test Client
JNDI Explorer
JNDI Name:
Lookup
jdbc
jta
CustomerHome (_CustomerHome_Stub)
MyHelloWorld (com.ibm.itso.roch.wasaejb._MyHelloWorldHome_Stub)
Stock1Home (_Stock1Home_Stub)
StockHome (com.ibm.itso.roch.wasaejb._StockHome_Stub)

Figure 9-29 Exploring the JNDI names

18. You can see StockHome in the namespace. Click the **StockHome** link. This invokes the EJB in the test client as shown in Figure 9-30.

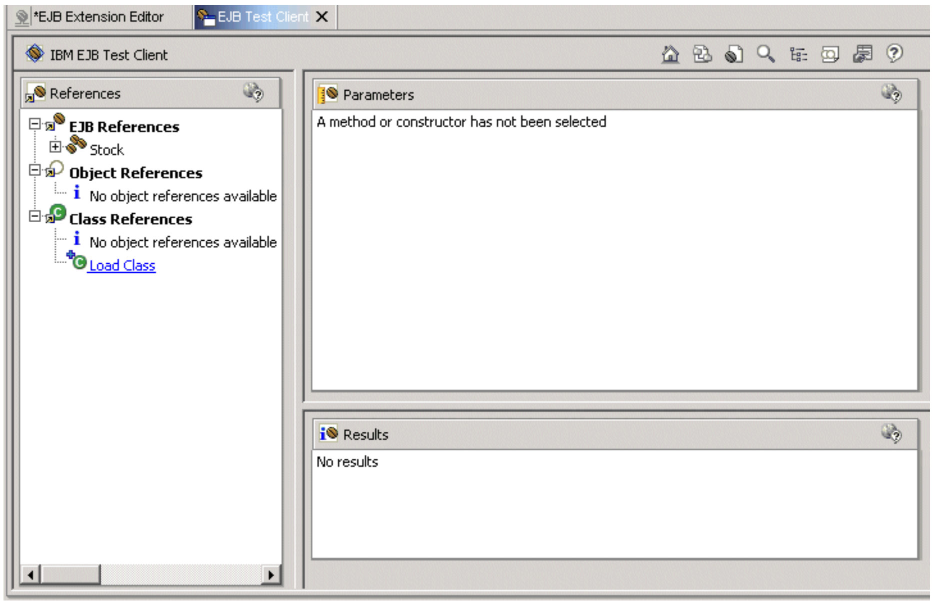
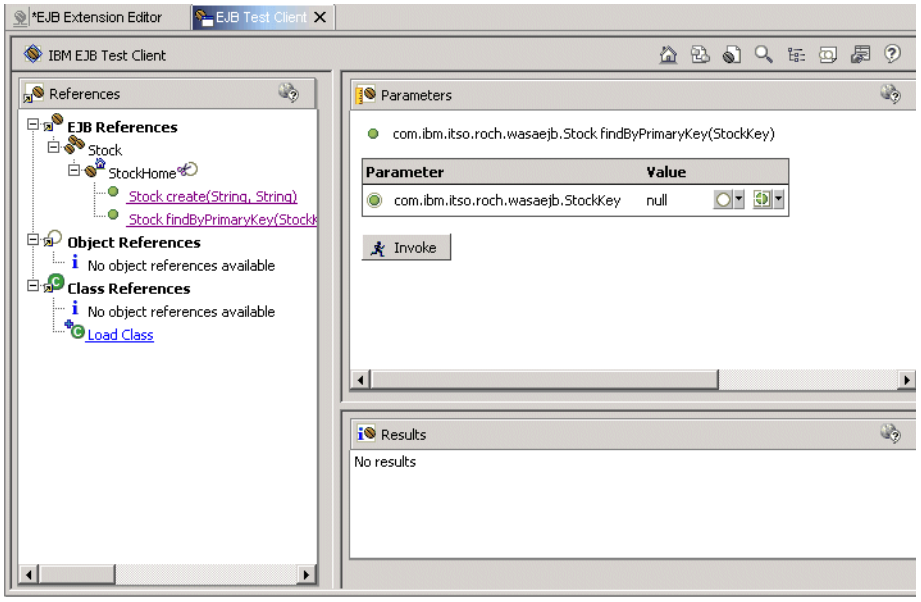


Figure 9-30 EJB page for the Stock EJB

19. Expand the **EJB references** tree until you see the methods available on the home interface (`create` and `findByPrimaryKey`).

20. Click the **findByPrimaryKey** method. You see the `findByPrimaryKey` method open in the parameter pane in the right pane as shown in Figure 9-31.



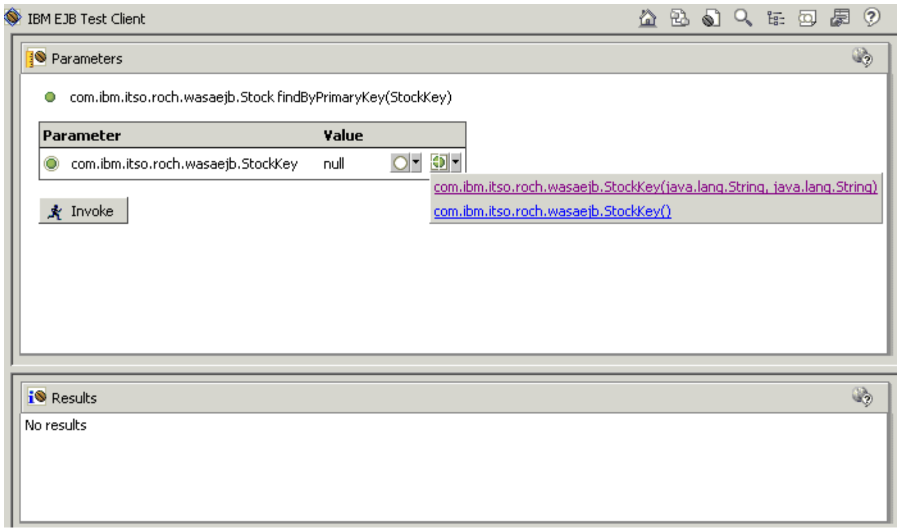
com.ibm.itso.roch.wasaejb.Stock findByPrimaryKey(StockKey)

Parameter	Value
com.ibm.itso.roch.wasaejb.StockKey	null

No results

Figure 9-31 The findByPrimaryKey method

21.On the parameter frame, click the **Constructor drop-down** list and select **com.ibm.itso.roch.wasaejb.StockKey(java.lang.String,java.lang.Sring)** as shown in Figure 9-32.


IBM EJB Test Client
Parameters
com.ibm.itso.roch.wasaejb.StockKey(java.lang.String, java.lang.String)
com.ibm.itso.roch.wasaejb.StockKey()
Invoke
Results

com.ibm.itso.roch.wasaejb.Stock findByPrimaryKey(StockKey)

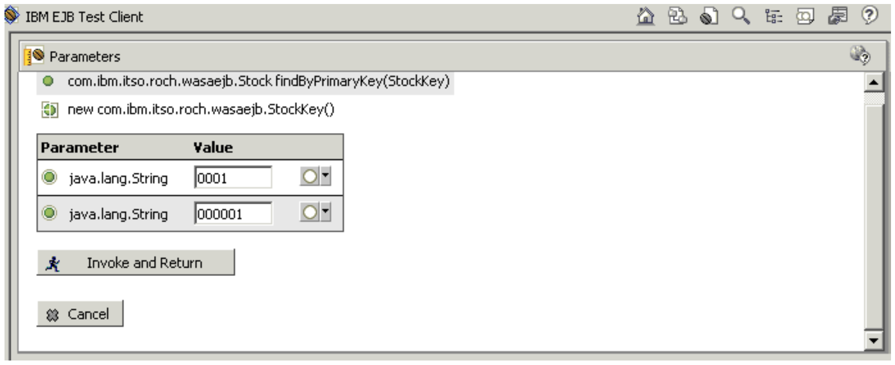
Parameter	Value
com.ibm.itso.roch.wasaejb.StockKey	null

No results

Figure 9-32 Creating the parameter for the findByPrimaryKey method

22.This link invokes a page that prompts for the key constructor parameter. Enter `0001` for stwid (stock warehouse ID) and `000001` for stiid (stock item ID). This forms the key of an existing row in the STOCK file.

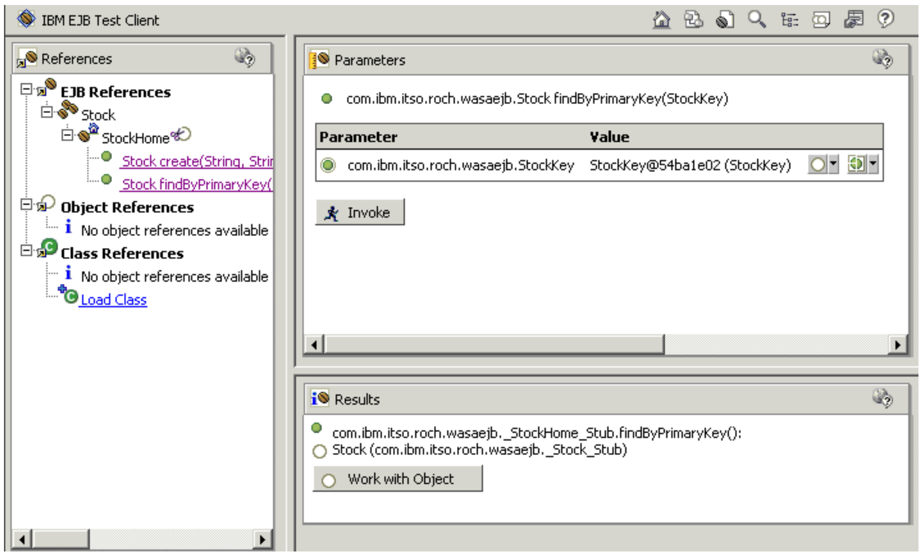
23.Click the **Invoke and Return** button as shown in Figure 9-33.


IBM EJB Test Client
Parameters
com.ibm.itso.roch.wasaejb.Stock findByPrimaryKey(StockKey)
new com.ibm.itso.roch.wasaejb.StockKey()
Invoke and Return
Cancel

Parameter	Value
java.lang.String	0001
java.lang.String	000001

Figure 9-33 Invoking the findByPrimaryKey method

24. In the resulting screen, click the **Invoke button** to complete the call on the `fndByPrimaryKey` method.
25. In the results pane, you see an instance of the Stock remote interface returned from the server. Click the **Work with Object** button as shown in Figure 9-34.



Parameter	Value
com.ibm.itso.roch.wasaejb.StockKey	StockKey@54ba1e02 (StockKey)

com.ibm.itso.roch.wasaejb._StockHome_Stub.findByPrimaryKey():
Stock (com.ibm.itso.roch.wasaejb._Stock_Stub)

Figure 9-34 Stock remote method

26. The EJB remote interface matching the Stock Key value appears in the EJB reference tree in the left frame. Expand the **Stock remote interface** to display the methods available on the Stock EJB remote interface.
27. Click the **BigDecimal getStqty()** method as shown in Figure 9-35.

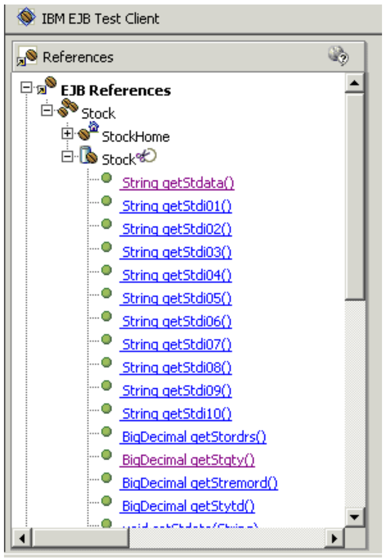
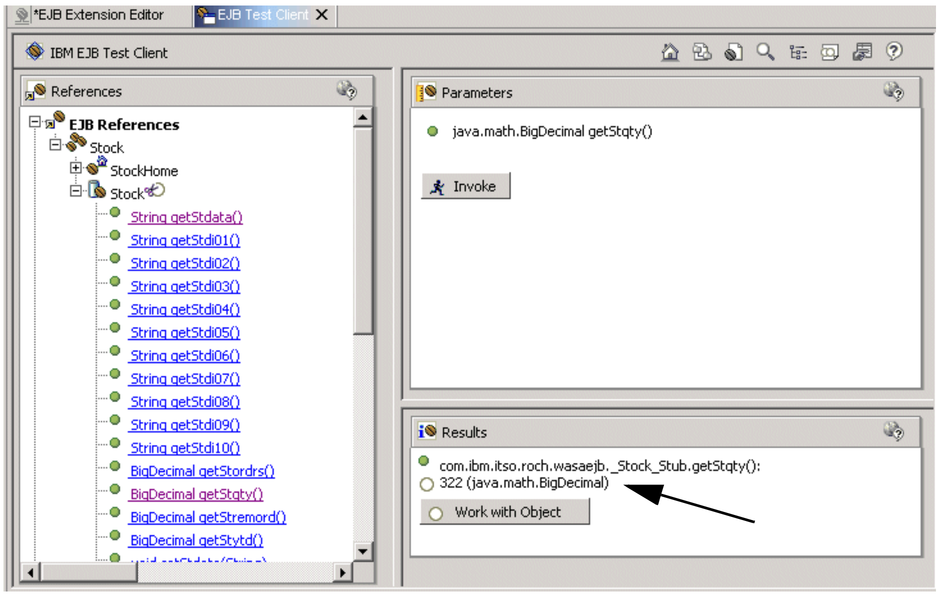


Figure 9-35 Remote methods of Stock EJB

28. On the parameter pane, click the **Invoke** button.

    The results pane displays the stock quantity for the stock key selected as shown in Figure 9-36.



```
com.ibm.itso.roch.wasaejb._Stock_Stub.getStqty():
322 (java.math.BigDecimal)
```

Figure 9-36 Results from the getStockQuantity method

29. We can repeat the same steps to test the other remote methods.

We have now tested the Stock entity EJB using the EJB container in the WebSphere Test Environment in Application Developer.

9.2 Top-down mapping

This approach assumes that you already have existing enterprise beans. In this approach, the enterprise bean design determines the database design.

After you finish defining your enterprise beans, you can generate a schema and map. They are used to create the database table used to persist the entity bean data.

A set of tables are generated to support the CMP entities inside the EJB project. In these tables, each column corresponds to a CMP field of the enterprise bean, and the generated mapping maps the field to the column. Relationship associations are mapped to foreign-key relationships.

In the previous section, you saw how easy it is to generate the CMP entity bean directly from the iSeries database table to which you want to map it. However, this technique has a couple of disadvantages:

- One property is generated in the entity bean for every field in the database file.
- The property names are exactly the same as the field names in the iSeries table.

Perform the following steps to perform top-down mapping:

1. Switch to the J2EE View of J2EE perspective, and create a new EJB project as explained in 9.1.1, "Creating an EJB project" on page 266. We name it *ManualMap*.
2. You can see the ManualMap module under the EJB Modules. Right-click **EJB Module** and select **New-> Enterprise Bean** from the menu as shown in Figure 9-37.

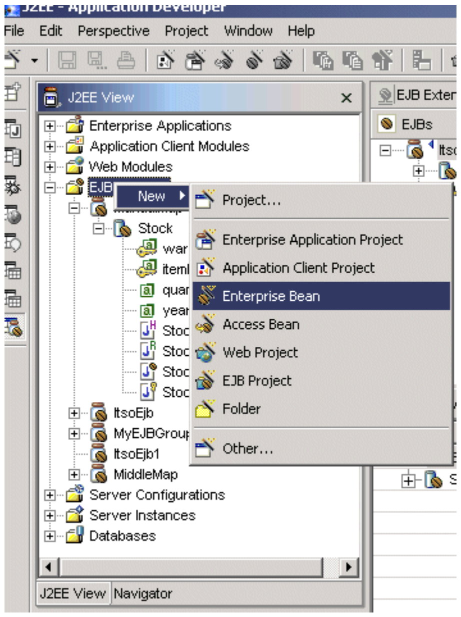
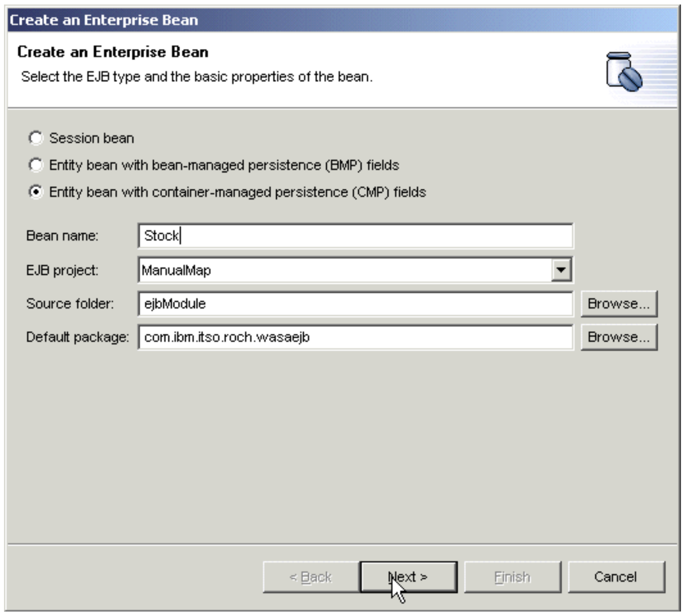


Figure 9-37 Creating Enterprise Beans

3. In the create EJB window complete these tasks. Use Figure 9-38 as a reference.
   a. Enter `Stock` in the Bean name field.
   b. Select **ManualMap** in the EJB project field.
   c. Select the **Entity bean with container-managed persistence (CMP) fields** radio button.

d. Type the default package name as `com.ibm.itso.roch.wasaejb`. The names for the home interface, remote interface, and key class are automatically generated.


Create an Enterprise Bean

Create an Enterprise Bean

Select the EJB type and the basic properties of the bean.

- ( ) Session bean
- ( ) Entity bean with bean-managed persistence (BMP) fields
- (●) Entity bean with container-managed persistence (CMP) fields

Bean name: Stock

EJB project: ManualMap

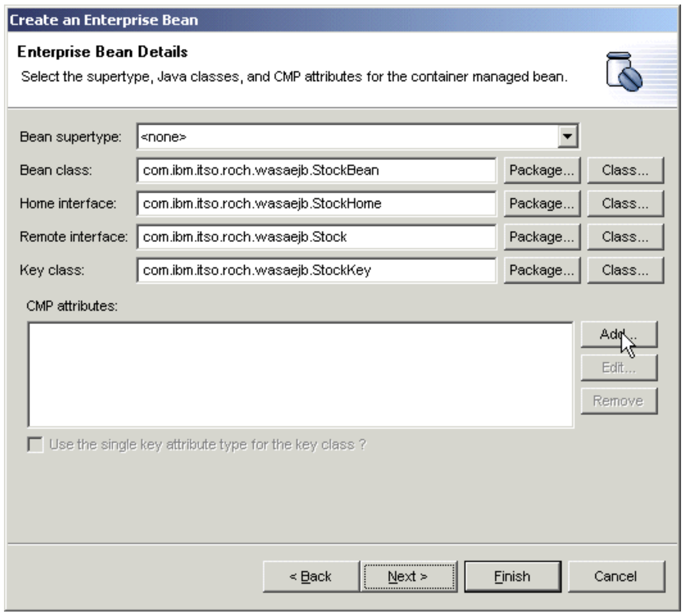
Source folder: ejbModule

Default package: com.ibm.itso.roch.wasaejb

Figure 9-38   Create Enterprise Bean wizard

e. Click **Next** to move to the Enterprise Bean Details window as shown in Figure 9-39.

f. Click the **Add** button next to CMP attributes.


Create an Enterprise Bean

Enterprise Bean Details

Select the supertype, Java classes, and CMP attributes for the container managed bean.

Bean supertype: <none>

Bean class: com.ibm.itso.roch.wasaejb.StockBean

Home interface: com.ibm.itso.roch.wasaejb.StockHome

Remote interface: com.ibm.itso.roch.wasaejb.Stock

Key class: com.ibm.itso.roch.wasaejb.StockKey

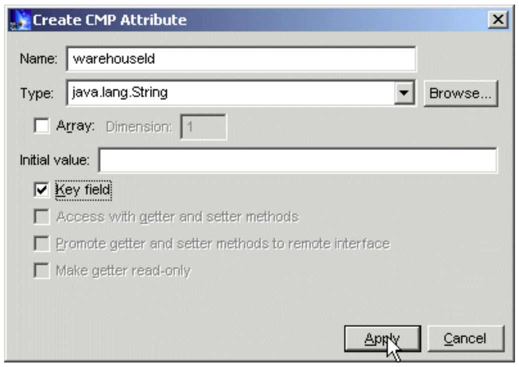
CMP attributes:

[ ] Use the single key attribute type for the key class ?

Figure 9-39   Create Enterprise Bean wizard

4. The create CMP attribute window appears as shown Figure 9-40. The key to the Stock table is composed of warehouse ID and item ID. First, we create a field for the warehouse ID. Enter a meaningful name for the warehouse ID field in the Field Name field.

5. Because the warehouse ID field type is of type CHAR, select **java.lang.String** in the Type field drop-down list. Because it is part of the STOCK file key, select the **Key field** check box. Click the **Apply** button and continue adding the other fields.



Name: warehouseId
Type: java.lang.String
☐ Array: Dimension: 1
Initial value:
☑ Key field
☐ Access with getter and setter methods
☐ Promote getter and setter methods to remote interface
☐ Make getter read-only

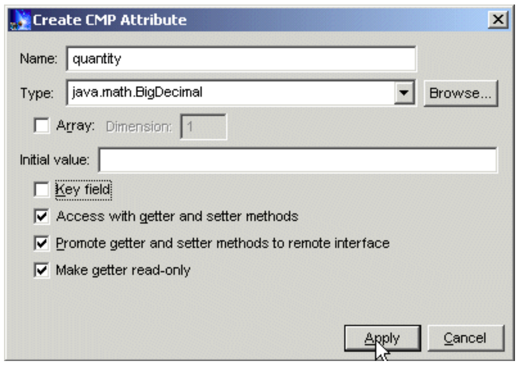
Figure 9-40 Creating persistent fields

6. Repeat the same process for the other character key field, item ID.
7. As explained in 9.1, “Bottom-up mapping” on page 266, the automatic generation of an entity bean from an iSeries table takes care of the mapping between database types and Java types. In our new example, we control the mapping. Refer to the JDBC documentation for a correct mapping. Table 9-1 shows the mapping of the most common database types.

Table 9-1 iSeries types to Java types mapping

iSeries type	SQL type	Java type
CHAR	CHAR	java.sql.String
PACKED	DECIMAL	java.math.BigDecimal
ZONED	NUMERIC	java.math.BigDecimal
DATE	DATE	java.sql.Date
BINARY	INTEGER	int
FLTDBL	FLOAT	float
FLTDBL	DOUBLE	double

8. Add the quantity and year-to-date fields. Refer to Figure 9-41 for an example.

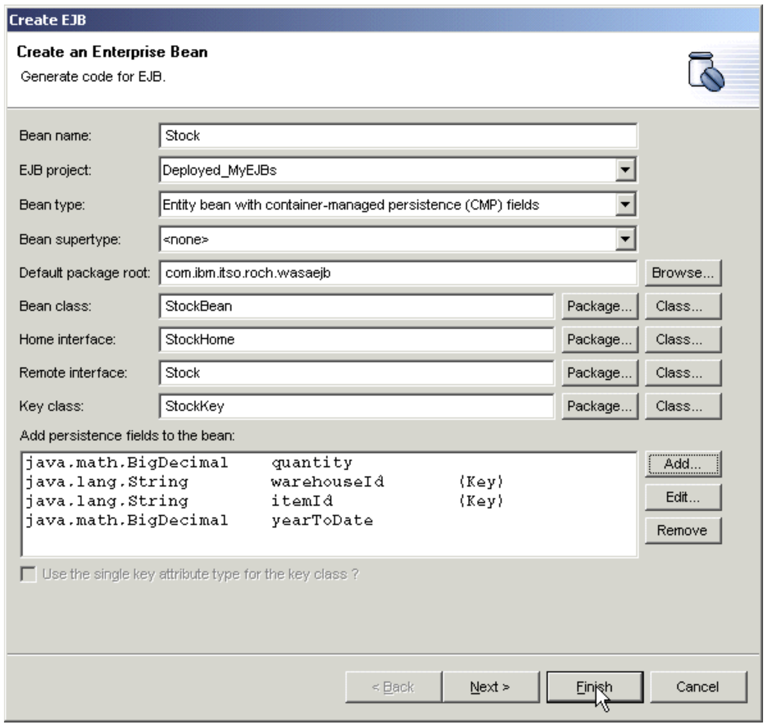


Name: quantity
Type: java.math.BigDecimal
☐ Array: Dimension: 1
Initial value:
☐ Key field
☑ Access with getter and setter methods
☑ Promote getter and setter methods to remote interface
☑ Make getter read-only

Figure 9-41 Creating a quantity CMP field

   a. For the quantity and yearToDate field, enter `java.math.BigDecimal` in the Type field drop-down list. You can use the **Browse...** button to help find the class you need. The mapping database fields are of type PACKED.
   b. Deselect the **Key Field** check box.
   c. Select the **Access with getter and setter methods** check box. The setter and getter methods are then automatically generated in the StockBean class.
   d. Optionally, you can select the **Promote getter and setter methods to remote interface** check box to have them in the Stock remote interface as well.

9. When you finish adding fields to the Stock entity bean, click **Cancel** on the create CMP attributes window and then click **Finish** on the create EJB window as shown in Figure 9-42.



Bean name:	Stock
EJB project:	Deployed_MyEJBs
Bean type:	Entity bean with container-managed persistence (CMP) fields
Bean supertype:	<none>
Default package root:	com.ibm.itso.roch.wasaejb
Bean class:	StockBean
Home interface:	StockHome
Remote interface:	Stock
Key class:	StockKey

Add persistence fields to the bean:

```
java.math.BigDecimal    quantity
java.lang.String        warehouseId       (Key)
java.lang.String        itemId            (Key)
java.math.BigDecimal    yearToDate
```

Figure 9-42 Creating the Stock enterprise bean

Once the Stock bean is created, you can see the implementation of its classes and methods as shown in Figure 9-43.

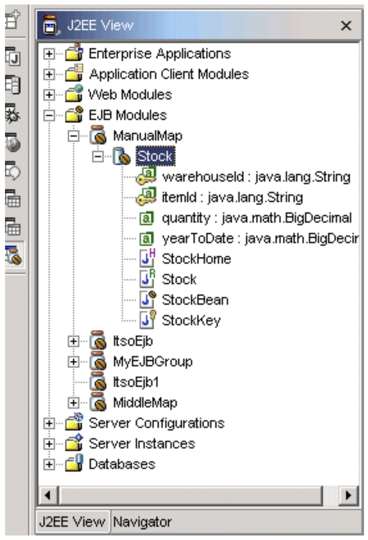


Figure 9-43 Stock bean implementation

Note the meaningful names for the fields, unlike the bottom-up mapping example.

9.2.1 Adding methods to the Stock bean

To add a user-defined method, follow these steps:

1. Switch to the J2EE View in the J2EE perspective. Drill down the tree to see the Stock bean under the ManualMap module.
2. Expand the **StockBean** to display StockBean, StockHome, Stock, and StockKey as shown in Figure 9-44.

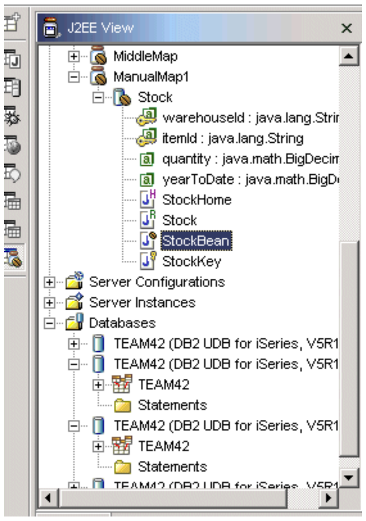

J2EE View
MiddleMap
ManualMap1
Stock
warehouseId : java.lang.Strir
itemId : java.lang.String
quantity : java.math.BigDecim
yearToDate : java.math.BigD
StockHome
Stock
StockBean
StockKey
Server Configurations
Server Instances
Databases
TEAM42 (DB2 UDB for iSeries, V5R1
TEAM42 (DB2 UDB for iSeries, V5R1
TEAM42
Statements
TEAM42 (DB2 UDB for iSeries, V5R1
TEAM42
Statements

Figure 9-44 J2EE perspective of StockBean in the ManualMap module

3. Right-click **StockBean** and select **Open With-> Enterprise Bean Java Editor**.
4. To add a user-defined method, enter the code in the Enterprise bean Java editor. To add an `increaseStockQuantity` method, add the code shown in Figure 9-45.

```
public void increaseStockQuantity(int qty) throws javax.ejb.EJBException{
   quantity= new java.math.BigDecimal(quantity.intValue() + qty);
   }
```

Figure 9-45 The increaseStockQuantity() method code

5. Declare that the method throws a javax.ejb.EJBException exception. Keep in mind that BigDecimal is not the same type as int, so you must convert it before using it.
6. After adding a method, right-click anywhere in the editor and click **Save**. Add the methods to the remote interface by right-clicking the method in outline view and selecting **Enterprise Bean-> Promote to Remote Interface** as shown in Figure 9-46.

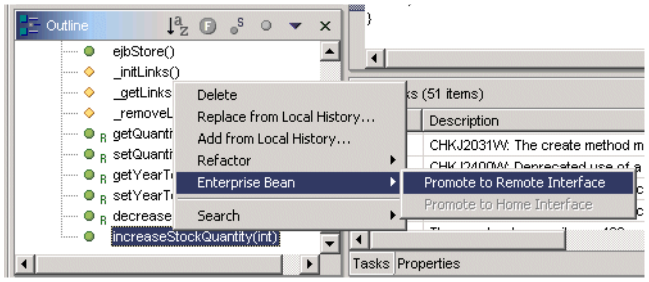

Outline
ejbStore()
_initLinks()
_getLinks
_removeL
getQuanti
setQuanti
getYearT
setYearT
decrease
increaseStockQuantity(int)
Delete
Replace from Local History...
Add from Local History...
Refactor
Enterprise Bean
Search
Promote to Remote Interface
Promote to Home Interface
s (51 items)
Description
CHKJ2031W: The create method m
Tasks
Properties

Figure 9-46 Promoting a method to the remote interface

7. Add another method to decrease the quantity, named `decreaseStockQuantity`, using the same technique.
8. Close the Stock bean and save your work.

9.2.2 Mapping the Stock bean

Before you deploy the Stock bean, you must create a mapping and schema. To do this follow these steps:

1. Switch back to the J2EE view of the J2EE perspective. Right-click **ManualMap** under EJB modules and select **Generate-> EJB to RDB mapping**.
2. The Creating a new EJB/RDB mapping window appears. Select the **Top-down** radio button and select the **Open mapping editor after completion** check box as shown in Figure 9-47. Click **Next.**

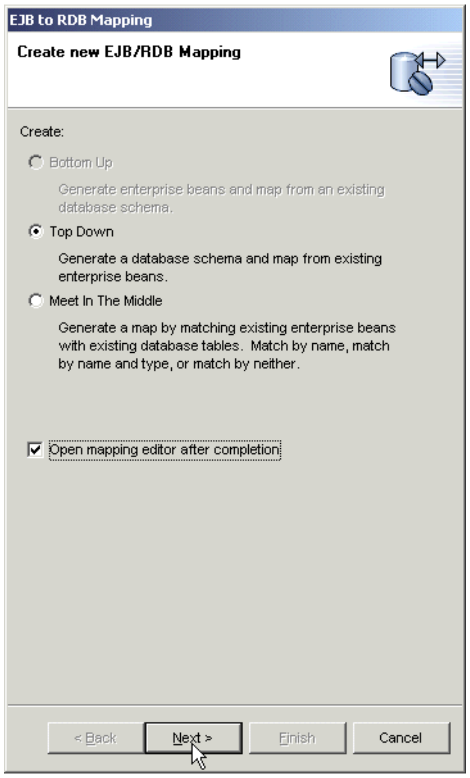
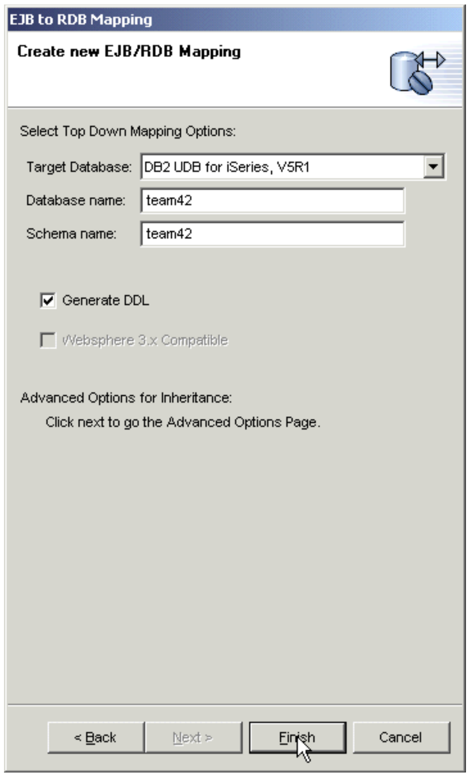

EJB to RDB Mapping
Create new EJB/RDB Mapping
Create:
Bottom Up
Generate enterprise beans and map from an existing database schema.
Top Down
Generate a database schema and map from existing enterprise beans.
Meet In The Middle
Generate a map by matching existing enterprise beans with existing database tables. Match by name, match by name and type, or match by neither.
Open mapping editor after completion
< Back
Next >
Finish
Cancel

Figure 9-47 Creating a new EJB/RDB mapping for ManualMap

3. In the EJB/RDB Mapping dialog, select **DB2 UDB for iSeries, V5R1** for Target database. Enter the Database name and Schema name that was imported earlier in 9.1.2, "Importing a schema" on page 266. This is shown in Figure 9-48.


EJB to RDB Mapping

Create new EJB/RDB Mapping

Select Top Down Mapping Options:

Target Database: DB2 UDB for iSeries, V5R1

Database name: team42

Schema name: team42

[✓] Generate DDL

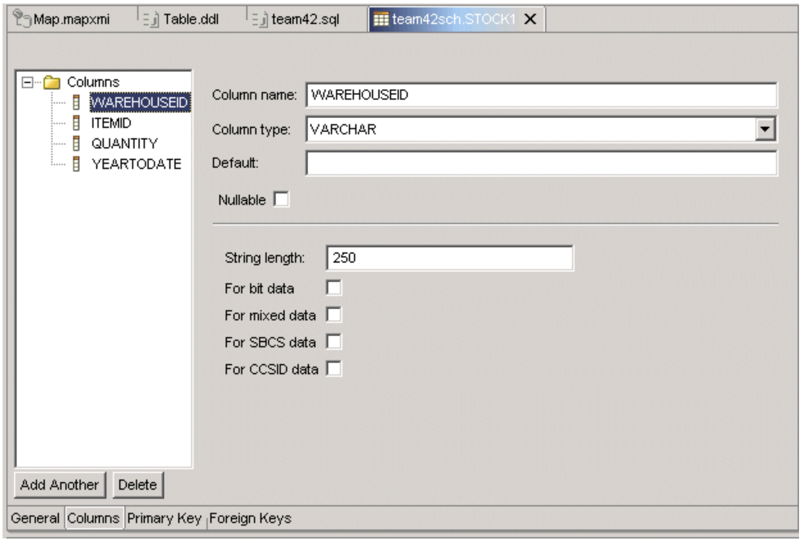
[ ] Websphere 3.x Compatible

Advanced Options for Inheritance:

Click next to go the Advanced Options Page.

Figure 9-48 Creating a new EJB/RDB mapping for ManualMap

4. Click **Finish** to generate the mapping. Spend some time investigating the Map.mapxmi files to see whether the mapping is correct. Also navigate to see the files generated as explained in 9.1.3, “Creating the entity EJB from the imported schema” on page 272.
5. After the schema is generated, in the Navigator view of the J2EE perspective, expand the tree structure until you find the **.tblxmi** file for the schema in the ManualMap project. This is the schema generated by top-down mapping.
6. Double-click the **.tblxmi** file to open it in the table editor as shown in Figure 9-49.



Column name: WAREHOUSEID

Column type: VARCHAR

Default:

Nullable [ ]

String length: 250

For bit data [ ]

For mixed data [ ]

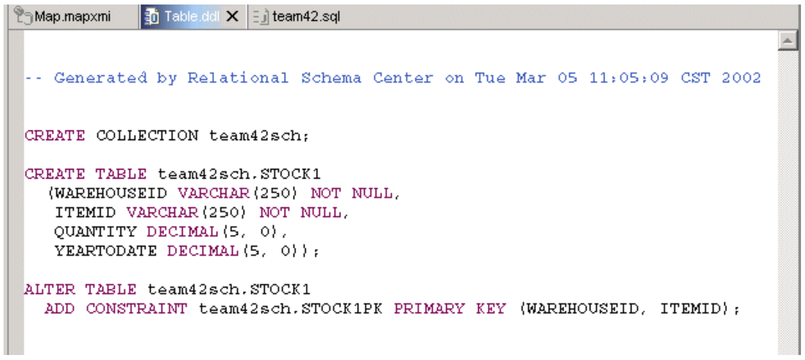
For SBCS data [ ]

For CCSID data [ ]

Figure 9-49 Schema in the table editor

If you want to change the column name or types, you can do so in the table editor.

7. After any change, save your work by pressing Ctrl-S.
8. In the Navigator view, locate the **Table.ddl** file. This file contains the generated data definition language (DDL) statements that create the table on the iSeries server. The DDL source is shown in Figure 9-50.



```
-- Generated by Relational Schema Center on Tue Mar 05 11:05:09 CST 2002


CREATE COLLECTION team42sch;

CREATE TABLE team42sch.STOCK1
  (WAREHOUSEID VARCHAR(250) NOT NULL,
   ITEMID VARCHAR(250) NOT NULL,
   QUANTITY DECIMAL(5, 0),
   YEARTODATE DECIMAL(5, 0));

ALTER TABLE team42sch.STOCK1
  ADD CONSTRAINT team42sch.STOCK1PK PRIMARY KEY (WAREHOUSEID, ITEMID);
```

Figure 9-50 The DDL generated for top-down mapping

9. Copy the script from the Table.dll file and run it on the iSeries server to create the table and schema. You can do this with interactive SQL or with Operations Navigator.
10. You are now ready to test. Before testing, you need to point the data source to the new schema. If you are working on an existing schema, check to ensure that the data source in the WebSphere Test Environment points to your schema.

9.2.3 Deploying the stock bean and testing

To deploy and test the stock bean created by manual mapping follow the steps shown in 9.1.5, “Deploying the Stock bean in the WebSphere Test Environment” on page 277.

9.3 Meet-in-the-middle mapping

In the meet-in-the-middle approach of mapping enterprise beans to database tables, it is assumed that you have existing enterprise beans and a database schema. You can perform meet-in-the-middle mapping by matching by name, by type, or no matching.

In this approach, you map each field of the enterprise bean to the corresponding column of a table within the selected schema. This technique provides an alternative technique to map CMP entity beans to existing database tables. The objective is to create a Stock entity bean whose properties map to only *some* of the iSeries STOCK table columns and use meaningful property names.

Manual mapping is generally the preferred way to create CMP entity beans because it gives the developer the most control over how the object-relational mapping takes place.

9.3.1 Creating the stock enterprise bean

In this approach, we first create the Stock Enterprise bean and to add the methods to the bean. To create the Stock Enterprise bean, follow these steps:

1. Switch to the J2EE View of the J2EE perspective, and create a new EJB project as explained in 9.1.1, “Creating an EJB project” on page 266. We name it *MiddleMeet*.

2. You can see the MiddleMeet module under the EJB Modules. Right-click **EJB Module** and select **New-> Enterprise Bean** from the menu as shown in Figure 9-51.

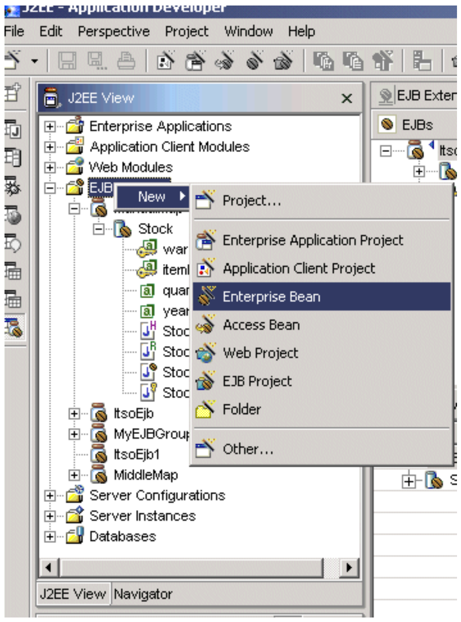
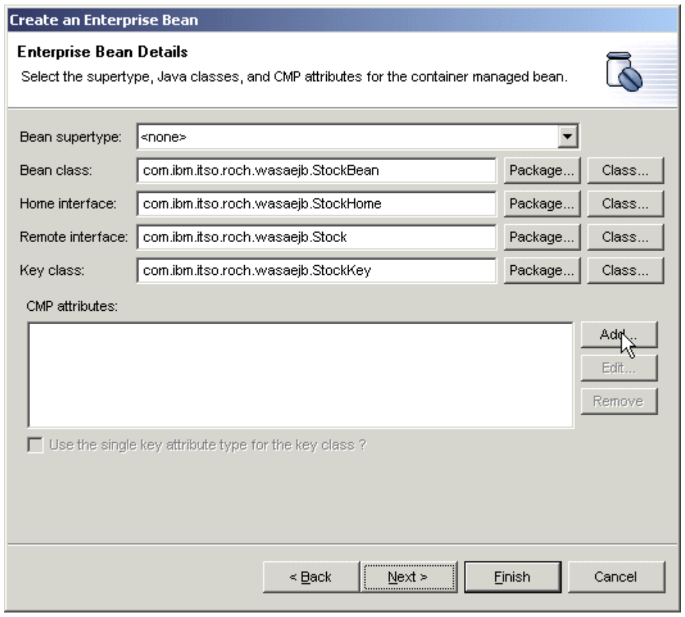


Figure 9-51 Creating an enterprise bean

3. In the create EJB window complete these tasks.
   a. Enter `Stock` in the Bean name field.
   b. Select **MiddleMeet** in the EJB project field.
   c. Select **Entity bean with container-managed persistence (CMP) fields** in the Beantype drop-down list.
   d. Enter the default package name as `com.ibm.itso.roch.wasaejb`. The names for the home interface, remote interface, and key class are automatically generated.
   e. Click **Next** to move to the next screen.
   f. Click the **Add** button next to the CMP attributes fields of the bean as shown in Figure 9-52.


Create an Enterprise Bean

Enterprise Bean Details

Select the supertype, Java classes, and CMP attributes for the container managed bean.

Bean supertype: <none>

Bean class: com.ibm.itso.roch.wasaejb.StockBean

Home interface: com.ibm.itso.roch.wasaejb.StockHome

Remote interface: com.ibm.itso.roch.wasaejb.Stock

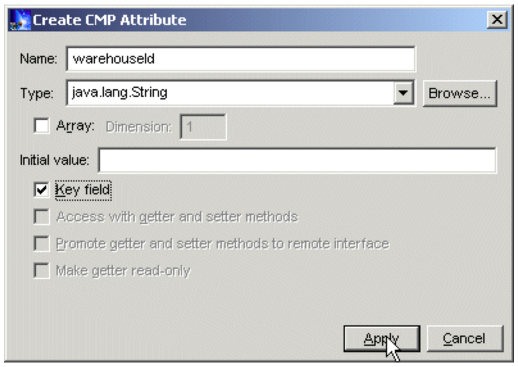
Key class: com.ibm.itso.roch.wasaejb.StockKey

CMP attributes:

Use the single key attribute type for the key class ?

Figure 9-52 Create Enterprise Bean wizard

4. The create CMP Attribute window appears as shown Figure 9-53. Enter a meaningful name for the Warehouse ID field in the Field Name field.
5. Because the warehouse ID field type in the Stock table is of type CHAR, select **java.lang.String** in the Type field drop-down list. Because it is part of the STOCK file key, select the **Key field** check box. Click the **Apply** button and continue adding the other fields.


Create CMP Attribute

Name: warehouseId

Type: java.lang.String

Array: Dimension: 1

Initial value:

[✓] Key field

Access with getter and setter methods

Promote getter and setter methods to remote interface

Make getter read-only

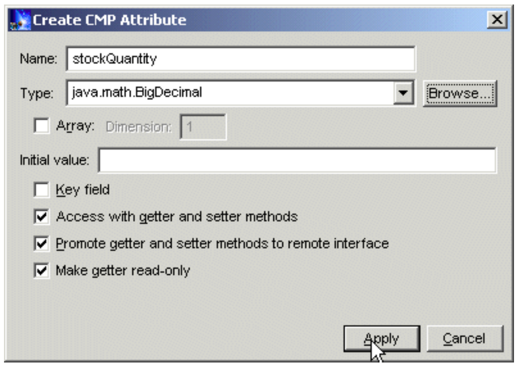
Figure 9-53 Creating persistent fields

6. Repeat the same process for the other character key field, item id. The item ID field in the Stock file is of type CHAR. Select **java.lang.String** in the Field type drop-down list. Select the **Key field** check box.
7. As explained in 9.1, “Bottom-up mapping” on page 266, the automatic generation of an entity bean from an iSeries table takes care of the mapping between database types and Java types. In our new example, we control the mapping. Refer to the JDBC documentation for a correct mapping. Table 9-1 on page 290 shows the mapping of the most common database types.
8. Add the rest of the fields to the Stock bean. They are not primary key fields, so deselect the **Key field** check box. The fields to add are shown in Table 9-2.

Table 9-2 Stock bean fields

Description	Table column	Bean field name	Java type
Order Quantity	STORDRS	orderQuantity	BigDecimal
Remaining Order Quantity	STREMORD	remOrderQuantity	BigDecimal
Stock Quantity	STQTY	stockQuantity	BigDecimal
Year to Date	STYTD	yearToDate	BigDecimal

Figure 9-54 shows an example of adding the stockQuantity field.


Create CMP Attribute

Name: stockQuantity

Type: java.math.BigDecimal

☐ Array: Dimension: 1

Initial value:

☐ Key field

☑ Access with getter and setter methods

☑ Promote getter and setter methods to remote interface

☑ Make getter read-only

Figure 9-54 Creating the stockQuantity CMP field

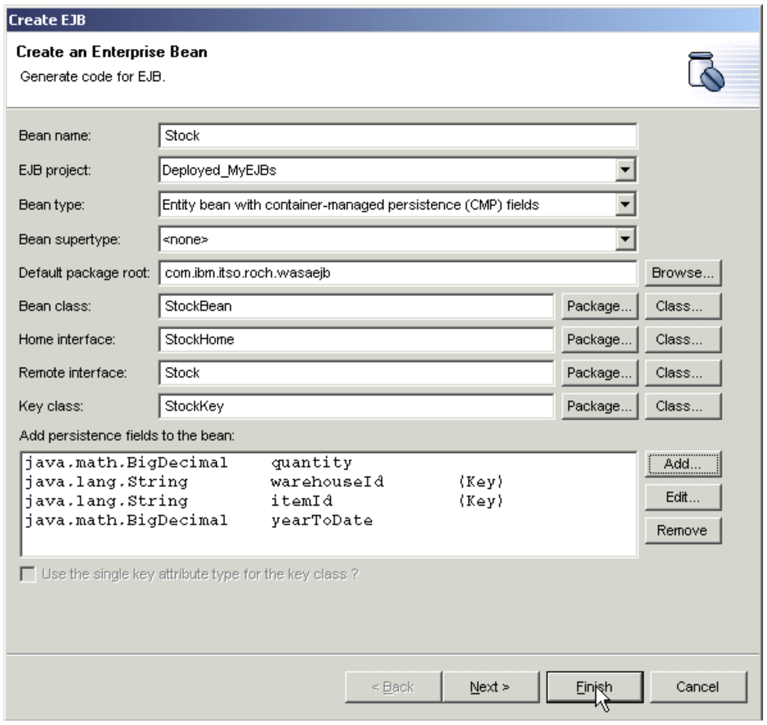
a. For the all the fields, select **java.math.BigDecimal** in the Field type drop-down list. You can use the **Browse...** button to help find the class you need. The mapping database fields are of type PACKED.

b. Deselect the **Key Field** check box.

c. Select the **Access with getter and setter methods** check box. The setter and getter methods are then automatically generated in the StockBean class.

d. Optionally, you can select the **Promote getter and setter methods to remote interface** check box to have them in the Stock remote interface as well.

9. When you finish adding the fields to the Stock entity bean, click **Cancel** on the create persistent field window and then click the **Finish** button on the Create an Enterprise Bean window as shown in Figure 9-55.


Create EJB

Create an Enterprise Bean

Generate code for EJB.

Bean name:	Stock
EJB project:	Deployed_MyEJBs
Bean type:	Entity bean with container-managed persistence (CMP) fields
Bean supertype:	<none>
Default package root:	com.ibm.itso.roch.wasaejb
Bean class:	StockBean
Home interface:	StockHome
Remote interface:	Stock
Key class:	StockKey

Add persistence fields to the bean:

```
java.math.BigDecimal    quantity
java.lang.String        warehouseId      (Key)
java.lang.String        itemId           (Key)
java.math.BigDecimal    yearToDate
```

Figure 9-55 Creating a Stock enterprise bean

Once the Stock bean is created, you can see the implementation of its classes and methods as shown in Figure 9-56.

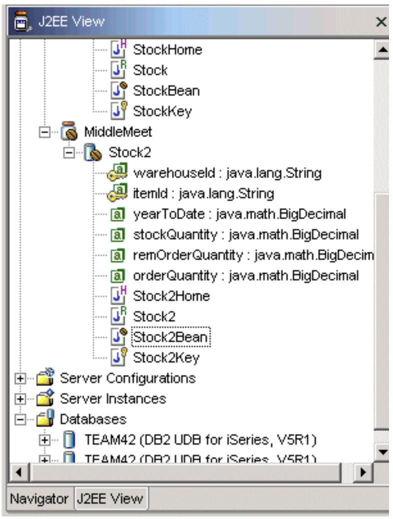

```
J2EE View
StockHome
Stock
StockBean
StockKey
MiddleMeet
  Stock2
    warehouseId : java.lang.String
    itemId : java.lang.String
    yearToDate : java.math.BigDecimal
    stockQuantity : java.math.BigDecimal
    remOrderQuantity : java.math.BigDecim
    orderQuantity : java.math.BigDecimal
    Stock2Home
    Stock2
    Stock2Bean
    Stock2Key
Server Configurations
Server Instances
Databases
  TEAM42 (DB2 UDB for iSeries, V5R1)
  TEAM42 (DB2 UDB for iSeries, V5R1)
```

Figure 9-56 Stock bean implementation

Note the meaningful names for the fields unlike in bottom-up mapping. Once the bean is created, we are ready to map the bean to the schema.

9.3.2 Adding the methods

To add the user defined methods, follow the steps as explained in “Adding methods to the Stock bean” on page 292. In this section, we create more user-defined methods:

1. We add the following methods:
   - `void decreaseRemOrderQuantity(int qty)`
   - `void decreaseStockQuantity(int qty)`
   - `void decreaseOrderQuantity(int qty)`
   - `void decreaseYearToDate(int qty)`
   - `void increaseOrderQuantity(int qty)`
   - `void increaseRemOrderQuantity(int qty)`
   - `void increaseStockQuantity(int qty)`
   - `void increaseYearToDate(int qty)`

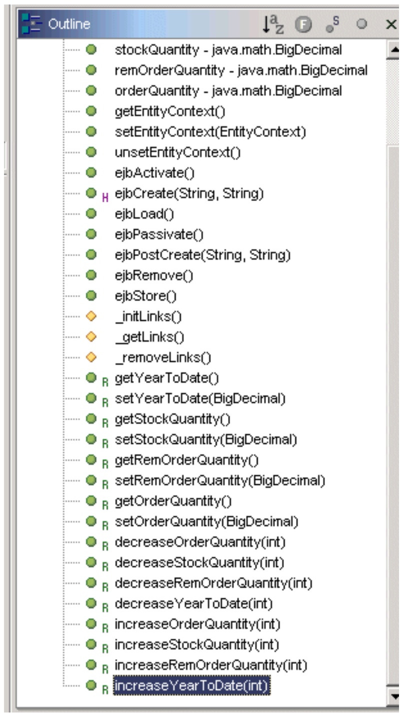
   Figure 9-57 shows a code example of how to write the logic for the methods.

```
public void decreaseOrderQuantity(int qty) throws javax.ejb.EJBException{
orderQuantity = new java.math.BigDecimal(orderQuantity.intValue() - qty);
}
```

Figure 9-57 decreaseOrderQuantity() method logic

2. After you add a method, right-click anywhere on the editor and click **Save**. Add the methods to the remote interface by right-clicking the method in outline view and selecting **Enterprise Bean-> Promote to Remote Interface**.

   After the methods are added to the remote interface of the bean, the outline view looks like the example in Figure 9-58.



Outline

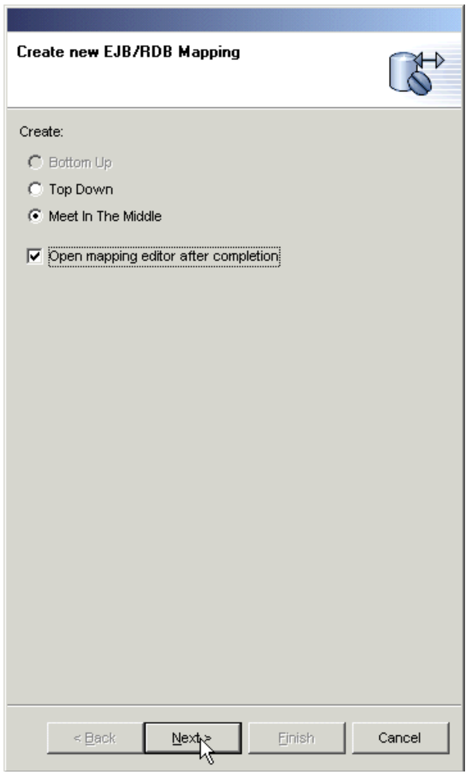
stockQuantity - java.math.BigDecimal
remOrderQuantity - java.math.BigDecimal
orderQuantity - java.math.BigDecimal
getEntityContext()
setEntityContext(EntityContext)
unsetEntityContext()
ejbActivate()
ejbCreate(String, String)
ejbLoad()
ejbPassivate()
ejbPostCreate(String, String)
ejbRemove()
ejbStore()
_initLinks()
_getLinks()
_removeLinks()
getYearToDate()
setYearToDate(BigDecimal)
getStockQuantity()
setStockQuantity(BigDecimal)
getRemOrderQuantity()
setRemOrderQuantity(BigDecimal)
getOrderQuantity()
setOrderQuantity(BigDecimal)
decreaseOrderQuantity(int)
decreaseStockQuantity(int)
decreaseRemOrderQuantity(int)
decreaseYearToDate(int)
increaseOrderQuantity(int)
increaseStockQuantity(int)
increaseRemOrderQuantity(int)
increaseYearToDate(int)

Figure 9-58 Outline view of the Stock bean

9.3.3 Mapping the stock bean

In the meet-in-the-middle approach of mapping enterprise beans to database tables, it is assumed that you have existing enterprise beans and a database schema. We now have the enterprise bean. To create the mapping, follow these steps:

1. The first action is to import the schema of the Stock table from the iSeries database table into your working project as explained in 9.1.2, “Importing a schema” on page 266. Once the schema is imported, the enterprise been and schema are ready.
2. Switch back to the J2EE view of the J2EE perspective. Select the project under EJB modules and select **Generate-> EJB to RDB mapping**.
3. The Create a new EJB/RDB Mapping window (Figure 9-59) appears. Select the **Meet In The Middle** radio button and select the **Open mapping editor after completion** check box. Click **Next**.


Create new EJB/RDB Mapping

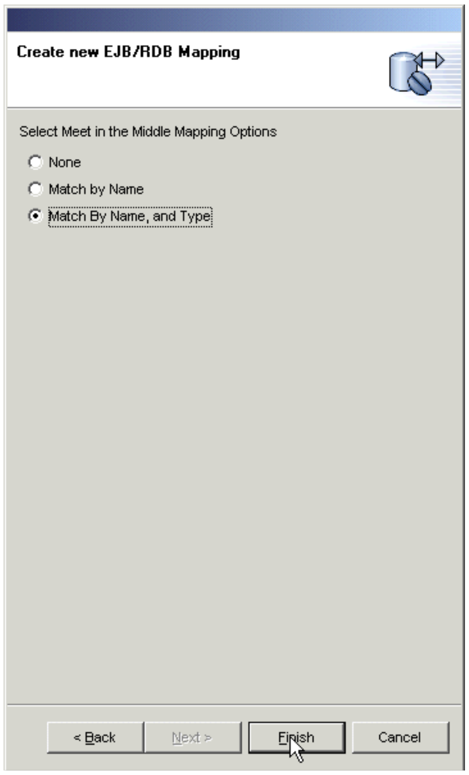
Create:

- Bottom Up
- Top Down
- Meet In The Middle [✓]

[✓] Open mapping editor after completion

Figure 9-59 Creating EJB/RDB mapping for meet-in-the-middle

4. On the window (Figure 9-60), select the **Match By Name, and Type** radio button and click **Finish**.

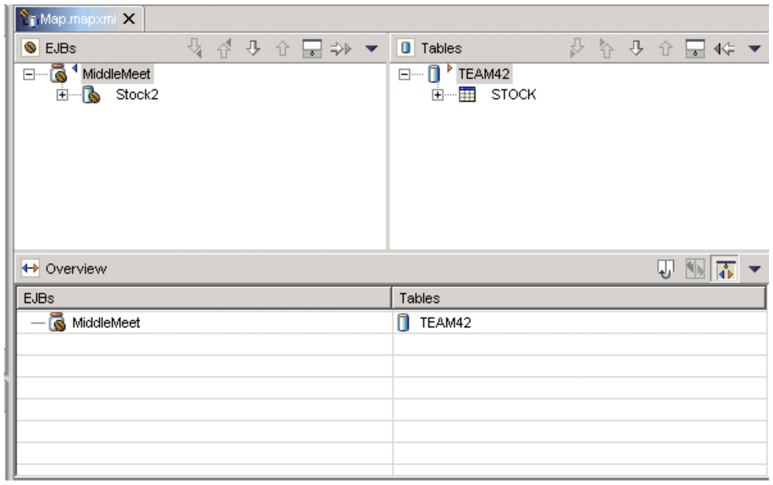

Create new EJB/RDB Mapping

Select Meet in the Middle Mapping Options

( ) None
( ) Match by Name
[✓ Match By Name, and Type]

Figure 9-60 Creating EJB/RDB mapping with match by name and type

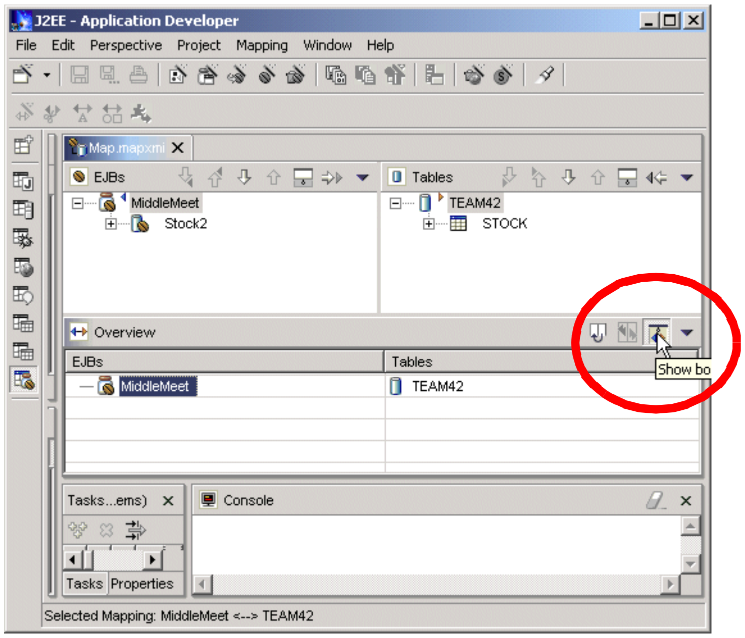
Once the mapping is generated, you can see that no fields are mapped as shown in Figure 9-61.



EJBs	Tables
MiddleMeet	TEAM42

Figure 9-61 Meet in the middle mapping

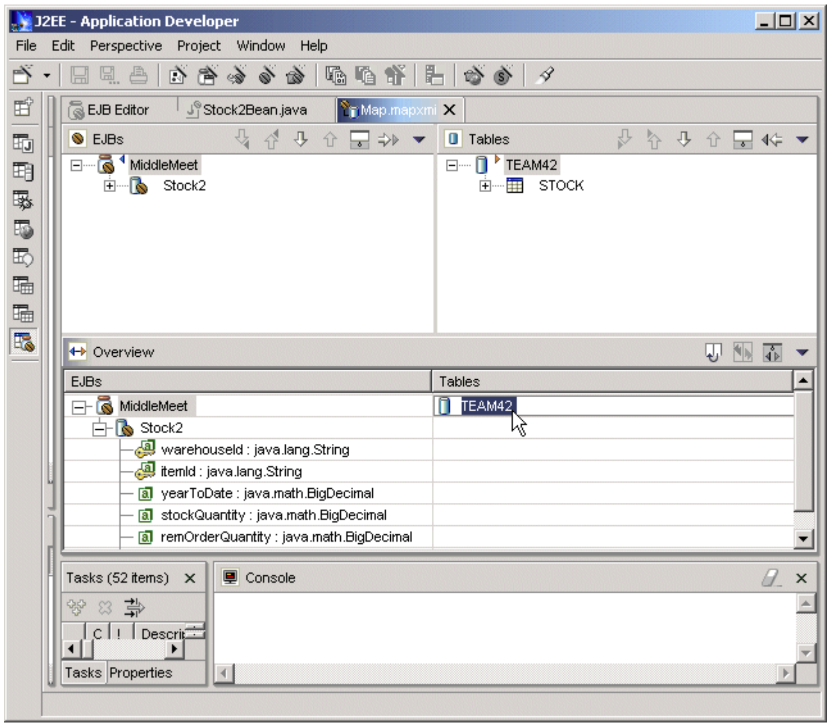
5. We need to manually map the existing fields in the Stock enterprise bean to the columns in the Stock database schema. We follow these steps:
   a. Select **MiddleMeet (Project Name)** in the lower pane of the map editor and click the **Show both mapped and unmapped objects** icon (Figure 9-62).



Selected Mapping: MiddleMeet <--> TEAM42

Figure 9-62 Show both the mapped and unmapped objects

b. A plus (+) sign appears next to the project name in the lower pane. Click it to expand the tree to view the enterprise bean and all the fields as shown in Figure 9-63.



warehouseId : java.lang.String
itemId : java.lang.String
yearToDate : java.math.BigDecimal
stockQuantity : java.math.BigDecimal
remOrderQuantity : java.math.BigDecimal

Figure 9-63 Manual mapping for the bean

c. Select the Stock bean in the lower left pane and select the schema in the lower right pane.

d. Select the **warehouseId** field of the bean on the left side. Click the drop-down list and select the **STWID** column from the schema as shown in Figure 9-64.

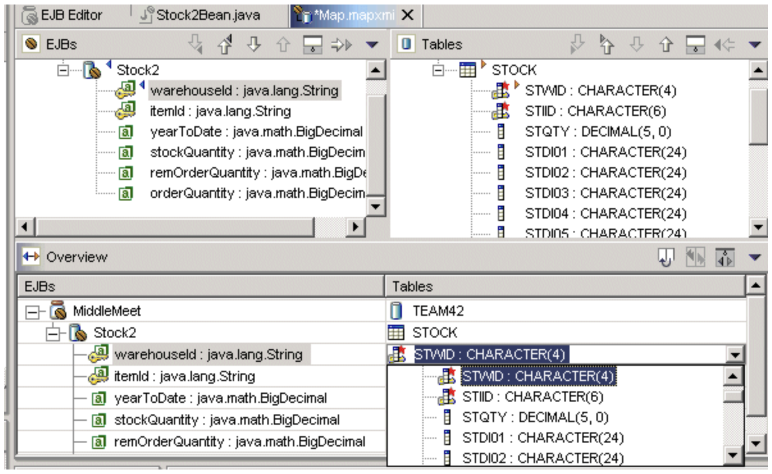


Figure 9-64 Mapping the warehouseId field

e. Repeat these steps to map the other fields listed in Table 9-3.

Table 9-3 Stock bean to Stock table mapping

Stock bean field	Stock table field
itemId	STIID
stockQuantity	STQTY
yearToDate	STYTD
orderQuantity	STORDRS
remOrderQuantity	STREMORD

Once all the fields are mapped, the map editor looks like the example in Figure 9-65.

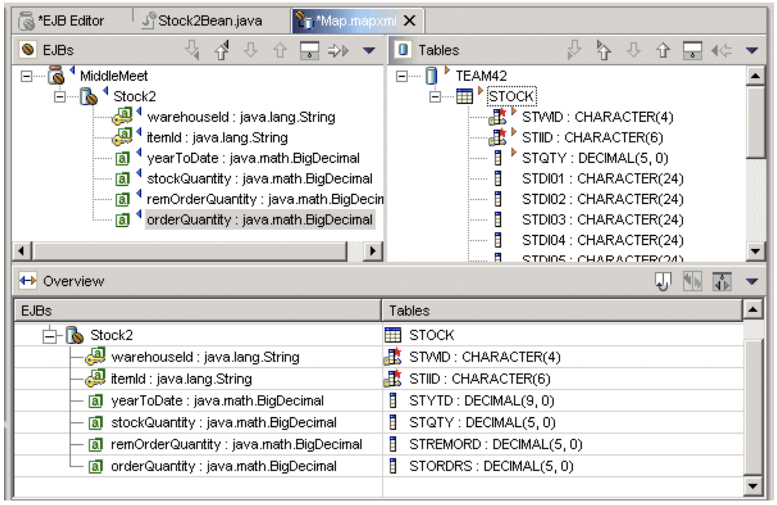


Figure 9-65 Completed mapping for the Stock bean

6. Be aware that iSeries Stock table fields that are not mapped to Stock bean properties must be null capable fields. Otherwise, inserts through the Stock bean `create()` method fail. Add the following code to the `ejbCreate()` method:

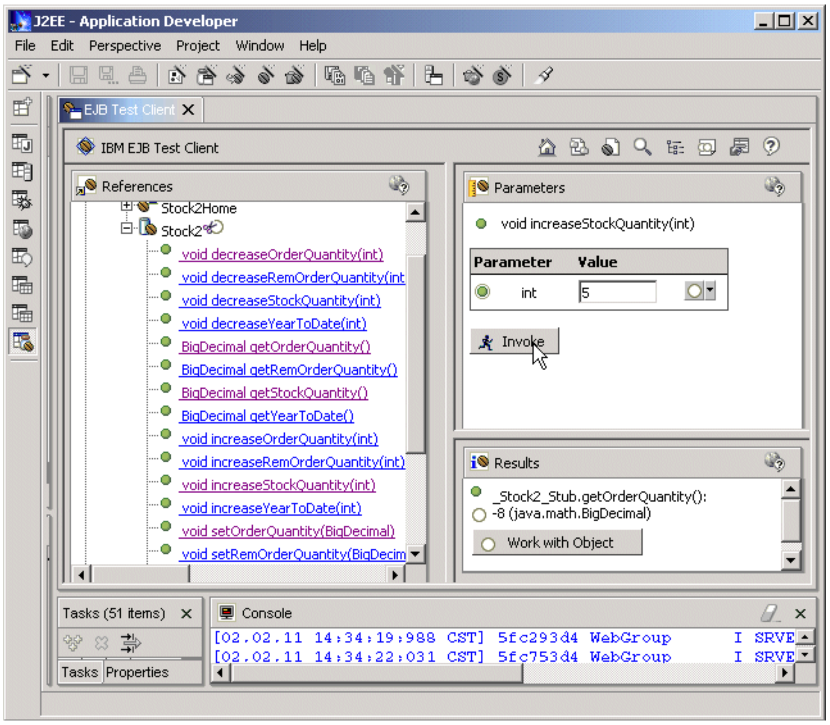
```
stockQuantity = new java.math.BigDecimal(0.0);
yearToDate = new java.math.BigDecimal(0.0);
orderQuantity = new java.math.BigDecimal(0.0);
remOrderQuantity = new java.math.BigDecimal(0.0);
```

7. Save the changes by selecting **File-> Save Map.mapxmi**.

9.3.4 Deploying and testing the enterprise bean

To deploy the Stock bean created by manual mapping, follow the steps shown in 9.1.5, “Deploying the Stock bean in the WebSphere Test Environment” on page 277. Beside testing the `getStockQuantity()` method as discussed earlier, invoke the other new methods added in meet-in-the-middle mapping:

1. Once the `getStockQuantity` method returns the stock quantity value, select the **increaseStockQuantity()** method to increase the stock quantity in the iSeries Stock table through the CMP Stock entity bean.
2. In the parameters pane, enter a value of the quantity to be increased and click the **Invoke** button as shown Figure 9-66.


J2EE - Application Developer
File Edit Perspective Project Window Help
EJB Test Client
IBM EJB Test Client
References
Stock2Home
Stock2
void decreaseOrderQuantity(int)
void decreaseRemOrderQuantity(int
void decreaseStockQuantity(int)
void decreaseYearToDate(int)
BigDecimal getOrderQuantity()
BigDecimal getRemOrderQuantity()
BigDecimal getStockQuantity()
BigDecimal getYearToDate()
void increaseOrderQuantity(int)
void increaseRemOrderQuantity(int)
void increaseStockQuantity(int)
void increaseYearToDate(int)
void setOrderQuantity(BigDecimal)
void setRemOrderQuantity(BigDecim
Parameters
Invoke
Results
Work with Object
Tasks (51 items)
Tasks Properties
Console

void increaseStockQuantity(int)

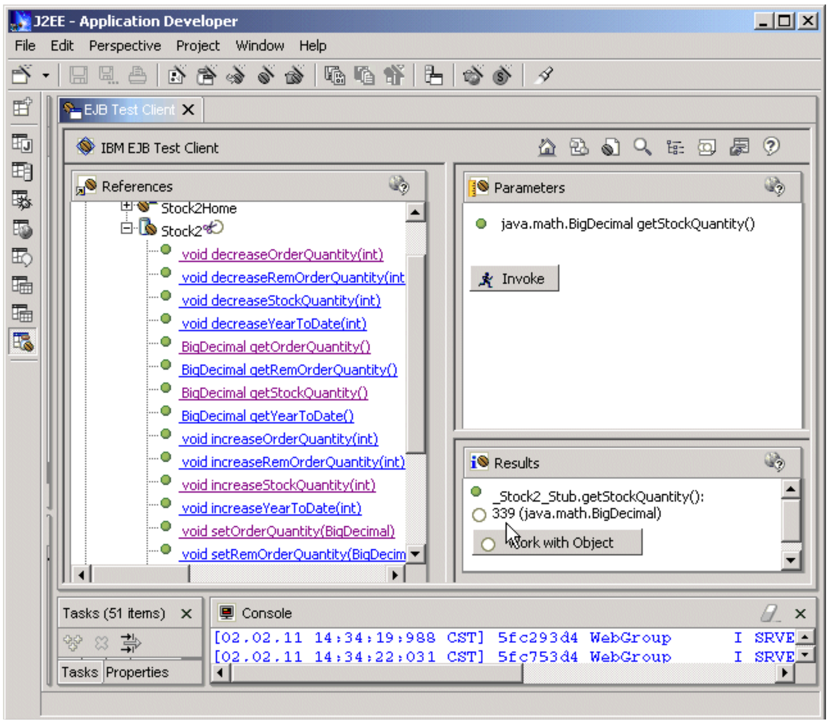
Parameter	Value
int	5

_Stock2_Stub.getOrderQuantity():
-8 (java.math.BigDecimal)

```
[02.02.11 14:34:19:988 CST] 5fc293d4 WebGroup      I SRVE
[02.02.11 14:34:22:031 CST] 5fc753d4 WebGroup      I SRVE
```

Figure 9-66 Invoking the increaseStockQuantity() method

3. Invoke the `getStockQuantity()` method to see that the increase to stock quantity has occurred as shown in Figure 9-67.


J2EE - Application Developer
File Edit Perspective Project Window Help
EJB Test Client
IBM EJB Test Client
References
Stock2Home
Stock2
void decreaseOrderQuantity(int)
void decreaseRemOrderQuantity(int
void decreaseStockQuantity(int)
void decreaseYearToDate(int)
BigDecimal getOrderQuantity()
BigDecimal getRemOrderQuantity()
BigDecimal getStockQuantity()
BigDecimal getYearToDate()
void increaseOrderQuantity(int)
void increaseRemOrderQuantity(int)
void increaseStockQuantity(int)
void increaseYearToDate(int)
void setOrderQuantity(BigDecimal)
void setRemOrderQuantity(BigDecim
Parameters
java.math.BigDecimal getStockQuantity()
Invoke
Results
_Stock2_Stub.getStockQuantity():
339 (java.math.BigDecimal)
Work with Object
Tasks (51 items)
Tasks Properties
Console

```
[02.02.11 14:34:19:988 CST] 5fc293d4 WebGroup     I SRVE
[02.02.11 14:34:22:031 CST] 5fc753d4 WebGroup     I SRVE
```

Figure 9-67 Invoking the getStockQuantity method

4. You can also query iSeries STOCK table using interactive SQL or Operations Navigator and see if there is an increase in the stock quantity.
5. Repeat the same procedure to try the other methods.

9.4 Developing a bean-managed persistence (BMP) entity bean

After discussing all the possible alternatives to develop and deploy a container-managed persistence entity bean, let's look at bean-managed persistence entity beans. You may want to develop BMP entity beans for two main reasons:

- Performance
- Complex entity/database mapping

BMP application development is more complicated. Application Developer helps you create BMP beans, but you must handle persistence in the code.

In this example, we use an existing project that we created earlier called *ItsoEjb*. Once the working project is ready, follow these steps:

1. Switch to the J2EE view in the J2EE perspective. Right-click the **ItsoEjb** project and select **New-> Enterprise Bean** as shown in Figure 9-68.

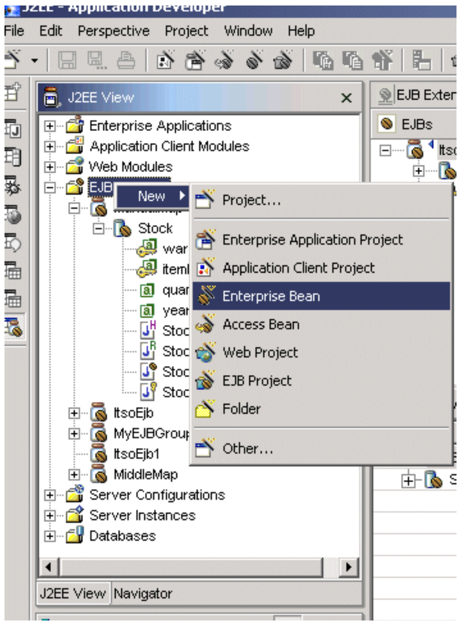
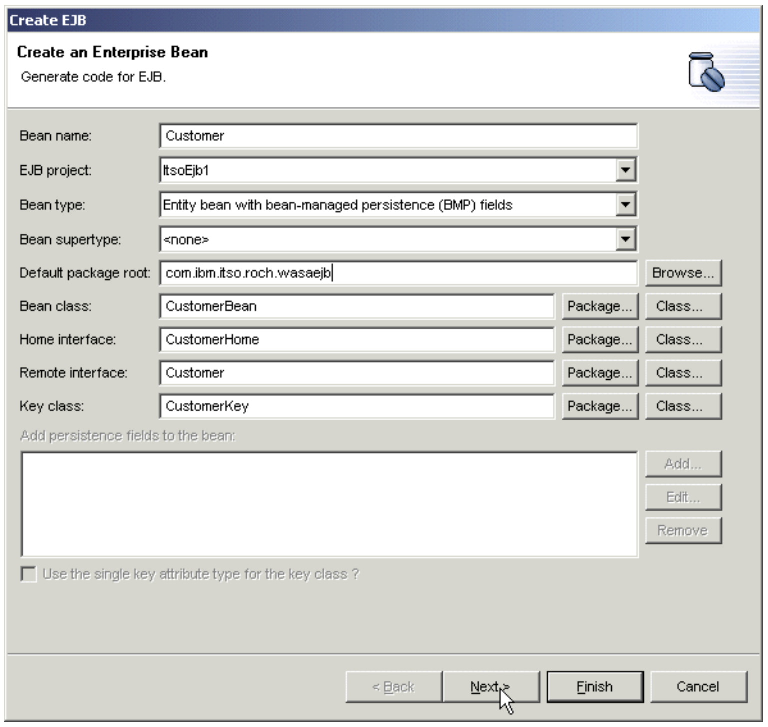


Figure 9-68 Creating an enterprise bean

2. In the create EJB window, complete these tasks. Use Figure 9-69 as a reference.
   a. Enter `Customer` in the Bean name field.
   b. Select **ItsoEjb** for the EJB project field.
   c. Select **Entity bean with bean-managed persistence (BMP) fields** from the Beantype drop-down list.
   d. Enter the default package name as `com.ibm.itso.roch.wasaejb`. The names for the home interface, remote interface, and key class are automatically generated.
   e. Click the **Next** button.


Create EJB

Create an Enterprise Bean

Generate code for EJB.

Bean name: Customer

EJB project: ItsoEjb1

Bean type: Entity bean with bean-managed persistence (BMP) fields

Bean supertype: <none>

Default package root: com.ibm.itso.roch.wasaejb

Bean class: CustomerBean

Home interface: CustomerHome

Remote interface: Customer

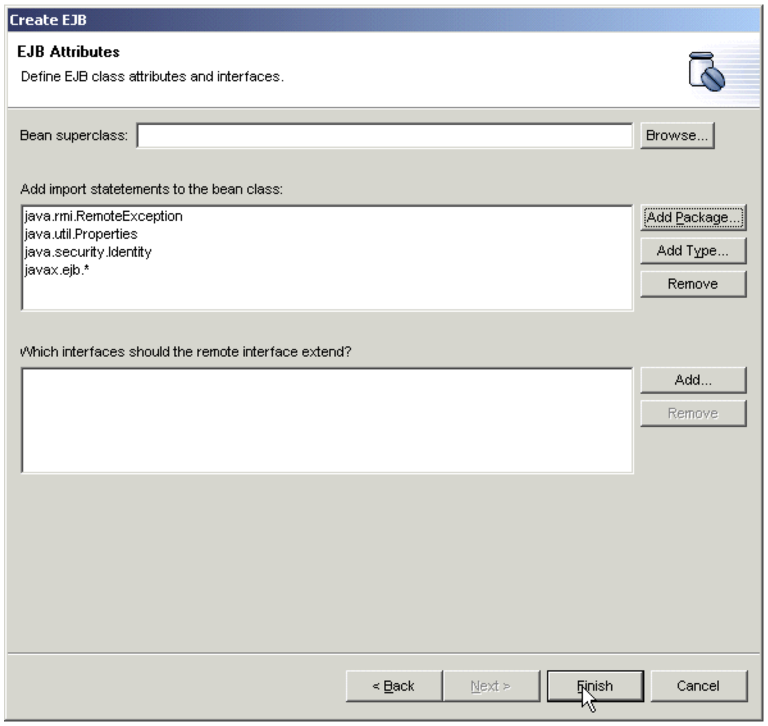
Key class: CustomerKey

Add persistence fields to the bean:

Use the single key attribute type for the key class ?

Figure 9-69   Creating the Customer CMP bean

3. The EJB attribute window appears. Add the packages as shown in Figure 9-70. Click the **Add Type** and **Add Package** buttons next to Add import statements to the bean class to find the package and type you want to add.


Create EJB

EJB Attributes

Define EJB class attributes and interfaces.

Bean superclass:

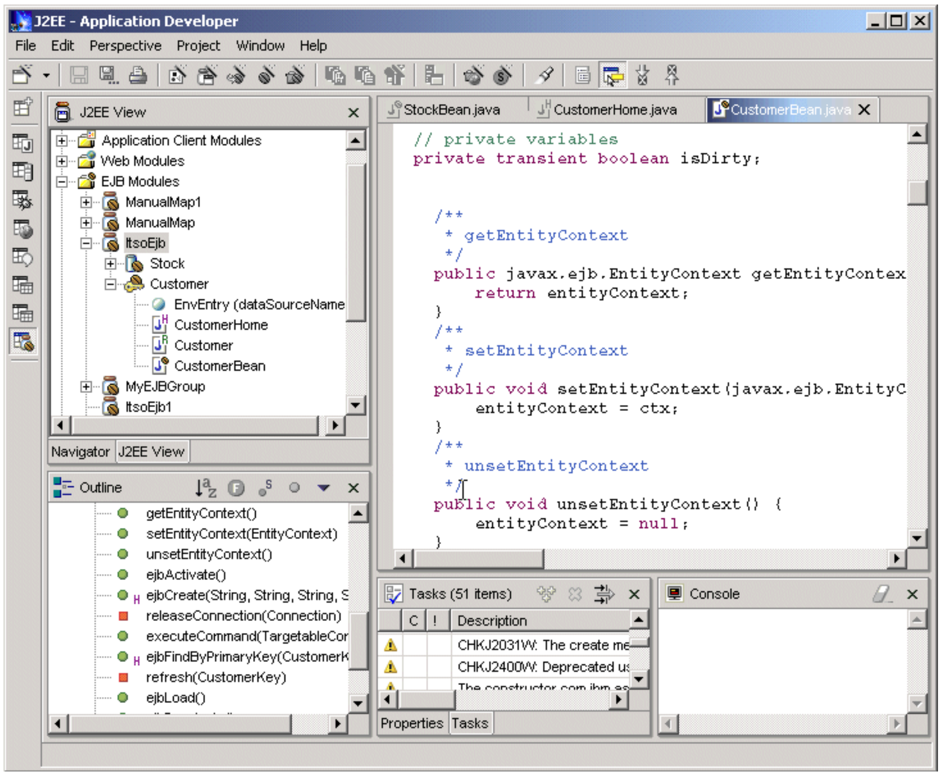
Add import statetements to the bean class:

```
java.rmi.RemoteException
java.util.Properties
java.security.Identity
javax.ejb.*
```

Which interfaces should the remote interface extend?

Figure 9-70   Adding import statements to the Customer bean

4. Click the **Finish** button to generate the bean. At this point, its worth spending some time to see the files generated. In the J2EE perspective, you see that CustomerHome, Customer and CustomerBean are automatically generated with all the methods required by the Enterprise JavaBeans specifications. This is shown in Figure 9-71.



```
// private variables
private transient boolean isDirty;


  /**
   * getEntityContext
   */
  public javax.ejb.EntityContext getEntityContex
      return entityContext;
  }
  /**
   * setEntityContext
   */
  public void setEntityContext(javax.ejb.EntityC
      entityContext = ctx;
  }
  /**
   * unsetEntityContext
   */
  public void unsetEntityContext() {
      entityContext = null;
  }
```

```
CHKJ2031W: The create me
CHKJ2400W: Deprecated us
The constructor com.ibm.as
```

Figure 9-71 Customer bean and methods

You still have the ability to add methods to the remote and home interfaces. However no fields, no key fields, and no field setter and getter methods are generated. They must be created manually by the developer. Just as creating methods to enforce business rules is a developer responsibility, so is entity data persistence.

5. We add the following code:

   a. We update the `ejbCreate()` method of the Customer Bean class to insert a new record in the iSeries Customer table. The `ejbCreate()` method is shown in Example 9-1.

Example 9-1 ejbCreate code for customer CMP bean

```
public com.ibm.itso.roch.wasaejb.CustomerKey ejbCreate(String custID, String fN, String lN,
String phone) throws javax.ejb.CreateException, javax.ejb.EJBException {
   // Get a DataSource
   try {
   // get a reference to the DataSource.
      InitialContext initCtx = new InitialContext();
      String dataSourceName =
               (String)initCtx.lookup("java:comp/env/dataSourceName");
      ds = (DataSource) initCtx.lookup("jdbc/" + dataSourceName);
   }
   catch (Exception e) {
      throw new javax.ejb.CreateException("Error in ejbCreate: " + e.getMessage());
   }
   // Set Field Variables
   ivCustID = custID;
   ivFirstName = fN;
   ivLastName = lN;
   ivPhone = phone;
   ivAddress = new Address();
   isDirty = true;
   // Use a JDBC connection to insert a row into the customer data base
   Connection con = null;
   Statement stmt = null;
   try {
   // get a connection from the dataSource,  generate SQL to insert this
           row into the database.
      con = ds.getConnection();
      stmt = con.createStatement();
      String stmtString = "insert into CSTMR (cid, cfirst, clast,
                  cphone) " + "values
                  ('" + ivCustID + "', '" + ivFirstName
                  + "', '" + ivLastName + "', '" + ivPhone + "')";
   if (stmt.executeUpdate( stmtString ) != 1) {
   throw new CreateException ("JDBC did not create a customer row");
   }
   // Create the primary key object and return it.
   CustomerKey cID = new CustomerKey();
   cID.primaryKey = ivCustID;
   return cID;
   } catch (CreateException ce) {
      throw ce;
   }
   catch (SQLException sqe) {
      throw new CreateException (sqe.getMessage());
   }
   finally {
      try {
      // close the statement and return the connection to the pool
         stmt.close();
         releaseConnection(con);
      }
      catch (Exception ignore) {}
   }
}
```

b. We update the `ejbLoad()` method to retrieve data from the Customer table and place it in the bean properties. Example 9-2 shows the `ejbLoad()` method.

Example 9-2 ejbLoad() code for customer CMP bean

```
public void ejbLoad() throws javax.ejb.EJBException {
   try {
      InitialContext initCtx = new InitialContext();
      String dataSourceName =
              (String)initCtx.lookup("java:comp/env/dataSourceName");
      ds = (DataSource) initCtx.lookup("jdbc/" + dataSourceName);
   }
   catch (Exception e) {
   throw new EJBException("Error in ejbCreate: " + e.getMessage());
   }
   try {
      // use the "refresh" method to populate the fields.
      refresh((CustomerKey) getEntityContext().getPrimaryKey());
   } catch (FinderException fe) {
      throw new EJBException(fe.getMessage());
   }
}
```

c. We update the `ejbStore()` method to update a row in the Customer table from the bean's properties. Example 9-3 shows the `ejbStore` method.

Example 9-3 ejbStore() code for customer bean

```
public void ejbStore() throws javax.ejb.EJBException {
   Connection con = null;
   Statement stmt = null;
   try {
     // Use JDBC to update a row in the data base
     con = ds.getConnection();
     stmt = con.createStatement();
     // modify the statement below for proper SQL
     String statement = "update CSTMR  set";
     if ( ivFirstName != null ) {
       statement += " cfirst = '" + ivFirstName + "'";
     }
     if ( ivLastName != null ) {
       statement += ", clast = '" + ivLastName + "'";
     }
     if ( ivInits != null ) {
       statement += ", cinit = '" + ivInits + "'";
     }
     if ( ivPhone != null ) {
       statement += ", cphone = '" + ivPhone + "'";
     }
     if ( ivAddress.ivAddressLine1 != null ) {
       statement += ", caddr1 = '" + ivAddress.ivAddressLine1 + "'";
     }
     if ( ivAddress.ivAddressLine2 != null ) {
       statement += ", caddr2 = '" + ivAddress.ivAddressLine2 + "'";
     }
     if ( ivAddress.ivCity != null ) {
       statement += ", ccity = '" + ivAddress.ivCity + "'";
     }
     if ( ivAddress.ivState != null ) {
       statement += ", cstate = '" + ivAddress.ivState + "'";
     }
     if ( ivAddress.ivZip != null ) {
       statement += ", czip = '" + ivAddress.ivZip + "'";
     }
     if ( ivCreditLimit != 0 ) {
       statement += ", ccrdlm = " + ivCreditLimit;
     }
     if ( ivBalance != 0 ) {
       statement += ", cbal = " + ivBalance;
     }
     if ( ivYearToDateBalance != 0 ) {
       statement += ", cytd = " + ivYearToDateBalance;
     }
     statement += " where cid = '" + ivCustID + "'";
     int i = 0;
     i = stmt.executeUpdate(statement);
```

```
      if (i == 0) {
       throw new EJBException ("ejbStore: CustomerBean (" + ivCustID + ") not
                    updated");
      }
    }
    catch (EJBException re) {
      throw re;
    }
    catch (SQLException sqe) {
      throw new EJBException (sqe.getMessage());
    }
    finally {
      try {
       stmt.close();
       releaseConnection(con);
      }
      catch (Exception ignore) {}
    }
}
```

d. We update the `ejbRemove()` method to delete a row from the Customer table. Example 9-4 shows the `ejbRemove()` method.

Example 9-4 ejbRemove() code for customer bean

```
public void ejbRemove() throws java.rmi.RemoteException, javax.ejb.RemoveException {
   Connection con = null;
   Statement stmt = null;
   try {
   // Use JDBC to delete the row from the data base. HINT: the  primary
          key is in the EntityContext.
   con = ds.getConnection();
   CustomerKey pk = (CustomerKey) getEntityContext().getPrimaryKey();
   stmt = con.createStatement();
   int i = stmt.executeUpdate("delete from CSTMR where cid = '" +
          pk.primaryKey + "'");
   if (i == 0) {
      throw new EJBException ("CustomerBean "  + pk.primaryKey + "
             not found");
   }
   }
   catch (EJBException re) {
      throw re;
   }
   catch (SQLException sqe) {
      throw new RemoteException (sqe.getMessage());
   }
   finally {
     try {
      stmt.close();
      releaseConnection(con);
     }
     catch (Exception ignore) {}
   }
}
```

9.4.1 Testing the BMP bean

Testing the BMP is the same as testing the CMP beans. We follow these steps:

1. Generate the deployed code for the Customer Bean using Application Developer. Start the WebSphere Test Environment and test the Customer Bean as explained in 9.1.5, "Deploying the Stock bean in the WebSphere Test Environment" on page 277.
2. Invoke the `create (String, String, String, String)` method to create a record in Customer database table on the iSeries server.
3. Create a new customer record with the following value:

   ```
   2204 Dean Ascheman 5233726
   ```
4. Return to the home interface in the test client. Retrieve the row just added using the finder and getter methods.
5. Close the test client.

9.5 Conclusion

In this chapter, we discussed the different application development scenarios with respect to container-managed persistence and bean-managed persistence entity Enterprise JavaBeans.

We covered the following application development scenarios:

- Bottom-up CMP entity bean mapping
- Top-down CMP entity bean mapping
- Meet-in-the-middle CMP entity bean mapping
- Developing a BMP entity bean

10

Building Java applications with Enterprise JavaBeans

This chapter discusses building iSeries Java applications using Enterprise JavaBeans. We use the Enterprise JavaBeans described in Chapter 8, “iSeries EJB application development scenario” on page 245, to provide access to iSeries resources. In this chapter, we go through the following types of application development scenarios:

- Java applications
- Java servlets

We begin by developing a simple HelloWorld EJB. Then we develop a servlet and a Java client application which use the HelloWorld bean. Next we develop the OrderEntry application, which uses the entity and session beans developed earlier.

10.1 Developing the HelloWorld EJB application

In this section, we start by developing the HelloWorld Enterprise JavaBean using Application Developer. We then test it using the WebSphere Test Environment under Application Developer. The objective of this section is to take you through the complete development of an EJB session bean and the development of a Java client application and servlet that use the HelloWorld EJB.

In this section, we:

- Use Application Developer to create the HelloWorld session bean.
- Test the HelloWorld session bean inside Application Developer.
- Develop a Java client application which uses the HelloWorld bean.
- Develop a servlet which uses the HelloWorld bean.
- Install the Enterprise application under WebSphere Application Server on the iSeries server.
- Test the enterprise application running on the iSeries server.

10.1.1 Creating the HelloWorld bean in Application Developer

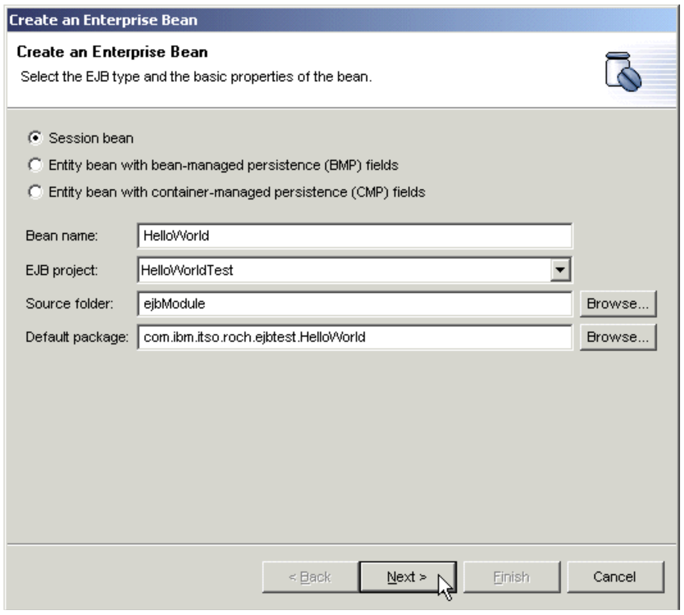
We begin our discussion by creating a simple HelloWorld EJB session bean. To do this, we follow these steps:

1. In the J2EE view of the J2EE perspective, select **File->New->EJB Project**.
2. Enter `HelloWorldTest` as the project name.
3. Type or select the enterprise application project name to which this EJB project will be added as a module. If the enterprise application does not exist, it is created.
4. Click **Next**. You can also click **Finish** at this point to create a default EJB project if you have no module dependencies or build settings to specify.
5. Under the EJB modules in the J2EE perspective, select your working project. In this case we use **HelloWorldTest** as our project.
6. Right-click the project and select **New-> Enterprise Bean**.
7. In the Create an Enterprise bean window, enter the information as shown in Table 10-1.

Table 10-1 Creating an enterprise bean values

Name	Value
Bean Name	HelloWorld
EJB Project	HelloWorldTest
Bean type	Session Bean

If you want to place the EJB in a unique package, you define the package as shown in Figure 10-1. Otherwise, the Default package of “root” is used.


Create an Enterprise Bean

Create an Enterprise Bean

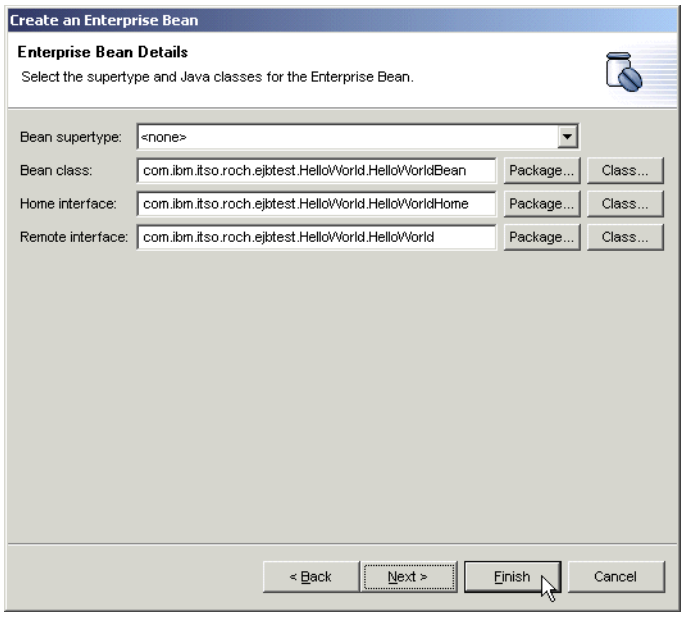
Select the EJB type and the basic properties of the bean.

(●) Session bean
( ) Entity bean with bean-managed persistence (BMP) fields
( ) Entity bean with container-managed persistence (CMP) fields

Bean name:	HelloWorld
EJB project:	HelloWorldTest
Source folder:	ejbModule
Default package:	com.ibm.itso.roch.ejbtest.HelloWorld

Figure 10-1 Creating the HelloWorld bean

8. Click **Next** to display the Enterprise Bean Details window as shown in Figure 10-2.


Create an Enterprise Bean

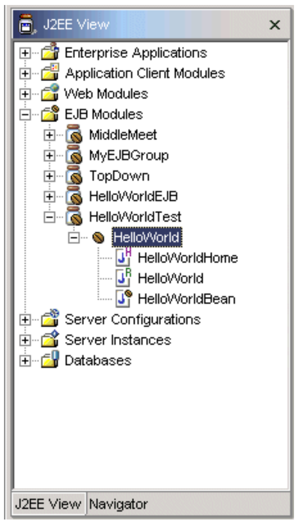
Enterprise Bean Details

Select the supertype and Java classes for the Enterprise Bean.

Bean supertype:	<none>
Bean class:	com.ibm.itso.roch.ejbtest.HelloWorld.HelloWorldBean
Home interface:	com.ibm.itso.roch.ejbtest.HelloWorld.HelloWorldHome
Remote interface:	com.ibm.itso.roch.ejbtest.HelloWorld.HelloWorld

Figure 10-2 Create an Enterprise Bean wizard

9. Click the **Finish** button to create the HelloWorld bean. It's worth spending some time to navigate the files generated by Application Developer as shown in Figure 10-3.



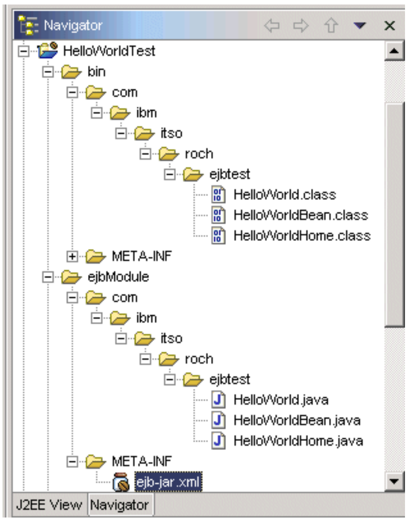


Figure 10-3 J2EE/Navigator view of the HelloWorld bean

Notice what Application Developer has generated:

– HelloWorldHome is the home interface for the bean.
– HelloWorld is the remote interface.
– HelloWorldBean is the implementation of the bean.

Also in the Navigator view, you can see the .class files and .java files generated under the package defined while creating the bean.

10. We write a business method that returns a string that reads “Hello from ITSO”. To add a method, double-click **HelloWorldBean.java** to open it. Enter the code shown in Example 10-1 at the end of the file, before the final “}”.

Example 10-1 The printHello method

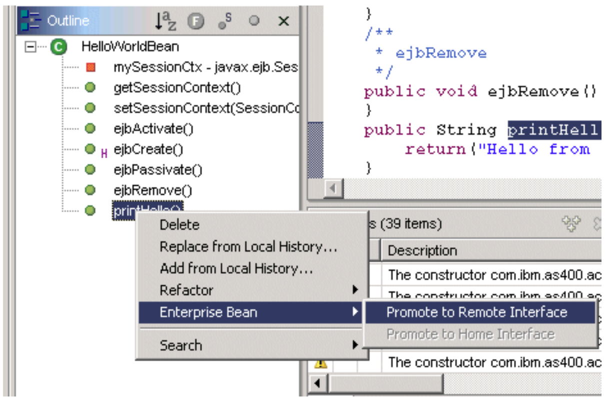
```
public String printHello() throws javax.ejb.EJBException{ return("Hello from ITSO");
}
```

11. After you add the method, save the file by selecting **File-> Save-> HelloWorldBean.java** from the menu.

12. Add the following import statement to both the HelloWorldBean.java and HelloWorld.java files:

```
import javax.ejb.EJBException;
```

13. Add the **printHello()** method to the remote interface of the bean by right-clicking the method in the outline view. Then select **Enterprise Bean-> Promote to Remote Interface** as shown in Figure 10-4.



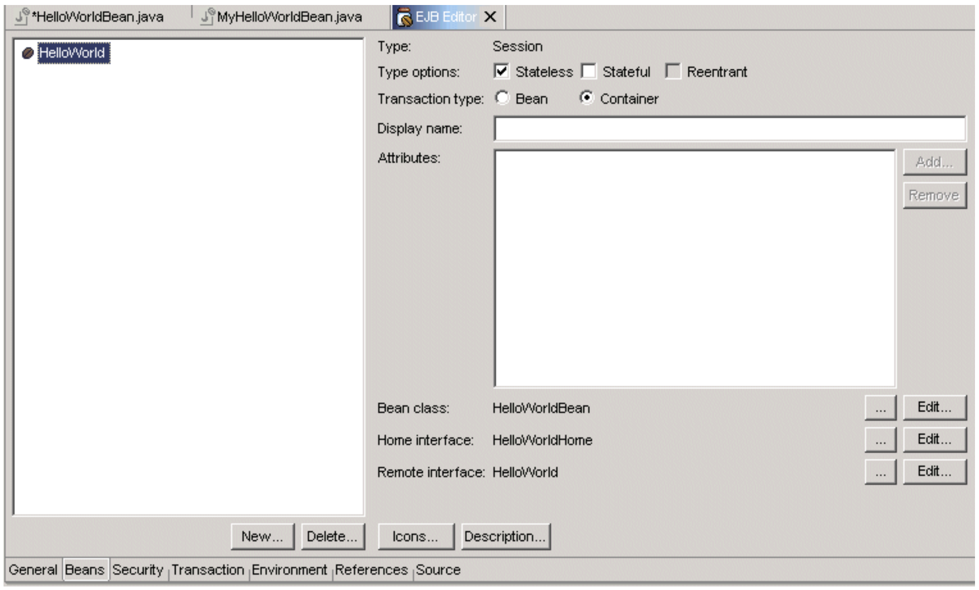
```
}
/**
 * ejbRemove
 */
public void ejbRemove()
}
public String printHell
    return("Hello from
}
```

Outline
HelloWorldBean
mySessionCtx - javax.ejb.Ses
getSessionContext()
setSessionContext(SessionCo
ejbActivate()
ejbCreate()
ejbPassivate()
ejbRemove()
Delete
Replace from Local History...
Add from Local History...
Refactor
Enterprise Bean
Search
Promote to Remote Interface
Promote to Home Interface
s (39 items)
Description
The constructor com.ibm.as400.ac
The constructor com.ibm.as400.ac

Figure 10-4 Adding the printHello() method to the remote interface

14. While in the Navigator view, expand the tree for the MyHelloWorld project to see the ejb-jar.xml file under the META-INF folder. Double-click the **ejb-jar.xml** file. This is the deployment descriptor.

15. In the deployment descriptor, click the **Beans** tab and select the **HelloWorld** bean. Ensure the bean is a **Stateless** session bean as shown in Figure 10-5.



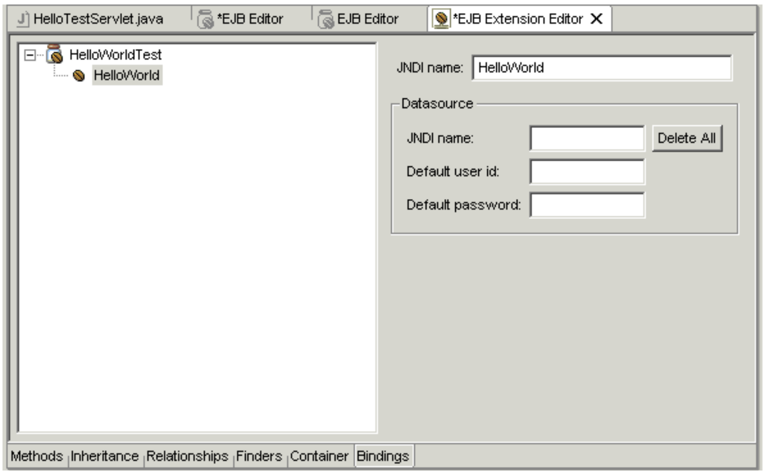
Type: Session
Type options: [✓ Stateless] Stateful Reentrant
Transaction type: Bean [✓ Container]
Display name:
Attributes:
Bean class: HelloWorldBean
Home interface: HelloWorldHome
Remote interface: HelloWorld

Figure 10-5 Deployment descriptor for the HelloWorld bean

16. Press Ctrl-S to save the settings, if necessary.

17. To register HelloWorld in the JNDI namespace, switch to the J2EE view. Select the EJB project. Then right-click and select **Open with-> EJB Extension Editor**.

18. In the EJB Extension Editor, click the **Bindings** tab and select the **HelloWorld** bean under HelloWorldTest. Enter `HelloWorld` in the JNDI name field on the right side of the page as shown in Figure 10-6.



JNDI name: HelloWorld

Datasource

JNDI name:

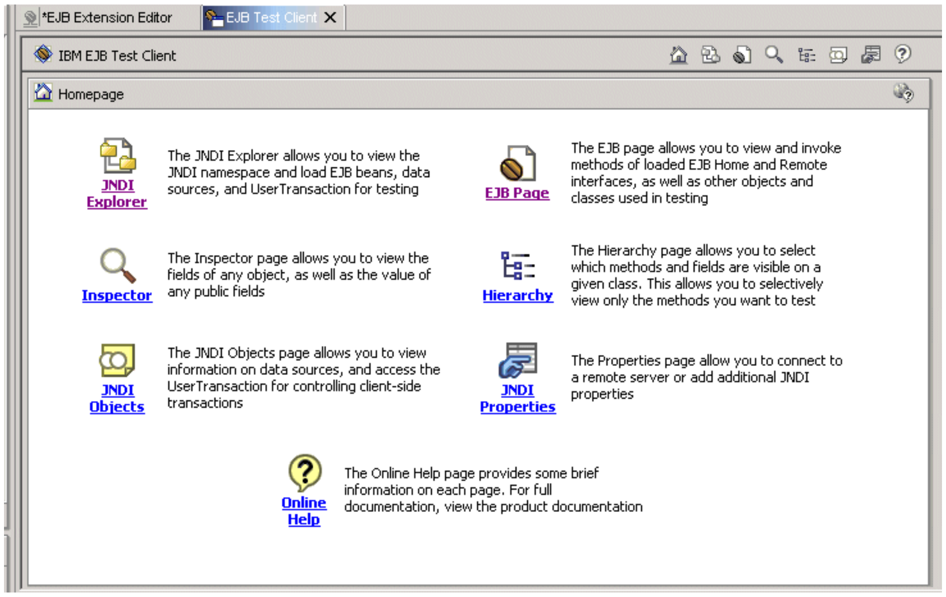
Default user id:

Default password:

Figure 10-6 JNDI namespace

19. Save the changes by selecting **File-> Save EJB Extension Editor**. You can also press Ctrl-S.
20. Generate the deployed code by right-clicking the **HelloWorld** bean in the J2EE perspective and selecting **Generate Deployed Code**.
21. To test the EJB, right-click the **HelloWorldTest** EJB project and select **Run on Server**.

    If the test server is not started, it is now started. Look for the “`Server Default Server open for e-business`” message in the console view or a started status in the server control panel view.
22. The EJB Test Client opens. The first step is to see if the HelloWorld EJB has been added to the JNDI namespace. Click the **JNDI Explorer** link on the EJB Test Client as shown Figure 10-7.



The JNDI Explorer allows you to view the JNDI namespace and load EJB beans, data sources, and UserTransaction for testing

The EJB page allows you to view and invoke methods of loaded EJB Home and Remote interfaces, as well as other objects and classes used in testing

The Inspector page allows you to view the fields of any object, as well as the value of any public fields

The Hierarchy page allows you to select which methods and fields are visible on a given class. This allows you to selectively view only the methods you want to test

The JNDI Objects page allows you to view information on data sources, and access the UserTransaction for controlling client-side transactions

The Properties page allow you to connect to a remote server or add additional JNDI properties

The Online Help page provides some brief information on each page. For full documentation, view the product documentation

Figure 10-7 Home page for the EJB Test Client

23. You can see HelloWorldHome in the namespace. Click the **HelloWorld** link to look up the EJB home for the selected item. Once the instance of the EJB home is found, the window shown in Figure 10-8 appears in the test client.

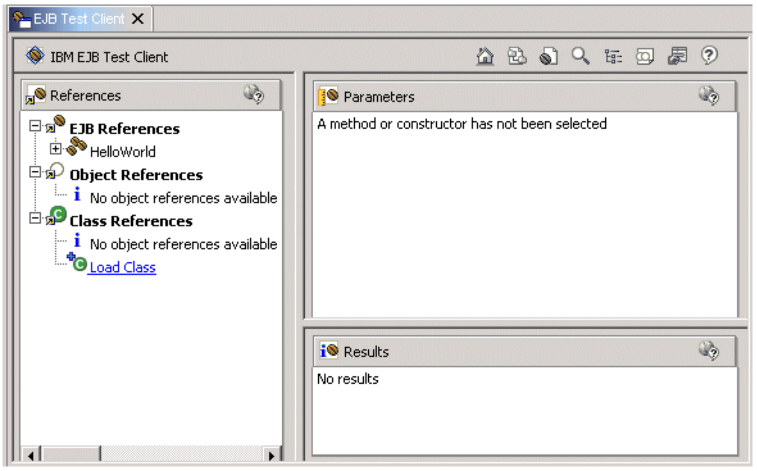


Figure 10-8 EJB page for the HelloWorld bean

24. Expand the **EJB references** tree for the bean until you see the create methods available in the home interface.

25. Click the **create** method. You see the create method open in the parameter pane, on the right-hand side, as shown in Figure 10-9.

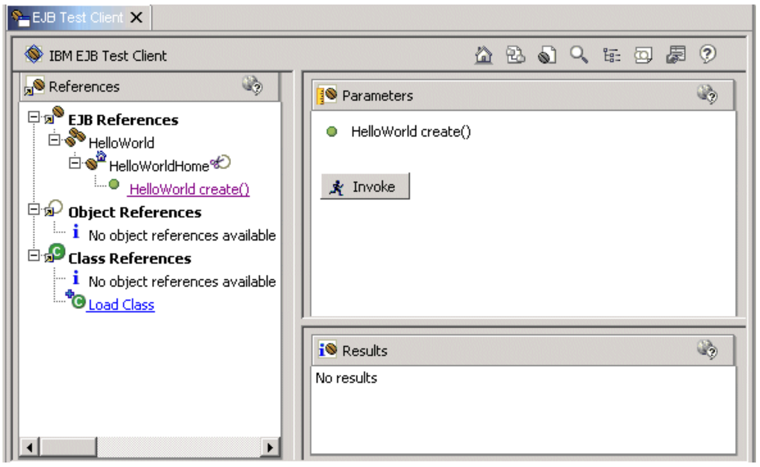


Figure 10-9 Invoking the create method

26. In the parameters frame, click the **Invoke** button to create an instance of the HelloWorld EJB.

27. Click the **Work with Object** button in the results pane. You see the remote interface of the bean under the EJB reference.

28. Expand the remote interface of the bean and select the **printHello()** method as shown in Figure 10-10.

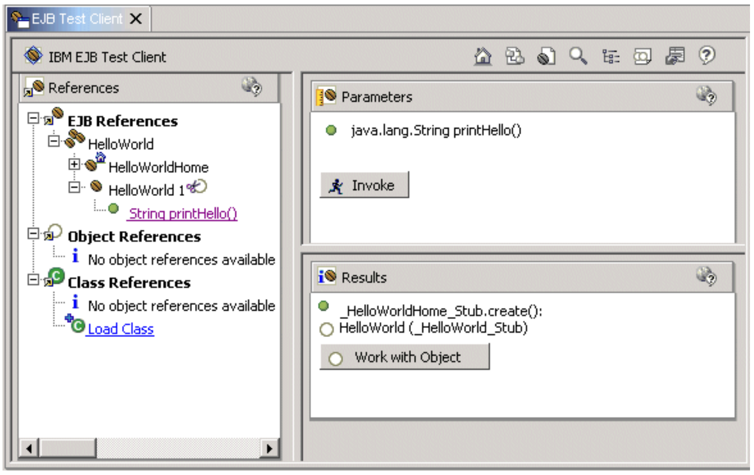
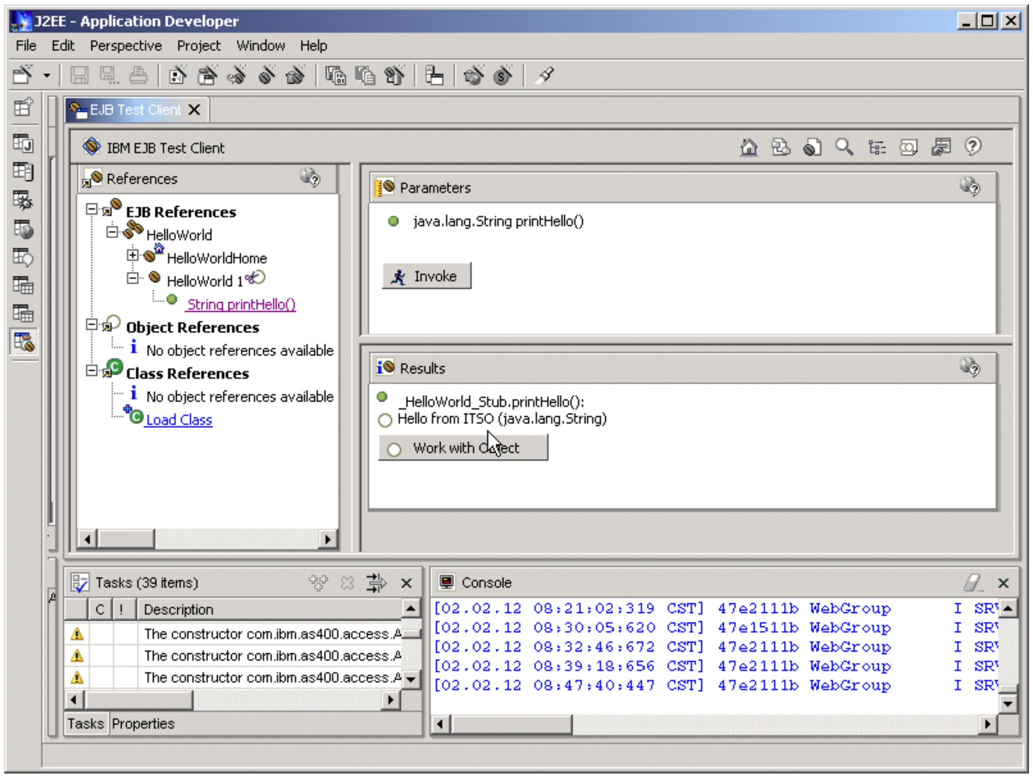


Figure 10-10 Invoking the printHello() method

29. In the parameters pane, click the **Invoke** button. Once the method runs, you see the output "`Hello from ITSO`" in the results pane as shown in Figure 10-11.


J2EE - Application Developer
File Edit Perspective Project Window Help
EJB Test Client
IBM EJB Test Client
References
EJB References
HelloWorld
HelloWorldHome
HelloWorld 1
String printHello()
Object References
No object references available
Class References
No object references available
Load Class
Parameters
java.lang.String printHello()
Invoke
Results
_HelloWorld_Stub.printHello():
Hello from ITSO (java.lang.String)
Work with Object
Tasks (39 items)
C ! Description
The constructor com.ibm.as400.access.A
The constructor com.ibm.as400.access.A
The constructor com.ibm.as400.access.A
Tasks Properties
Console

```
[02.02.12 08:21:02:319 CST] 47e2111b WebGroup      I SR
[02.02.12 08:30:05:620 CST] 47e1511b WebGroup      I SR
[02.02.12 08:32:46:672 CST] 47e2111b WebGroup      I SR
[02.02.12 08:39:18:656 CST] 47e2111b WebGroup      I SR
[02.02.12 08:47:40:447 CST] 47e2111b WebGroup      I SR
```

Figure 10-11 Results of the HelloWorld EJB

10.1.2 Creating a servlet that uses the EJB

The objective in this section is to create a servlet that uses the HelloWorld bean created in the previous section. To create a servlet that accesses the HelloWorld EJB, we use the following steps:

1. Switch to the **Web perspective**. Right-click anywhere and select **New->Web Project** as shown in Figure 10-12.

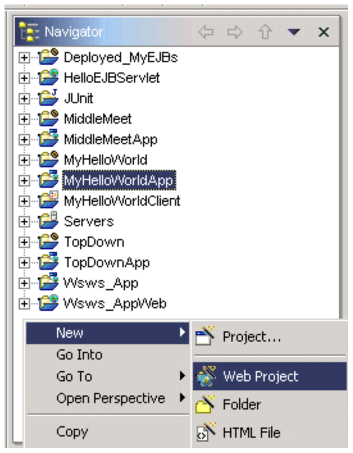


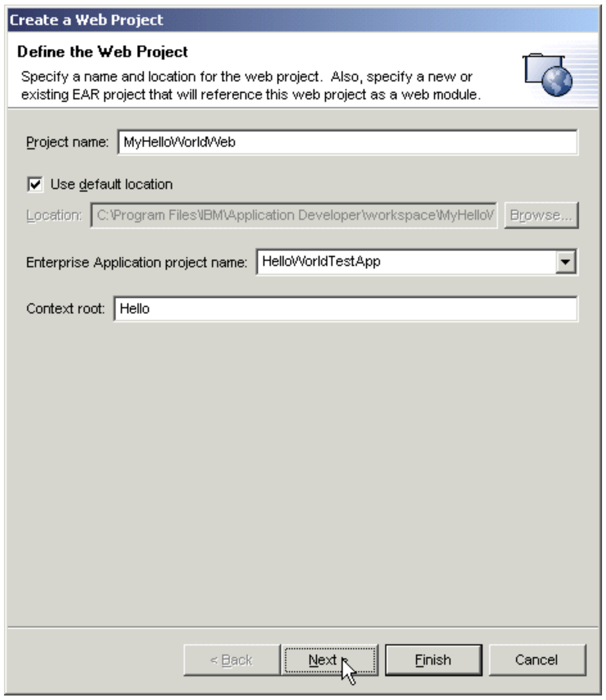
Figure 10-12 Creating a Web project

2. In the create a Web project window, enter the information as shown in Table 10-2.

Table 10-2 Creating the Web project

Name	Value
Project Name	MyHelloWorldWeb
Enterprise Application project name	HelloWorldTestApp (select the application which has the HelloWorld bean
Context root	Hello

3. Click the **Next** button as shown in Figure 10-13.


Create a Web Project

Define the Web Project

Specify a name and location for the web project. Also, specify a new or existing EAR project that will reference this web project as a web module.

Project name: MyHelloWorldWeb

☑ Use default location

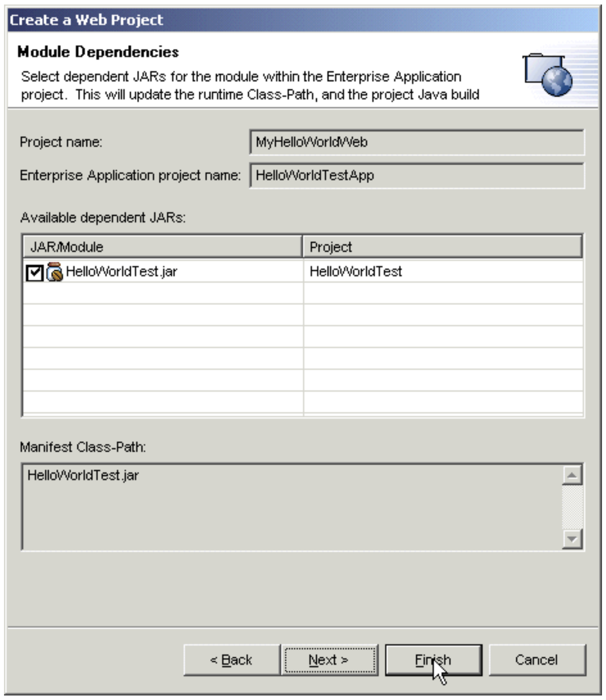
Location: C:\Program Files\IBM\Application Developer\workspace\MyHelloV

Enterprise Application project name: HelloWorldTestApp

Context root: Hello

Figure 10-13 Defining the Web project

4. In the Module Dependencies window, select the **HelloWorldTest.jar** check box and click **Finish** as shown in Figure 10-14. This updates the runtime classpath and the Java project build.



Select dependent JARs for the module within the Enterprise Application project. This will update the runtime Class-Path, and the project Java build

Project name: MyHelloWorldWeb

Enterprise Application project name: HelloWorldTestApp

Available dependent JARs:

JAR/Module	Project
✓ HelloWorldTest.jar	HelloWorldTest

Manifest Class-Path:

HelloWorldTest.jar

Figure 10-14 Module dependencies

Once the Web project is created, the navigator view looks like the example in Figure 10-15.

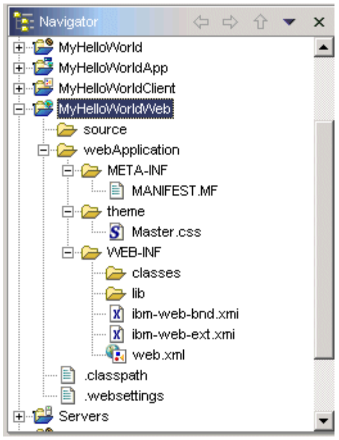

```
Navigator
MyHelloWorld
MyHelloWorldApp
MyHelloWorldClient
MyHelloWorldWeb
    source
    webApplication
        META-INF
            MANIFEST.MF
        theme
            Master.css
        WEB-INF
            classes
            lib
            ibm-web-bnd.xmi
            ibm-web-ext.xmi
            web.xml
    .classpath
    .websettings
Servers
```

Figure 10-15 Generated files after the Web project is created

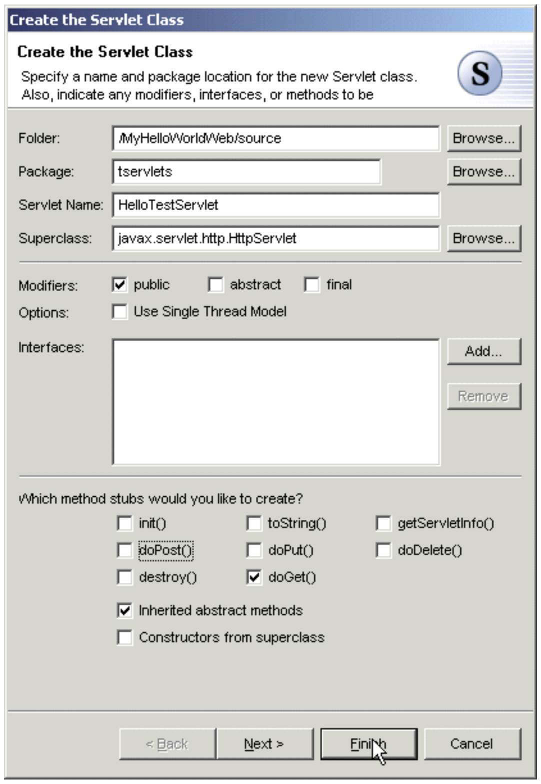
It’s worth spending some time to review the files generated by Application Developer. For Web application development, the key files managed in a Web project are:

– **web.xml**: The deployment descriptor for the Web module. This file contains general information on servlet mapping, security information, and the Web page.

– **ibm-web-bnd.xml**: The WebSphere bindings for the Web application. This file contains bindings to references used at the Web module level.

- **ibm-web-ext.xml**: This file is used by WebSphere to support additional options beyond the J2EE specification such as reloading intervals, the default error page, if file serving is allowed, and if servlet invoking are enabled in the Web module.
- **Master.css**: This is the default cascading style sheet that the Application Developer page designer uses for any new HTML or JSP pages.
- **.classpath**: Application Developer uses this file to store metadata about the build path for the project when compiling Java classes and executing Java applications. Do not edit this file directly. To change the path information, simply click the properties context menu for the project and modify the Java Build Path item.

5. Select the **MyHelloWorldWeb** project. Right-click and select **New-> Other-> Web-> Servlet** from the menu. Click **Next**.
6. The Create the Servlet Class window (Figure 10-16) appears. Enter the package name as `tservlets` and the servlet name as `HelloTestServlet`. Deselect the **doPost** check box. Click the **Finish** button.


Create the Servlet Class

Create the Servlet Class

Specify a name and package location for the new Servlet class. Also, indicate any modifiers, interfaces, or methods to be

Folder: /MyHelloWorldWeb/source

Package: tservlets

Servlet Name: HelloTestServlet

Superclass: javax.servlet.http.HttpServlet

Modifiers: [✓ public] abstract final

Options: Use Single Thread Model

Interfaces:

Which method stubs would you like to create?

init() toString() getServletInfo()

doPost() doPut() doDelete()

destroy() [✓ doGet()]

[✓ Inherited abstract methods]

Constructors from superclass

Figure 10-16 Creating the servlet class

7. Double-click and open the **HelloTestServlet.java** file. Enter the code as shown in Example 10-2 in the `doGet` method.

Example 10-2 The doGet method

```
PrintWriter out = response.getWriter();
HelloWorldHome home = null;
   try {
      Properties p = new Properties();
      p.put(Context.INITIAL_CONTEXT_FACTORY,
           "com.ibm.websphere.naming.WsnInitialContextFactory");
```

```
        InitialContext initCtx = new InitialContext(p);
          // Look up the EJB
        Object o = initCtx.lookup("java:comp/env/HelloWorld");
        System.out.println(" -- lookup was successful");
        home = (HelloWorldHome) javax.rmi.PortableRemoteObject.narrow(o,
        HelloWorldHome.class);
        System.out.println(" -- narrow was successful");
        HelloWorld myEJB = home.create();
        System.out.println(" -- create was successful");
        // call methods
        String msg = myEJB.printHello();
        System.out.println("Message from Hello EJB: " + msg);
        out.println("Message from Hello EJB: " + msg);
        // destroy ejb
        myEJB.remove();
        System.out.println("HelloServlet ran successfully.");
    } catch (EJBException e) {
        out.println("remoteException " + e.getMessage());
        e.printStackTrace();
        } catch (NullPointerException e) {
        if (home == null)
        out.println("noHome " + e.getMessage());
        else
        e.printStackTrace();
        } catch (Exception e) {
            out.println("generalException " + e.getMessage());
            e.printStackTrace();
        } finally {
            out.close();
        }
```

8. Add the import statements shown in Example 10-3.

Example 10-3 Adding the import statements

```
import com.ibm.itso.roch.ejbtest.HelloWorld.*;
import java.util.*;
import javax.naming.*;
import java.rmi.RemoteException;
import java.io.*;
```

9. Review the servlet code. Here is what it does:
   a. Creates a Properties object to hold the values required to create an InitialContext object. The InitialContext object is actually the naming service. When it is instantiated, it uses the name of the service provider and the URL where it is located. In this example, we use the IBM WebSphere JNDI naming service.
   b. Creates an InitialContext object using the properties object that we created.
   c. After the InitialContext object is created, the home interface for the bean must be located. We accomplish this through a method call to the lookup method of the InitialContext object. The home interface for the bean is located by name. The application programmer only needs to know the name of the interface and the class type it returns.
   d. Because the InitialContext object returns any type that is registered with it, the application programmer must cast to the correct type. We use the static method

`narrow()` to cast the java.lang.Object returned by the lookup method to the correct home interface type. The `narrow()` method takes the object to be narrowed and the class of the EJB home object be returned as parameters.

e. We use the home interface to create an instance of the HelloWorld EJB, which we name *myEJB*.

f. The myEJB object can be used to call the methods defined in the Remote interface. We use it to call the `printHello` method.

g. We display the value returned by the `printHello` method in the browser. We use the `out.println` method to do this.

h. We remove the EJB.

10. Save the file by selecting **File -> Save HelloTestServlet.java** file. Make sure that you have no errors.

11. The notation java:comp/env defines that the lookup is to a local reference of HelloWorld instead of an entity in the global JNDI namespace. We map this using the reference definition in the deployment descriptor.

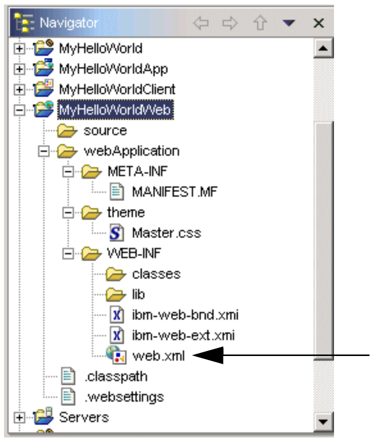


Figure 10-17 Editing the web.xml file

a. Switch to the Navigator view and select the **web.xml** file (Figure 10-17).

b. Double-click to open it in the editor.

c. Select the **References** tab.

d. Select the **EJB References** radio button and click **Add** to add a reference to the HelloWorld EJB.

e. Use the values shown in Table 10-3.

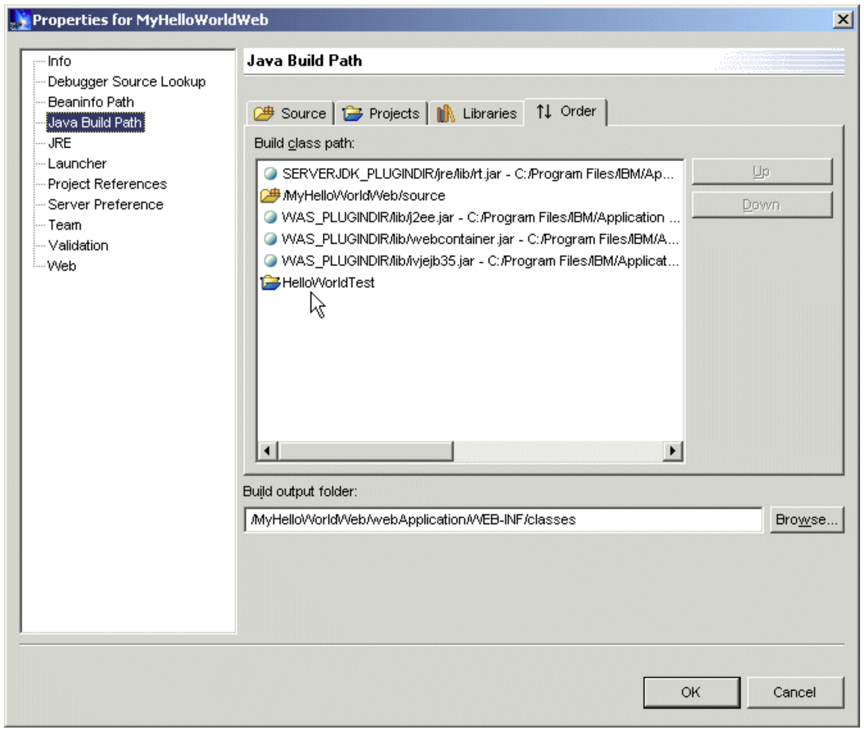
Table 10-3 EJB reference values

Name	Value
EJB Reference	HelloWorld
Type	Session
Home	com.ibm.itso.roch.ejbtest.HelloWorld. HelloWorldHome
Remote	com.ibm.itso.roch.ejbtest.HelloWorld.HelloWorld
JNDI Name	HelloWorld

f. Press Ctrl-S to save your work.

12. Switch back to the Web perspective. Select the **MyHelloWorldWeb** project, right-click, and select **Properties**.

13. Make sure that the EJB project is added in the classpath. If it is not, add it now as shown in Figure 10-18.



Java Build Path

Build class path:

SERVERJDK_PLUGINDIR/jre/lib/rt.jar - C:/Program Files/IBM/Ap...
/MyHelloWorldWeb/source
WAS_PLUGINDIR/lib/j2ee.jar - C:/Program Files/IBM/Application ...
WAS_PLUGINDIR/lib/webcontainer.jar - C:/Program Files/IBM/A...
WAS_PLUGINDIR/lib/ivjejb35.jar - C:/Program Files/IBM/Applicat...
HelloWorldTest

Build output folder:

/MyHelloWorldWeb/webApplication/WEB-INF/classes

Figure 10-18 Java Build Path

14. Expand the MyHelloWorldWeb project by selecting **MyHelloWorldWeb-> webApplication-> WEB-INF-classes-> tservlets**.

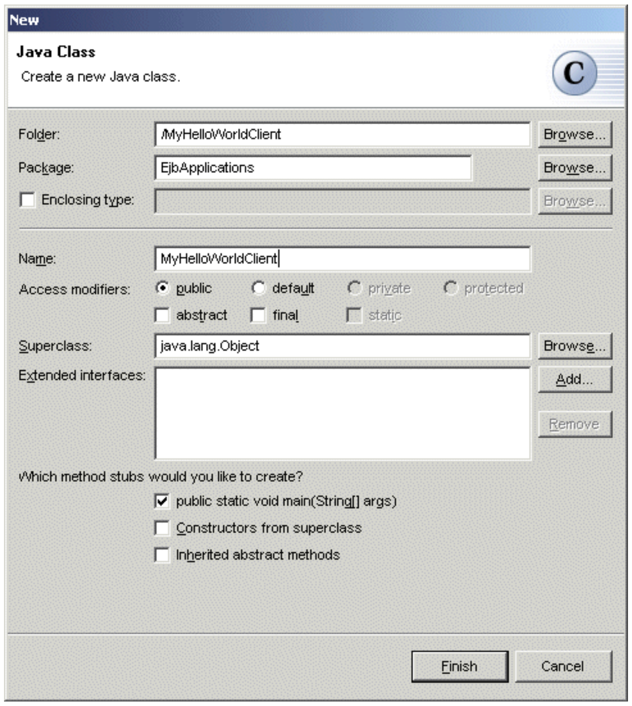
15. Right-click **HelloTestServlet.class** and select **Run on Server**.

The Web browser opens and displays the message, "`Message from Hello EJB: Hello from ITSO`."

10.1.3 Creating a Java client application that uses the EJB

The objective in this section is to create a client application that uses the HelloWorld bean created in 10.1.1, "Creating the HelloWorld bean in Application Developer" on page 316. To create a Java application that accesses the HelloWorld EJB, we follow these steps:

1. Switch to the Java perspective. Right-click and create a new Java project named *MyHelloWorldClient*.
2. Right-click the project and select **New-> Class**.
3. In the Java Class window, enter the package name and the class name as shown in Figure 10-19.



Folder: /MyHelloWorldClient
Package: EjbApplications
☐ Enclosing type:
Name: MyHelloWorldClient
Access modifiers: [✓ public] default private protected
☐ abstract ☐ final ☐ static
Superclass: java.lang.Object
Extended interfaces:
Which method stubs would you like to create?
☑ public static void main(String[] args)
☐ Constructors from superclass
☐ Inherited abstract methods

Figure 10-19 Creating a Java class

4. Select the **public static void main(String[] args)** check box. Click **Finish** to create the Java program.
5. Double-click to open the **HelloWorldClient.java** file and enter the code shown in Example 10-4 in the main method.

Example 10-4 Client application logic

```
try {
   // Get the J2EE name space context
   Properties p = new Properties();
   p.put(
   Context.INITIAL_CONTEXT_FACTORY,"com.ibm.websphere.naming.WsnInitialContextFactory");
      String provider_url = args[0];
      p.put(Context.PROVIDER_URL, "iiop://" + provider_url);
      InitialContext initCtx = new InitialContext(p);
   // Look up the EJB
      System.out.println("Before lookup " + "url = " + provider_url);
      Object o = initCtx.lookup("HelloWorld");
      MyHelloWorldHome home =
       (HelloWorldHome) javax.rmi.PortableRemoteObject.narrow(o, HelloWorldHome.class);
      MyHelloWorld myEJB = home.create();
   // Retrieve the text message from the EJB
      String msg = myEJB.printHello();
      System.out.println();
      System.out.println("Message from Hello EJB: " + msg);
      System.out.println();
      System.out.println("HelloClient ran successfully.");
   }
   catch (Throwable t) {
      t.printStackTrace();
```

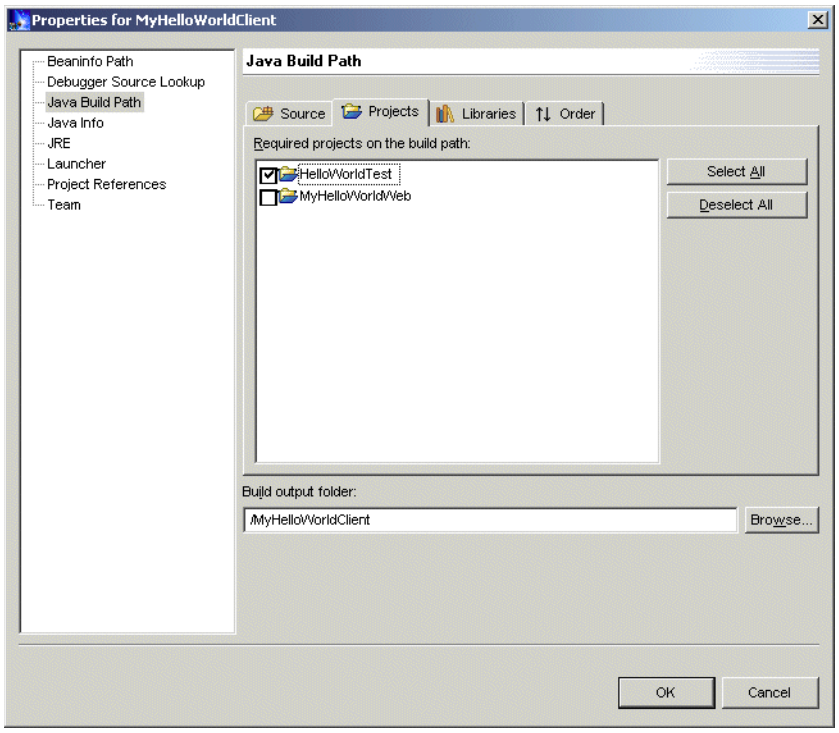
```
    }
    //Required if prompted by security
    System.exit(0);
```

6. Add the import statements shown in Example 10-5. The code is similar to the servlet created in 10.1.2, "Creating a servlet that uses the EJB" on page 322.

Example 10-5 Adding import statements

```
import com.ibm.itso.roch.ejbtest.HelloWorld.*;
import java.util.*;
import javax.naming.*;
```

7. Save the work. You still see some errors, but we can resolve them by setting properties for the Java build.
8. Right-click **MyHelloWorldClient** and select **Properties**.
9. We need to set the Java Build Path for the client application. Select **Java Build Path** in the properties window. In the right pane, select the **Projects** tab and select the EJB project as shown in Figure 10-20.



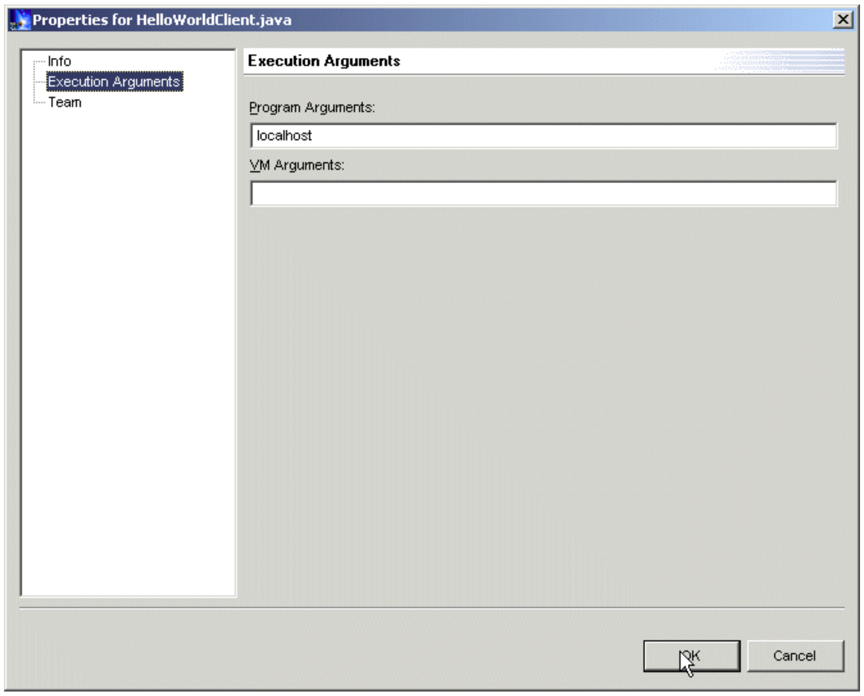
Required projects on the build path:
[✓] HelloWorldTest
[ ] MyHelloWorldWeb

Build output folder: /MyHelloWorldClient

Figure 10-20 Java Build Path

10. Click the **Libraries** tab and select **Add External Jars**.
11. Locate the **j2ee.jar** file and add it to the libraries list. It is found in the <AD install>\plugins\com.ibm.etools.websphere.runtime\lib directory.
12. Select **Launcher**. In the right pane, select **Java Application** from the drop-down list.
13. Click **OK** to close the Properties dialog and save your changes.
14. Right-click **HelloWorldClient.java** and select **Properties**.

15. Type `localhost` in the Program Arguments text box as shown in Figure 10-21.



Program Arguments: localhost

VM Arguments:

Figure 10-21 Properties for the client application

16. Click **OK** and save the work.

Attention: There are two Java Runtime Environments (JRE) that come with Application Developer. The Workbench is run by the one found in <install-dir>\jre. A second JRE is provided by WebSphere that is a prerequisite to run WebSphere applications. Java projects and J2EE application client projects use the workbench's JRE by default. You get the `java.lang.NoClassDefFoundError: com/ibm/rmi/iiop/GIOPVersionException` exception when you try to obtain the InitialContext.

You need to switch the JRE of your Java projects or J2EE application client projects to use WebSphere's JRE:

a. Open the **Window-> Preference** dialog. Under the Java section, select **Installed JREs**.

b. Add a new JRE. The JRE home directory is <install-dir>\plugins\com.ibm.etools.server.jdk\jre.

c. Open the Properties dialog of the project. Select JRE. Select **Use custom JRE for launching** and the newly added JRE.

17. Make sure the server is running. Click the **Run** button on the toolbar.

18. Select **Java Application**.

19. Application Developer switches to the Debug view. You see the following messages in the Console view:

```
Running the J2EE Application Client HelloEJB Sample
Before lookup url = localhost
-- lookup was successful
-- narrow was successful
-- create was successful
```

```
Message from HelloEJB: Hello from ITSO
HelloClient ran successfully.
```

10.2 Building Java applications with Application Developer

In this section, we use Application Developer to build a Java application similar to the RPG OrderEntry application discussed in Chapter 7, “Overview of the OrderEntry application” on page 231. To make it easy to reuse the classes that we build for our application, we separate the access to the iSeries server from the graphical user interface. We create a package named *Support*, which contains a number of support classes.

Figure 10-22 shows the classes contained in the Support package. The ItemsDb class is responsible for all access to the iSeries server. It uses the Enterprise JavaBeans described in Chapter 8, “iSeries EJB application development scenario” on page 245, to access the iSeries server.

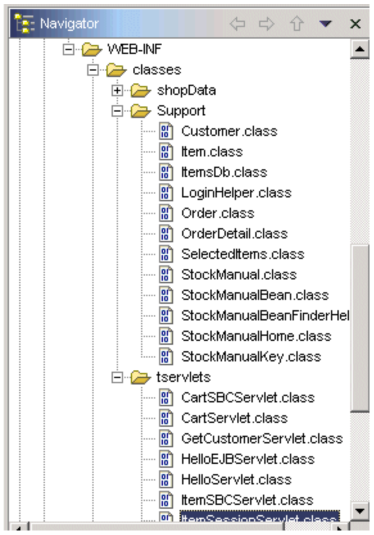


Figure 10-22 The Support package

The following list shows the other Support package classes that are supporting classes for applications:

- **Customer**: An object-oriented representation of a Customer table row
- **Item**: An object-oriented representation of an Item table row
- **Order**: An object-oriented representation of an Order table row
- **OrderDetail**: An object-oriented representation of an OrderLine table row

10.2.1 The ItemsDb class

This section investigates the ItemsDb class. It provides a level of abstraction for client applications. The goal is to allow client applications to use the Enterprise JavaBeans without having to deal with the implementation details and complexity. We look at how the ItemsDb class accesses the iSeries resources. The following key methods are provided:

- The `getInitialContext` method creates an InitialContext object.
- The `connect` method establishes a connection to the Java server.
- The `getAllCustomers` method retrieves a list of customers from the server.
- The `getItems` method retrieves a list of items from the server.

- The `findRangeOfItems` method retrieves a subset of items from the server.
- The `verifyCustomer` method verifies that a customer number is valid.
- The `confirmOrder` method places and confirms an order.
- The `submitOrder` method places and confirms an order using a shopping cart.
- The `connectStateless` method establishes a stateless connection to the Java server for servlets.
- The `submitOrderStateless` method places an order given a customer ID and a shopping cart.

All the methods in the ItemsDb class, except `connectStateless` and `submitOrderStateless`, use the OrderEntryClerk session Enterprise JavaBean to access iSeries resources. The stateless methods use the OrderPlacement stateless session EJB.

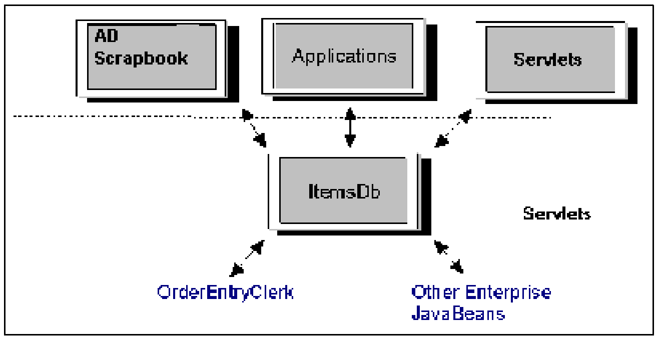


Figure 10-23 Interface to the ItemsDb class

Our intent is to create an access class that is capable of running on its own. That is, you can use it even without any user interfaces. As shown in Figure 10-23, the advantage of this approach is that you can use the access class in any context. For example, you can use a graphical user interface (GUI) on top of the access class when you want to create a stand-alone Java application. You also use exactly the same class when you want to develop a Java servlet. In this case, replace the GUI frontend with a layer that is capable of running as a servlet. You can also implement a distributed application where some parts of the application run on a server. Our implementation using Enterprise JavaBeans is an example of this. When we call the methods of the Enterprise JavaBeans, we are actually running code on the server.

Separating the layers properly and using a clean and well-defined interface between the layers is important if you want to take advantage of object orientation.

To use Enterprise JavaBeans in an application, you must be able to access them. The way a client program accesses enterprise beans is defined by two interfaces:

- Home interface
- Remote (EJBObject) interface

The home interface contains methods that describe how you can instantiate an enterprise bean object. The remote interface, by comparison, defines the methods of an enterprise bean that can be accessed by your user program. To access an enterprise bean, your user program goes through the following steps:

1. Obtains a context to the name server (name service context).
2. Looks up the home of the enterprise bean using the name service context.
3. Creates an enterprise bean instance from the enterprise bean home, which returns an enterprise bean proxy object.
4. Accesses the remote methods of the enterprise bean instance through an enterprise bean proxy object. Each call to the enterprise bean proxy object is a remote call that can throw an exception, such as javax.ejb.EJBException.

Import statements

Example 10-6 shows the class description for the ItemsDb class. You must import classes from the javax.naming, javax.ejb, and java.rmi packages to use Enterprise JavaBeans. You must also import the interfaces for the Enterprise JavaBeans that you use. They are found in the com.ibm.itso.roch.wasejb package.

Example 10-6 The ItemsDb class description

```
import java.math.*;
import java.util.*;
import com.ibm.itso.roch.wasejb.*;
import javax.ejb.*;
import javax.naming.*;
import java.rmi.RemoteException;
import java.rmi.Remote;
import java.util.*;
import java.io.*;
public class ItemsDb extends java.lang.Object {
```

The getInitialContext method

To use the Java server and the Enterprise JavaBeans, you need to access the Java server's Java Naming Directory Interfaces (JNDI) naming service. This is done by instantiating an InitialContext object. You use the `getInitialContext` method to create the InitialContext object. The code is shown in Example 10-7.

Example 10-7 The getInitialContext method

```
public static Context getInitialContext() throws Exception {
   Properties p = new Properties();
   try {
      p.put(Context.INITIAL_CONTEXT_FACTORY,
                 "com.ibm.websphere.naming.WsnInitialContextFactory");
      p.put(Context.PROVIDER_URL, "iiop://" +
                 getSystemName() + ":" + getPort());
      System.out.println("port: " + getPort());
      System.out.println("user: " + getUserId());
      System.out.println("password: " + getPassword());
      System.out.println("system: " + getSystemName());
      InitialContext cx = new InitialContext(p);
      return cx;
   } catch (Exception e) {
      System.out.println("error creating Context " + e.getMessage());
      e.printStackTrace();
      throw (e);
   }
}
```

The InitialContext object is actually the naming service. When it is instantiated, it uses the name of the service provider and the URL where it is located. In this example, we use the IBM WebSphere Advanced Edition JNDI naming service. We pass in the name of the server and the TCP/IP port number in the URL. Optionally, you can use a user ID and password. It is important to notice that this is a user ID and password for the naming service provider, not for the system. This is not the same as the iSeries user profile security.

The connect method

The `connect` method is used to connect to the Java server. The `connect` method is shown in Example 10-8.

Example 10-8 The connect method

```
public String connect() throws Exception {
      try{
      Context ctx = getInitialContext();
      java.lang.Object tempObject= ctx.lookup("OrderEntryClerk");
      OrderEntryClerkHome home =
      (OrderEntryClerkHome)javax.rmi.PortableRemoteObject.narrow(
      (org.omg.CORBA.Object) tempObject,
      com.ibm.itso.roch.wasaejb.OrderEntryClerkHome.class);
      clerk = (OrderEntryClerk) home.create();
      } catch (FinderException fe) {
      System.out.println ("Could not find order clerk " + fe.getMessage());
      return ("Could not find order clerk " + fe.getMessage());
      } catch (Throwable t) {
      System.out.println ("Could not connect " + t.getMessage());
      return ("Could not connect " + t.getMessage());
      }
      System.out.println("Connected to " + getSystemName() +":" + getPort());
      return "Connected to " + getSystemName() +":" + getPort();
}
```

You call the `getInitialContext` method to create an InitialContext object. After the InitialContext object is created, the home interface for the bean must be located. You accomplish this through a method call to the `lookup` method of the InitialContext object.

The home interface for the bean is located by name. The application programmer only needs to know the name of the interface and the class type that is returned. Because the InitialContext object returns any type that is registered with it, the application programmer must cast to the correct type.

You use the static `narrow()` method to cast the java.lang.Object returned by the lookup method to the correct home interface type. The `narrow()` method takes the object to be narrowed and the class of the EJB home object to be returned as parameters. We use the home interface to create an instance of the OrderEntryClerk EJB, which we name *clerk*. The clerk object knows how to do many things associated with the order entry system. For example, the clerk can perform the following tasks:

- Return a list of items from the Item table
- Return a list of customers from the Customer table
- Validate a customer number
- Create an order on the iSeries server

We use the OrderEntryClerk object named clerk to handle the application processing.

The getAllCustomers method

The `getAllCustomers` method retrieves all the rows from the iSeries Customer table. Example 10-9 shows the code.

Example 10-9 The getAllCustomers method

```
public java.util.Vector getAllCustomers() {
   java.util.Vector tempCust = new java.util.Vector();
   try {
      tempCust = clerk.findAllCustomers();
   } catch (Exception e) {
      System.out.println(":::::::::::::: Unexpected Error ::::::::::::::");
      e.printStackTrace();
   }

   return tempCust;
```

To retrieve all customers, you call the OrderEntryClerk's `findAllCustomers()` method. It returns a vector containing information for all customers. The vector contains a String array element for each customer in the Customer table. The String array contains entries that correspond to the fields in the rows of the Customer table. You return the vector to the caller of this method.

The getItems method

The `getItems` method retrieves all rows from the iSeries Item table. Example 10-10 shows the code.

Example 10-10 The getItems method

```
public java.util.Vector getItems() {
   try {
      ejbItems = clerk.findAllItems();

   } catch (Exception e) {
      System.out.println(":::::::::::::: Unexpected Error ::::::::::::::");
      e.printStackTrace();
   }
   System.out.println("all items returned");
   return ejbItems;
}
```

To retrieve all items, you call the OrderEntryClerk's `getItems()` method. It returns a vector containing all items. The vector contains a String array element for each item in the Item table. The String array contains entries that correspond to the fields in the rows of the Item table. You return the vector to the caller of this method.

The findRangeOfItems method

The `findRangeOfItems` method retrieves a subset of rows from the Items table. Example 10-11 shows the code.

Example 10-11 The findRangeOfItems method

```
public java.util.Vector findRangeOfItems(String itemnoMin, String itemnoMax) {
   try {
   ejbItems = clerk.findRangeOfItems(itemnoMin,itemnoMax);
   } catch (Exception e) {
      System.out.println(":::::::::::::: Unexpected Error ::::::::::::::");
      e.printStackTrace();
   }
   System.out.println("all items returned");
   return ejbItems;
}
```

To retrieve a subset of items, you call the OrderEntryClerk's `findRangeOfItems` method. You pass it parameters containing the value of the first item and the value of the last item to return. It returns a vector containing all items within the range. You return the vector to the caller of this method.

The verifyCustomer method

The `verifyCustomer` method verifies that a customer number contains a valid row in the Customer table. Example 10-12 shows the code.

Example 10-12 The verifyCustomer method

```
public boolean verifyCustomer(String customerId)
{
   boolean isValid = false;
   System.out.println("isValid = " + isValid);
   try
   {
      isValid = clerk.verifyCustomer(customerId);
       System.out.println("isValid = " + isValid);
      if (isValid)
         validCustomerId = customerId;
   }
   catch (Exception e)
   {
      return isValid;
   }
   return isValid;
}
```

To verify that a customer exists in the Customer table, you call the OrderEntryClerk's `verifyCustomer` method. You pass it a parameter containing the customer number. It returns a boolean that is true or false, depending on whether the customer is valid. You return the boolean to the caller of this method.

The submitOrder method

When you are ready to submit an order for processing on the iSeries server, you use the `ItemsDb submitOrder` method. It, in turn, uses methods provided by the OrderEntryClerk bean. Example 10-13 shows the code.

Example 10-13 The submitOrder method

```
public String submitOrder(Order anOrder) throws Exception {
   try {
      OrderDetail orderLine = null;
      //set the customer number
      clerk.setCustomer(anOrder.getCustomer().getId().toString());
      BigDecimal orderLineCount = new BigDecimal(anOrder.getOrderDetails().size());
      for (java.util.Enumeration itemE = anOrder.getOrderDetails().elements();
         itemE.hasMoreElements();) {
         orderLine = (OrderDetail) itemE.nextElement();
         clerk.addOrderLine(orderLine.getItem().getId(),
          orderLine.getQuantity());
      }
      // place the order
      String orderNumber = clerk.placeOrder();
      return orderNumber;
   } catch (Exception e) {
      throw (e);
         }
}
```

We use the following steps to submit an order:

1. Set the name of the customer using the `setCustomer` method.
2. Pass in as parameters, the item number and the quantity for each item you want to order using the `addOrderLine` method of the OrderEntryClerk.
3. Place the order using the `placeOrder` method of the OrderEntryClerk. It returns the order number of the order that is created.
4. Return the order number to the caller of this method.

The `submitOrder` methods demonstrates one of the key advantages of using Enterprise JavaBean technology. You only need to know what the bean does and how to interface to it. Do not be concerned with the details of how it accomplishes its task. If you want to implement the order processing logic in your application without using Enterprise JavaBeans, the application code is much more complex because you must provide the code that does the database access and order processing.

The stateless methods

To properly support servlet clients, we provide two stateless methods in the ItemsDb class that don't use the OrderEntryClerk session bean at all – `connectStateless` and `submitOrderStateless`. The only constraint to using these methods is that the `connectStateless` method must be called before the `submitOrderStateless` method. These methods are similar to the `connect` and `submitOrder` methods, but use the OrderPlacement session bean (stateless) instead of the OrderEntryClerk session bean.

The `connectStateless` method (Example 10-14) provides a connection to the OrderPlacement session bean.

Example 10-14 The connectStateless method

```
public String connectStateless() throws Exception {

   try {
      Context ctx = getInitialContext();
      java.lang.Object tempObject= ctx.lookup("java:comp/env/OrderPlacement");

      OrderPlacementHome home = (OrderPlacementHome)javax.rmi.PortableRemoteObject.narrow(
             (org.omg.CORBA.Object) tempObject,
             com.ibm.itso.roch.wasaejb.OrderPlacementHome.class);
      OrderPlacer = (OrderPlacement) home.create();

   } catch (FinderException fe) {
      System.out.println("Could not find order placer " + fe.getMessage());
      return ("Could not find order placer " + fe.getMessage());
      } catch (Throwable t){
```

```
      t.printStackTrace();
      return ("Could not connect " + t.getMessage());
   }
   return "Connected to " + getSystemName() + ":" + getPort();
}
```

The `submitOrderStateless` method, shown in Example 10-15, is used by a client application to place an order. It calls the `placeOrder` method of the OrderPlacement session bean. The input parameters for this method are a string containing the customer ID and a vector containing the items to order. It returns the order number of the new order.

Example 10-15 The submitOrderStateless method

```
public int submitOrderStateless(String CustID, Vector OrderLines) throws Exception {
   int returnvalue;
   try {
      returnvalue = (int)OrderPlacer.placeOrder("0001", "1", CustID, OrderLines);
   } catch (Exception e) {
      throw (e);
   }
   return returnvalue;
}
```

10.2.2 Using the ItemsDb class

Now let's put it all together. First, we run the ItemsDb class using only scripts in the Application Developer Scrapbook. We create a new instance of the ItemsDb class and call its connect method. The ItemsDb class also provides methods to set values for the user ID, password, TCP/IP port, and system name.

Example 10-16 Testing the ItemsDb class in the Application Developer Scrapbook

```
Support.ItemsDb aItemsDb = new Support.ItemsDb();
aItemsDb.setUserId("cpwejb");
aItemsDb.setPassword("cpwejb400");
aItemsDb.setPort("900");
aItemsDb.setSystemName("localhost");
aItemsDb.connect();
```

To run the code (Example 10-16) in the Application Developer Scrapbook, select and highlight it, right-click, and select **Run**. To help test the code, we write messages to the Java console using the `System.out.println` method. In this example, we connect to the Java server running on the local system and listening on port 900. If the server is active and the security information is valid, we see the following message on the Java console.

```
Connected to localhost:900
```

If this is successful, we try to retrieve information from the Customer table on the server. To accomplish this, we use the `getAllCustomers` method from the ItemsDb class. Example 10-17 shows the code.

Example 10-17 Retrieving customers using the scrapbook

```
Support.ItemsDb aItemsDb = new Support.ItemsDb();
aItemsDb.setUserId("cpwejb");
aItemsDb.setPassword("cpwejb400");
aItemsDb.setPort("900");
aItemsDb.setSystemName("localhost");
aItemsDb.connect();
java.util.Vector customerList = aItemsDb.getAllCustomers();
for (java.util.Enumeration e = customerList.elements(); e.hasMoreElements();) {
      String[] array = (String[]) e.nextElement();
      System.out.println(array[0] + " " + array[1]);
   }
```

If this is successful, we retrieve the rows from the Customer table and display the first two fields for each row on the Java console. The `getAllCustomers` method returns a vector. The vector contains a String array element for each customer in the Customer table. The String array contains entries that correspond to the fields in the rows of the Customer table. For each String array element, we print the first two array elements. Example 10-18 shows the Java console output.

Example 10-18 Displaying the customer file rows on the Java console

```
Connected to localhost:900
0001 OAKLEY
0002 BARBER
0003 ABLE
0004 WILLIS
0005 MULLEN-SCHULTZ
0006 MAATTA
0007 FAIR
0008 COULTER
0009 GOUDET
0010 LLAMES
```

In this section, we tested the ItemsDb class without using a graphical user interface. In the next section, we build a servlet based OrderEntry application. We use the ItemsDb class to access the iSeries server.

10.3 Building servlets

Servlets are inherently multithreaded. Recall that stateful session beans are used to maintain a state for one client. Even if multiple Web users may be accessing the servlet, multithreading makes it appear as if the servlet is one client. A state is not automatically maintained across method calls for each Web client. This means that if you're going to use a stateful session bean, you have to explicitly manage that connection.

The easiest and usually best way to connect servlets to session beans is to manage state information within the servlet, using stateless beans to perform business tasks. The *stateless* methods in the ItemsDb class do this.

As shown in Figure 10-24, we use two servlets. They are found in the tservlets package. They are ItemSessionServlet and CartServlet.

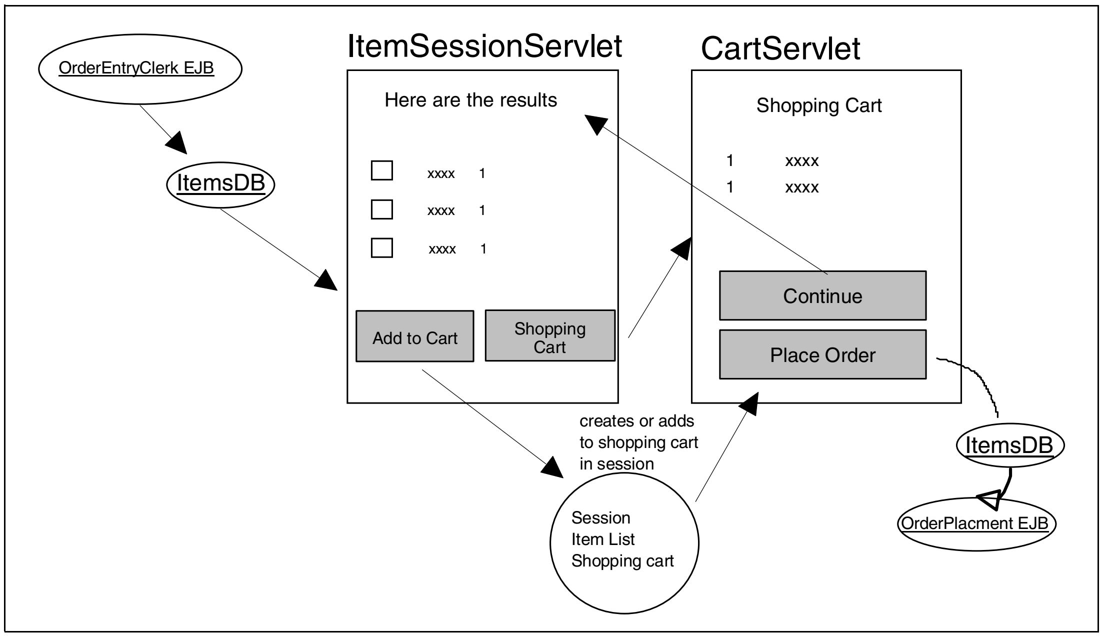


Figure 10-24 OrderEntry servlet architecture

ItemSessionServlet

The ItemSessionServlet servlet is fairly simple. It displays a list of the items available for ordering. It also allows the user to select items to add to their shopping cart. The connection occurs in exactly the same way as we saw previously in the application using the ItemsDb class.

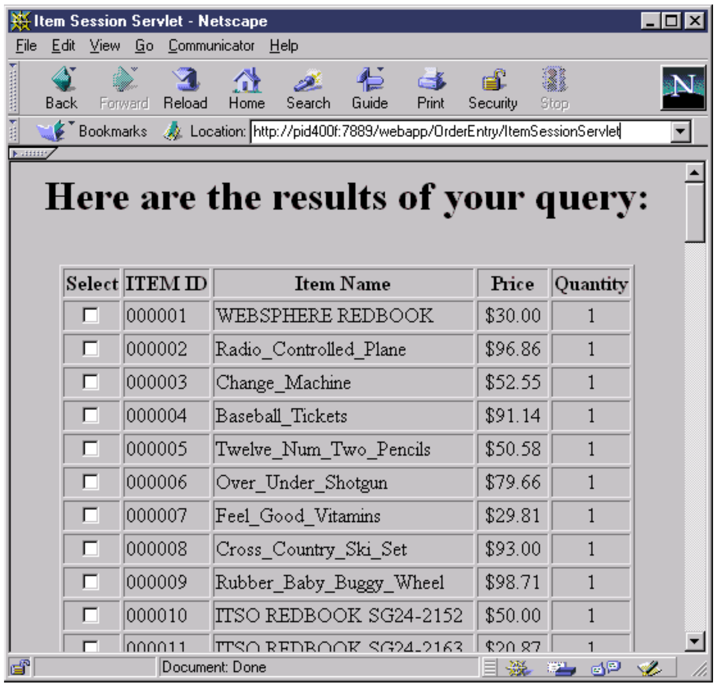
CartServlet

The CartServlet servlet is a command-driven servlet that supports adding items to a shopping cart and placing an order. It uses the ItemsDb class to actually place the order.

Servlet application flow

The application flow happens like this:

1. When the ItemSessionServlet is started, it connects to the OrderEntryClerk session bean using the ItemsDb class. It maintains this object, so all threads use the same object.
2. When a user executes the ItemSessionServlet, it causes the `doPost()` method to run. The `doPost()` method executes the `getAllItems()` method of the ItemsDb class. It returns a vector of items that is used to populate the items table displayed on the form. This is shown in Figure 10-25.

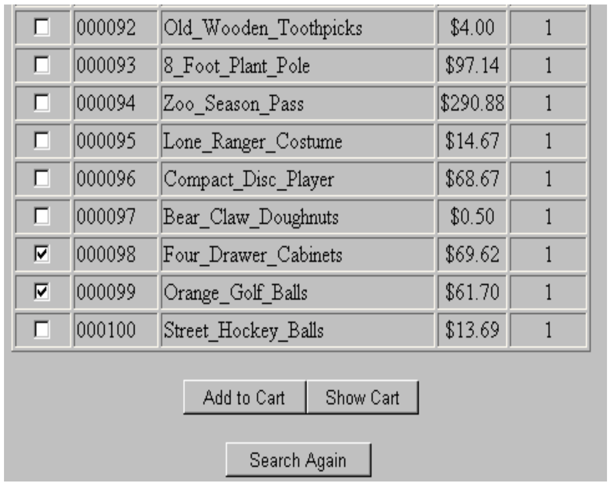

Item Session Servlet - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://pid400f:7889/webapp/OrderEntry/ItemSessionServlet
Document: Done

Here are the results of your query:

Select	ITEM ID	Item Name	Price	Quantity
☐	000001	WEBSPHERE REDBOOK	$30.00	1
☐	000002	Radio_Controlled_Plane	$96.86	1
☐	000003	Change_Machine	$52.55	1
☐	000004	Baseball_Tickets	$91.14	1
☐	000005	Twelve_Num_Two_Pencils	$50.58	1
☐	000006	Over_Under_Shotgun	$79.66	1
☐	000007	Feel_Good_Vitamins	$29.81	1
☐	000008	Cross_Country_Ski_Set	$93.00	1
☐	000009	Rubber_Baby_Buggy_Wheel	$98.71	1
☐	000010	ITSO REDBOOK SG24-2152	$50.00	1
☐	000011	ITSO REDBOOK SG24-2163	$20.87	1

Figure 10-25 The ItemSession servlet

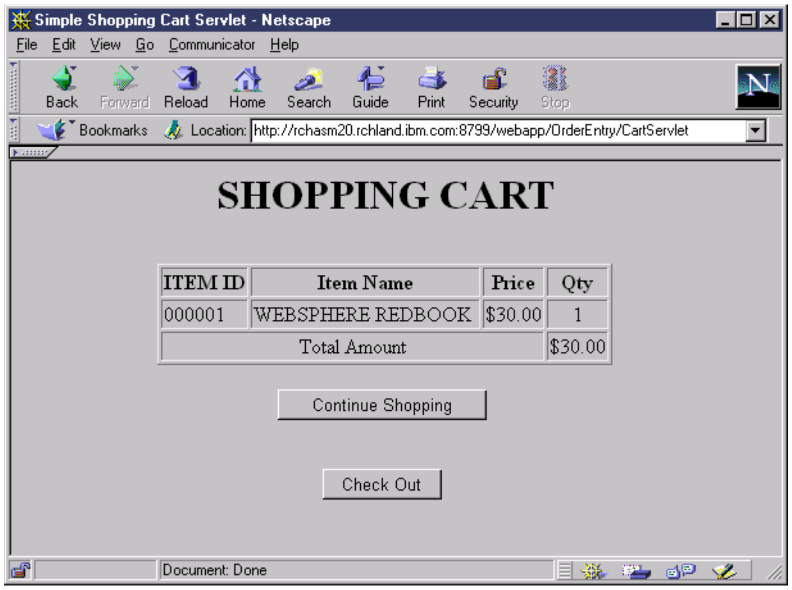
3. The user selects the items they want to order and clicks the **Add to Cart** button on the form (Figure 10-26).



☐	000092	Old_Wooden_Toothpicks	$4.00	1
☐	000093	8_Foot_Plant_Pole	$97.14	1
☐	000094	Zoo_Season_Pass	$290.88	1
☐	000095	Lone_Ranger_Costume	$14.67	1
☐	000096	Compact_Disc_Player	$68.67	1
☐	000097	Bear_Claw_Doughnuts	$0.50	1
☑	000098	Four_Drawer_Cabinets	$69.62	1
☑	000099	Orange_Golf_Balls	$61.70	1
☐	000100	Street_Hockey_Balls	$13.69	1

Figure 10-26 Add to Cart button

4. This posts the form to the CartServlet using the Add to Cart command. The form shown in Figure 10-27 appears. The CartServlet creates a shopping cart object in the servlet session object.


Simple Shopping Cart Servlet - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://rchasm20.rchland.ibm.com:8799/webapp/OrderEntry/CartServlet

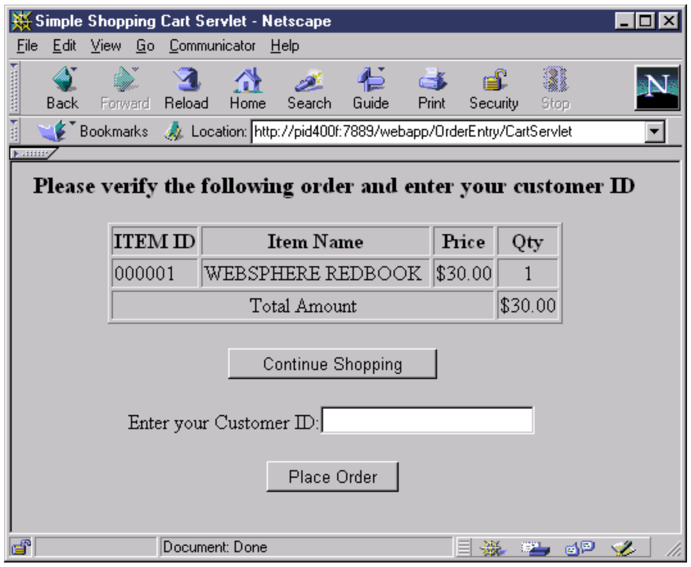
SHOPPING CART

ITEM ID	Item Name	Price	Qty
000001	WEBSPHERE REDBOOK	$30.00	1
Total Amount			$30.00

Continue Shopping
Check Out
Document: Done

Figure 10-27 The servlet shopping cart

5. When the user is done shopping, they can click the **Check Out** button on the form to place an order. This action passes the Check Out command to the CartServlet servlet.
6. The CartServlet servlet posts a verification form, shown in Figure 10-28, and requests a customer number.


Simple Shopping Cart Servlet - Netscape
File Edit View Go Communicator Help
Back Forward Reload Home Search Guide Print Security Stop
Bookmarks Location: http://pid400f:7889/webapp/OrderEntry/CartServlet

Please verify the following order and enter your customer ID

ITEM ID	Item Name	Price	Qty
000001	WEBSPHERE REDBOOK	$30.00	1
Total Amount			$30.00

Enter your Customer ID:

Continue Shopping
Place Order
Document: Done

Figure 10-28 CartServlet servlet

7. The user enters a customer number and clicks the **Place Order** button. This causes the `placeOrder` method, shown in Example 10-19, to be called. It calls the `connectStateless` and `submitOrderStateless` methods in the ItemsDb class, which in turn, connect to the OrderPlacement session bean (which is stateless) and submit the order.

Example 10-19 The placeOrder method in CartServlet

```
private void placeOrder(PrintWriter out, ShoppingCart cart, String custID) throws
IOException {
    flexLog("CartServlet: placeOrder()...");
         Vector OrderLines = new Vector();

      Vector cartItems = cart.getItems();
      if (cartItems.size() > 0) {
         for (int i = 0; i < cartItems.size(); i++) {
            CartItem citem = (CartItem) cartItems.elementAt(i);
            com.ibm.itso.roch.cpwejb.interfaces.OrderDetail thisOrderDetail
               = new com.ibm.itso.roch.cpwejb.interfaces.OrderDetail(citem.getItemId(),
                Float.valueOf(citem.getPrice().replace('$','0')).floatValue(),
                 1);
            OrderLines.addElement(thisOrderDetail);
         }; // end for
         try{
            ItemsDB MyItemsDB = new ItemsDb();
            MyItemsDB.connectStateless();
            out.println("<H3>Your order has been processed.</H3> <BR>");
            out.println("Order number : ");
            out.println(MyItemsDB.submitOrderStateless(custID, OrderLines));
            out.println("<BR><BR>Thanks for your business");
            out.flush();
         }
         catch (Exception e) {
            e.printStackTrace();
            out.println(e.getMessage());
         }
      }
}
```

10.4 Migration from EJB version 1.0 to version 1.1

This section describes features that are new or have changed in the EJB 1.1 specification. It also discusses migration issues for enterprise beans written to version 1.0 of the EJB specification. We mainly concentrate on the changes we made to the code while migrating the OrderEntry application from version 1.0 to version 1.1.

From the client's perspective, enterprise beans written to version 1.1 of the EJB specification appear nearly identical to enterprise beans written to version 1.0. From the application developer's perspective, the following changes need to be made to make enterprise beans written to version 1.0 of the EJB specification compatible with version 1.1 of the specification:

- Enterprise beans written to version 1.1 of the EJB specification are registered in a different part of the JNDI namespace. For example, a client can look up the initial context of a version 1.0 enterprise bean in JNDI by using the `initialContext.lookup()` method as follows:

  ```
  initialContext.lookup("com/ibm/Hello")
  ```

  The JNDI lookup for the equivalent version 1.1 enterprise bean is:

  ```
  initialContext.lookup("java:comp/env/ejb/Hello")
  ```

- The return value of the `ejbCreate()` method must be modified for all entity beans using CMP. The `ejbCreate()` method is now required to return the same type as the primary key; the actual value returned must be null.

- You must define and implement an `ejbCreate()` method for each way in which you want a new instance of an enterprise bean to be created. For each `ejbCreate()` method that you provide for an entity bean, you must also define a corresponding `ejbPostCreate()` method. Each `ejbCreate()` and `ejbPostCreate()` method pair must correspond to a specific `create()` method in the home interface that has the same number and types of arguments.
- The `EJBContext getEnvironment()` method is deprecated. Use the JNDI naming context java:comp/env to access the enterprise beans environment. For example, the code in version 1.0 looks like this:

  ```
  ds = (DataSource) initCtx.lookup("jdbc/” +
  getEntityComtext().getEnvironment().getProperty(“dataSourceName”);
  ```

  The EJB version 1.1 of the code looks like this:

  ```
  String dataSourceName = (String)initCtx.lookup(“java:comp/env/dataSourceName”);
  ds = (DataSource) initCtx.lookup("jdbc/” + dataSourceName);
  ```
- Throwing the java.rmi.RemoteException exception from the bean implementation is deprecated in version 1.1. This exception should be replaced by the javax.ejb.EJBException or a more specific exception such as the javax.ejb.CreateException. The javax.ejb.EJBException class inherits from javax.ejb.RuntimeException and does not need to be explicitly declared in the throws clause. Declare the javax.ejb.EJBException exception in the remote and home interfaces, as required by RMI.

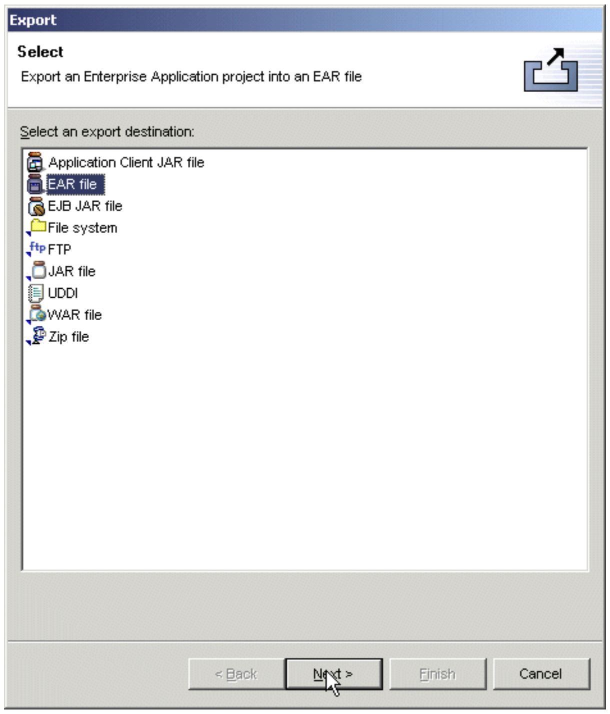
10.5 Installing the OrderEntry application on the server

In this section, we install the OrderEntryApp enterprise application on WebSphere Application Server Advanced Edition using the Administrative Console. We export the .ear file from Application Developer and then deploy it on the WebSphere Application Server Version 4.0 Advanced Edition.

10.5.1 Generating the OrderEntry enterprise application

To generate the OrderEntry enterprise application file, follow these steps:

1. Select **File-> Export** from the Application Developer main screen.
2. The Export window appears as shown in Figure 10-29. Click **Next**.


Export

Select

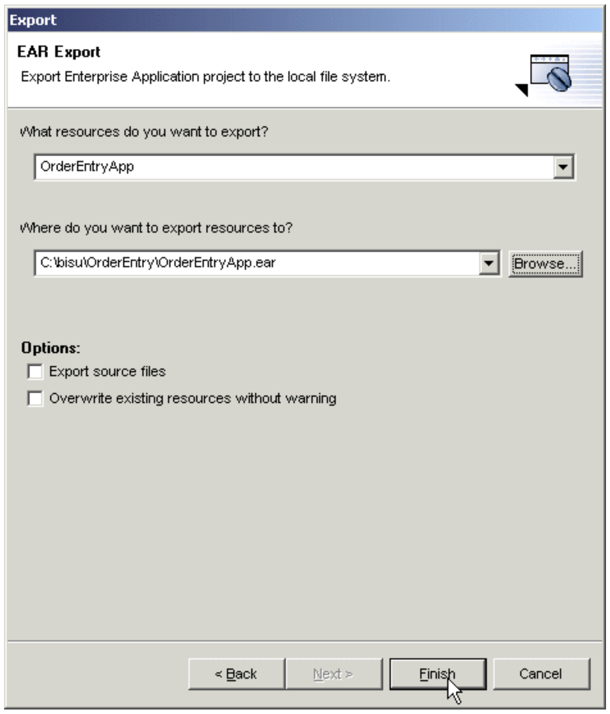
Export an Enterprise Application project into an EAR file

Select an export destination:

- Application Client JAR file
- EAR file
- EJB JAR file
- File system
- FTP
- JAR file
- UDDI
- WAR file
- Zip file

Figure 10-29 Exporting an Enterprise Application project

3. In the next window, select the **OrderEntryApp** resource from the drop-down list for the What resource do you want to export? field.
4. Enter a local folder for the Where do you want to export the resources to? field. Click **Finish** as shown in Figure 10-30.


Export

EAR Export

Export Enterprise Application project to the local file system.

What resources do you want to export?

OrderEntryApp

Where do you want to export resources to?

C:\bisu\OrderEntry\OrderEntryApp.ear

Options:

- Export source files
- Overwrite existing resources without warning

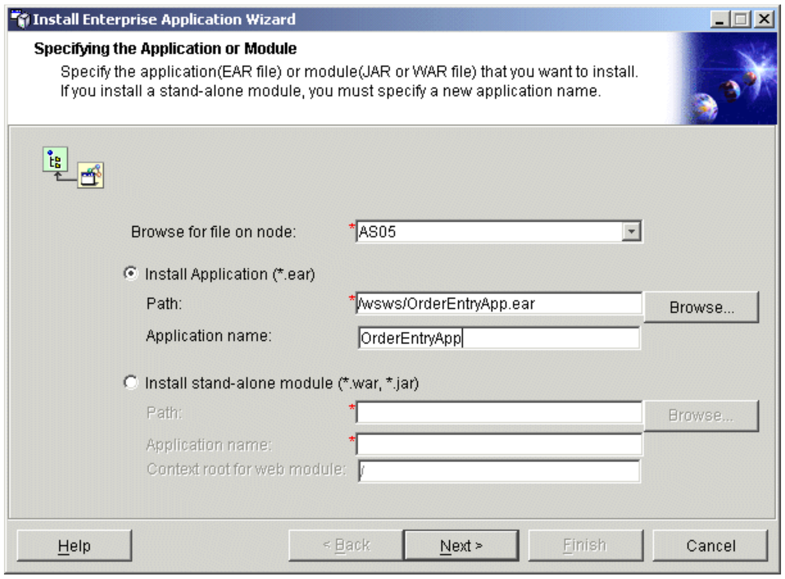
Figure 10-30 EAR export window

Once the OrderEntry application is exported, you can see the file in your local folder.

10.5.2 Deploying

First we copy the OrderEntryApp.ear file from our local drive to the iSeries IFS. We use the wsws directory. The Administrative Console can now access it when creating enterprise applications. To install the EAR file, follow these steps:

1. Open a command prompt window to start the Administrative Console. Wait until you see the message `Console Ready` in the Console.
2. In the Console, select the wizard icon and click **Install Enterprise Application**. The Specifying the Application or Module window displays, as shown in Figure 10-31. Make sure that the **Install Application radio** button is selected. Click the **Browse** button next to Path to locate the **OrderEntryApp.ear** file in the wsws directory. Enter `OrderEntryApp` for the Application name.


Install Enterprise Application Wizard

Specifying the Application or Module

Specify the application(EAR file) or module(JAR or WAR file) that you want to install.
If you install a stand-alone module, you must specify a new application name.

Browse for file on node: * AS05

(●) Install Application (*.ear)

Path: * /wsws/OrderEntryApp.ear

Application name: OrderEntryApp

( ) Install stand-alone module (*.war, *.jar)

Path: *

Application name: *

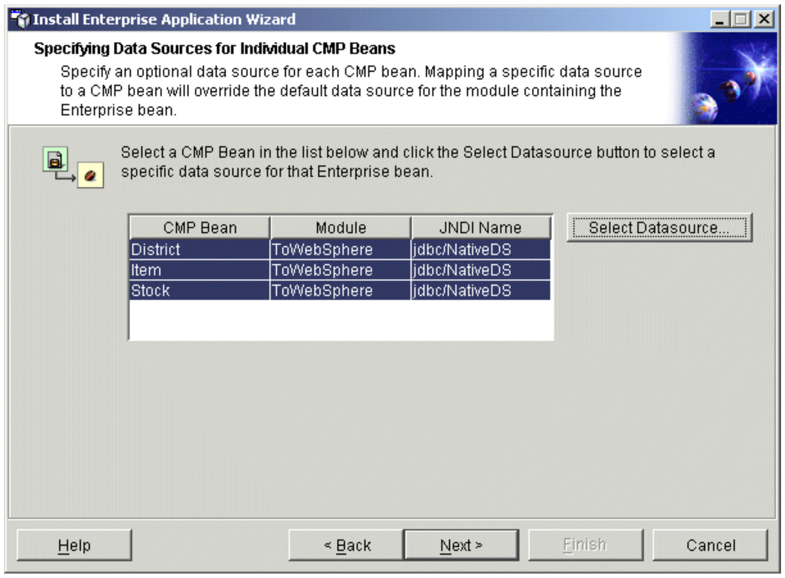
Context root for web module: /

Figure 10-31 Installing the application

3. Keep clicking **Next** until you see the Specifying the Default Datasource for EJB Modules window. Click the **Select Datasource** button. Select the **NativeDS** Datasource. Enter a user ID and password (twice) and click **OK**.

> **Note:** We use a data source named *NativeDS*. For information on how to create a data source for WebSphere Application Server 4.0, see the redbook *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server*, SG24-6815.

4. Click **Next**. In the Specifying Data Sources for individual CMP beans window, select all three of the CMP beans.
5. Click the **Select Datasource** button. Then select the **NativeDS** Datasource.
6. Enter a user ID and password (twice) and click **OK**. Now we have a Data Source for each CMP bean as shown in Figure 10-32.


Install Enterprise Application Wizard

Specifying Data Sources for Individual CMP Beans

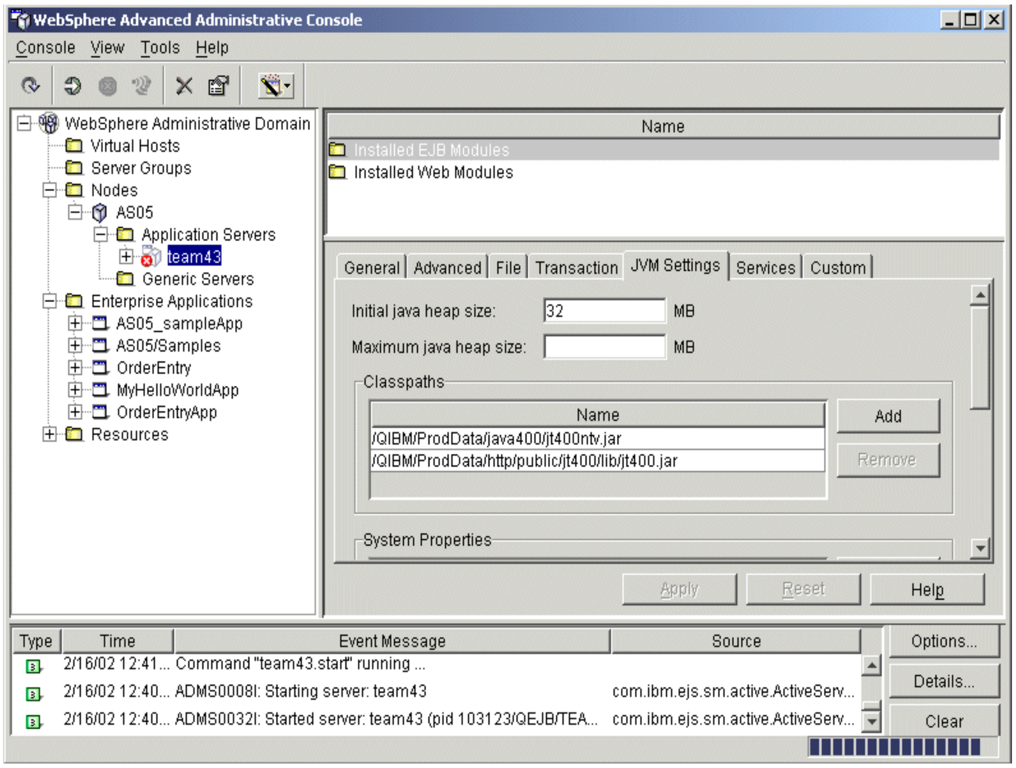
Specify an optional data source for each CMP bean. Mapping a specific data source to a CMP bean will override the default data source for the module containing the Enterprise bean.

Select a CMP Bean in the list below and click the Select Datasource button to select a specific data source for that Enterprise bean.

CMP Bean	Module	JNDI Name
District	ToWebSphere	jdbc/NativeDS
Item	ToWebSphere	jdbc/NativeDS
Stock	ToWebSphere	jdbc/NativeDS

Figure 10-32 Specifying Data Sources for CMP beans

7. Keep clicking **Next** until you see the Completing the Application Installation window.
8. Click **Finish** to install the application. When the Regenerate the application dialog displays, click **No**.
9. Now we have successfully installed the OrderEntryApp enterprise application on WebSphere Application Server Version 4.0 Advanced Edition. We need to stop the server. Before we restart it, we set up the classpath to find the IBM Toolbox for Java classes used by this application. As shown as Figure 10-33, click the server in the console. Click the **JVM Settings** tab in the right pane. Add the following JAR files to the Classpath Settings and click **Apply**:
   - /QIBM/ProdData/Java400/jt400ntv.jar
   - /QIBM/ProdData/http/public/jt400/lib/jt400.jar



Initial java heap size: 32 MB

Maximum java heap size: MB

Name
/QIBM/ProdData/java400/jt400ntv.jar
/QIBM/ProdData/http/public/jt400/lib/jt400.jar

Type	Time	Event Message	Source
	2/16/02 12:41...	Command "team43.start" running ...	
	2/16/02 12:40...	ADMS0008I: Starting server: team43	com.ibm.ejs.sm.active.ActiveServ...
	2/16/02 12:40...	ADMS0032I: Started server: team43 (pid 103123/QEJB/TEA...	com.ibm.ejs.sm.active.ActiveServ...

Figure 10-33 Setting the classpath

10. Restart the server to make the new application ready. For an external HTTP server, you need to regenerate the Web server plug-ins.
11. Finally test the application and see if everything works properly. To test the application, open the browser and enter the following URL:

    ```
    http://systemname:port/OrderEntry2/ItemSessionServlet
    ```

    Replace *systemname* with the name of your iSeries server and the *port* with the HTTP port number.

10.6 Conclusion

In this chapter, the focus of discussion was to create EJB applications using Application Developer. We discussed the steps to create a simple session EJB and then develop a servlet and application that uses the bean.

We also discussed the OrderEntry application in detail. It is an EJB-based version of the RPG OrderEntry application discussed in Chapter 7, “Overview of the OrderEntry application” on page 231.

11

Interfacing to legacy applications

When developing new e-business applications, you need to consider using already existing applications. In many cases, you have applications written in traditional iSeries languages that perform complex business logic. Rather than re-writing these applications to Java, you may want to interface with them from your new Java-based Web applications.

This chapter discusses using Enterprise JavaBeans to interface with legacy applications. In this case, we interface with the OrderEntry application discussed in Chapter 7, "Overview of the OrderEntry application" on page 231.

Sometimes you need some services from other applications that do not reside on your system. You can reach these applications using middleware software such as MQSeries. We show an example of using MQSeries to interface from Enterprise JavaBeans to other applications.

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11.1 Interfacing to legacy applications

There are a number of available options to call an existing traditional application from Java. Some of the most commonly used options are:

- **Distributed Program Call support** is available with IBM Toolbox for Java. You can pass parameters to and receive parameters back from an existing iSeries program. You must handle all conversions between the Java and iSeries format.
- **Program Call Markup Language (PCML)** is a tag language that helps you call iSeries programs while writing less Java code. PCML is based on XML, a tag syntax that you use to describe the input and output parameters for iSeries programs. PCML enables you to define tags that fully describe iSeries programs that will be called by your Java application.
- **Data queues** are iSeries objects that can be used to store data. They are convenient for passing information between applications. If you use a data queue to interface between a Java program and an existing iSeries non-Java program, you must handle data conversions.
- **Java Native Interface (JNI)** for Java is part of the Java Development Kit (JDK). JNI allows Java programs that run in a Java Virtual Machine (JVM) to operate with applications that are written in other languages such as C, C++, and RPG. The IBM Toolbox classes are easier to program than JNI. The advantage of JNI is that both the calling program and the called program run in the same process (job). The other methods start a new process. This makes JNI calls faster at start-up time and less resource intensive.

11.2 Modifying the RPG application

This section offers details about the transition of the RPG code on the host. The changes are made to allow the application to run in one of two modes: as a native application with 5250 display interaction or in conjunction with the OrderEntryClerk Enterprise JavaBean.

11.2.1 Processing the submitted order

The iSeries server RPG program that handles a request to submit an order is ORDENTR. When the OrderEntry application is run from an iSeries server 5250 session (no Java client), ORDENTR is the entry point of the application. It displays the 5250 windows that correspond to the Order Entry window in the Java client version. As shown in Figure 11-1, we use the IBM Toolbox for Java Distributed Program Call interface to call the ORDENTR program from the OrderEntryClerk EJB.

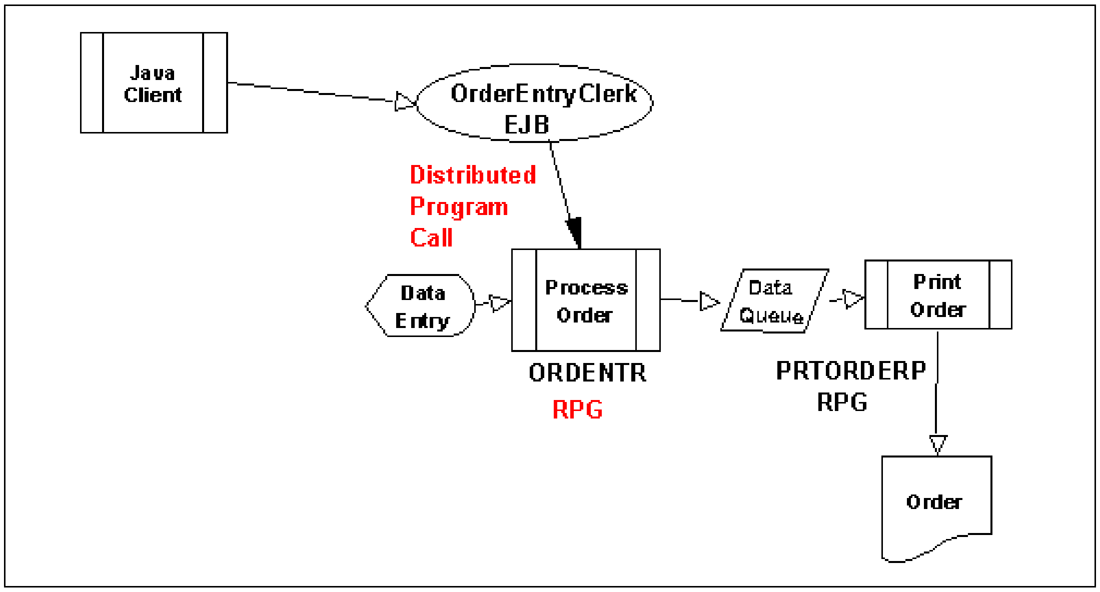


Figure 11-1 Calling the RPG program from an EJB

The ORDENTR program must be changed so that it recognizes the fact that it is being invoked from Java. First, the number of parameters are ascertained through the program status data structure using the following statements:

```
D PgmStsDS       SDS
D   NbrParms        *PARMS
```

If the number of parameters is greater than zero, it is assumed that the program has been invoked as a distributed program.

Since the Java client passes in two parameters, two data structures are declared that map to the parameters. The Enterprise JavaBean passes two strings. The first string is nine characters representing the customer ID (four characters) and the number of detail entries (five characters). A data structure named *CustDS* is declared for this first parameter using the following statements:

```
D CustDS          DS
D   CustNbr                           LIKE(CID)
D   OrdLinCnt                    5  0
```

The second parameter is a string that represents a contiguous grouping of detail entries. Each entry has a length of 40, and there are a maximum of 50 entries. A data structure named *OrderMODS* is declared for this parameter using the following statements:

```
D OrderMODS       DS                  OCCURS(50)
D   PartNbrX                          LIKE(IID)
D   PartDscX                          LIKE(INAME)
D   PartPriceX                   5  2
D   PartQtyX                     5  0
```

An entry parameter list is added to the initialization subroutine. This ensures that the data structures are loaded with the parameter values passed in using the following statements:

```
C     *ENTRY        PLIST
C                   PARM                    CustDS
C                   PARM                    OrderMODS
```

As in the other RPG programs, the USROPN keyword is added to the file specification since the file is not opened when invoked as a distributed program. The portion of the file specification with the USROPN keyword is added using the following statements:

```
 ...WORKSTN SFILE(ORDSFL:SflRrn) USROPN
```

The mainline logic of the program is changed to check the number of parameters. If there are parameters, a new subroutine called CmtOrder2 is invoked, and all display file processing is bypassed using the following statements:

```
C                    IF        NbrParms > *ZERO
C                    EXSR      CmtOrder2
C                    EXSR      EndPgm
C                    ENDIF
```

The CmtOrder2 subroutine is similar to the original CmtOrder subroutine. However, it retrieves the order information from the CustDS and OrderMODS data structures rather than from the display file and sub-file records.

11.3 Enhancing the Java application

The Program Call feature of IBM Toolbox for Java allows a Java program to directly execute any non-interactive program object (*PGM) on the iSeries, passing parameters and returning results through parameters. The Java developer must use the data conversion classes from IBM Toolbox for Java to convert input parameters from the Java format to an iSeries data type and convert output parameters from the iSeries format to a Java format.

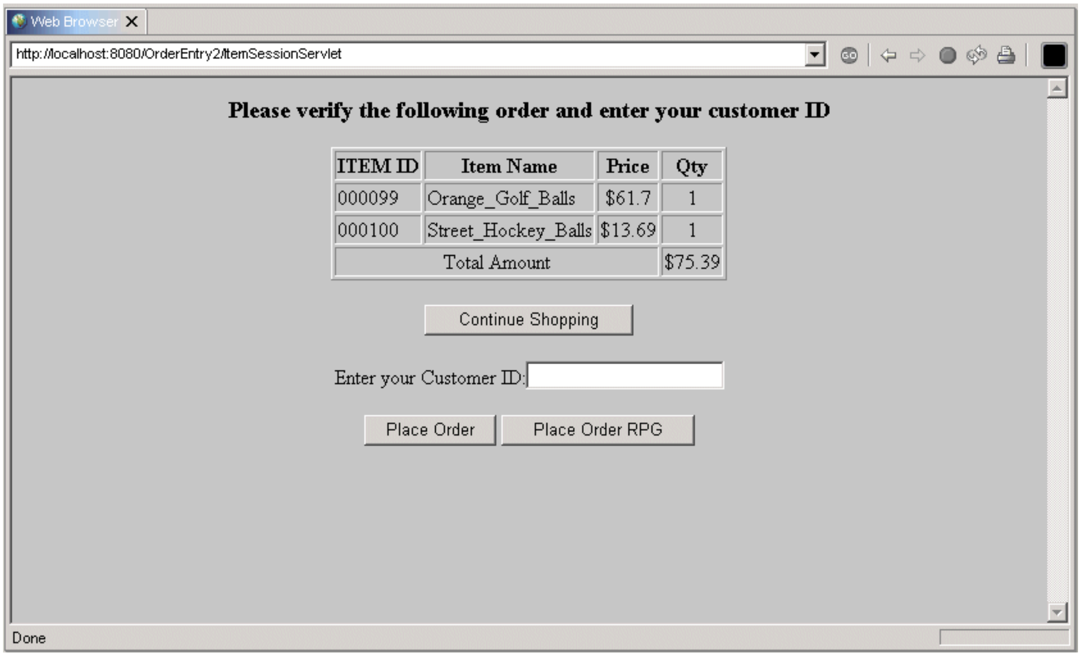
The advantage of using the Distributed Program Call classes is that native non-interactive programs can be executed in your Java application unchanged. Native program calls can also result in better performance of your Java application when compared with JDBC. In addition, this interface can call programs on the iSeries that do more than just database access. For example, a Java application can call a program that starts nightly job processing, saves libraries to tape, or sends or receives data via communication lines.

11.3.1 Changing the CartServlet servlet

The CartServlet is the responsible for showing the customer's cart with the selected items and allowing the customer to place an order. In the original application, the CartServlet uses EJBs to do the placement of the order. We change the CartServlet servlet to interface with the RPG program.

Adding the Place Order RPG option

We change the CartServlet to provide a second option for placing an order. As shown in Figure 11-2, we add a new button labeled Place Order RPG. Clicking this button calls the RPG program to place the order.



Please verify the following order and enter your customer ID

ITEM ID	Item Name	Price	Qty
000099	Orange_Golf_Balls	$61.7	1
000100	Street_Hockey_Balls	$13.69	1
Total Amount			$75.39

Figure 11-2 Placing an order

As shown in Example 11-1, the `outputOrderForm` method in the CartServlet program is updated to display the new button.

Example 11-1 The updated outputOrderForm method

```
private void outputOrderForm(PrintWriter out, ShoppingCart cart) throws IOException {
   flexLog("CartServlet: outputOrderForm()...");
   try{out.println("<CENTER>");
      out.println("<H3> Please verify the following order and enter your customer
         ID</H3>");
      out.println("<FORM  METHOD=POST   ACTION=\"/OrderEntry2/ItemSessionServlet\" >");
      out.println("<CENTER>");
      outputCartTable(out, cart);
      out.println("<BR><INPUT TYPE=submit value=\"Continue Shopping\" name=\"partno\">");
      out.println("</CENTER>");
      out.println("</FORM>");
      out.println("<FORM  METHOD=POST   ACTION=\"/OrderEntry2/CartServlet\" >");
      out.println("Enter your Customer ID:<INPUT TYPE=TEXT name=\"custid\"> <BR><BR>");
      out.println("<INPUT TYPE=submit value=\"Place Order\" name=\"command\">");
      out.println("<INPUT TYPE=submit value=\"Place Order RPG\" name=\"command\">");
      out.println("</CENTER>");
      out.println("</BODY></HTML>");
      flexLog("CartServlet: outputOrderForm() executed.");
   } catch (Exception e) {
      e.printStackTrace();
      flexLog(e.getMessage());
   }
} // end outputItemInformation()
```

Managing Place Order input in CartServlet

Why can we use a single parameter to check whether you click the Place Order or Place Order RPG button? It is because we give both buttons the name command. We check the value of the command button to determine which button was clicked. When the customer clicks the Place Order RPG button, the CartServlet receives the input through the `doPost` method. The value of the parameter determines what to do. As shown in Example 11-2, if the value is *Place Order RPG*, the `doPost` method calls the `placeOrderRPG` method.

Example 11-2 Changing the doPost method

```
      else if (parameter.equalsIgnoreCase("Place Order RPG")){
         String custID = request.getParameter("custid");
         if (null == custID) custID="";
           // Make sure next order is clean
           session.invalidate();
           placeOrderRPG(out, cart, custID);
      }
```

Creating the placeOrderRPG method

The `placeOrderRPG` method is shown in Example 11-3.

Example 11-3 The CartServlet placeOrderRPG method

```
private void placeOrderRPG(PrintWriter out, ShoppingCart cart, String custID) throws
IOException {
       flexLog("CartServlet: placeOrder()...");
      Vector OrderLines = new Vector();

      Vector cartItems = cart.getItems();
      if (cartItems.size() > 0) {
         for (int i = 0; i < cartItems.size(); i++) {
            CartItem citem = (CartItem) cartItems.elementAt(i);
            com.ibm.itso.roch.cpwejb.interfaces.OrderDetail thisOrderDetail
               = new com.ibm.itso.roch.cpwejb.interfaces.OrderDetail(citem.getItemId(),
                 Float.valueOf(citem.getPrice().replace('$','0')).floatValue(),
                 1);
            OrderLines.addElement(thisOrderDetail);
         }; // end for
         try{
            MyItemsDB.connectStateless();
            out.println("<FORM METHOD=\"get\"
               ACTION=\"/OrderEntry2/ItemSessionServlet\">");

            out.println("<H3>Your order has been processed by an RPG program.</H3> <BR>");
            out.println("Order number : ");
            out.println(MyItemsDB.submitOrderStatelessRPG(custID, OrderLines));
            out.println("<BR><BR>Thanks for your business<BR><BR>");

            out.println("<BR><BR><INPUT TYPE=submit value=\"Shop Some More...\"
                name=\"command\">");

            out.flush();
         }
         catch (Exception e) {
            e.printStackTrace();
            out.println(e.getMessage());
         }
      }
}
```

This method retrieves the items from the shopping cart and adds them to a vector. It uses the ItemsDb class to interface with the OrderPlacement EJB. An instance of the ItemsDb class named MyItemsDB is instantiated. The MyItemsDB object `submitOrderStatelessRPG` method is called to submit the order to the server. The customer number and the vector containing the items to order are passed to this method. The `submitOrderStatelessRPG` method returns the order number, and it is displayed on the browser.

11.3.2 Changing the ItemsDb class

We add a new method to the ItemsDb class named `submitOrderStatelessRPG`.

Example 11-4 The ItemDb submitOrderStatelessRPG method

```
public int submitOrderStatelessRPG(String CustID, java.util.Vector OrderLines) throws
Exception {
   int returnvalue;
   try {
      returnvalue = (int)OrderPlacer.placeOrderRPG("0001", 1, CustID, OrderLines);
   } catch (Exception e) {
      throw (e);
   }
   return returnvalue;
}
```

OrderPlacer is an instance of the OrderPlacement session EJB. We call its `placeOrderRPG` method. Four parameters are passed in. The warehouse ID and district ID are set to “0001” and 1 respectively. The customer number and a vector containing the items to order are passed in. If everything works successfully, the `placeOrderRPG` method returns the order number of the order created.

11.3.3 Changing the OrderPlacement session bean

Now we need to enhance the OrderPlacement session bean to call the RPG program to place an order. We add a new method to the OrderPlacement bean named `placeOrderRPG`. This is the method that is called from the ItemsDb class as we saw in the previous topic. We also add a new internal method to OrderPlacement named `submitOrder(String header, String detail)`. The `submitOrder` method contains the actual IBM Toolbox for Java calls. It is called from the `placeOrderRPG` method. It cannot be called from a client application because we do not add it to the remote interface.

First, we use Application Developer to externalize the name of the program to call. We also store the iSeries user ID and password to use when creating the AS400 object. To add these values to the bean properties, follow these steps:

1. In the WebSphere Application Developer, open the J2EE perspective, as shown in Figure 11-3.

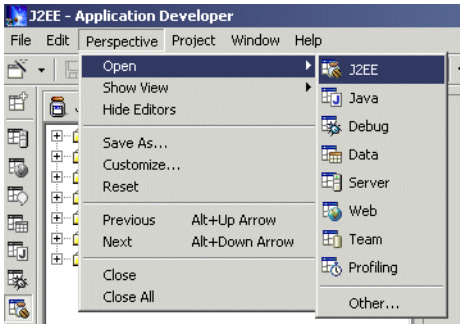


Figure 11-3 Opening the J2EE perspective

2. In the J2EE view, expand **EJB Modules**.
3. Right-click the **ToWebSphere** EJB Module and select **Open With-> EJB Editor** as shown in Figure 11-4.

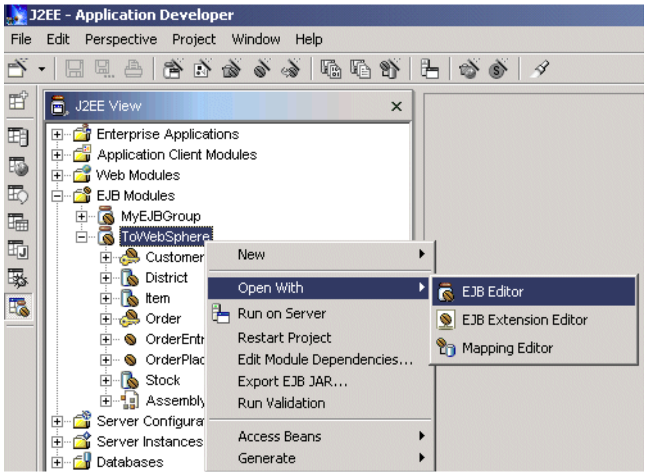


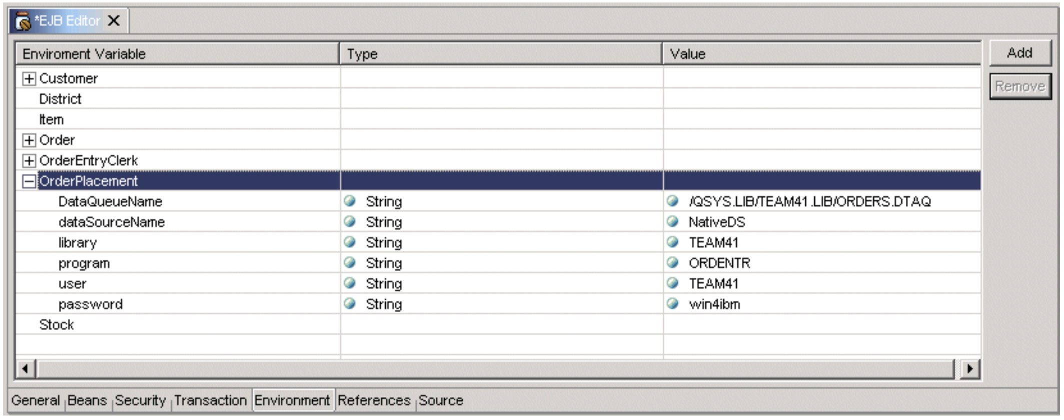
Figure 11-4 Opening the EJB Editor

4. Go to the Environment pane.
5. Select the **OrderPlacement** EJB and click the **Add** button.
6. Select (New Variable) and change it to `dataSourceName`.
7. Select the value column for the dataSourceName property and enter `NativeDS`.
8. Add the variables as shown in Table 11-1.

Table 11-1 Properties for OrderPlacement EJB

Environment variable	Type	Value
DataQueueName	String	/QSYS.LIB/TEAM41.LIB/ORDERS.DTAQ
library	String	TEAM41
program	String	ORDENTR
user	String	A valid user ID
password	String	A valid password

Figure 11-5 shows the EJB editor with all the environment variables.



Enviroment Variable	Type	Value
⊞ Customer		
District		
Item		
⊞ Order		
⊞ OrderEntryClerk		
⊟ OrderPlacement		
DataQueueName	● String	● /QSYS.LIB/TEAM41.LIB/ORDERS.DTAQ
dataSourceName	● String	● NativeDS
library	● String	● TEAM41
program	● String	● ORDENTR
user	● String	● TEAM41
password	● String	● win4ibm
Stock		

Figure 11-5 EJB Editor - Environment pane

The placeOrderRPG method

Now we create the `placeOrderRPG` method as shown in Example 11-5.

Example 11-5 The placeOrderRPG method

```
public float placeOrderRPG(String wID, int dID, String cID, java.util.Vector orderLines)
throws EJBException {
   System.out.println("into placeOrderRPG");
   String orderNumber = null;
   String custID = cID;
   Vector items = orderLines;
   try {
      // Maximum of 50 order lines
      String numLines = null;
      if (items.size() >= 10)
         numLines = "000" + Integer.toString(items.size());
      else
         numLines = "0000" + Integer.toString(items.size());
      String header = custID + numLines;
      String details = null;
      InitialContext initCtx = new InitialContext();
      ItemHome iHome = (ItemHome) initCtx.lookup("Item");
      for (int i = 0; i < items.size(); i++) {
         OrderDetail od = (OrderDetail) items.elementAt(i);
         Item item = iHome.findByPrimaryKey(new ItemKey(od.getItemID()));
         String qty;
         if (od.getItemQty() < 10)
            qty = "0000" + Integer.toString(od.getItemQty());
         else
            qty = "000" + Integer.toString(od.getItemQty());
         StringBuffer priceBuffer = new StringBuffer(5);
         String priceString = Float.toString(item.getItemPrice());
         int decimalPosition = priceString.indexOf('.');
         String priceString1 = priceString.substring(0, decimalPosition);
         String priceString2 = priceString.substring(decimalPosition + 1);
         if (priceString2.length() == 1) {
            priceString2 += "0";
         }
         priceString = priceString1 + priceString2;
         for (int j = 0; j < 5 - priceString.length(); j++) {
                priceBuffer.append('0');
            }
            priceBuffer.append(priceString);
            // set the name making sure trailing blanks are there
            StringBuffer nameBuffer = new StringBuffer(24);
            nameBuffer.append(item.getItemName());
            for (int j = nameBuffer.length() + 1; j < 25; j++) {
                nameBuffer.append(' ');
            }
            if (details == null)
                details = od.getItemID() + nameBuffer + priceBuffer + qty;
            else
                details += od.getItemID() + nameBuffer + priceBuffer + qty;
        }
        // call the submitOrder method to place the order
        orderNumber = submitOrder(header, details);
        // Clear out the state of the session bean at this point
        items = new Vector();
        custID = null;
    } catch (Exception e) {
        throw new EJBException(e.getMessage());
    }
    return Float.parseFloat(orderNumber);
}
```

The `placeOrderRPG` method is responsible for calling the `submitOrder` method, which contains the actual IBM Toolbox for Java code that calls the RPG program.

Before we call the `submitOrder` method, we set two parameters:

- The first parameter is a string that is a concatenation of the customer ID and the number of entries in the order. This data is fixed in length. The first four bytes are designated for the customer ID, while the last five bytes are for the number of entries. This character data will be interpreted as two separate zoned numeric fields on the iSeries server. These nine bytes of data are the first nine bytes in the string returned by the `Order.toString()` method.
- The second parameter is a block of character data that represents an array corresponding to the order information. Each element in the array corresponds to an item to be ordered. Each row is a fixed length String with the different elements of an entry beginning at the following offsets:
  - item id: offset 0
  - item desc: offset 6
  - item qty: offset 30
  - item price: offset 35

The submitOrder method

Calling a native iSeries program using The IBM Toolbox for Java Distributed Program Call class involves the following steps:

1. Connect to the iSeries server by creating an AS400 object.
2. Create a ProgramCall object.
3. Define and initialize a ProgramParameter array for passing parameters to and from the called program.
4. Use the Data Conversion classes to convert input parameter values from the Java to iSeries format.

5. Use the `setProgram` method to specify the qualified name of the program to call and parameters to use.
6. Execute the program using the `run` method.
7. If the `run` method fails, obtain detailed error information via AS400Message objects.
8. Retrieve output parameters using the `getOutputData` method of the ProgramParameter object.
9. Convert the output parameter values using the data conversion classes.

The data conversion classes provide the capability to convert numeric and character data between the iSeries and Java formats. Conversion may be needed when accessing iSeries data from a Java program. The data conversion classes support the conversion of various numeric formats and between various EBCDIC code pages and unicode.

The AS400DataType is an interface that defines the methods required for data conversion. A Java program uses data types when individual pieces of data need to be converted. Conversion classes exist for the following types of data:

- Numeric
- Text (character)
- Composite (numeric and text)

The data description classes build on the data conversion classes to convert all fields in a record with a single method call. The RecordFormat class allows the program to describe data that makes up a DataQueueEntry, ProgramCall parameter, a record in a database file accessed through record-level access classes, or any buffer of iSeries data. The Record class allows the program to convert the contents of the record and access the data by field name or index.

The IBM Toolbox for Java provides classes for building on the data types classes to handle converting data one record at a time instead of one field at a time. For example, suppose a Java program reads data off a data queue. The data queue object returns a byte array of iSeries data to the Java program. This array can potentially contain many types of iSeries data. The application can convert one field at a time out of the byte array by using the data types classes. Or, the program can create a record format that describes the fields in the byte array. That record then does the conversion.

Record format conversion can be useful when you are working with data from the program call, data queue, and record-level access classes. The input and output from these classes are byte arrays that can contain many fields of various types. Record format converters can make it easier to convert this data between the iSeries format and Java format.

Conversion with the record format uses three classes:

- *Field description* classes identify a field or parameter with a data type and a name.
- A *record format* class describes a group of fields.
- A *record class* joins the description of a record (in the record format class) with the actual data.

The `submitOrder` method, shown in Example 11-6, uses the IBM Toolbox for Java Distributed Program Call class (DPC) to call the RPG program named *ORDENTR*. It passes two parameters to the ORDENTR program. The first parameter contains information about the customer. The second parameter contains information about the items to order. The RPG program contains all the logic for creating an order and updating the appropriate tables.

Example 11-6 The submitOrder method

```
    private String submitOrder(String header, String detail) throws
            java.rmi.RemoteException {
  String newOrder = null;
  try {
        AS400 as400 = new AS400("localhost",
                    mySessionCtx.getEnvironment().getProperty("user"),
                    mySessionCtx.getEnvironment().getProperty("password"));
        ProgramCall ordEntrPgm = new ProgramCall(as400);
        QSYSObjectPathName pgmName = new

         QSYSObjectPathName(mySessionCtx.getEnvironment().getProperty("library"),
                    mySessionCtx.getEnvironment().getProperty("program"), "PGM");
        ProgramParameter[] parmList = new ProgramParameter[2];
    // set the first parameter which is the order header
        AS400Text text1 = new AS400Text(9);
        byte[] headerInfo = text1.toBytes(header);
        parmList[0] = new ProgramParameter(headerInfo, 9);
        AS400Text text2 = new AS400Text(detail.length());
        byte[] detailInfo = text2.toBytes(detail);
        parmList[1] = new ProgramParameter(detailInfo);
        ordEntrPgm.setProgram(pgmName.getPath(), parmList);
        if (ordEntrPgm.run() != true) {
            // If you get here, the program failed to run.
            // Get the list of messages to determine why
            // the program didn't run.
              AS400Message[] messageList = ordEntrPgm.getMessageList();
             throw new CpwejbException("OrderEntryClerkBean: " +
                  messageList[0].getText());
    }
        newOrder = ((String) (new AS400Text(9).toObject(parmList[0].getOutputData(),
                0))).substring(0, 4);
  } catch (Exception e) {
        throw new RemoteException("Error submitting order: " + e.getMessage());
  }
  return newOrder;
  }
```

We first create an AS400 object. The system name is localhost. Using the properties that we retrieve from the deployment descriptor, we set the user ID and password.

Next, we set the name of the program to call. Again we use properties to set these values. Before we call the program, we set two parameters:

- The first parameter is a string that is a concatenation of the customer ID and the number of entries in the order.
- The second parameter is a block of character data that represents an array corresponding to the order information.

After we run the program, we check to see whether the program is a success or failure. If the program fails, we retrieve the error messages. If it is successful, the new order number is returned in the first parameter. We return it to our caller.

In this example, an RPG program is called from an Enterprise JavaBean. The server must find the RPG program. This is accomplished by changing the current library for the user profile that calls the program to the library containing the program. In this case, the RPG program in stored in a library named *TEAM41*.

11.4 Using data queues to interface to legacy applications

A data queue is a system object that exists on the iSeries server. Data queues have the following characteristics:

- They can be accessed by many jobs simultaneously.
- They can be used to hold data being passed back and forth between jobs.
- Messages on a data queue are free format; fields are not required like they are in a database.
- The data queue is a fast means of communications between jobs on the iSeries server. This makes it an excellent way to communicate or synchronize iSeries jobs.
- The messages on a data queue can be ordered in one of three ways:
  - **LIFO**: The last message (newest) placed on the data queue is the first message taken off of the queue.
  - **FIFO**: The first message (oldest) placed on the data queue is the first message taken off of the queue.
  - **KEYED**: Each message on the data queue has a key associated with it. A message can only be taken off of the queue by requesting the key associated with it.

The DataQueue classes allow Java programs to interact with iSeries data queues. They provide a complete set of interfaces for accessing the iSeries data queues from your Java program. It is an excellent way to communicate between Java programs and iSeries programs. You can write the iSeries program in any language.

A required parameter of each data queue object is the AS400 object that represents the iSeries server that has the data queue or where the data queue is to be created. Using the data queue classes causes the AS400 object to connect to the server. Each data queue object requires the integrated file system path name of the data queue. The type for the data queue is DTAQ.

11.4.1 Interfacing to data queues from EJBs

As shown in Figure 11-6, we use data queue support to interface between the OrderPlacement enterprise bean and an RPG program named *PRTORDERP*. The RPG program prints order requests.

The OrderPlacement bean places order information on an iSeries data queue each time it places an order. PRTORDERP is a never-ending RPG program that runs in the batch subsystem. It waits for entries to appear on the data queue. When an entry appears, it uses the information to create a print request. The output produced by PRTORDERP is shown in Figure 11-7.

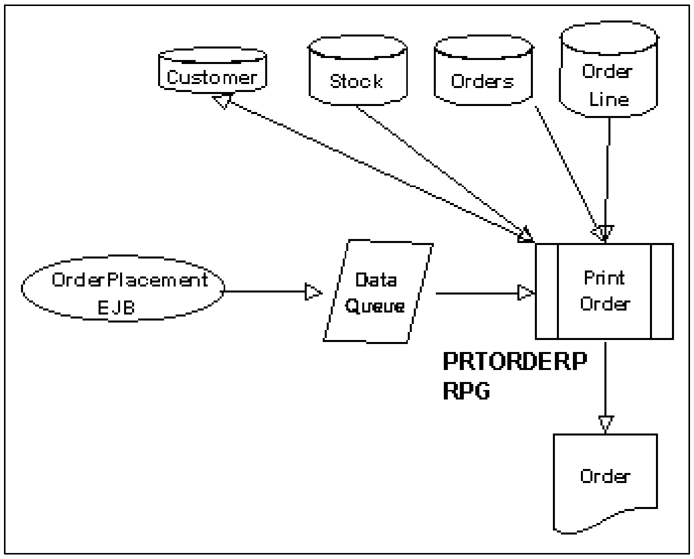
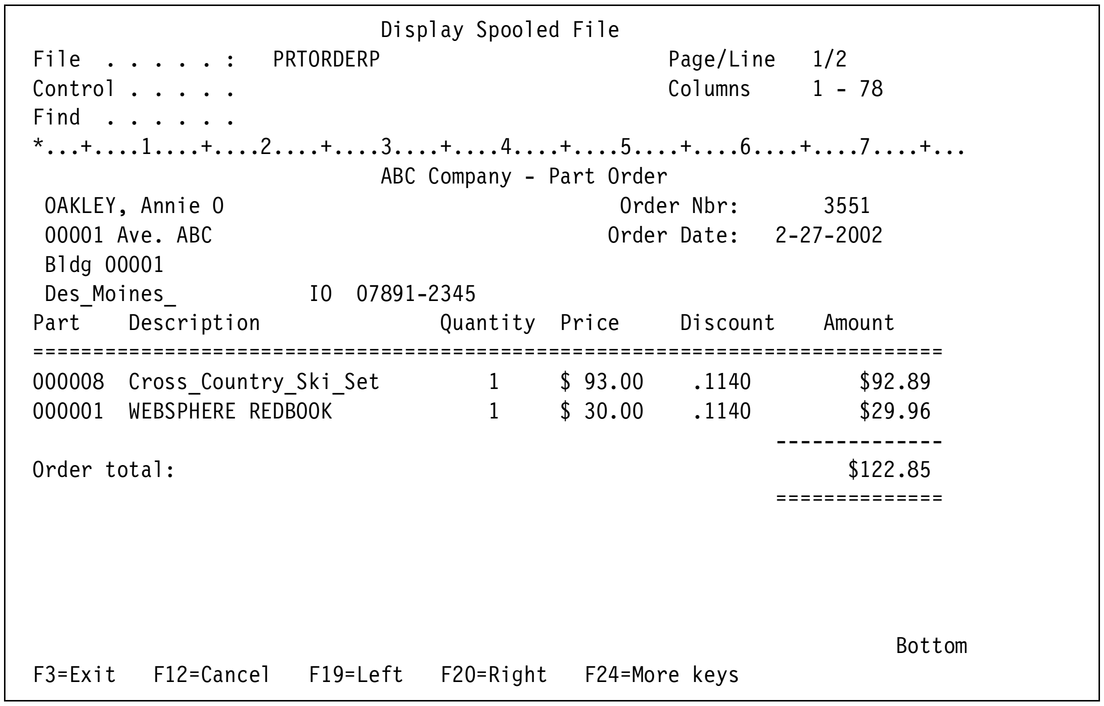


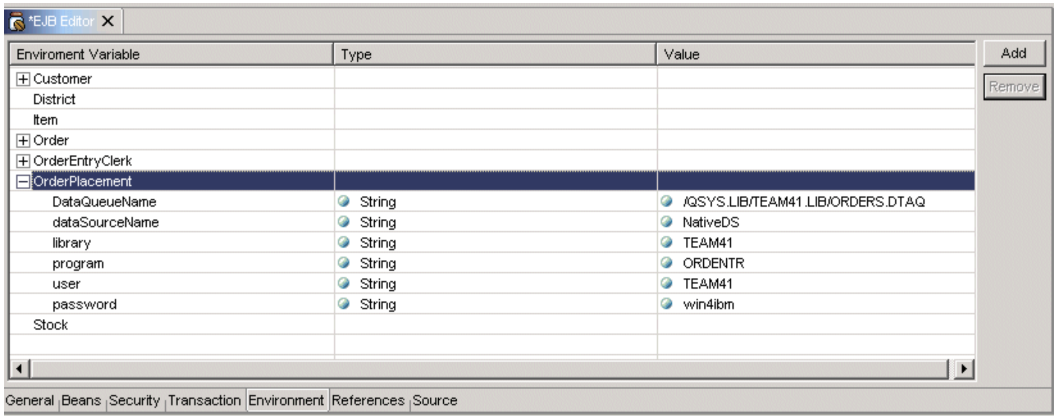
Figure 11-6 Using data queues to interface with RPG



```
                              Display Spooled File
File  . . . . . :   PRTORDERP                         Page/Line   1/2
Control . . . . .                                     Columns     1 - 78
Find  . . . . . .
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+...
                              ABC Company - Part Order
 OAKLEY, Annie O                                  Order Nbr:       3551
 00001 Ave. ABC                                  Order Date:   2-27-2002
 Bldg 00001
 Des_Moines_          IO  07891-2345
Part    Description              Quantity  Price     Discount    Amount
============================================================================
000008  Cross_Country_Ski_Set        1     $ 93.00    .1140         $92.89
000001  WEBSPHERE REDBOOK            1     $ 30.00    .1140         $29.96
                                                              --------------
Order total:                                                       $122.85
                                                              ==============




                                                                        Bottom
F3=Exit   F12=Cancel   F19=Left   F20=Right   F24=More keys
```

Figure 11-7   A printed order

Figure 11-8 shows the deployment descriptor used to externalize the name of the data queue. This helps us avoid having to make program changes when we want to change the name of the data queue.



Enviroment Variable	Type	Value
⊞ Customer		
District		
Item		
⊞ Order		
⊞ OrderEntryClerk		
⊟ OrderPlacement		
DataQueueName	String	/QSYS.LIB/TEAM41.LIB/ORDERS.DTAQ
dataSourceName	String	NativeDS
library	String	TEAM41
program	String	ORDENTR
user	String	TEAM41
password	String	win4ibm
Stock		

Figure 11-8   Setting the data queue name

11.4.2 The writeDataQueue method

We add the `writeDataQueue` method to the OrderPlacement EJB. It is called from the `placeOrder` method. It places the order information on the data queue so it can be read and printed by the RPG program. We do not add the `writeDataQueue` method to the remote interface because we do not want to make it available to client programs. It can only be called by methods of the OrderPlacement EJB. See Example 11-7.

Example 11-7 The writeDataQueue method

```
      private void writeDataQueue(String wID, int dID, String cID, float oID) throws
Exception {
 AS400 as400 = new AS400("localhost", "*current", "*current");
 CharacterFieldDescription as4CustomerID = new
                CharacterFieldDescription(new AS400Text(4), "customerID");
 PackedDecimalFieldDescription as4DistrictID = new
                PackedDecimalFieldDescription(new AS400PackedDecimal(3,0), "districtID");
 CharacterFieldDescription as4WarehouseID = new
                CharacterFieldDescription(new AS400Text(4), "warehouseID");
 PackedDecimalFieldDescription as4OrderID = new
                PackedDecimalFieldDescription(new AS400PackedDecimal(9,0), "orderID");
 String dataQueueName = props.getProperty("DataQueueName");
 DataQueue dqOutput = new DataQueue(as400, dataQueueName);

 RecordFormat rfOutput = new RecordFormat();
 rfOutput.addFieldDescription(as4CustomerID);
 rfOutput.addFieldDescription(as4DistrictID);
 rfOutput.addFieldDescription(as4WarehouseID);
 rfOutput.addFieldDescription(as4OrderID);
// Create wrappers for dID and oID because setField only works on objects.
       BigDecimal dIDObject = new BigDecimal(dID);
       BigDecimal oIDObject = new BigDecimal(oID);
      // Set up the data queue entry field values
       Record recordOutput = rfOutput.getNewRecord();
       recordOutput.setField("customerID", cID);
       recordOutput.setField("warehouseID", wID);
       recordOutput.setField("orderID", oIDObject);
       recordOutput.setField("districtID", dIDObject);
      // Send the data queue entry
       dqOutput.write(recordOutput.getContents());
       return;
   }  }
```

The AS400 object allows special values for system name, user ID, and password when the Java program is running on the iSeries Java Virtual Machine. They are *localhost* for system name and **current* for user ID and password.

When you run a program on the iSeries JVM, be aware of some special values and other considerations:

- If the system name, user ID, or password is not set on the AS400 object, the AS400 object connects to the current system by using the user ID and password of the job that started the Java program.
- The special value, *localhost*, can be used as the system name. In this case, the AS400 object connects to the current system.
- The special value, **current*, can be used as the user ID or password on the AS400 object when the Java program is running on the JVM of one iSeries server and is accessing resources on another iSeries server. In this case, the user ID and password of the job that started the Java program on the source system are used when connecting to the target system.
- The Java program cannot set the password to "*current" if you are using record-level access. When you use record-level access, "localhost" is valid for system name and "*current" is valid for user ID. However, the Java program must supply the password.
- The value **current* works only on systems running at Version 4 Release 3 (V4R3) and later. The password and user ID must be specified on systems running at V4R2.

In this example, we use record format conversion. It can be useful when you are working with data from data queues. The input and output from these classes are byte arrays that can contain many fields of various types. Record format converters can make it easier to convert this data between the iSeries format and the Java format.

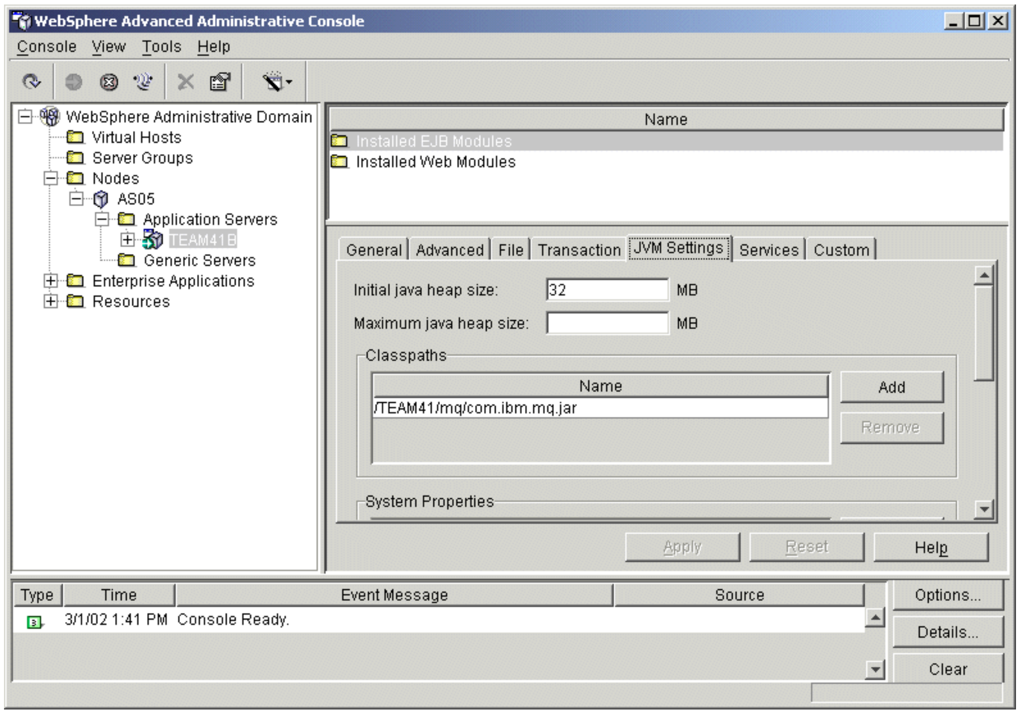
We show the call to write the entry to the data queue. Since we have set up a record format to handle the data conversions. We only have to set the fields of the record format before writing the entry to the data queue.

11.5 Using MQSeries to interface to legacy applications

MQSeries is a middleware product that runs on many platforms. It uses queues to allow applications to interface with other applications. It is similar to iSeries data queue support. However, data queue support only runs on the iSeries server. With MQSeries, you can interface to applications running on many different environments, including the iSeries server. The applications can be on the same system or different systems.

This section shows you how to send data to an MQSeries queue using Java application programming interfaces (APIs). These APIs allow you to integrate your application with any other application that can read messages from an MQSeries queue. We change the application discussed in 11.4, “Using data queues to interface to legacy applications” on page 363, to use an MQSeries queue instead of a data queue. This allows us to send the order information to any platform capable of running MQSeries.

The MQSeries API classes are included in the com.ibm.mq.jar file. To use MQSeries in Application Developer, you must add this file to the Java Build Path of your project properties. To run an application using MQSeries on WebSphere Application Server, you need to add this file to the classpath, as shown in Figure 11-9.



Initial java heap size: 32 MB
Maximum java heap size: MB

Name
/TEAM41/mq/com.ibm.mq.jar

Type	Time	Event Message	Source
	3/1/02 1:41 PM	Console Ready.	

Figure 11-9 Including the com.ibm.mq.jar file in the JVM settings

You can download this file from:
http://www.iseries.ibm.com/developer/ebiz/mqseries/mqjava400.html

When you use the MQSeries API, you must understand these concepts:

- *Hostname* is the machine that allocates the MQSeries server. This machine can be the same one that is running your application or a different one.
- *Queue Manager* provides message queueing services for applications.
- *Channel* connects an MQSeries client to a queue manager on a server system and transfers MQ calls and responses.
- *Queue* is an MQSeries object. Clients can put messages on, and get messages from, a queue.

11.5.1 The MQCon class

To encapsulate all the MQSeries APIs, we create a class that provides all the functionality that applications require. To make application methods easier to write, all the MQSeries functions are found in this class.

Declaration of the MQCon class

First we import the classes that are included into the com.ibm.mq package. We create the variables that define the MQSeries objects. These objects are hostname, queue manager, channel, and the queue. We also declare a queue manager object. The MQCon class is defined as shown in Example 11-8.

Example 11-8 The MQCon class definition

```
import com.ibm.mq.*;

public class MQCon
{
   private String hostname;
   private String qManager;
   private String channel;
   private String queue;

   private MQQueueManager qMgr;
```

The MQCon constructor

The constructor for the MQCon class (Example 11-9) accepts the values of the declared variables. When you create an MQCon object, you pass in hostname, queue manager, channel, and queue. In the constructor these parameters are set to the class variables. We also need to set the hostname and the channel for the MQSeries environment. We set two environment transport properties.

Example 11-9 The MQCon constructor

```
public MQCon(String hostname_, String qManager_, String channel_, String queue_)
{
   super();
   hostname = hostname_;
   qManager = qManager_;
   channel = channel_;
   queue = queue_;

   MQEnvironment.hostname = hostname;
   MQEnvironment.channel = channel;
   MQEnvironment.properties.put(MQC.TRANSPORT_PROPERTY,MQC.TRANSPORT_MQSERIES);
}
```

Connecting to the queue manager

We create a method to make the connection to the queue manager (Example 11-10). This method can be used when you need to interact with MQSeries. The method returns *true* if the connection is successful. You must handle an MQException that can be thrown when trying to connect to the queue manager.

Example 11-10 The connectTOQM method

```
public boolean connectTOQM()
{
   boolean res = true;
   try
   {
      qMgr = new MQQueueManager(qManager);
      System.out.println("connected");
   }
   catch (MQException ex)
   {
      res = false;
      String resS = "ERROR MQSeries : Completion Code " + ex.completionCode +
                        " Reason Code " + ex.reasonCode;
      System.out.println(resS);
   }
   return res;
}
```

Putting messages in a queue

To put messages in the queue, we create a method named `putMQ` (Example 11-11). This method receives the message through a parameter. If the message is sent to the queue correctly, the method returns the message ID. If an error occurs, the method returns “ERROR” and an explanation of the error.

The method connects to the queue manager using the `connectTOQM` method. Then it opens the queue using simple options. A MQMessage instance is created, and we can write messages to it. Finally, we close the queue, disconnect from the queue manager, and return the message ID value.

Example 11-11 The putMQ method

```
public byte[] putMQ(String msg)
{
   byte[] res;
   try
   {
      if (this.connectTOQM())
      {
         int openOptions = MQC.MQOO_INPUT_AS_Q_DEF |
                      MQC.MQOO_OUTPUT;

         MQQueue mqQueue = qMgr.accessQueue(queue,
                                openOptions);
         MQMessage mqMsg = new MQMessage();
         mqMsg.writeUTF(msg);

         MQPutMessageOptions pmo = new MQPutMessageOptions();
         mqQueue.put(mqMsg, pmo);
         System.out.println("MQCon.putMQ():Message:<<" +
                         new String(mqMsg.messageId) + ">>" +
                         msg + "=");

         res = mqMsg.messageId;

         mqQueue.close();
         qMgr.disconnect();
      }
      else
      {
         res = new String("ERROR MQSeries connection:" + msg).getBytes();
      }
   }
   catch (MQException ex)
   {
      res = new String("ERROR MQSeries : Completion Code " + ex.completionCode +
                          " Reason Code " + ex.reasonCode).getBytes();
      System.out.println(res);
   }
   catch (java.io.IOException ex)
   {
      res = new String("ERROR MQSeries IO:"+ ex).getBytes();
      System.out.println(res);
   }
   return res;
}
```

Reading messages

We also create a method named `getMQ` (Example 11-12). This method is not necessary for our application, but we include it to show how to get a message from a queue. This method receives the message Id of the message to read.

The method connects to the queue manager using the `connectTOQM` method. A MQMessage instance is created. We read the message using the `readUTF` method. Finally, we close the queue, disconnect from the queue manager, and return the message.

Example 11-12 The getMQ method

```
public String getMQ(byte[] msgId)
{
   String res = "ERROR";

   try
   {
      if (this.connectTOQM())
      {
         int openOptions = MQC.MQOO_INPUT_AS_Q_DEF |
                           MQC.MQOO_OUTPUT;

         MQQueue mqQueue = qMgr.accessQueue(queue,
                                        openOptions);

         MQMessage retrievedMessage = new MQMessage();
         retrievedMessage.messageId = msgId;

         MQGetMessageOptions gmo = new MQGetMessageOptions();

         mqQueue.get(retrievedMessage, gmo);
         res = retrievedMessage.readUTF();

         System.out.println("MQCon.getMQ():Message:<<" +
                              new String(retrievedMessage.messageId) + ">>" +
                              res + "=");

         mqQueue.close();
         qMgr.disconnect();
      }
      else
      {
         res = "ERROR MQSeries connection";
      }
   }
   catch (MQException ex)
   {
      res = "ERROR MQSeries : Completion Code " + ex.completionCode +
                              " Reason Code " + ex.reasonCode;
      System.out.println(res);
   }
   catch (java.io.IOException ex)
   {
      res = "ERROR MQSeries IO:"+ ex;
      System.out.println(res);
   }

   return res;
}
```

11.5.2 Including MQSeries in the OrderEntry application

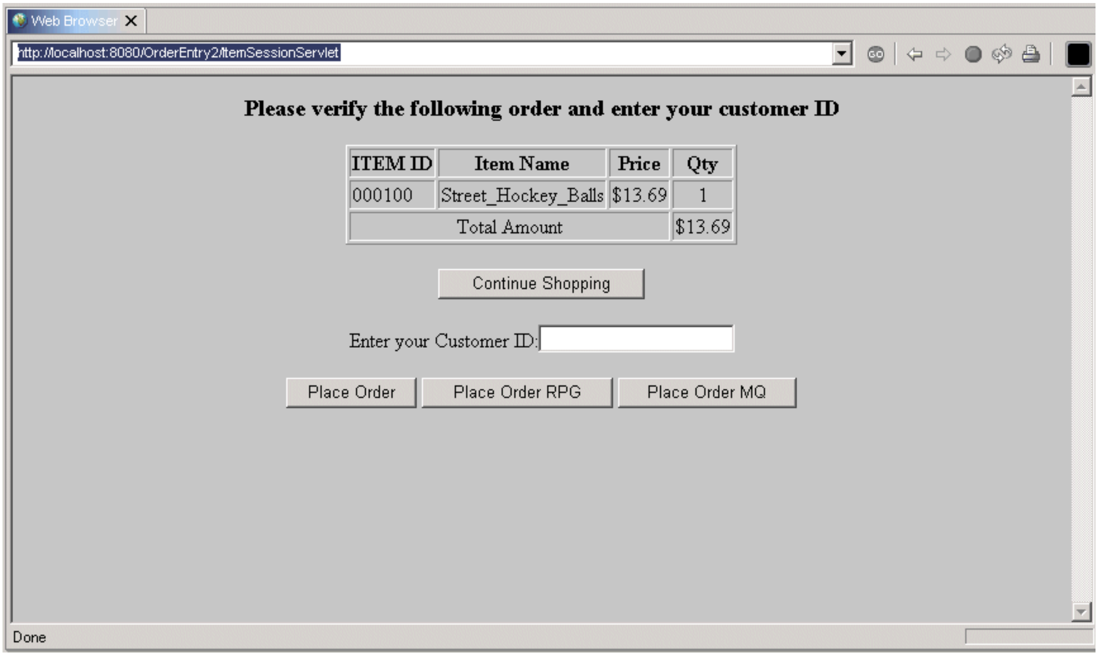
In this section, we show how to include MQSeries calls in the OrderEntry application.

Changing the CartServlet servlet

The CartServlet is the responsible of showing the customer's cart with the selected items and allowing the customer to place an order. We change the CartServlet servlet to use the MQSeries interface.

Showing the Place Order MQ option

We add a new button to the CartServlet output form. It allows customers to place and order and have the order information placed on a MQSeries queue. This interface is similar to the data queue example discussed in 11.4, “Using data queues to interface to legacy applications” on page 363. The difference is that data queues only work on the iSeries server, while MQSeries works on many platforms. The new form is shown in Figure 11-10.



Please verify the following order and enter your customer ID

ITEM ID	Item Name	Price	Qty
000100	Street_Hockey_Balls	$13.69	1
Total Amount			$13.69

Continue Shopping

Enter your Customer ID:

Place Order | Place Order RPG | Place Order MQ

Figure 11-10 The place order page

Example 11-13 shows the updated `outputOrderForm` method. We add a new button with a type of submit and a value of Place Order MQ.

Example 11-13 The outputOrderForm

```
private void outputOrderForm(PrintWriter out, ShoppingCart cart) throws IOException {
   flexLog("CartServlet: outputOrderForm()...");
   try{out.println("<CENTER>");
      out.println("<H3> Please verify the following order and enter your customer
        ID</H3>");
      out.println("<FORM  METHOD=POST   ACTION=\"/OrderEntry2/ItemSessionServlet\" >");
      out.println("<CENTER>");
      outputCartTable(out, cart);
      out.println("<BR><INPUT TYPE=submit value=\"Continue Shopping\" name=\"partno\">");
      out.println("</CENTER>");
      out.println("</FORM>");
      out.println("<FORM  METHOD=POST   ACTION=\"/OrderEntry2/CartServlet\" >");
      out.println("Enter your Customer ID:<INPUT TYPE=TEXT name=\"custid\"> <BR><BR>");
      out.println("<INPUT TYPE=submit value=\"Place Order\" name=\"command\">");
      out.println("<INPUT TYPE=submit value=\"Place Order RPG\" name=\"command\">");
      out.println("<INPUT TYPE=submit value=\"Place Order MQ\" name=\"command\">");
      out.println("</CENTER>");
      out.println("</BODY></HTML>");
      flexLog("CartServlet: outputOrderForm() executed.");
   } catch (Exception e) {
      e.printStackTrace();
      flexLog(e.getMessage());
   }
} // end
outputItemInformation()
```

Managing the Place Order input in CartServlet

We use a single parameter to check whether you click the Place Order, the Place Order RPG, or the Place Order MQ button. This is because we give all the buttons the name command. We check the value of the command button to determine which button was clicked. When the customer clicks the Place Order MQ button, the CartServlet receives the input through the `doPost` method. The value of the parameter determines what to do. As shown in Example 11-14, if the value is “Place Order MQ”, the `doPost` method calls the `placeOrderMQ` method.

Example 11-14 Changing the doPost method

```
      else if (parameter.equalsIgnoreCase("Place Order MQ")){
         String custID = request.getParameter("custid");
         if (null == custID) custID="";
            // Make sure next order is clean
         session.invalidate();
         placeOrderMQ(out, cart, custID);
      }
```

The placeOrderMQ method

To process the order with the RPG program, we create a new method. This method is called `placeOrderMQ` and is shown in Example 11-15.

Example 11-15 The placeOrderMQ method in CartServlet

```
private void placeOrderMQ(PrintWriter out, ShoppingCart cart, String custID) throws
IOException {
       flexLog("CartServlet: placeOrderMQ()...");
      Vector OrderLines = new Vector();

      Vector cartItems = cart.getItems();
      if (cartItems.size() > 0) {
         for (int i = 0; i < cartItems.size(); i++) {
            CartItem citem = (CartItem) cartItems.elementAt(i);
            com.ibm.itso.roch.cpwejb.interfaces.OrderDetail thisOrderDetail
               = new com.ibm.itso.roch.cpwejb.interfaces.OrderDetail(citem.getItemId(),
                 Float.valueOf(citem.getPrice().replace('$','0')).floatValue(),
                 1);
            OrderLines.addElement(thisOrderDetail);
         }; // end for
         try{
            MyItemsDB.connectStateless();
            out.println("<FORM METHOD=\"get\"
               ACTION=\"/OrderEntry2/ItemSessionServlet\">");

            out.println("<H3>Your order has been processed and sent to an MQ queue.</H3>
               <BR>");
```

```
          out.println("Order number : ");
          out.println(MyItemsDB.submitOrderStatelessMQ(custID, OrderLines));
          out.println("<BR><BR>Thanks for your business<BR><BR>");

          out.println("<BR><BR><INPUT TYPE=submit value=\"Shop Some More...\"
              name=\"command\">");

          out.flush();
       }
       catch (Exception e) {
          e.printStackTrace();
          out.println(e.getMessage());
       }
    }
}
```

This method retrieves the items from the shopping cart and adds them to a vector. It uses the ItemsDb class to interface with the OrderPlacement EJB. An instance of the ItemsDb class named MyItemsDB is instantiated. The MyItemsDB object `submitOrderStatelessMQ` method is called to submit the order to the server. The customer number and the vector containing the items to order is passed to this method. The `submitOrderStatelessMQ` method returns the order number; it is displayed on the browser.

11.5.3 Changing the ItemsDb class

As we saw in the previous section, the CartServlet uses an instance of the ItemDb class to place an order. We add the `submitOrderStatelessMQ` method (Example 11-16) to this class.

Example 11-16 The submitOrderStatelessMQ method

```
public int submitOrderStatelessMQ(String CustID, java.util.Vector OrderLines) throws
Exception {
   int returnvalue;
   try {
      returnvalue = (int)OrderPlacer.placeOrderMQ("0001", 1, CustID, OrderLines);
   } catch (Exception e) {
      throw (e);
   }
   return returnvalue;
}
```

OrderPlacer is an instance of the OrderPlacement session EJB. We call its `placeOrderMQ` method. Four parameters are passed in. The warehouse ID and district ID are set to “0001” and 1 respectively. The customer number and a vector containing the items to order are passed in. If everything works successfully, the `placeOrderMQ` method returns the order number of the order created.

11.5.4 Changing the OrderPlacement session bean

We need to enhance the OrderPlacement session bean to send a message to an MQSeries queue after placing the order. We add a new method to the OrderPlacement bean named `placeOrderMQ`. This is the method that is called from the `ItemsDb submitOrderStatelessMQ` method. We also add a new internal method to the OrderPlacement EJB named `writeMQ`. The `writeMQ` method creates an instance of an MQCon object in order to send the message to the queue. The `writeMQ` method is called from the `placeOrderMQ` method. It cannot be called from a client application because we do not add it to the remote interface.

We use Application Developer to externalize the name of the MQSeries resources such as hostname, queue manager, channel, and queue. To add these values to the bean properties, follow these steps:

1. In the WebSphere Application Developer, open the J2EE perspective, as shown in Figure 11-11.

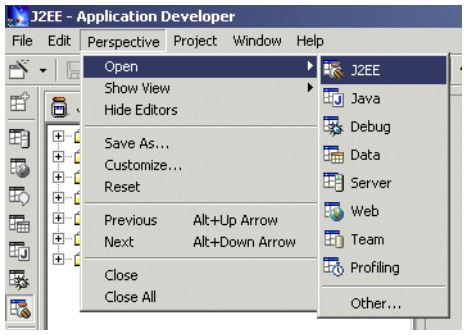


Figure 11-11 Opening the J2EE perspective

2. In the J2EE view, expand **EJB Modules**.
3. Right-click the **ToWebSphere** EJB Module and select **Open With-> EJB Editor**, as shown in Figure 11-12.

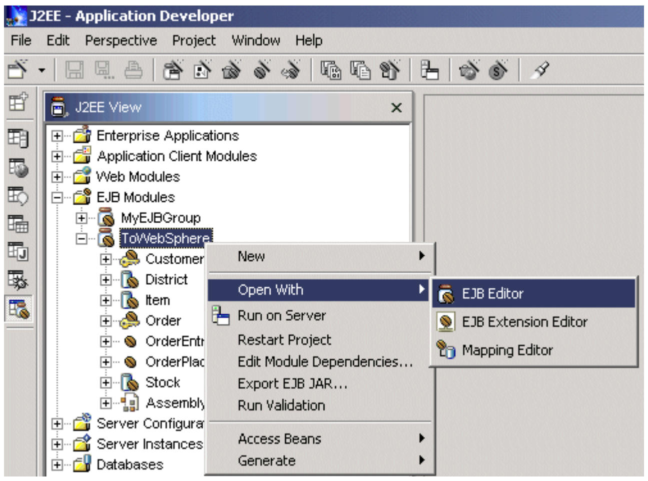


Figure 11-12 Opening the EJB Editor

4. Go to the Environment pane.
5. Select the **OrderPlacement** EJB and click the **Add** button.
6. Select (New Variable) and change it to hostname.

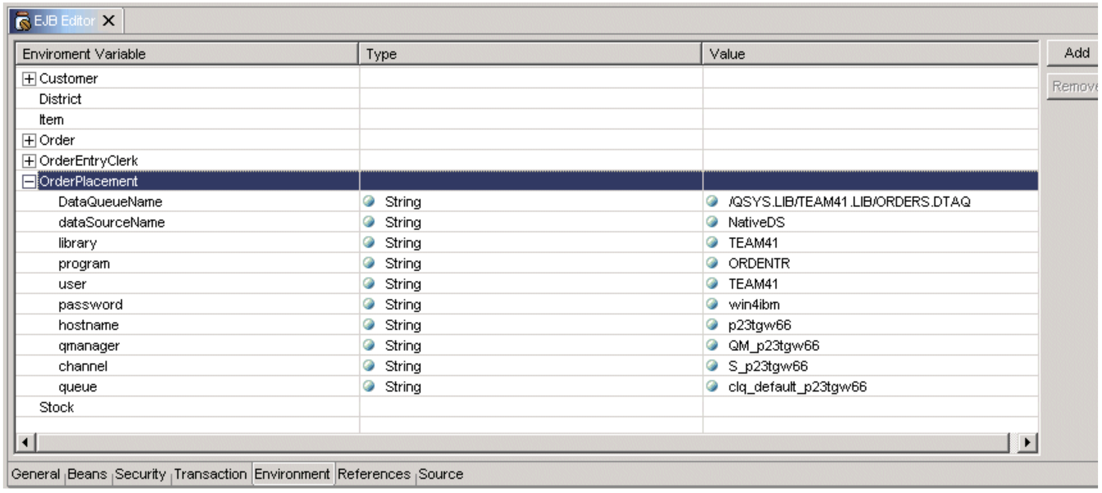
7. Select the value column for the hostname property and enter the name of the server that contains the MQSeries server.

We add the environment variables shown in Table 11-2.

Table 11-2 Properties for OrderPlacement EJB

Environment variable	Type	Value
hostname	String	The name of the machine that contains the MQServer
qmanager	String	The name of the Queue Manager
channel	String	The name of the Channel
queue	String	The name of the queue

Figure 11-13 shows the EJB Editor with our values.



Enviroment Variable	Type	Value
⊞ Customer		
District		
Item		
⊞ Order		
⊞ OrderEntryClerk		
⊟ OrderPlacement		
DataQueueName	String	/QSYS.LIB/TEAM41.LIB/ORDERS.DTAQ
dataSourceName	String	NativeDS
library	String	TEAM41
program	String	ORDENTR
user	String	TEAM41
password	String	win4ibm
hostname	String	p23tgw66
qmanager	String	QM_p23tgw66
channel	String	S_p23tgw66
queue	String	clq_default_p23tgw66
Stock		

Figure 11-13 OrderPlacement MQSeries properties

Now we create the `placeOrderMQ` method as shown in Example 11-17. This method is similar to the original `placeOrder` method. The only difference is we call the MQSeries interface instead of the data queue interface.

Example 11-17 The placeOrderMQ method.

```
public float placeOrderMQ(String wID, int dID, String cID, Vector orderLines) throws
EJBException {
   float oID = 0;
   try {

      //The InitialContext will let us retrieve references to the entity beans we need.
      InitialContext initCtx = new InitialContext();
            //Get the Order Number from the District entity bean.
      DistrictHome dHome = (DistrictHome) initCtx.lookup("District");
      DistrictKey districtID = new DistrictKey(dID, wID);
      District district = (District) dHome.findByPrimaryKey(districtID);
      int oIDint;
      oIDint = district.getNextOrderId(true); //'true' tells the District to increment the
               order id.
      oID = oIDint;
      //Update the Stock level for each item in an order line using the Stock entity bean
      StockHome sHome = (StockHome) initCtx.lookup("Stock");
      Enumeration lines = orderLines.elements();
      float orderTotal = 0;
      while (lines.hasMoreElements()) {
         OrderDetail od = (OrderDetail) lines.nextElement();
         String itemID = od.getItemID();
         int itemQty = od.getItemQty();
         orderTotal += od.getItemAmount(); //Calculate the order total while we are going
                through the orders.
         StockKey stockID = new StockKey(wID, itemID);
         //StockKey stockID = new StockKey(itemID, wID);
         Stock stock = (Stock) sHome.findByPrimaryKey(stockID);
         stock.decreaseStockQuantity(itemQty);
      }
       //Save the Order to the database by creating an Order entity bean
      OrderHome oHome = (OrderHome) initCtx.lookup("Order");
      oHome.create(wID, dID, cID, oID, orderLines);
         //Update the Customer records using the Customer entity bean
      CustomerHome cHome = (CustomerHome) initCtx.lookup("Customer");
      CustomerKey customerID = new CustomerKey(cID);
      Customer customer = (Customer) cHome.findByPrimaryKey(customerID);
      customer.updateBalance(orderTotal);
      //Write the order to the MQ queue.
      try {
            writeMQ(wID, dID, cID, oID);

      } catch (Exception e) {
         System.out.println("writeMQ error: " + e.getMessage());
         throw new RemoteException(e.getMessage());
      }

   } catch (Exception e) {
      throw new EJBException(e.getMessage());
   }
   return oID;
}
```

The `writeMQ` method, shown in Example 11-18, uses the MQCon class to send the message to MQSeries. First, the MQSeries resource names are obtained from the OrderPlacement properties using the InitialContex object. We create an String object that contains the order data. A new MQCon instance is created. We put the order on the queue using the `putMQ` method.

Example 11-18 The writeMQ method

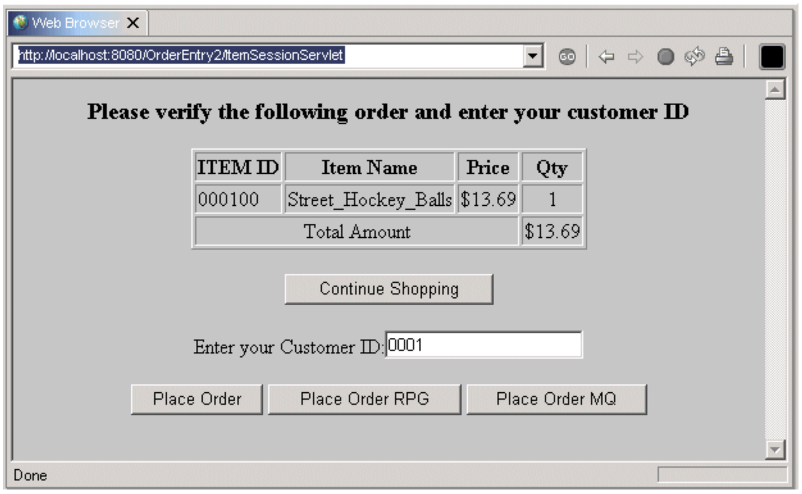
```
private void writeMQ(String wID, int dID, String cID, float oID) throws Exception
{
   InitialContext initCtx = new InitialContext();

   String hostname = (String)initCtx.lookup("java:comp/env/hostname");
   String channel = (String)initCtx.lookup("java:comp/env/channel");
   String qmanager = (String)initCtx.lookup("java:comp/env/qmanager");
   String queue = (String)initCtx.lookup("java:comp/env/queue");

   String order= wID + "=" + dID + "=" + cID + "=" + oID;
   MQCon mqcon = new MQCon(hostname, qmanager, channel, queue);
```

```
    byte[] res = mqcon.putMQ(order);
    System.out.println(new String(res));
}
```

With the `writeMQ` method, we only put a message into a queue. MQSeries can send the message to a program on the same system or another system. This is controlled by the hostname variable.

Testing the MQSeries application

In the OrderEntry application, we place an order using the Place Order MQ button as shown in Figure 11-14.



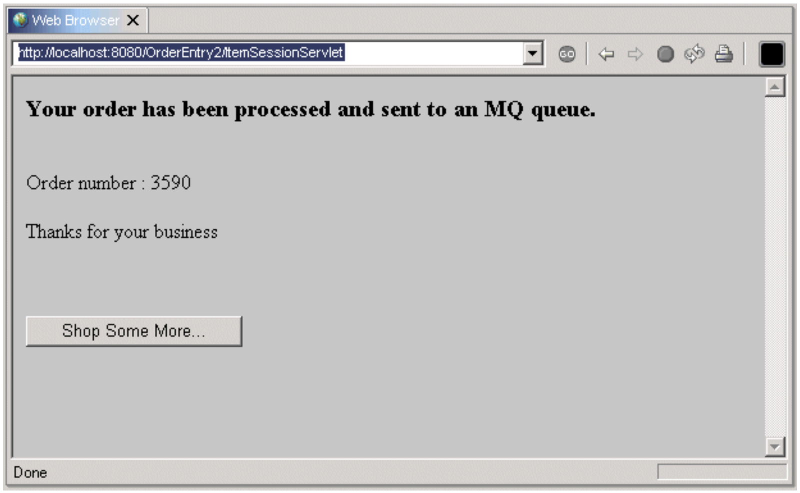
Please verify the following order and enter your customer ID

ITEM ID	Item Name	Price	Qty
000100	Street_Hockey_Balls	$13.69	1
Total Amount			$13.69

Enter your Customer ID: 0001

Figure 11-14 Using the Place Order MQ button

The application returns an order confirmation message as shown in Figure 11-15. The order information has also been placed on the MQSeries queue. MQSeries can route the message to a program on the iSeries server or to another platform.



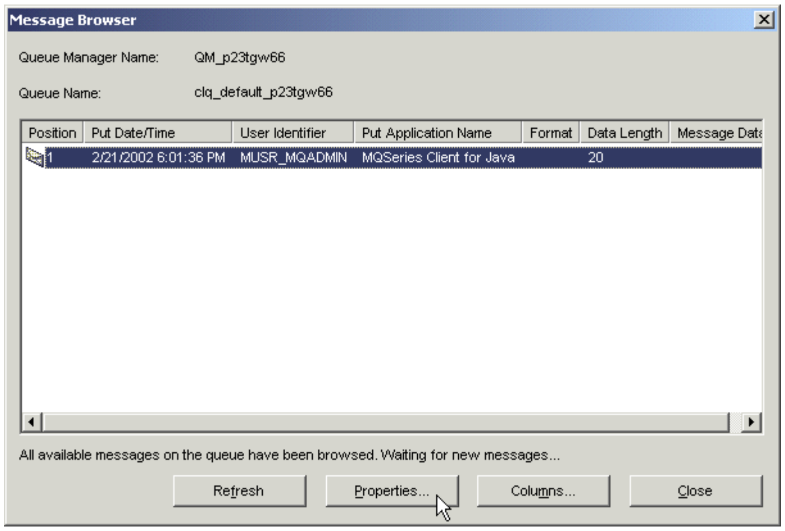
Your order has been processed and sent to an MQ queue.

Order number : 3590

Thanks for your business

Figure 11-15 Order sent to the MQSeries queue message

For the MQSeries server, we use a Windows 2000 workstation. We can see the message in the queue browser as shown in Figure 11-16.


Message Browser

Queue Manager Name: QM_p23tgw66

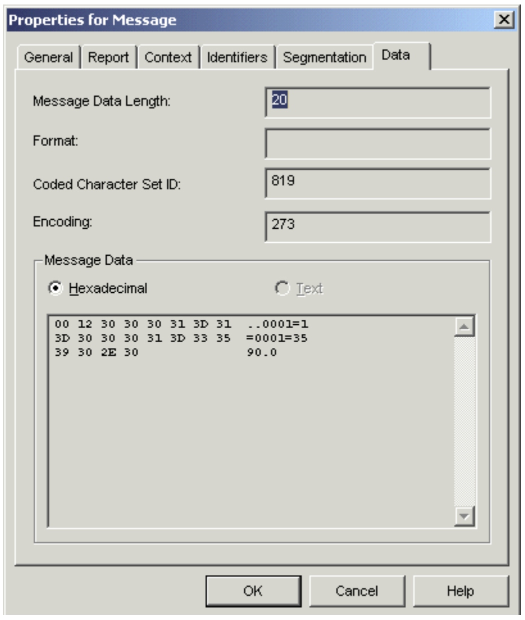
Queue Name: clq_default_p23tgw66

Position	Put Date/Time	User Identifier	Put Application Name	Format	Data Length	Message Data
1	2/21/2002 6:01:36 PM	MUSR_MQADMIN	MQSeries Client for Java		20	

All available messages on the queue have been browsed. Waiting for new messages...

Figure 11-16   The message in the MQSeries queue

We select the message from the browser and click the **Properties** button. If we select the Data pane, we see the order data as shown in Figure 11-17.


Properties for Message

Message Data Length: 20

Format:

Coded Character Set ID: 819

Encoding: 273

Message Data

(● Hexadecimal) ○ Text

```
00 12 30 30 30 31 3D 31  ..0001=1
3D 30 30 30 31 3D 33 35  =0001=35
39 30 2E 30              90.0
```

Figure 11-17   The message properties with the order data

For further information about using MQSeries from a Java application, refer to *MQSeries: Using Java,* SC34-5456.

11.6 Using XML to interact with applications

The previous sections explained how to send messages to another application using MQSeries or data queues. Sometimes these messages are difficult to read because they became an array of characters without any meaning. The receiver of these messages needs to know the exact structure of the data. With XML, we can send messages that include the structure of the data. This makes it easier for the receiver of the message to process it. Also, the message may be read by many receivers. Each one can read only the information it needs.

You can send an XML file as a message through a queue. You need to convert the file into a String object and then send it to the queue.

This section shows how to create XML messages and send them through MQSeries or data queues. We enhance the OrderEntry application and change the information we send to the MQSeries queue to use XML.

11.6.1 Using XML

For interacting with XML, we need to create XML files and write Java code that manages the information in these files. There are several ways to handle XML with Java code:

- **Document Object Model (DOM)**: DOM defines a set of interfaces to access tree-structured XML documents. The root of the inheritance tree is a Node, that defines the necessary methods to navigate and manipulate the tree-structure of XML documents.
- **Simple API for XML (SAX)**: SAX is an event-driven lightweight API for accessing XML documents and extracting information from them. It cannot be used to manipulate the internal structures of XML documents. As the document is parsed, the application using SAX receives information about the various parsing events.

We use DOM in our example.

The XML file

First, we create an XML file with the structure of the data we want to send. In this file, we include all the fields in the order record that we place on the MQSeries queue. Remember that the order information we send contains four fields: warehouse id, district id, customer number, and order number. The order.XML file is shown in Example 11-19.

Example 11-19 The order.xml file

```
<?xml version="1.0" encoding="UTF-8"?>
  <order>
    <warehouse>warehouse</warehouse>
    <district>district</district>
    <customer>customer</customer>
    <orderNum>orderNum</orderNum>
  </order>
```

To create this file with Application Developer, follow these steps:

1. In the main menu, click **Perspective-> Open-> XML** as shown in Figure 11-18.

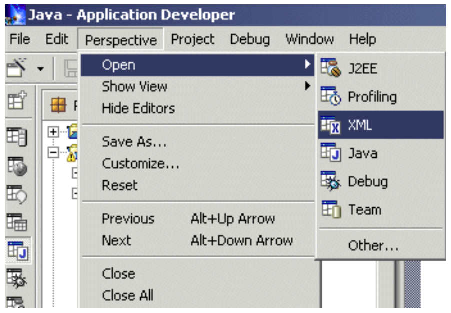


Figure 11-18 Opening the XML perspective

2. In the Navigator view, right-click the folder that will contain the XML file. Then, in the pop-up menu, select **New-> XML File** as shown in Figure 11-19.

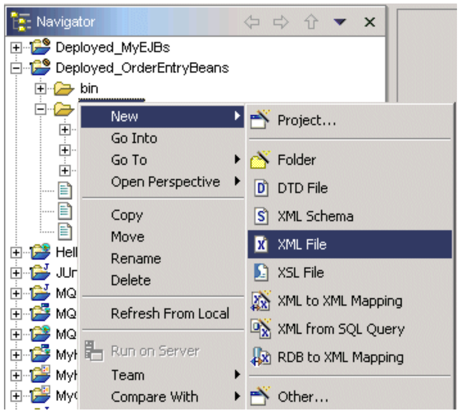


Figure 11-19 Creating an XML file

3. Select **Create XML file from scratch** as shown in Figure 11-20 and click **Next**.

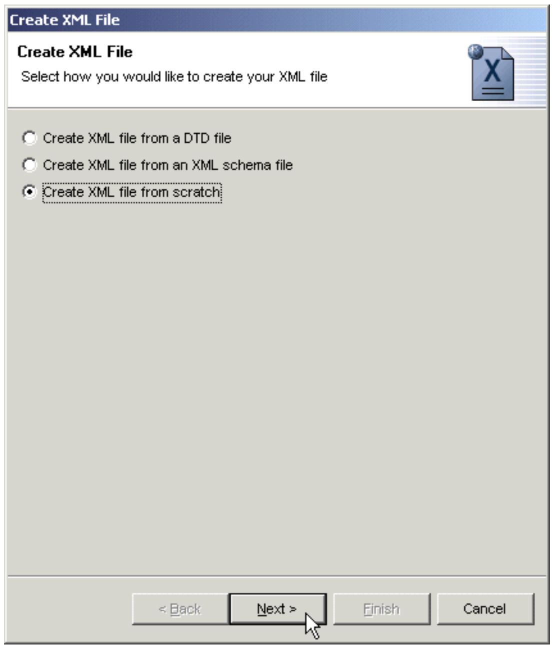
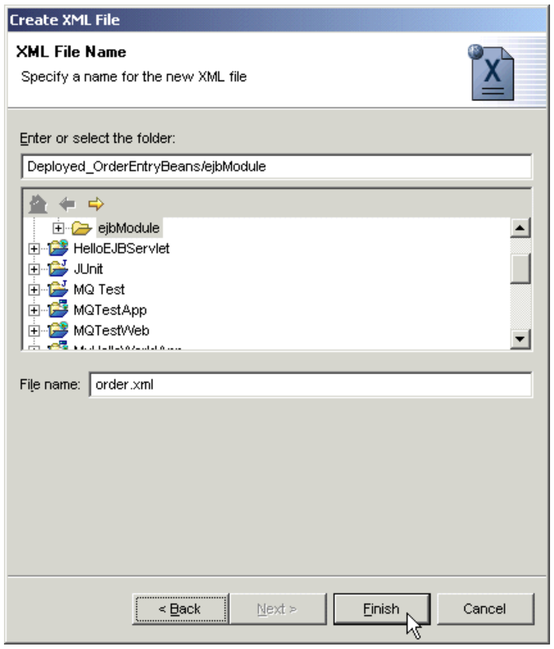

Create XML File
Create XML File
Select how you would like to create your XML file
Create XML file from a DTD file
Create XML file from an XML schema file
Create XML file from scratch
< Back
Next >
Finish
Cancel

Figure 11-20 Selecting Create XML file from scratch

4. Enter `order.xml` as the name of the XML file, as shown in Figure 11-21, and click **Finish**.


Create XML File

XML File Name

Specify a name for the new XML file

Enter or select the folder:

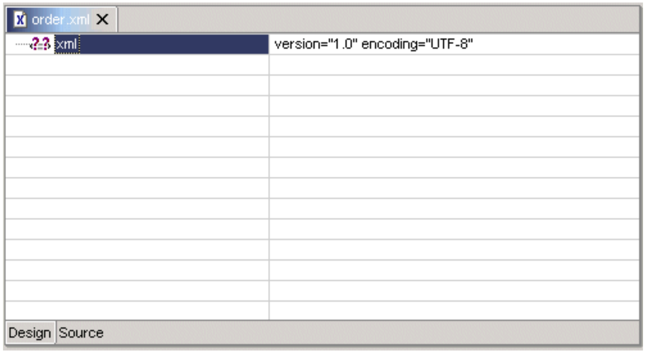
Deployed_OrderEntryBeans/ejbModule

File name: order.xml

Figure 11-21 XML file name

5. Once the XML file is created the XML editor opens. This editor has two views, Design and Source. In the Design view, the XML is represented graphically, and in the Source view, we see the XML code itself.

   Change to the Design view in the XML editor as shown in Figure 11-22.


order.xml

xml version="1.0" encoding="UTF-8"

Figure 11-22 Design view in the XML editor

6. Right-click the **XML element** and in the pop-up menu, select **Add after-> New element** as shown in Figure 11-23.

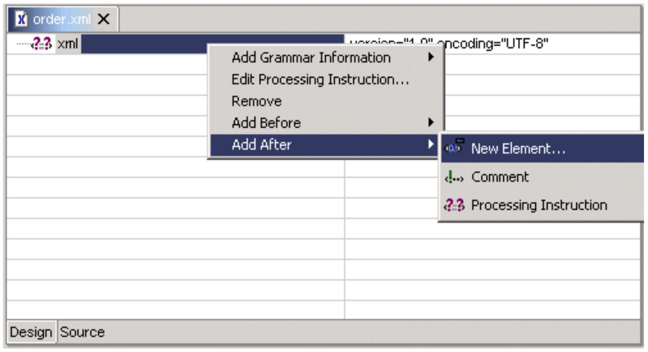
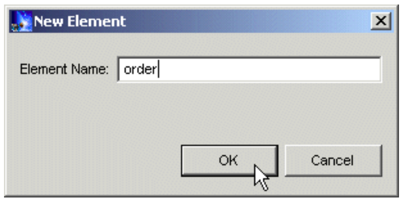


Figure 11-23 Creating a new element in an XML file

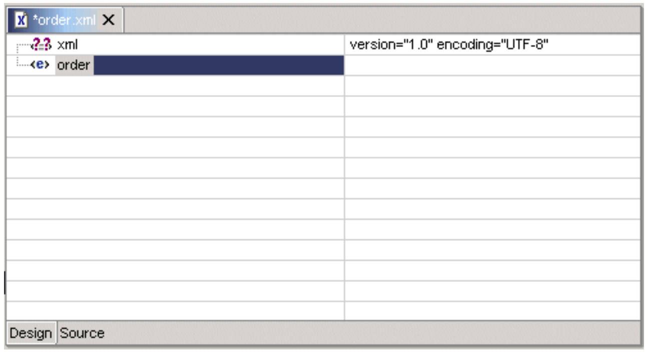
7. Enter `order` as the Element Name in the New Element window and click **OK** as shown in Figure 11-24.



Element Name: order

Figure 11-24 New Element window

The XML editor looks like the example in Figure 11-25.



version="1.0" encoding="UTF-8"

Figure 11-25 The order element in the XML editor

8. Right-click the order element, and in the pop-up menu, select **Add Child-> New Element** as shown in Figure 11-26.

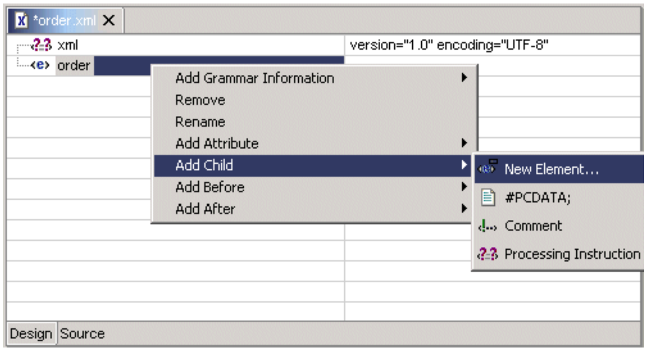


Figure 11-26 Adding a child element

9. Enter `warehouse` as the new element name and click **OK**.

   Now we have a child element of the order element as shown in Figure 11-27.

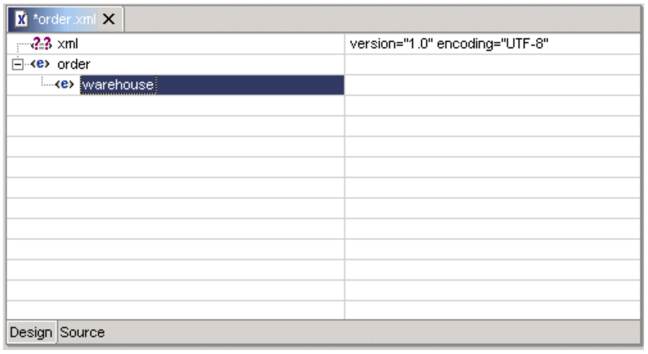


Figure 11-27 Child added to the order element

10. In the right column, enter `warehouse` as the element value as shown in Figure 11-28.

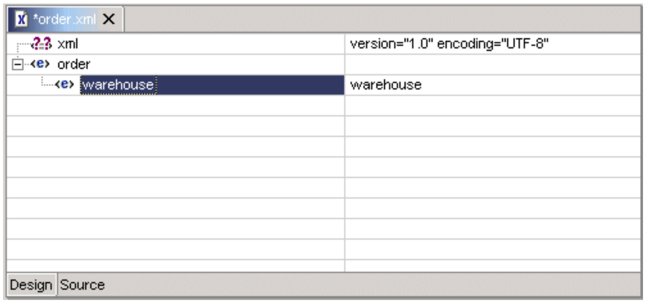
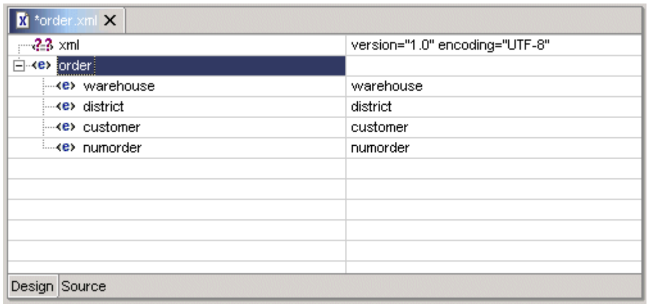


Figure 11-28 Entering the value of the warehouse element

11. As we did with warehouse, we add district, customer, and numorder as child elements as shown in Figure 11-29.

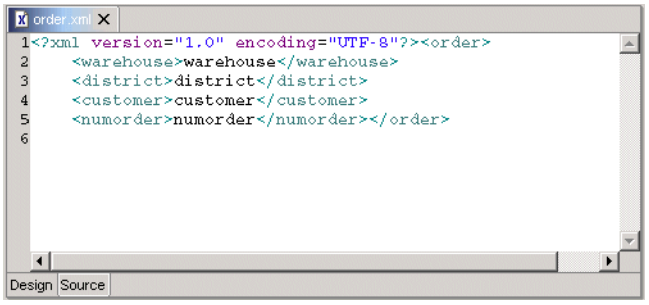


xml	version="1.0" encoding="UTF-8"
order	
warehouse	warehouse
district	district
customer	customer
numorder	numorder

Figure 11-29 The order.xml file in the Design view

12. Save the file by pressing Ctrl-S.

Now we can switch to the Source view to see the actual XML source. This is shown in Figure 11-30.



```
<?xml version="1.0" encoding="UTF-8"?><order>
    <warehouse>warehouse</warehouse>
    <district>district</district>
    <customer>customer</customer>
    <numorder>numorder</numorder></order>
```

Figure 11-30 The order.xml file in the source view

The XmlDoc class

For this example, we create a Java class that encapsulates the XML interface methods. The XmlDoc class is a simple class that contains the code we use to interface with XML in our application. The XmlDoc class uses the DOM interface.

XmlDoc declaration and constructor

There are a number of packages we need to import in order to use the DOM parsers. See Example 11-20. The first two are common Java packages. The other three packages are needed in order to use DOM. We declare a private document called *doc*. This is the root node of the tree of our XML document.

Example 11-20 XmlDoc declaration and constructor

```
import java.io.*;
import java.util.*;

import javax.xml.parsers.*;
import org.w3c.dom.*;
import org.xml.sax.InputSource;

public class XmlDoc
{
   private org.w3c.dom.Document doc = null;

public XmlDoc() {
   super();
}
```

Parsing the XML document

First, we need to get the document tree. A document tree is a tree representation of a well-formed XML document. This is called *parsing the XML document*. We use the `parseXmlUri` method (Example 11-21) to do this. The input String uri parameter contains the path and the name of the XML file. We instantiate an org.w3c.dom.Document object that we put into the doc variable declared in the class definition.

Example 11-21 The parseXmlUri method

```
public boolean parseXmlUri(String uri)
{
   boolean parsed = true;

   try
   {
      DocumentBuilderFactory dF = DocumentBuilderFactory.newInstance();
      DocumentBuilder DOMBuilder = dF.newDocumentBuilder();
      doc = DOMBuilder.parse(uri);
   }
   catch (Exception e)
   {
      parsed = false;
      System.out.println("XmlDoc.parseXmlUri(String):Not parsed:"+e);
   }
   return parsed;
}
```

We also include another method, the `parseXmlString` method (Example 11-22), to parse an XML document. In this case, the input parameter is a String that contains the XML file itself. This is useful when you receive an XML file from an input source such as MQSeries.

Example 11-22 The parseXmlString method

```
public boolean parseXmlString(String xmlString)
{
   boolean parsed = true;

   StringReader sr = new StringReader(xmlString);
   InputSource iSrc = new InputSource(sr);
   try
   {
      DocumentBuilderFactory dF = DocumentBuilderFactory.newInstance();
      DocumentBuilder DOMBuilder = dF.newDocumentBuilder();
      doc = DOMBuilder.parse(iSrc);
   }
   catch (Exception e)
   {
      parsed = false;
      System.out.println("XmlDoc.parseXmlString(String):not parsed:"+e);
   }
   return parsed;
}
```

One of these two methods is the first method we call when using the XmlDoc class. If we get a true return, we have the DOM tree in the doc object.

Changing the values of the XML tree

Once we get the XML DOM tree in our private doc object, we need to put the values of the order into the XML fields. For example, customer will became a real customer ID, not the word "customer" as it is in the XML file. We create a method called `setValuesXML`. This method has a java.util.Properties object as an input parameter and calls the `setValuesXML(Node, Properties)` method as shown in Example 11-23.

Example 11-23 The setValuesXML(java.util.Properties) method

```
public void setValuesXML(java.util.Properties data)
{
   setValuesXML(getDoc(),data);
}
```

A second method, `setValuesXML(Node, Properties)`, contains the code for changing the XML tree. Using a recursive algorithm, it goes through the whole tree and changes all the values of the nodes as shown in Example 11-24.

Example 11-24 The setValuesXML(Node, java.util.Properties) method

```
private void setValuesXML(Node node, java.util.Properties data)
{
   int type = node.getNodeType();
   switch (type)
   {
      case Node.DOCUMENT_NODE:
      {
         setValuesXML(((Document)node).getDocumentElement(), data);
         break;
      }
      case Node.ELEMENT_NODE:
      {
         NodeList children = node.getChildNodes();
         if (children != null)
         {
            int len = children.getLength();
            for (int i = 0; i < len; i++)
               setValuesXML(children.item(i), data);
         }
         break;
      }
      case Node.TEXT_NODE:
      {
         String valor =
            data.getProperty(node.getParentNode().getNodeName(),node.getNodeValue());
         node.setNodeValue(valor);
         break;
```

```
        }
    }
}
```

We put all the information that we want to change as properties in the Properties object. For example, the XML file contains a field named customer. We update the customer property with the value of the customer:

```
orderProp.put("customer","0001");
```

Recursion is used in case the node is a DOCUMENT_NODE, to go through all the possible children of an ELEMENT_NODE. When a TEXT_NODE is found, we change its value to the value included in the Properties object.

Converting the XML data into a String object

When the XML tree is populated with the correct values, we need to convert it into a String object in order to send it as a message to a data queue or an MQSeries queue. We obtain a String object using the `toString()` method. This is shown in Example 11-25.

Example 11-25 The toString() method

```
public String toString()
{
    String sDoc = "";
    sDoc = toString(getDoc(),sDoc);
    return sDoc;
}
```

The `toString()` method calls a second `toString` method. This second method is a private method and accepts two parameters. The first parameter is an XML node, and the second is the String we want to create. Again we use a recursive algorithm to go through the XML tree and get all the nodes and add them to the String object. The returned String object contains the XML document. The `toString(Node, String)` method is shown in Example 11-26.

Example 11-26 The toString(Node, String) method

```
private String toString(Node node, String sDoc)
{
    int type = node.getNodeType();
    switch (type)
    {
        case Node.DOCUMENT_NODE:
        {
            sDoc = sDoc +
                    toString(((Document)node).getDocumentElement(), sDoc);
            break;
        }
        case Node.ELEMENT_NODE:
        {
            sDoc = sDoc + "<" + node.getNodeName();
            NamedNodeMap attrs = node.getAttributes();
            for (int i=0; i< attrs.getLength(); i++)
            {
                Node attr = attrs.item(i);
                sDoc = sDoc + " " + attr.getNodeName() +
                        "=\"" + attr.getNodeValue() +
                        "\"";
          }
          sDoc = sDoc + ">";

          NodeList children = node.getChildNodes();
          if (children != null)
          {
             int len = children.getLength();
             for (int i = 0; i < len; i++)
                sDoc =  toString(children.item(i), sDoc);
          }
          break;
       }
       case Node.TEXT_NODE:
       {
          sDoc = sDoc + node.getNodeValue();
          break;
       }
   }
   if (type == Node.ELEMENT_NODE)
   {
      sDoc = sDoc +"</" + node.getNodeName() + ">";
   }
   return sDoc;
}
```

Other methods

It may be useful to place all the data contained in an XML file into a Properties object. For that, we create the `toProperties()` method. This method has a further call to a private `toProperties` method (Example 11-27).

Example 11-27 The toProperties() method

```
public Properties toProperties()
{
   Properties data= new Properties();
   toProperties(doc, data);
   return data;
}
```

The `toProperties(Node, Properties)` method again uses a recursive algorithm to retrieve the data. It goes through the whole DOM tree and puts a property into the Properties object when it finds a TEXT_NODE node.

Example 11-28 The toProperties(Node, Properties) method

```
private void toProperties(Node node, Properties data)
{
   int type = node.getNodeType();
   switch (type)
   {
      case Node.DOCUMENT_NODE:
      {
         toProperties(((Document)node).getDocumentElement(), data);
```

```
            break;
         }
         case Node.ELEMENT_NODE:
         {
            NodeList children = node.getChildNodes();
            if (children != null)
            {
               int len = children.getLength();
               for (int i = 0; i < len; i++)
                  toProperties(children.item(i), data);
            }
            break;
         }
         case Node.TEXT_NODE:
         {
            data.put(node.getParentNode().getNodeName(),node.getNodeValue());
            break;
         }
      }
}
```

Enhancing the OrderEntry application with XML

Now we can use of the XmlDoc class in our OrderEntry application. We follow these steps:

1. Open the **J2EE perspective**.
2. Expand **EJB Modules**.
3. Expand the **ToWebSphere** EJB Module.
4. Expand the **OrderPlacement** EJB.
5. Double-click **OrderPlacementBean** to open it.
6. We add the `writeMQXml` method as shown in Example 11-29.
7. We change the OrderPlacement EJB `placeOrderMQ` method to call the `writeMQXml` method after placing an order.

Example 11-29 The writeMQXml method

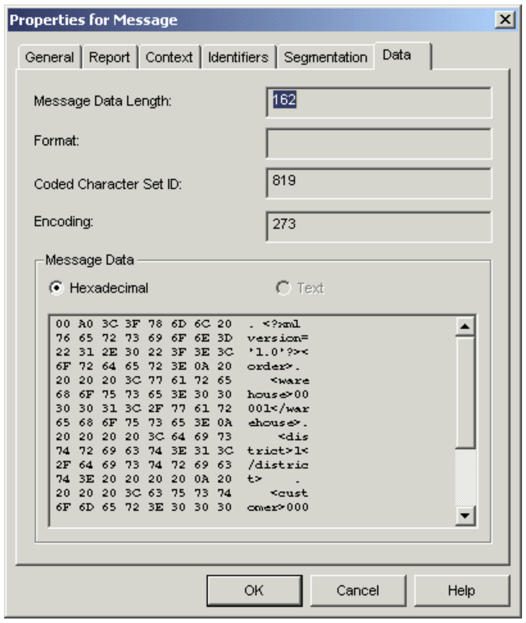
```
private void writeMQXml(String wID, int dID, String cID, float oID) throws Exception
{
   InitialContext initCtx = new InitialContext();

   String hostname = (String)initCtx.lookup("java:comp/env/hostname");
   String channel = (String)initCtx.lookup("java:comp/env/channel");
   String qmanager = (String)initCtx.lookup("java:comp/env/qmanager");
   String queue = (String)initCtx.lookup("java:comp/env/queue");

   XmlDoc xmlDoc = new XmlDoc();
   xmlDoc.parseXmlUri("order.xml");

   Properties orderProp = new Properties();
   orderProp.put("warehouse",wID);
   orderProp.put("district",dID);
   orderProp.put("customer",cID);
   orderProp.put("ordernum",oID);

   xmlDoc.setValuesXML(orderProp);
```

```
    String orderXml = xmlDoc.toString();

    MQCon mqcon = new MQCon(hostname, qmanager, channel, queue);
    byte[] res = mqcon.putMQ(orderXml);
}
```

The `writeMQXml` method receives the order information as input parameters. The logic of the `writeMQXml` method is:

1. Obtain an instance of the XmlDoc class named xmlDoc.
2. Call the `parseXMlUri` method to parse the order.xml XML file.
3. Add the input parameters as properties to a Properties object named *orderProp*.
4. Call the `setValuesXML` method passing in the Properties object to set the values of the order in the XML document.
5. Convert the XML document to a String object.
6. Place the String object on an MQSeries queue.

The name of the XML file contains the complete path its location on the server. In this case, it is in the root of the WebSphere instance directory. If you run the application again and browse the messages in the MQSeries server queue, you see the XML file in it as shown in Figure 11-31.



Message Data Length: 162
Format:
Coded Character Set ID: 819
Encoding: 273

Message Data
[✓ Hexadecimal] Text

```
00 A0 3C 3F 78 6D 6C 20  . <?xml
76 65 72 73 69 6F 6E 3D  version=
22 31 2E 30 22 3F 3E 3C  '1.0'?><
6F 72 64 65 72 3E 0A 20  order>.
20 20 20 3C 77 61 72 65     <ware
68 6F 75 73 65 3E 30 30  house>00
30 30 31 3C 2F 77 61 72  001</war
65 68 6F 75 73 65 3E 0A  ehouse>.
20 20 20 20 3C 64 69 73      <dis
74 72 69 63 74 3E 31 3C  trict>1<
2F 64 69 73 74 72 69 63  /distric
74 3E 20 20 20 20 0A 20  t>     .
20 20 20 3C 63 75 73 74     <cust
6F 6D 65 72 3E 30 30 30  omer>000
```

Figure 11-31 The XML message in the MQSeries queue

11.7 Conclusion

This chapter showed you how Enterprise JavaBeans can interface with other applications.

The IBM Toolbox for Java provides many options for interfacing to legacy applications:

- Distributed Program Call (DPC)
- Data Queues
- Program Control Markup Language (PCML)

We added a new method to the OrderEntryClerk EJB named `placeOrderRPG`. It uses the Distributed Program Call interface to call the ORDENTR RPG program to place an order. A client program can call this method to interface with the RPG program. It doesn't need to know the details about how the Distributed Program Call interface works. The implementation details are handled by the OrderEntryClerk bean.

We added a new `writeDataQueue` method to the OrderPlacement EJB. It uses the data queue support to interface with the PRTORDERP RPG program. This method is used internally by the OrderPlacement bean. Whenever its `placeOrder` method is called to place an order, it in turn, calls the `writeDataQueue` method. The PRTORDERP RPG program reads the entries off the data queue and prints an order request document. Data queue support only works on the iSeries server.

We added a new `writeMQ` method to the OrderPlacement EJB. It uses MQSeries queues support to interface with a MQSeries Queue Manager and place messages on MQSeries queues. MQSeries allows you to interface with applications running on any platform that supports MQSeries.

We also showed an example that uses XML. XML is useful for passing information from one application to another. An XML document contains not only the data, but a description of what the data means.

12

The Command package

In this chapter, we modify the EJB-based OrderEntry application to use the Command package. It provides a framework that can improve distributed application performance by providing a mechanism for collecting sets of requests and submitting them as a unit of work. The objective is to reduce the number of individual remote calls. This architecture is very helpful for a 3-tier distributed environment as recommended by the IBM Framework for e-business. In this environment, application logic and business services are separated into components that communicate with each other across a network. Application developers must be aware of the performance impacts of distributing application components across a network.

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12.1 The IBM Framework for e-business

As shown in Figure 12-1, IBM Framework for e-business is at the core of the IBM e-business software strategy. IBM developed the Framework for e-business to help customers build, run, and manage successful e-business applications. When customers adopt the Framework, they adopt a proven methodology, products, and tools.

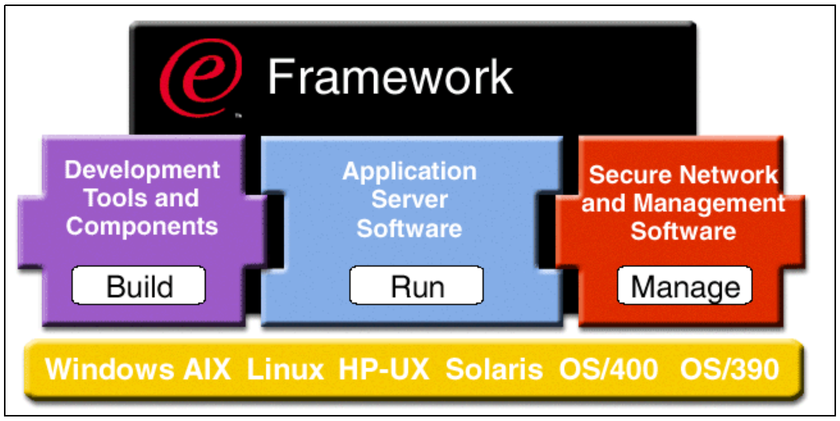

Framework
Development Tools and Components
Build
Application Server Software
Run
Secure Network and Management Software
Manage
Windows AIX Linux HP-UX Solaris OS/400 OS/390

Figure 12-1 IBM Framework for e-business

Generally speaking, the Framework is a distributed computing model, which assumes that e-business applications comprise multiple executable program modules that run on different hardware and software platforms linked by networking. This model is designed to support clients with high-function Web application and enterprise servers. The Framework for e-business architecture provides a full range of services for developing and deploying e-business applications. Because it is based on industry standards, the Framework has the ability to “plug and play” multiple components provided by any vendor.

Figure 12-2 shows the e-business application model.

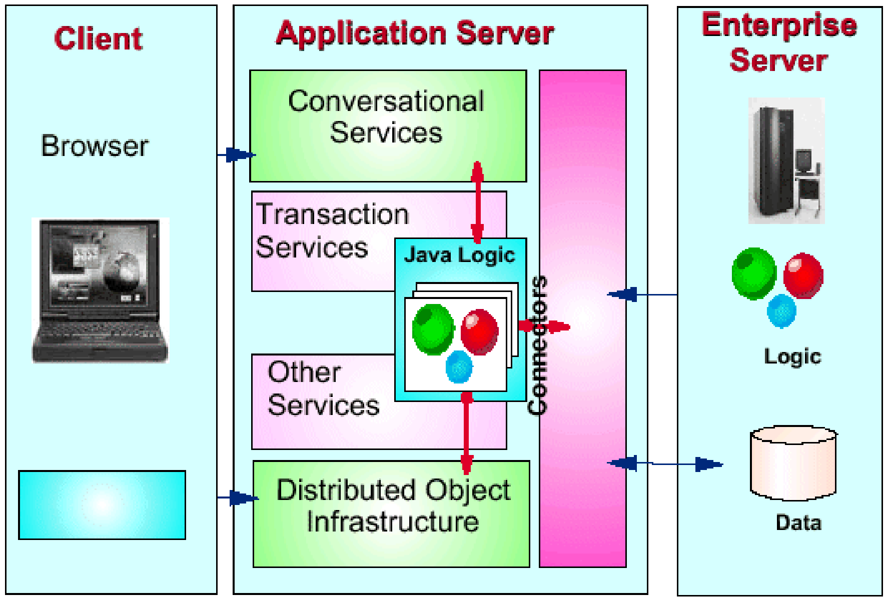


Figure 12-2 The e-business application model

The architecture is composed of the following key elements:

- Clients based on a Web browser or Java applet model that enables universal access to Framework applications and on-demand delivery of application components.
- A network infrastructure that provides such services as TCP/IP, directory, and security whose capabilities can be accessed via open, standard interfaces, and protocols.
- Application server software that provides a platform for e-business applications and includes an HTTP server, database and transaction services, mail and groupware services, and messaging services.
- Application integration that allows disparate applications to communicate and provides Web access to existing data and applications.
- A Web application programming environment that provides the server-side Java programming environment for creating dynamic and robust e-business applications.
- e-business application services that provide higher level application specific functionality to facilitate the creation of e-business solutions.
- Systems management functions that accommodate the unique management requirements of network computing across all elements of the system, including users, applications, services, infrastructure, and hardware.
- Development tools to create, assemble, deploy, and manage applications.

12.2 Distributed Java applications

Distributed applications are defined by the ability to use remote resources as if they were local. However, this remote work affects the performance of distributed applications. Distributed applications can improve performance by using remote calls sparingly. If a server does several tasks for a client, the application can run more efficiently if the client bundles requests together, which reduces the number of individual remote calls. The Command package provides a mechanism for collecting sets of requests to be submitted as a unit.

In addition to giving you a way to reduce the number of remote invocations a client makes, the Command package provides a generic way of making requests. A client instantiates the command, sets its input data, and tells it to run. The Command infrastructure determines the target server and passes a copy of the command to it. The server runs the command, sets any output data, and copies it back to the client. The package provides a common way to issue a command, locally or remotely, and independently of the server's implementation. Any server (an enterprise bean, a Java Database Connectivity (JDBC) server, a servlet, and so on) can be a target of a command if the server supports Java access to its resources and provides a way to copy the command between the client's JVM and its own JVM.

This chapter demonstrates how to use the Command framework in the OrderEntry application. The Model-View-Controller architecture is applied to the application to improve the encapsulation of business logic and provide a separation between the modules.

12.3 The Command package

A Web application is essentially a series of interactions between a client and a particular Web site. When the client and server run on different JVMs, the Web application needs to enable remote method invocation (RMI) via server-specific protocols. This can become considerably inefficient in terms of both time and resource, particularly when crossing a network.

The command bean infrastructure allows a command to be run within the environment of a target server. Therefore, multiple accesses by the command to server resources avoid distributed overhead. Any server can be a target if it supports Java access to its resources and provides a protocol to copy the command bean between a Web application JVM and the command server JVM.

Command beans allow the server side of the Web application to be partitioned into efficient units of interaction. The Web application parts, such as the interaction controller and user interface logic, are independent of the style of the command bean's implementation and independent of where the command bean is physically executed.

Command beans that execute locally (in other words, in the same JVM as the Web application) simply implement the Command interface. If a command bean is to execute remotely on another server, it implements the TargetableCommand interface, which is an extension of the Command interface that allows for remote execution. This is done by extending the TargetableCommandImpl class. Regardless of whether the command bean executes locally or remotely, the JSP or servlet executes the command bean in the same way. If it is conceivable that a command could ever be remote, then it should implement the TargetableCommand interface. Then a change in deployment does not cause a source code change.

With the release of WebSphere 3.5, the Command model is formalized in the Command package (com.ibm.websphere.command) and extended to accommodate command shipping (called TargetableCommand). The concept behind command shipping is to intercept `execute()` methods, ship the command to a better execution point, execute it, and then ship it back to the caller.

WebSphere 3.5.3 introduces a command target for EJBs named *EJBCommandTarget*. This is the command target for commands that are executed on an EJB server. It uses a server-side entity bean to allow concurrent access by different transactions to execute a command on the server.

The WebSphere Command support is available for both WebSphere Application Server Version 4.0 Advanced Edition and WebSphere Application Server Version 4.0 Advanced Single Server Edition.

12.3.1 The Command interface

The most basic features of the Command framework are specified in the Command interface, which extends java.io.Serializable. It contains the following three abstract methods:

- `execute()`
- `isReadyToCallExecute()`
- `reset()`

These methods control the life cycle of a command. When a command has been instantiated, it is in the *new* state. Running a command often requires a set of input properties. The `isReadyToCallExecute()` method can be used to check whether the requirement of input has been satisfied. It is called on the client side before the command is passed to the server for execution. If the `isReadyToCallExecute()` method returns true, the command is in the *initialized* state, and the `execute()` method is ready to be invoked. After the `execute()` method is successfully run, the command goes from the *initialized* state to the *executed* state. This is demonstrated in Figure 12-3.

The `reset()` method retains the previously set input properties, but resets the output properties of the object back to the original values prior to any execute calls (such as, null or 0). It converts the command from an *executed* state back to the *initialized* state. Resetting the output properties prevents exposing outdated output values of previous command executions to later executions.

Resetting the same command instance is convenient if there are several complex input properties that do not need to be changed for the next invocation. This reuse also avoids the overhead of instantiation and garbage collection.

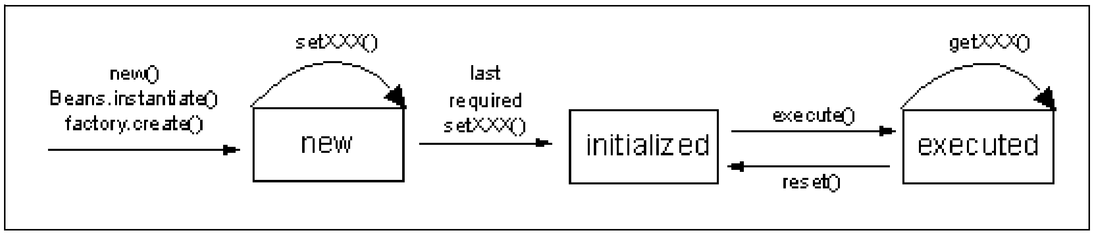


Figure 12-3 The Command life cycle

12.3.2 Facilities for creating commands

The steps to write a command are:

1. Create a command interface.
2. Implement the command.
3. Implement the target.

In practice, most commands implement the TargetableCommand interface, which allows the command to be executed remotely. Example 12-1 shows the structure of a command interface for a targetable command.

Example 12-1 The structure of an interface for a targetable command

```
...
import com.ibm.websphere.command.*;
public interface MyCommand extends TargetableCommand {
      // Declare application methods here
}
```

The interface TargetableCommand extends com.ibm.websphere.command.Command. In addition to the three methods described previously, the TargetableCommand interface declares the methods shown in Table 12-1.

Table 12-1 TargetableCommand methods

Methods	Purpose
setCommandTarget()	Specifies the target object of a command.
getCommandTarget()	Returns the target object of a command.
setCommandTargetName()	Specifies the target name to a command.
getCommandTargetName()	Returns the target name of a command.

Methods	Purpose
hasOutputProperties()	Indicates whether the command has output that must be copied back to the client. The implementation class also provides the `setHasOutputProperties()` method, for setting the output of this method. By default, the `hasOutputProperties()` method returns true.
setOutputProperties()	Saves the output values from the command for return to the specific client.
performExecute()	Encapsulates the application specific work. It is called by the `execute()` method declared in the Command interface.

The `performExecute()` method is the only method that must be implemented by the application developer. The others have been implemented in the TargetableCommandImpl class in the same package, which also implements the `execute()` method declared in the Command interface.

As we have discussed, a targetable command extends the TargetableCommand interface, which allows the client to direct a command to a particular server. The TargetableCommand interface and the TargetableCommandImpl class provide two ways for a client to specify a target:

- **`setCommandTarget()` method**: Allows the client to set the target object directly on the command
- **`setCommandTargetName()` method**: Allows the client to refer to the server by name, an approach that is useful when the client is not directly aware of server objects.

A targetable command also has corresponding `getCommandTarget()` and `getCommandTargetName()` methods.

A command needs to identify its target. Because there is more than one way to specify the target and because different applications can have different requirements, the Command package does not specify a selection algorithm. Instead, it provides a TargetPolicy interface with one method, `getCommandTarget()`, and a default implementation. This allows applications to devise custom algorithms for determining the target of a command when appropriate. The TargetableCommandImpl abstract class provides two methods for setting and returning the target policy associated with the command:

- void `setTargetPolicy`(com.ibm.websphere.command.TargetPolicy)
- com.ibm.websphere.command.TargetPolicy `getTargetPolicy()`

12.4 Creating a command

In this section, we create a simple command named *GetCustomerCmdEJB*. The purpose of this command is to retrieve customer information using the Command framework. In this example, we use the EJBCommandTarget class. It is a command target for commands that target Enterprise JavaBeans on an EJB server.

12.4.1 Benefits of the Command package framework

As shown in the previous chapters, the Customer entity bean has methods for retrieving any customer record from the corresponding database table. We could simply obtain an instance of the bean by invoking the `findByPrimaryKey()` method and then retrieving all the information we need about that customer through getter methods. However, this is not efficient, especially when the client and the EJB run on different JVMs. This is because it requires multiple RMI calls. As illustrated in the Figure 12-4, if we rely on the getter methods on the Customer bean, each of these calls is a remote call. With the approach of command shipping, which allows bundling of these calls, we greatly reduce the remote calls and improve performance.

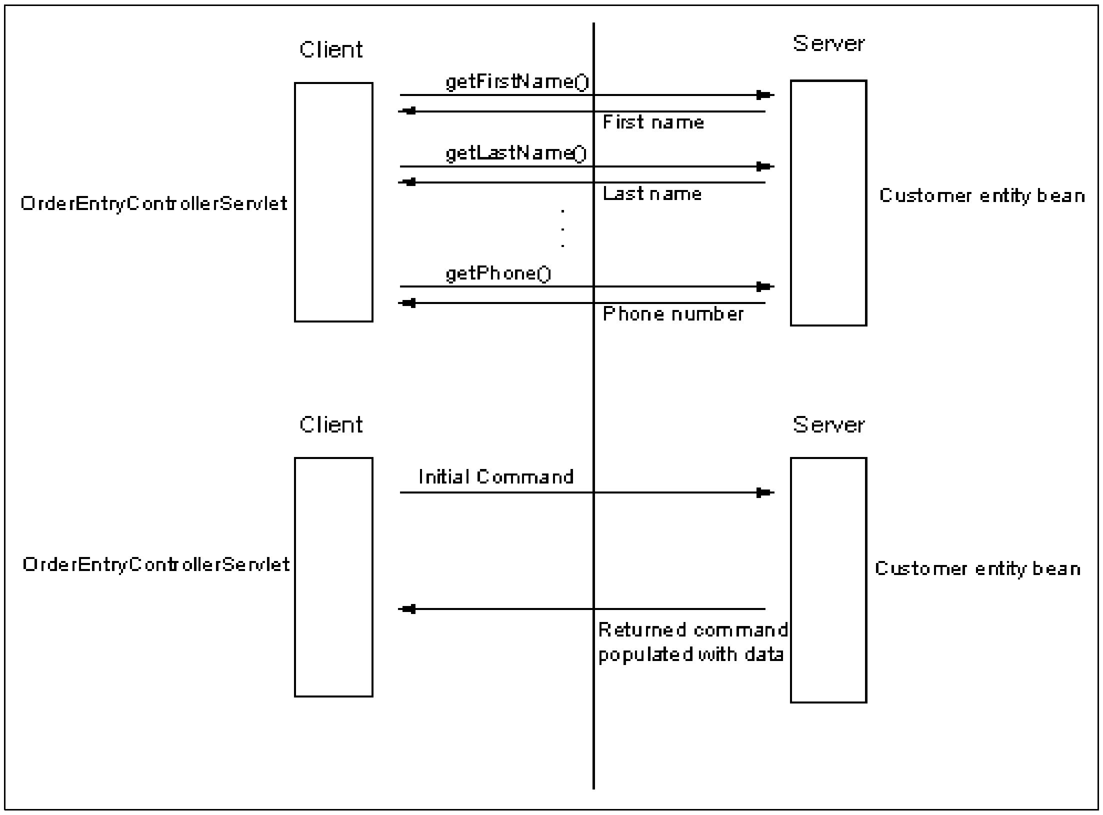


Figure 12-4 Comparing the original method to the command method

12.4.2 Using the EJBCommandTarget class

In this example, we use the EJBCommandTarget class. The EJBCommandTarget class is provided by the WebSphere Command framework to allow us to run a command in a designated server without providing our own command target implementation.

The EJBCommandTarget object serves as a wrapper for an EJB command target. The CommandServerEntityBean is the WebSphere implementation of the EJB CommandTarget class. It is a stateless bean managed persistent bean, so there is no database table associated with this bean. The command developer can set the EJBCommandTarget object as the target for a command. The WebSphere Application Server administrator deploys the CommandServerEntityBean into the application server where the command is executed.

12.4.3 Creating the GetCustomerCmdEJB command

In this section, we define the *GetCustomerCmdEJB* interface that extends the TargetableCommand class. It defines the business logic methods of the command, as shown in Example 12-2.

Example 12-2 The GetCustomerCmdEJB interface

```
import com.ibm.websphere.command.*;
import com.ibm.itso.roch.wasaejb.*;

public interface GetCustomerCmdEJB extends TargetableCommand{
   String getAddressLine1();
   String getAddressLine2();
   String getCity();
   Customer getCustomer();
   String getFirstName();
   String getMiddleInitials();
   String getPhone();
   String getState();
   String getZip();
   void setCustomer(Customer cust);
}
```

The GetCustomerCmdEJBImpl class extends the TargetableCommandImpl and implements the GetCustomerCmd interface as shown in Example 12-3.

Example 12-3 Definition of the GetCustomerCmdEJBImpl class

```
import java.lang.reflect.*;
import com.ibm.websphere.command.*;
import com.ibm.itso.roch.wasaejb.*;
import javax.naming.*;
import java.rmi.RemoteException;
import java.util.*;

public class GetCustomerCmdEJBImpl extends TargetableCommandImpl implements
     GetCustomerCmdEJB {

   private Customer customer = null;

   private String customerID = null;
   private String firstName = null;
   private String lastName = null;
   private String middleInitials = null;

   private String addressLine1 = null;
   private String addressLine2 = null;
   private String city = null;
   private String state = null;
   private String zip = null;
   private String phone = null;

   private float creditLimit = 0;
   private float balance = 0;
   private float yearToDateBalance = 0;
}
```

We place the GetCustomerCmdEJB interface and the GetCustomerCmdEJBImpl class, as well as the other command-related interfaces or classes described in this chapter, into the OrderEntryCommandPkg package.

To implement the business logic defined in the GetCustomerCmdEJB interface, we add the methods defined in the GetCustomerEJBCmd interface to the GetCustomerCmdEJBImpl class as shown in Example 12-4.

Example 12-4 Implementation of the methods defined in the GetCustomerCmdEJB interface

```
   public String getFirstName(){
      return firstName;
   }
   public String getMiddleInitials(){
      return middleInitials;
   }
   public String getLastName(){
      return lastName;
   }
   public String getAddressLine1(){
      return addressLine1;
   }
   public String getAddressLine2(){
      return addressLine2;
   }
   public String getCity(){
      return city;
   }
   public String getState(){
      return state;
   }
   public String getZip(){
      return zip;
   }
   public String getPhone(){
      return phone;
   }
   public void setCustomer(Customer cust){
      customer = cust;
   }
   public Customer getCustomer(){
      return customer;
   }
```

The most important method in the GetCustomerCmdEJBImpl class that needs to be implemented is the `performExecute()` method. We define this method as shown in Example 12-5.

Example 12-5 The performExecute() method in the GetCustomerCmdEJBImpl class

```
public void performExecute() throws Exception {
try {
        Context initCtx = getInitialContext();
        CustomerHome customerHome = (CustomerHome) initCtx.lookup("Customer");
        CustomerKey custKey = new CustomerKey(customerID);
        customer = (Customer) customerHome.findByPrimaryKey(custKey);
        customerID = customer.getCustomerID();
        firstName = customer.getFirstName();
        lastName = customer.getLastName();
        middleInitials = customer.getMiddleInitials();
        addressLine1 = customer.getAddressLine1();
        addressLine2 = customer.getAddressLine2();
        city = customer.getCity();
        state = customer.getState();
        zip = customer.getZip();
        phone = customer.getPhone();
        setHasOutputProperties(true);
} catch (Exception ex) {
        ex.printStackTrace();
        throw ex;
    }
}
```

The `performExecute()` method should be programmed using the server programming model. The other methods should be programmed as if server facilities are not available.

We obtain an InitialContext object and look up the home interface of the Customer EJB. We use the `findByPrimaryKey` method to obtain an instance of the Customer bean.

The last method in the GetCustomerCmdEJBImpl class that must be implemented is the `isReadyToCallExecute()` method as shown in Example 12-6. It tells the Command infrastructure when the `execute()` method is ready to be invoked.

Example 12-6 The isReadyToCallEexecute() method in the GetCustomerCmdEJBImpl class

```
public boolean isReadyToCallExecute() {
   if (customerID != null)
      return true;
   else
      return false;
}
```

As discussed previously, implementation of the `reset()` method is optional. It helps to reuse the command and to save the overhead of instantiating a new command and garbage collecting the old instance. We define the `reset()` method as shown in Example 12-7.

Example 12-7 The reset() method in the GetCustomerCmdEJBImpl class

```
public void reset() {
   customer = null;
   customerID = null;
   firstName = null;
   lastName = null;
   middleInitials = null;
   addressLine1 = null;
   addressLine2 = null;
   String city = null;
   String state = null;
   String zip = null;
   String phone = null;
   creditLimit = 0;
   balance = 0;
   yearToDateBalance = 0;
}
```

To accept a command, the target must implement the CommandTarget interface. In this example, the EJBCommandTarget class implements the CommandTarget interface. The Command package provides mechanisms for determining where to run the command.

A *target policy* associates a command with a target. Later, you will see how to use a target policy to associate the getCustomerCmdEJB command with the EJBCommandTarget class as its target. The the implementor of the CommandTarget interface (the EJBCommandTarget class, in our example) is responsible for ensuring the proper execution of a command in the desired target server environment. EJBCommandTarget is a command target for commands that are executed in an EJB server. It provides the client-side RMI/IIOP stub for the server-side entity bean that runs the command on the server.

12.4.4 Using the GetCustomerCmdEJB command

We test the GetCustomerCmdEJB command using a JSP and servlet. The servlet demonstrates how to use the command from a client application. We follow these steps:

1. Create a JavaServer Page file named *RetrieveCustomerInfo.jsp*. It displays an HTML page that allows a user to enter a customer ID.
2. After the user enters a customer ID and clicks the Submit button, the JSP invokes the GetCustomerServlet class. It creates an instance of the GetCustomerCmdEJB command, setting its target as EJBCommandTarget.
3. The command is executed on the iSeries EJB server.
4. The command is returned to the client with customer information. The customer information is displayed on the browser.

The JSP and servlet code are for the purpose of testing the remote execution of the command. They are not a part of the OrderEntry application. Later we show how to use the commands in the OrderEntry application. Example 12-8 shows the JSP code.

Example 12-8 The RetrieveCustomerInfo.jsp that takes a customer ID from user input

```
<html><head>
<title>Retrieve Customer Information</title>
</head><body><center>

<p></p>
<p></p>

<p><b><font face="Arial" size="3" color="#0000FF">Please enter Customer ID
below:</font></b><br>

<form method="POST" action="/OrderEntry2/GetCustomerServlet">
  <p align="center"> <input type="text" name="CustomerID" size="20"><br><br>
  <input type="submit" value="Submit" name="Submit"><input type="reset" value="Reset"
name="Reset"></p>

</center></form></body></html>
```

The action of the Submit button is to execute GetCustomerServlet, which is installed in the OrderEntry Web application.

Example 12-9 shows the code for the `init()` method for the GetCustomerServlet class.

Example 12-9 The code for the GetCustomerServlet init method

```
public void init(ServletConfig config) throws ServletException {
    getCustCmd = new GetCustomerCmdEJBImpl();
    policy = (TargetPolicyDefault) getCustCmd.getTargetPolicy();
    policy.registerCommand(
        "OrderEntryCommandPkg.GetCustomerCmdEJBImpl",
        "com.ibm.websphere.commandUtil.EJBCommandTarget");
}
```

In the `init()` method, we create an instance of the GetCustomerEJBImpl class named *getCustCmd*. We create a new TargetPolicyDefault object named *policy* and register the EJBCommandTarget class as the command target for the GetCustomerCmdEJB command. Since targetable commands can be run remotely in another JVM, the Command package provides mechanisms for determining where to run the command. A target policy associates a command with a target and is specified through the TargetPolicy interface.

We can design customized target policies by implementing this interface, or we can use the provided TargetPolicyDefault class. If we use this default implementation, the command determines the target by looking through an ordered sequence of four options:

1. The CommandTarget value
2. The CommandTargetName value
3. A registered mapping of a target for a specific command
4. A defined default target

If it finds no target, it returns null.

The TargetPolicyDefault class provides methods for managing the assignment of commands with targets (registerCommand, unregisterCommand, and listMappings), and a method for setting a default name for the target (`setDefaultTargetName`). The default target name is com.ibm.websphere.command.LocalTarget, where *LocalTarget* is a class that runs the command's `performExecute` method locally.

Example 12-10 shows the code for the `doPost()` method.

Example 12-10 Code for the GetCustomerServlet doPost method

```
public void doPost(HttpServletRequest request, HttpServletResponse response)
    throws ServletException, IOException {
    String newCustID = request.getParameter("CustomerID");
    getCustCmd = new GetCustomerCmdEJBImpl(policy);
    try {
        getCustCmd.setCustomerID(newCustID);
        getCustCmd.execute();
    } catch (Exception e) {
        System.out.println(e.getMessage());
        e.printStackTrace();
    }
    response.setContentType("text/html");
    PrintWriter out = response.getWriter();
    out.println("<html>");
    out.println("<head><title>Get Customer Information Servlet</title></head>");
    out.println("<body>");
    out.println(
        "<p><center><b><font face=\"Arial\" size=\"6\" color=\"Blue\">"
            + getCustCmd.getFirstName()
            + " "
            + getCustCmd.getLastName()
            + "</font></b></p>");
    out.println("</body></html>");
    out.close();
}
```

In the `doPost` method, we create an instance of the command, called *getCustCmd*. We initialize the command's parameters and execute it. This causes the `performExecute` method of the command to be invoked.

Since we registered EJBCommandTarget as the target for the command, the command is copied to the target server. The server runs the command, sets any output data, and copies it back to the client. When this is finished, the returned command contains the required customer information.

Assume the application has been deployed on WebSphere Application Server, run the RetrieveCustomerInfo JSP file by opening a browser session and entering:

```
http://sysname:port/OrderEntry2/RetrieveCustomerInfo.jsp
```

Enter a customer ID in the entry field and click **Submit**. The display appears like the example in Figure 12-5.

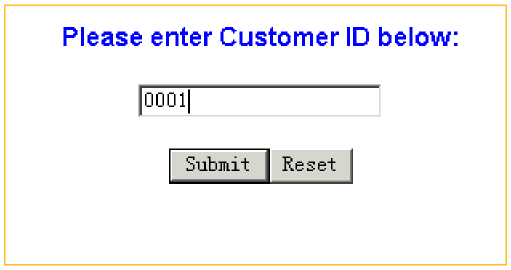
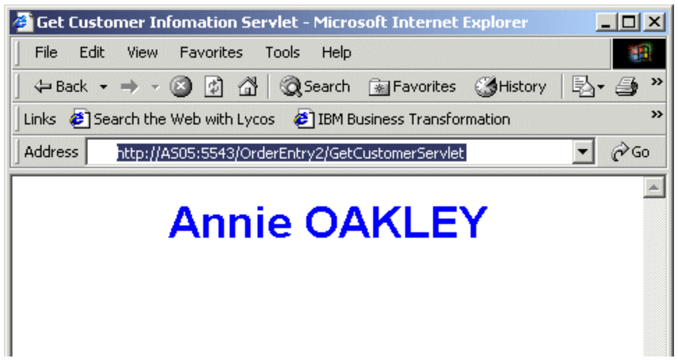


Figure 12-5 Entering the customer ID in the JSP file

If it works correctly, we see the first name and last name of the customer displayed on the browser (Figure 12-6). The servlet demonstrates that a command can be shipped to and executed on the EJB server, as well as carry any outputs back to the client.


Get Customer Infomation Servlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation
Address http://AS05:5543/OrderEntry2/GetCustomerServlet
Go

Annie OAKLEY

Figure 12-6 Displaying the customer information

12.5 Creating your own command targets

The Command framework provides a number of ways to create and implement commands. This section examines additional ways to use commands with Enterprise JavaBeans. Rather than using the EJBCommandTarget implementation, we can design commands that directly interface with our EJBs. You will see an example of using a custom target policy (CustomTargetPolicy).

We create a command named GetCustomerCmd, which is similar to GetCustomerCmdEJB, but directly interfaces with the Customer EJB. We also create the OrderPlacementCmd command, which uses the OrderPlacement session bean to place orders.

12.5.1 Constructing the GetCustomerCmd command and its target

The overall design in this example is to first construct an instance of the command, look up the Customer bean, and instantiate an instance of it using the `findByPrimaryKey()` method. Then a reference to this Customer object is assigned to the command so that the bean instance becomes the command target. The command is copied to the target server. The server runs the command, sets any output data, and copies it back to the client. When this is finished, the returned command copy contains the needed customer information.

First, we define the GetCustomerCmd interface that extends TargetableCommand. It defines the business logic methods of the command as shown in Example 12-11.

Example 12-11 The GetCustomerCmd interface

```
import com.ibm.websphere.command.*;
import com.ibm.itso.roch.wasaejb.*;

public interface GetCustomerCmd extends TargetableCommand{
   String getAddressLine1();
   String getAddressLine2();
   String getCity();
   Customer getCustomer();
   String getFirstName();
   String getMiddleInitials();
   String getPhone();
   String getState();
   String getZip();
   void setCustomer(Customer cust);
}
```

The GetCustomerCmdImpl class extends TargetableCommandImpl and implements the GetCustomerCmd interface as shown in Example 12-12.

Example 12-12 GetCustomerCmdImpl and its variables declaration

```
import java.lang.reflect.*;
import com.ibm.websphere.command.*;
import com.ibm.itso.roch.wasaejb.*;
import javax.naming.*;
import java.rmi.RemoteException;
import java.util.*;

public class GetCustomerCmdImpl extends TargetableCommandImpl implements GetCustomerCmd {
   private Customer customer = null;

   private String customerID = null;
   private String firstName = null;
   private String lastName = null;
   private String middleInitials = null;

   private String addressLine1 = null;
   private String addressLine2 = null;
   private String city = null;
   private String state = null;
   private String zip = null;
   private String phone = null;

   private float creditLimit = 0;
   private float balance = 0;
   private float yearToDateBalance = 0;
}
```

Now the question is how to initialize a GetCustomerCmdImpl instance. We define the constructor of the class as shown in Example 12-13. This constructor references a TargetPolicy object as a parameter. Then it calls the `setTargetPolicy()` methods inherited from the TargetableCommandImpl class to set the target policy, which associates the command with a specified target object.

Example 12-13 Constructor of the GetCustomerCmpImpll

```
public GetCustomerCmdImpl(CommandTarget target, TargetPolicy targetPolicy) {
   setTargetPolicy (targetPolicy);
}
```

As discussed earlier, there is more than one way to specify a command target. In this application, we adopt the approach of defining our own CustomTargetPolicy class that implements the TargetPolicy and the Serializable interfaces. Example 12-14 shows the definition of the CustomTargetPolicy used for targetting the Customer entity bean.

Example 12-14 Definition of CustomTargetPolicy used by the Customer command

```
import java.io.*;
import java.util.*;
import java.beans.*;
import com.ibm.websphere.command.*;

public class CustomTargetPolicy implements TargetPolicy, Serializable{

   public CommandTarget getCommandTarget (TargetableCommand command) {
      CommandTarget target = null;
      try {
         target = (CommandTarget) Beans.instantiate(null,
                  "com.ibm.itso.roch.wasaejb.CustomerBean");
      }
      catch (java.io.IOException ioEx){
         ioEx.printStackTrace();
      }
      catch (ClassNotFoundException cnfEx){
         cnfEx.printStackTrace();
      }
      return target;
   }
}
```

In the `getCommandTarget()` method, we use the static `instantiate()` method of the beans class defined in the java.beans package to search for CustomerBean and to instantiate an instance of it. A reference to the instance is returned. This instance becomes the target of the GetCustomerCmd command. As shown in Example 12-13, a reference of a CustomTargetPolicy object is passed into the GetCustomerCmdImpl constructor so the command knows its target of execution.

To implement the business logic defined in the GetCustomerCmd interface, we add the methods defined in the GetCustomerCmd interface to the GetCustomerCmdImpl class as shown in Example 12-15.

Example 12-15 Implementation of the methods defined in the GetCustomerCmd interface

```
   public String getFirstName(){
      return firstName;
   }
   public String getMiddleInitials(){
      return middleInitials;
   }
   public String getLastName(){
      return lastName;
   }
   public String getAddressLine1(){
      return addressLine1;
   }
   public String getAddressLine2(){
      return addressLine2;
   }
   public String getCity(){
      return city;
   }
   public String getState(){
      return state;
   }
   public String getZip(){
      return zip;
   }
   public String getPhone(){
      return phone;
   }
   public void setCustomer(Customer cust){
      customer = cust;
   }
   public Customer getCustomer(){
      return customer;
   }
```

Next, we create the `performExecute()` method. We define this method as shown in Example 12-16. We explain the invocation of this method later when we discuss how the command is used in the OrderEntry application.

Example 12-16 The performExecute() method in the GetCustomerCmdImpl class

```
public void performExecute() throws Exception {

   Customer customer = getCustomer();
   customerID = customer.getCustomerID();
   firstName = customer.getFirstName();
   lastName = customer.getLastName();
   middleInitials = customer.getMiddleInitials();
   addressLine1 = customer.getAddressLine1();
   addressLine2 = customer.getAddressLine2();
   city = customer.getCity();
   state = customer.getState();
   zip = customer.getZip();
   phone = customer.getPhone();
}
```

The last method in the GetCustomerCmdImpl class that must be implemented is `isReadyToCallExecute()` as shown in Example 12-17. It tells the Command infrastructure when the `execute()` method is ready to be invoked.

Example 12-17 The isReadyToCallExecute() method in the GetCustomerCmdImpl class

```
public boolean isReadyToCallExecute() {
   if (customer != null)
      return true;
   else
      return false;
}
```

As discussed earlier, implementation of the `reset()` method is optional. It helps to reuse the command and to save the overhead of instantiating a new command and garbage collecting the old instance. We define the `reset()` method as shown in Example 12-18.

Example 12-18 The reset() method in the GetCustomerCmdImpl class

```
public void reset() {
   customer = null;
   customerID = null;
   firstName = null;
   lastName = null;
   middleInitials = null;
   addressLine1 = null;
   addressLine2 = null;
   String city = null;
   String state = null;
   String zip = null;
   String phone = null;
   creditLimit = 0;
   balance = 0;
   yearToDateBalance = 0;
   targetPolicy = new TargetPolicyDefault();
}
```

To accept a command, the target must implement the CommandTarget interface. The implementor of the CommandTarget interface (the Customer entity bean in this example) is responsible for ensuring the proper execution of a command in the desired target server environment. Therefore, before we ship the command to its target server for execution, we have to modify the CustomerBean entity bean so that it implements the CommandTarget interface and its single `executeCommand()` method as shown in Example 12-19. Note this method must be added to the remote interface so that it can be seen by the client. Further, we need to re-generate the deployed code and deploy the modified Customer bean to the server to replace the original Customer bean.

Example 12-19 Implementation of the CommandTarget interface by the CustomerBean

```
...
import com.ibm.websphere.command.*;
import OrderEntryCommandPkg.*;

public class CustomerBean implements EntityBean, CommandTarget {
   // Original code

   public TargetableCommand executeCommand (TargetableCommand command) throws
                           RemoteException, CommandException {
      try {
         command.performExecute();
      }
      catch (Exception ex) {
         if (ex instanceof RemoteException) {
            RemoteException remoteException = (RemoteException) ex;
            if (remoteException.detail != null){
               throw new CommandException (remoteException.detail);
            }
            throw new CommandException (ex);
         }
      }
      if (command.hasOutputProperties()) {
         return command;
      }
      return null;
   }
   // Original code
}
```

As shown, this method references a TargetableCommand as a parameter and returns it after calling the `peformExecute()` method of the command. Therefore, we can put all the business logic in the `performExecute()` method. The Command package infrastructure will copy the command to the target server where the `performExecute()` method is invoked.

Using the GetCustomerCmd command in the OrderEntry application

Now that the command has been initialized and its target is set, we are ready to ship the command to the target server for execution. The Command package provides a convenient way to do this.

1. We simply call the `execute()` method in the command. Remember `execute()` is defined in the Command interface and is implemented in the TargetableCommandImpl class.
2. When `execute()` is invoked, a copy of the command is shipped to its target server. The `executeCommand()` method on the target will be called automatically.

3. After that, the command is shipped back to the client. In our example, the Customer command is copied to the Customer bean, populated with the customer information, and carried back by the Command infrastructure to the client site where the command was instantiated.

To use the command in the context of the OrderEntry application, we create a Java servlet called *OrderEntryControllerServlet*. We place this servlet and the others described in this chapter into a package called *tservlets* (Figure 12-7). The details of the OrderEntryControllerServlet servlet and the Model-View-Controller architecture are discussed later. For now, we focus on how to run the GetCustomerCmd command.

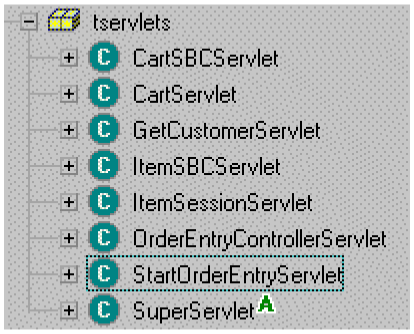

tservlets
- CartSBCServlet
- CartServlet
- GetCustomerServlet
- ItemSBCServlet
- ItemSessionServlet
- OrderEntryControllerServlet
- StartOrderEntryServlet
- SuperServlet

Figure 12-7 The tservlets package

The `init()` method of the OrderEntryControllerServlet first obtains an initial context object by calling the `getInitialContext()` method. It then looks up the CustomerHome home interface (Example 12-20). Therefore, after the servlet is started, a reference to the CustomerHome is already available.

Example 12-20 The init() and the getInitialContext() methods in the OrderEntryControllerServlet

```
public void init(ServletConfig config) throws ServletException {
   super.init(config, SuperServlet.SYSTEM);
   system = config.getInitParameter("system");
   userid = config.getInitParameter("userid");
   password = config.getInitParameter("password");
   port = config.getInitParameter("port");

   Context initCtx = null;
   try{
      initCtx = getInitialContext();
   }
   catch (Exception ex) {
      System.out.println ("Error in getting initial context: " + ex.getMessage());
   }
   try {
      cHome = (CustomerHome) initCtx.lookup("Customer");
   }
   catch (NamingException ne) {
      System.out.println("Error in looking up Customer entity bean: " + ne.getMessage());
   }
}

private static Context getInitialContext() throws Exception {
   Properties p = new Properties();
   try {
      p.put(Context.INITIAL_CONTEXT_FACTORY,
            "com.ibm.ejs.ns.jndi.CNInitialContextFactory");
      p.put(Context.PROVIDER_URL, "iiop://" + getSystem() + ":" + getPort());
      InitialContext cx = new InitialContext(p);
      return cx;
   }
   catch (Exception e) {
      System.out.println("Error creating Context " + e.getMessage());
      e.printStackTrace();
      throw (e);
```

```
    }
}
```

Example 12-21 shows how to instantiate and run the GetCustomerCmd command:

1. We declare an instance of the command and obtain a reference to the remote Customer bean by calling the private method `getCustomerByID()`.
2. We obtain a new CustomTargetPolicy object and instantiate a GetCustomerCmd command by passing the new CustomTargetPolicy instance into the GetCustomerCmdImpl constructor.
3. After the command is created, we call the `setCustomer()` method followed by the `execute()` method. As described earlier, calling the `execute()` method on a targetable command automatically invokes the `executeCommand()` method on the target object. Therefore, when the command is copied back to the client, it contains the customer information we need.

Example 12-21 Example code of how to run the customer command from a servlet

```
...
    GetCustomerCmd getCustCmd = null;
    com.ibm.itso.roch.wasaejb.Customer customer = null;
    try {
        customer = getCustomerByID(newCustID);
    }
    catch (RemoteException re){
      System.out.println(re.getMessage());
    }
    CustomTargetPolicy customPolicy = new CustomTargetPolicy();
    getCustCmd = new GetCustomerCmdImpl(customPolicy);
    try{
        getCustCmd.setCustomer(customer);
        getCustCmd.execute();
    }
    catch (Exception e) {
        System.out.println(e.getMessage());
    }
    getCustCmd.reset();
...
```

The update customer command

We create a second command that works with the Customer EJB. It is named *UpdateCustomerCmd*. Its implementation is done in the *UpdateCustomerCmdImpl* class. They are placed in the OrderEntryCommandPkg. The purpose of this command is to update customer information based on information passed in from a client application. It is similar to the GetCustomerCmd command and provides the same advantages.

12.5.2 The OrderPlacementCmd command

This command is designed to place an order by invoking the OrderPlacement session bean. The constructor of the OrderPlacementCmdImpl class (Example 12-22) is similar to the constructor of the GetCustomerCmdImpl class in that they both set the command target by instantiating a TargetPolicy object. After setting the command target, it obtains the next order ID by calling the `getNextOrderID()` private method and looks up the OrderPlacement bean by invoking the `lookupOrderPlacement()` method.

Example 12-22 The constructor of the OrderPlacementCmdImpl class

```
public OrderPlacementCmdImpl(CommandTarget target) {
   TargetPolicy targetPolicy = new CustomTargetPolicy2();
   setTargetPolicy (targetPolicy);

   // Get the next order id
   try {
      getNextOrderID();
   }
   catch (RemoteException re){
      System.out.println ("Fail to get next order id: " + re.getMessage());
   }
   lookupOrderPlacement();
}
```

Example 12-23 and Example 12-24 show the `getNextOrderID()` method and the `lookupOrderPlacement` method, respectively.

Example 12-23 The getNextOrderID() method

```
private void getNextOrderID() throws RemoteException {

   com.ibm.itso.roch.wasaejb.District district = null;
   Context initCtx = null;
   DistrictHome dHome = null;

   // Get the initial context
   try{
      initCtx = getInitialContext();
   }
   catch (Exception ex) {
      System.out.println ("Error in getting initial context: " + ex.getMessage());
   }
   // Look up District
   try {
      dHome = (DistrictHome) initCtx.lookup("District");
   }
   catch (NamingException ne) {
      System.out.println("Error in looking up District entity bean: " + ne.getMessage());
   }

   // Find by primary key for District
   try {
      DistrictKey distKey = new DistrictKey(dID, wID);
      district = (com.ibm.itso.roch.wasaejb.District) dHome.findByPrimaryKey(distKey);
   }
   catch (Exception e) {
      throw new RemoteException(e.getMessage());
   }
   // Return the next order id
   nextOrderID = district.getNextOrderId(true);
}
```

Example 12-24 The lookupOrderPlacement() method

```
private void lookupOrderPlacement () {
   Context initCtx = null;
   OrderPlacementHome opHome = null;
   try{
      initCtx = getInitialContext();
   }
   catch (Exception ex) {
      System.out.println ("Error in getting initial context: " + ex.getMessage());
   }
   try {
      opHome = (OrderPlacementHome)initCtx.lookup("OrderPlacement");
   }
   catch (NamingException ne){
      System.out.println ("Error in looking up OrderPlacement: " + ne.getMessage());
   }
   try {
      orderPlacement = opHome.create();
   }
   catch (Exception ex){
      System.out.println ("Error in creating orderPlacement: " + ex.getMessage());
   }
}
```

After we instantiate an instance of the OrderPlacementCmdImpl class, the instance already contains a new order ID and a reference to the remote OrderPlacement session bean. This is a modification to the original Order Entry design. We separate getting the new order ID from the order placement processing to avoid the situation where the District table is locked while the order placement is in process. Example 12-25 shows the `performExecute()` method. It simply executes the `placeOrder()` method on the target, which is the OrderPlacement bean instance.

Example 12-25 The performExecute() method in the OrderPlacementCmdImpl class

```
public void performExecute() throws Exception {
    orderPlacement.placeOrder(wID, dID, customerID, orderLines, nextOrderID);

}
```

12.6 Applying the Model-View-Controller architecture

This section looks at the Model-View-Controller (MVC) architecture. It explains how to apply it to the OrderEntry application and how the Command framework fits into the picture. The logic of the OrderEntry application is similar with the application we developed in 5.3, "Developing a new application with Application Developer" on page 195, with Application Developer. The difference is that we use normal Java classes to access the database in that chapter, while here we use Enterprise JavaBeans.

12.6.1 Re-designing the OrderEntry application using the MVC architecture

The MVC architecture was designed to reduce the programming effort required to build systems that make use of multiple, synchronized presentations of the same data. Its central characteristics are that the model, the controllers, and the views are treated as separate entities, and that changes made to the model should be reflected automatically in the views.

We can readily apply the MVC framework to a Web application. The idea is to split the application into three sections. A servlet handles any requests from the browser and acts as a controller. We put the business logic (the model) in Enterprise JavaBeans. Finally, we use JavaServer Pages to display the view. Figure 12-8 provides a high level overview of this architecture.

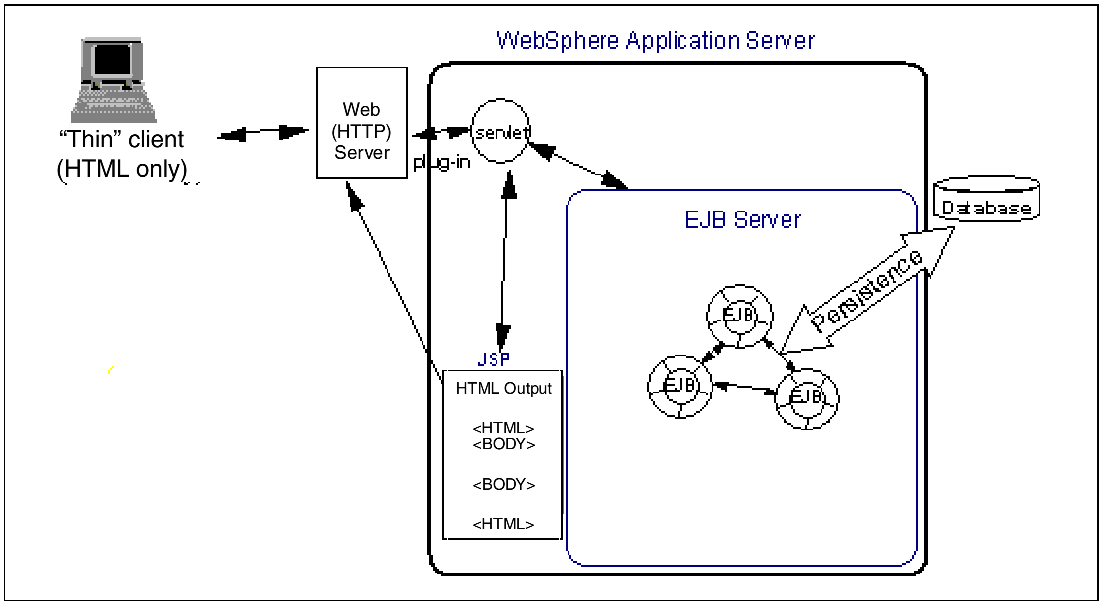


Figure 12-8 The Model-View-Controller architecture

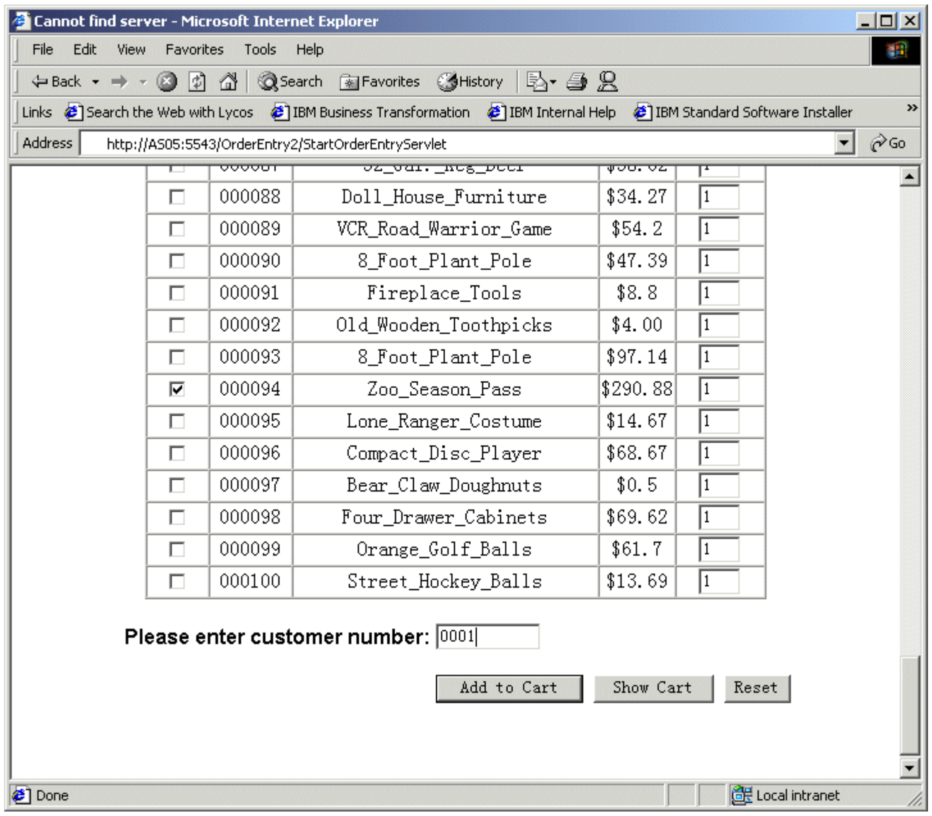
To apply the MVC architecture to the OrderEntry application, we use one servlet, the OrderEntryControllerServlet servlet, to handle all the user requests passed from the Web browser. Example 12-26 shows the `doPost()` method for this servlet.

Example 12-26 The doPost() method of the OrderEntryControllerServlet class

```
public void doPost(HttpServletRequest request, HttpServletResponse response) throws
                  IOException {
   HttpSession session = request.getSession(false);
   response.setContentType("text/html");
   response.setHeader("Pragma","no-cache");
   response.setHeader("Cache-Control","no-cache, must-revalidate");

   String action = null;
   String customerID = null;
   action = request.getParameter("action");
   customerID = request.getParameter("customerID");

   PrintWriter out = response.getWriter();

   if (session == null) {
      out.println("<BIG>Session object not available: getSession returned null.</BIG>");
      return;
   }
   if (action.equals("AddToCart")){
      addToCart(session, request, response, customerID);
   }
   else if (action.equals("ShowCart")){
      displayCart(customerID, response, session);
      }
     else if (action.equals("CheckOut")){
        placeOrder(session, response);
     }
     else if (action.equals("UpdateCustomerInformation")){
        updateCustomer(request, response, session);
     }
     else if (action.equals("ContinueShopping")){
        response.sendRedirect(response.encodeRedirectURL("StartOrderEntry.jsp"));
     }
     else if (action.equals("ShopSomeMore")){
        Vector itemVector = (Vector)(session.getAttribute("sessionlist.items"));
        String custID = (String)(session.getAttribute("customerID"));
        if (session != null)
           session.invalidate();

        session = request.getSession(true);
        session.setAttribute("sessionlist.items", itemVector);
        response.sendRedirect(response.encodeRedirectURL("StartOrderEntry.jsp"));
     }
}
```

This servlet performs various tasks depending on the requested action by the user. For example, if the user wants to purchase their selected items, the `doPost()` method calls the `placeOrder()` method. It processes the order and redirects the screen to the CheckOut JavaServer Page. The CheckOut JSP displays a message `Your order has been processed`, along with the order number. Therefore, the OrderEntryControllerServlet plays a role as a controller. It invokes the appropriate EJBs at run time to handle business logic and delegates the presentation logic to the JSPs.

We now discuss, in detail, the MVC-based version of the OrderEntry application that incorporates the techniques of the Command package. The application starts by calling a servlet named *StartOrderEntryServlet*. This servlet is different from the OrderEntryControllerServlet servlet and does not play the role of a controller. It simply invokes the OrderEntryClerk session bean to obtain all the available items that can be ordered. Once the item list is available, it calls the StartOrderEntry JSP to display these items, as shown in Figure 12-9.


Cannot find server - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://AS05:5543/OrderEntry2/StartOrderEntryServlet
Go
Done
Local intranet

☐	000088	Doll_House_Furniture	$34.27	1
☐	000089	VCR_Road_Warrior_Game	$54.2	1
☐	000090	8_Foot_Plant_Pole	$47.39	1
☐	000091	Fireplace_Tools	$8.8	1
☐	000092	Old_Wooden_Toothpicks	$4.00	1
☐	000093	8_Foot_Plant_Pole	$97.14	1
✓	000094	Zoo_Season_Pass	$290.88	1
☐	000095	Lone_Ranger_Costume	$14.67	1
☐	000096	Compact_Disc_Player	$68.67	1
☐	000097	Bear_Claw_Doughnuts	$0.5	1
☐	000098	Four_Drawer_Cabinets	$69.62	1
☐	000099	Orange_Golf_Balls	$61.7	1
☐	000100	Street_Hockey_Balls	$13.69	1

Please enter customer number: 0001

Figure 12-9 Displaying the available items using the StartOrderEntry JSP

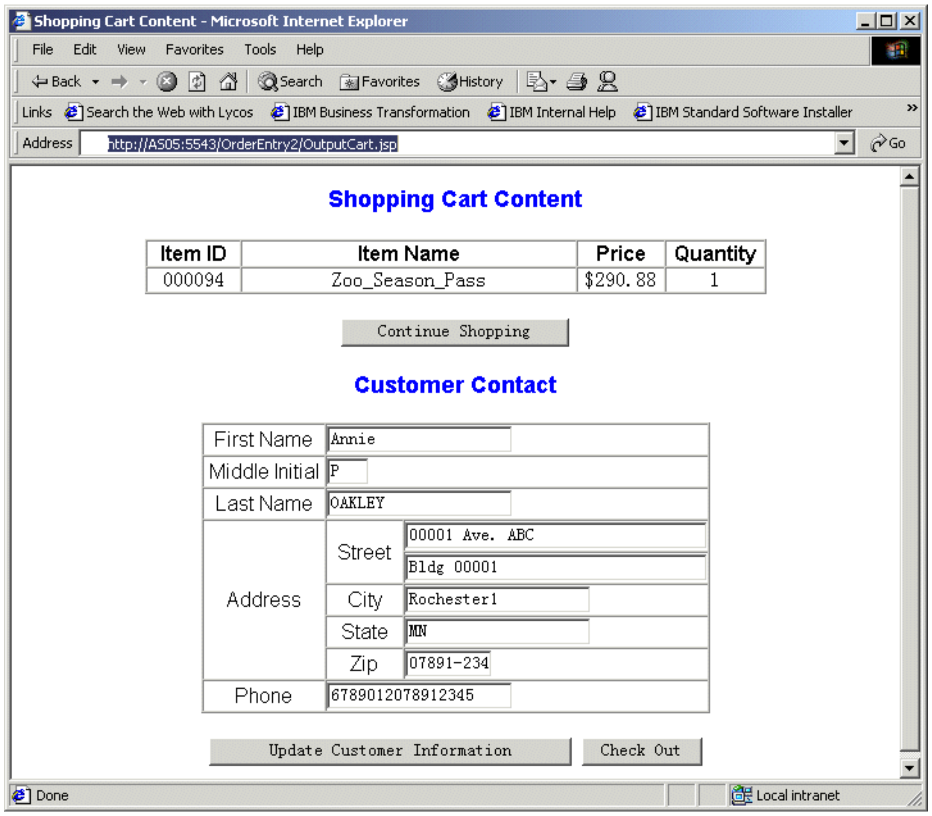
The user is prompted to enter their customer ID if they want to order any items. The Add To Cart and Show Cart buttons are disabled until the user enters their customer ID and selects at least one item.

If the user clicks the AddToCart button, a hidden field named *action* in the StartOrderEntry JSP is assigned the value *AddToCart*. Therefore, when the OrderEntryControllerServlet is invoked, it knows what action the user wants to perform. As shown in Example 12-26, the `doPost()` method calls the `addToCart()` method in response to the AddToCart action. Example 12-27 shows the `addToCart()` method.

Example 12-27 The addToCart () method in the OrderEntryControllerServlet

```
private void addToCart(HttpSession session, HttpServletRequest request, HttpServletResponse
response, String customerID){

   ShoppingCart cart=null;
   try{
      cart = (ShoppingCart) session.getAttribute("shopcart.selected");
   }
   catch (ClassCastException c){}

   if (cart == null) {
      cart = new ShoppingCart();
      flexLog("cart did not exist in session at this time");
   }
   else {
      flexLog("cart retrieved from session successfully, it has " + cart.getItems().size()
          + " elements");
   }

   Vector parts = (Vector) session.getAttribute("sessionlist.items");

   String[] value = request.getParameterValues("index");
   String[] quantity = request.getParameterValues("quantity");

   if (value != null) {
      int j = 0;
      for (int i = 0; i < value.length; i++) {
         j = Integer.parseInt(value[i]);
         String[] data = (String[]) parts.elementAt(j);

         Integer qty = new Integer (quantity[j]);
         CartItem aCartItem = new CartItem(data[0], data[1], data[2], data[3], qty);
         cart.getItems().addElement(aCartItem);
      }
      session.setAttribute("shopcart.selected", cart);
      displayCart(customerID, response, session);
   }
}
```

The `addToCart` method reads the selected items and their quantities from the user inputs and adds each item to the shopping cart, which is a vector of the CartItem objects. Then it calls the `displayCart()` method to display the selected items and the customer information as shown in Figure 12-10.


Shopping Cart Content - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://AS05:5543/OrderEntry2/OutputCart.jsp
Go
Done
Local intranet

Shopping Cart Content

Item ID	Item Name	Price	Quantity
000094	Zoo_Season_Pass	$290.88	1

Continue Shopping

Customer Contact

First Name		Annie
Middle Initial		P
Last Name		OAKLEY
Address	Street	00001 Ave. ABC
		Bldg 00001
	City	Rochester1
	State	MN
	Zip	07891-234
Phone		6789012078912345

Update Customer Information | Check Out

Figure 12-10 Displaying the selected items and the customer information

The `displayCart()` method in the OrderEntryControllerServlet (Example 12-28) first obtains the Customer bean instance based on the customer ID. Then it retrieves the customer information using the GetCustomerCmd command, which we discussed earlier. Finally, it directs the outputs to the OutputCart JSP to display the shopping cart content and the customer contact information.

Example 12-28 The displayCart() method in the OrderEntryControllerServlet

```
private void displayCart (String newCustID, HttpServletResponse response, HttpSession
session){

   session.setAttribute("custUpdateFlag", "false");
   if (newCustID != null && ! newCustID.equals("")) {
      session.setAttribute("customerID", newCustID);
      GetCustomerCmd getCustCmdImpl = null;
      com.ibm.itso.roch.wasaejb.Customer customer = null;

      try {
         customer = getCustomerByID(newCustID);
         session.setAttribute("customerObj", customer);
      }
      catch (RemoteException re){
         System.out.println(re.getMessage());
      }

      CustomTargetPolicy customPolicy = new CustomTargetPolicy();
      getCustCmdImpl = new GetCustomerCmdImpl(customPolicy);

      try{
         getCustCmdImpl.setCustomer(customer);
         getCustCmdImpl.execute();
      }
      catch (Exception e) {
         System.out.println(e.getMessage());
      }

      session.setAttribute("cFirstName", getCustCmdImpl.getFirstName());
      session.setAttribute("cMiddleInitials", getCustCmdImpl.getMiddleInitials());
      session.setAttribute("cLastName", getCustCmdImpl.getLastName());
      session.setAttribute("cAddressLine1", getCustCmdImpl.getAddressLine1());
      session.setAttribute("cAddressLine2", getCustCmdImpl.getAddressLine2());
      session.setAttribute("cCity", getCustCmdImpl.getCity());
      session.setAttribute("cState", getCustCmdImpl.getState());
      session.setAttribute("cZip", getCustCmdImpl.getZip());
      session.setAttribute("cPhone", getCustCmdImpl.getPhone());

      getCustCmdImpl.reset();
   }
   try {
      response.sendRedirect(response.encodeRedirectURL("/OutputCart.jsp"));
   }
   catch (Exception ex){
      System.out.println(ex.getMessage());
   }
}
```

If the user wants to update their contact information, they can enter the new data and then click the Update Customer Information button. In response to this request, the OrderEntryControllerServlet invokes the `updateCustomer()` method (Example 12-29).

Example 12-29 The updateCustomer() method in the OrderEntrControllerServlet class

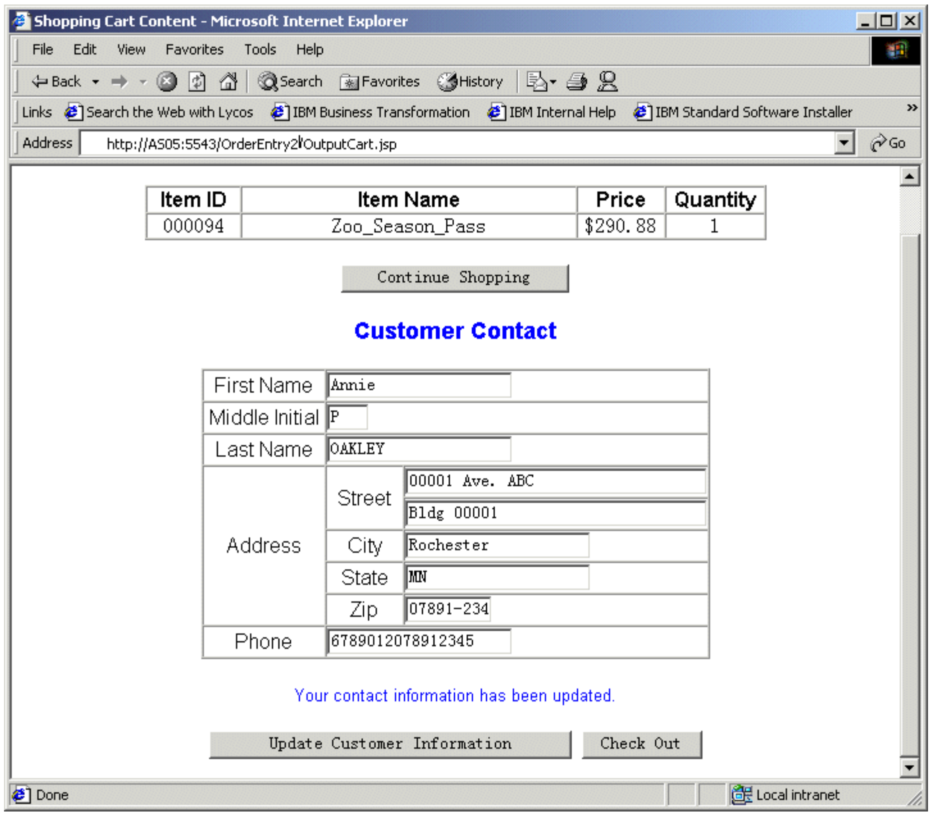
```
private void updateCustomer (HttpServletRequest request, HttpServletResponse response,
HttpSession session){

   String custID = (String)(session.getAttribute("customerID"));

   String firstName = request.getParameter("firstName");
   String middleInitials = request.getParameter("middleInitials");
   String lastName = request.getParameter("lastName");
   String addressLine1 = request.getParameter("addressLine1");
   String addressLine2 = request.getParameter("addressLine2");
   String city = request.getParameter("city");
   String state = request.getParameter("state");
   String zip = request.getParameter("zip");
   String phone = request.getParameter("phone");

   UpdateCustomerCmd updateCustCmdImpl = null;
   com.ibm.itso.roch.wasaejb.Customer customer =
(com.ibm.itso.roch.wasaejb.Customer)session.getAttribute("customerObj");

   CustomTargetPolicy customPolicy = new CustomTargetPolicy();
   updateCustCmdImpl = new UpdateCustomerCmdImpl(customer, customPolicy);

   updateCustCmdImpl.setFirstName(firstName);
   updateCustCmdImpl.setMiddleInitials(middleInitials);
   updateCustCmdImpl.setLastName(lastName);
   updateCustCmdImpl.setAddressLine1(addressLine1);
   updateCustCmdImpl.setAddressLine2(addressLine2);
   updateCustCmdImpl.setCity(city);
   updateCustCmdImpl.setState(state);
   updateCustCmdImpl.setZip(zip);
   updateCustCmdImpl.setPhone(phone);

   try{
      updateCustCmdImpl.setCustomer(customer);
      updateCustCmdImpl.execute();
      session.setAttribute("custUpdateFlag", "true");

      session.setAttribute("cFirstName", firstName);
      session.setAttribute("cMiddleInitials", middleInitials);
      session.setAttribute("cLastName", lastName);
      session.setAttribute("cAddressLine1", addressLine1);
      session.setAttribute("cAddressLine2", addressLine2);
      session.setAttribute("cCity", city);
      session.setAttribute("cState", state);
      session.setAttribute("cZip", zip);
      session.setAttribute("cPhone", phone);
   }
   catch (Exception ex) {
      System.out.println(ex.getMessage());
   }
   try {
      response.sendRedirect(response.encodeRedirectURL("/OutputCart.jsp"));
   }
   catch (Exception ex){
      System.out.println(ex.getMessage());
   }
}
```

Similar to the retrieval of customer information, we use a command named *UpdateCustomerCmd* to update the customer contact information. The approach allows us to reset all the customer data when we ship the command to the Customer entity bean and run it on the server. It saves many RMI calls compared to directly calling the setter methods on the Customer bean. Example 12-30 shows the `performExecute()` method in the UpdateCustomerCmdImpl class.

Example 12-30 The performExecute() method in the UpdateCustomerCmdImpl class

```
public void performExecute() throws Exception {

   Customer customer = getCustomer();
   customer.setFirstName(firstName);
   customer.setLastName(lastName);
   customer.setMiddleInitials(middleInitials);

   customer.setAddressLine1(addressLine1);
   customer.setAddressLine2(addressLine2);
   customer.setCity(city);
   customer.setState(state);
   customer.setZip(zip);
   customer.setPhone(phone);
}
```

After we update the customer information, the message `Your contact information has been updated` appears on the same screen (Figure 12-11).


Shopping Cart Content - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://AS05:5543/OrderEntry2/OutputCart.jsp
Go
Continue Shopping
Update Customer Information
Check Out
Done
Local intranet

Item ID	Item Name	Price	Quantity
000094	Zoo_Season_Pass	$290.88	1

Customer Contact

First Name		Annie
Middle Initial		P
Last Name		OAKLEY
Address	Street	00001 Ave. ABC
		Bldg 00001
	City	Rochester
	State	MN
	Zip	07891-234
Phone		6789012078912345

Your contact information has been updated.

Figure 12-11 Displaying a message indicating the successful update of customer information

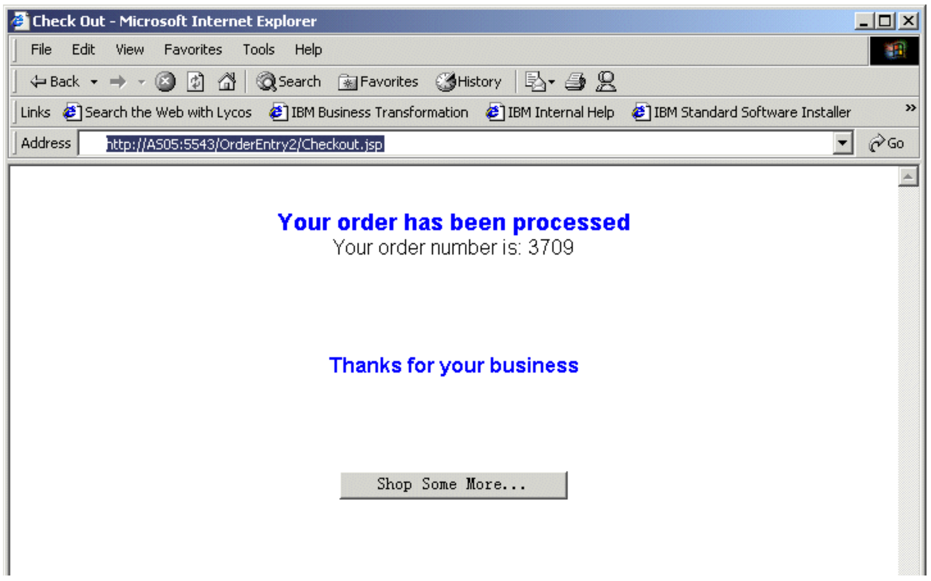
At this point, if the user wants to check out their items by clicking the Check Out button, the `doPost()` method in the OrderEntryControllerServlet calls the `placeOrder()` method shown in Example 12-31 to process the order.

Example 12-31 The placeOrder() method in the OrderEntryControllerServlet

```
private void placeOrder (HttpSession session, HttpServletResponse response) throws
IOException {

   OrderPlacementCmdImpl opCmdImpl = new OrderPlacementCmdImpl(null);

   Vector orderLines = new Vector();
   ShoppingCart cart = (ShoppingCart)session.getAttribute("shopcart.selected");
   String custID = (String)session.getAttribute("customerID");
   Vector cartItems = cart.getItems();

   if (cartItems.size() > 0) {
      for (int i = 0; i < cartItems.size(); i++) {
         CartItem citem = (CartItem) cartItems.elementAt(i);

         com.ibm.itso.roch.cpwejb.interfaces.OrderDetail thisOrderDetail
            = new com.ibm.itso.roch.cpwejb.interfaces.OrderDetail(citem.getItemId(),
                     Float.valueOf(citem.getPrice().replace('$','0')).floatValue(),
                     citem.getItemQuantity().intValue());

         orderLines.addElement(thisOrderDetail);
      }
      opCmdImpl.setOrderLines (orderLines);
```

```
        opCmdImpl.setCustomerID (custID);
    }
    try {
        opCmdImpl.execute();
        session.setAttribute("orderNumber", opCmdImpl.getNewOrderID() + "");
        response.sendRedirect(response.encodeRedirectURL("/CheckOut.jsp"));
    }
    catch (Exception ex){
        ex.printStackTrace();
    }
}
```

As we previously discussed, we process the order request through the OrderPlacementCmd command. After the command is successfully run on the OrderPlacement session bean, the program sets the new order ID as a session variable and displays it on the next screen using the CheckOut JSP (Figure 12-12).



Check Out - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Links Search the Web with Lycos IBM Business Transformation IBM Internal Help IBM Standard Software Installer
Address http://AS05:5543/OrderEntry2/Checkout.jsp
Go

Your order has been processed

Your order number is: 3709

Thanks for your business

Shop Some More...

Figure 12-12 Displaying the order number

Finally, if the user wants to shop for more items, they can select the Shop Some More... button. In response to this, the OrderEntryControllerServlet terminates the existing session, re-initiates a new session, and associates with it the item list. It then redirects the page to the StartOrderEntry JSP.

12.7 Conclusion

There are two major problems that the Command framework attempts to address. One problem is performance. The granularity of artifacts on the server (such as objects, tables, procedure calls, files, and so on) often causes a single client-initiated business logic request to involve several round-trip messages between the client and server. This might entail extra calls to perform the business task and then impose additional calls to retrieve the results of that task.

If the client and target server are not in the same JVM, these calls go between processes and are, therefore, expensive in terms of computer resources. If the calls must go over a network, they are even more costly. To prevent unnecessary delays and improve application performance, it is advantageous to perform a business task in as few interactions between the client and server sides as is natural to the task. Command beans provide the necessary building blocks to achieve this.

A second problem is that there are several possible styles for how business logic can be implemented. This includes EJB, JDBC direct database access, JDBC access to stored procedures, the Common Connector Framework, file system access, and so on. In addition to different implementation programming models, each of these styles has a different way to invoke a request to execute business logic. Because the Command framework is generic and extensible, it can hide all these different types of server invocation mechanisms under a simple and uniform mechanism.

We used the Command framework to enhance the OrderEntry application. First, we used the GetCustomerCmd command to bundle multiple client requests together to retrieve information with greater efficiency. Second, we applied a similar approach to updating customer information and processing order requests.

A

Additional material

This Redbook refers to additional material that can be downloaded from the Internet as described below.

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The additional Web material that accompanies this Redbook includes the following files:

File name	*Description*
sg246559ins.zip	A zip file that contains all the example applications
SG246559.dat	VisualAge for Java code in a repository file
readme.pdf	Instructions for restoring the programming examples

System requirements for downloading the Web material

The following system configuration is recommended:

Hard disk space:	10 MB is required for download material
Operating System:	Windows 98, NT, or 2000
Processor:	300 MHZ or higher
Memory:	128 MB

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How to use the Web material

Create a subdirectory (folder) on your workstation, and unzip the contents of the Web material zip file into this folder. Read the file named readme.pdf to view information about how to restore the program code to VisualAge for Java and the iSeries server.

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this Redbook.

IBM Redbooks

For information on ordering these publications, see “How to get IBM Redbooks” on page 428.

- *WebSphere 4.0 Installation and Configuration on the IBM @server iSeries Server,* SG24-6815
- *IBM WebSphere V4.0 Advanced Edition Handbook,* SG24-6176

Other resources

These publications are also relevant as further information sources:

- *Work Management Guide*, SC41-5306
- *MQSeries: Using Java,* SC34-5456
- Englander, Robert. *Developing JavaBeans*. Sebastopol, CA, O'Reilly & Associates, 1997 (ISBN 1-56592-289-1).
- Flanagan, David. *Java in a Nutshell: A Desktop Quick Reference*. O'Reilly & Associates, 1999 (ISBN 1-56592-487-8).
- Flanagan, David. *Java Enterprise in a Nutshell: A Desktop Quick Reference*. O'Reilly & Associates, 1999 (ISBN 1-56592-483-5).
- Fowler, Martin.*UML Distilled: A Brief Guide to the Standard Object Modeling Language*. Addison-Wesley Publishing Co., 1999 (ISBN 0-20165-783-X).
- Monson-Haefel, Richard. *Enterprise JavaBeans*. O’Reilly & Associates, 2000 (ISBN 1-56592-869-5).
- Morgan, Bryan. *Java Developer's Reference*. Sams, 1996 (ISBN 1-57521-129-7).
- Taylor, David. *Object Technology: A Manager's Guide*. Addison-Wesley Publishing Co., 1997 (ISBN 0-20130-994-7).

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Referenced Web sites

These Web sites are also relevant as further information sources:

- Javasoft home page: `http://www.javasoft.com`
- JavaServer Page specifications: `http://java.sun.com/products/jsp/download.html`
- Servlet specifications: `http://java.sun.com/products/servlet/2.2/`
- Enterprise JavaBeans home page: `http://www.java.sun.com/products/ejb`
- Linar J-Intrega homepage: `http://www.linar.com`
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Abbreviations and acronyms

IAFP	Advanced Function Printing
ASP	Active Server Pages
APA	All Points Addressable
AWT	Abstract Window Toolkit
CA	Certificate Authority
CORBA	Common Object Request Broker Architecture
COM	Component Object Model
CGI	Communications Gateway Interface
CPW	Commercial Processing Workload
DAX	Data Access Builder
DCM	Digital Certificate Manager
DDM	Distributed Data Management
DLL	Dynamic link library
DPC	Distributed Program Call
EAB	Enterprise Access Builder
EJB	Enterprise JavaBeans
FFST	First Failure Support Technology
GUI	Graphical user interface
GWAPI	Go Web Server API
HTML	Hypertext Markup Language
HTTP	Hypertext Transmission Protocol
HTTPS	Hypertext Transmission Protocol Secure
IBM	International Business Machines Corporation
ICAPI	IBM Connection API
IDE	Integrated development environment
IDL	Interface Definition Language
IIOP	Internet inter-ORB protocol
IP	Internet Protocol
ITSO	International Technical Support Organization
JAR	Java archive
JDBC	Java database connectivity
JDK	Java Development Toolkit
JFC	Java Foundation Classes
JIT	Just in Time Compiler
JPDC	Java Performance Data Converter
JSP	JavaServer Pages
JVM	Java Virtual Machine
LDAP	Lightweight Directory Access Protocol
MI	Machine interface
MIME	Multi-purpose Internet Mail Extensions
MVC	Model-View-Controller
NSAPI	Netscape API
ODBC	Open database connectivity
OOA	Object oriented analysis
OOD	Object oriented design
OOP	Object oriented programming
ORB	Object Request Broker
PEX	Performance Explorer
PCML	Program Call Markup Language
PDML	Panel Definition Markup Language
PTDV	Performance Trace Data Visualizer
PTF	Program temporary fix
RAD	Rapid Application Development
RAWT	Remote Abstract Windowing Toolkit
RMI	Remote method invocation
SCS	SNA Character Set

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SLIC	System Licensed Internal Code
S-MIME	Secure Multi-purpose Internet Mail Extensions
SNA	System Network Architecture
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TIMI	Technology Independent Machine Interface
UML	Unified Methodology Language
URL	Universal Resource Locator
VCE	Visual Composition Editor
WAS	WebSphere Application Server
WWW	World Wide Web
XML	Extensible Markup Language

Index

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