Assessment

J2EE Web Components Development

Set 1

1. (8%)	In a JSP page you are required to insert a JSP fragment called insert.jsp, where this JSP fragment requires an additional request parameter called title. What is necessary to perform this insertion?	
	A.	<%@ include file='insert.jsp' title='Web Wonk'%>
	B.	<jsp:include page="insert,jsp' title="Web Wonk"/>
	C.	<%@ include file='insert.jsp' %>Web Wonk<%@include%>
	D.	<jsp:include page='insert.jsp'> <jsp:param name='title' value='Web Wonk'/> </jsp:include>
Answer	D	

2. (10%)	Which deployment description snippet would you use to declare the use of a tag library?	
	A.	<taglib> <uri>http://jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </taglib>
	B.	<taglib> <taglib-uri>http:// jsp_prj.com/tablib.tld</taglib-uri> <taglib-location>/WEB-INF/tablib.tld</taglib-location> </taglib>
	C.	<tag-lib> <uri>http:// jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </tag-lib>
	D.	<tag-lib> <taglib-uri>http://jsp_prj.com /taglib.tld </taglib-uri> <taglib-location>/WEB-INF/taglib.tld</taglib-location> </tag-lib>
Answer	B	

3. (8%)	Where is the following declared JavaBean accessible? <jsp:useBean id=”ABean” class=”com.examples.ABean”/>	
	A.	Throughout the remainder of the JSP page.
	B.	Within other servlets or JSP pages in the same Web application.
	C.	Within other servlets or JSP pages in the same servlet context.
	D.	Throughout all future invocations of the JSP page, until the session expires.
Answer	A	

4. (10%)	Exhibit:
	1. public class ABean {
	2. private int count;
	3. public void setCount(int count) {
	4. this.count = count;
	5. }
	6. public int getCount() {
	7. return count;
	8. }
	9. }
	Given:
	1. <html>
	2. <body>
	3. <jsp:useBean id=”myBean” class=”ABean”>
	4.
	5. </jsp:useBean>
	6. </body>
	7. </html>
	Which of the following answer inserted individually at line 4, will initialize the count property of the newly created ABean myBean?	

	A.	<% myBean.count =1; %>
	B.	<% ABean.count=1; %>
	C.	<jsp:setProperty name=”myBean” property=”count” value=”1” />
	D.	<jsp:init property=”count” value=”1” />
Answer	C	

5. (8%)	Given servlet A:
	1. public class A extends HttpServlet {
	2. public void doPost(HttpServletRequest req,
	HttpServletResponse resp)
	throws ServletException {
	3. String id = "aString";
	4.
	5. }
	6. }
	Servlet A and servlet B share the same active session.
	Which, inserted at line 4, will allow servlet B to access the value "aString" in subsequent POST requests to servlet B?	

	A.	req.getSession().put("ID",id);
	B.	req.getSession().setValue("ID"),id)
	C.	req.getSession().putAttribute("ID",id);
	D.	req.getSession().setAttribute("ID",id);
Answer	D	

6. (8%)	Which method in the HttpServlet class services the HTTP POST request?	
	A.	doPost(ServletRequest, ServletResponse)
	B.	doPOST(ServletRequest, ServletResponse)
	C.	servicePost(HttpServletRequest, HttpServletResponse)
	D.	doPost(HttpServletRequest, HttpServletResponse)
Answer	D	

7. (8%)	Which method is required for using the URL rewriting mechanism of implementing session support?	
	A.	HttpServletRequest.encodeURL()
	B.	HttpServletRequest.rewriteURL()
	C.	HttpServletResponse.encodeURL()
	D.	HttpServletResponse.rewriteURL()
Answer	C	

8. (8%)	Which of the following implicit objects can be used to store attributes that need to be accessed from all the sessions of a web application?	
	A.	application
	B.	session
	C.	request
	D.	page
Answer	A	

9. (8%)	Select the correct statement about the following code.
	<%@ page language="java" %>
	<html><body>
	out.print("Hello ");
	out.print("World ");
	</body></html>	

	A.	It will print Hello World in a single line
	B.	It will generate compile-time errors.
	C.	It will only print Hello in one line and world in another line.
	D.	None of above.
Answer	D	

10. (8%)	Which of the following lines would you use to include the output of DataServlet into any other servlet?	
	A.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(response);
	B.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", request, response);
	C.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", response);
	D.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(request, response);
Answer	D	

11. (8%)	Which of the following code types cannot be used within a scriptlet tag?	
	A.	if block
	B.	while block
	C.	Code block
	D.	Static block
Answer	D	

12. (8%)	For a FilterChain object, chain, which of the following method can be called to invoke another Filter?	
	A.	chain.next();
	B.	chain.doNext();
	C.	chain.doFilter();
	D.	None of the above.
Answer	C	

Assessment

J2EE Web Components Development

Set 2

1. (8%)	Which method is required for using the URL rewriting mechanism of implementing session support?	
	A.	HttpServletRequest.encodeURL()
	B.	HttpServletRequest.rewriteURL()
	C.	HttpServletResponse.encodeURL()
	D.	HttpServletResponse.rewriteURL()
Answer	C	

2. (8%)	Where is the following declared JavaBean accessible? <jsp:useBean id=”ABean” class=”com.examples.ABean”/>	
	A.	Throughout the remainder of the JSP page.
	B.	Within other servlets or JSP pages in the same Web application.
	C.	Within other servlets or JSP pages in the same servlet context.
	D.	Throughout all future invocations of the JSP page, until the session expires.
Answer	A	

3. (8%)	Given servlet A:
	1. public class A extends HttpServlet {
	2. public void doPost(HttpServletRequest req,
	HttpServletResponse resp)
	throws ServletException {
	3. String id = “aString”;
	4.
	5. }
	6. }
	Servlet A and servlet B share the same active session.
	Which, inserted at line 4, will allow servlet B to access the value “aString” in subsequent POST requests to servlet B?	

	A.	req.getSession().put(“ID”,id);
	B.	req.getSession().setValue(“ID”),id)
	C.	req.getSession().putAttribute(“ID”,id);
	D.	req.getSession().setAttribute(“ID”,id);
Answer	D	

4. (8%)	For a FilterChain object, chain, which of the following method can be called to invoke another Filter?	
	A.	chain.next();
	B.	chain.doNext();
	C.	chain.doFilter();
	D.	None of the above.
Answer	C	

5. (8%)	Which of the following implicit objects can be used to store attributes that need to be accessed from all the sessions of a web application?	
	A.	application
	B.	session
	C.	request
	D.	page
Answer	A	

6. (8%)	In a JSP page you are required to insert a JSP fragment called insert.jsp, where this JSP fragment requires an additional request parameter called title. What is necessary to perform this insertion?	
	A.	<%@ include file='insert.jsp' title='Web Wonk'%>
	B.	<jsp:include page="insert,jsp' title="Web Wonk"/>
	C.	<%@ include file='insert.jsp' %>Web Wonk<%@include%>
	D.	<jsp:include page='insert.jsp'> <jsp:param name='title' value='Web Wonk'/> </jsp:include>
Answer	D	

7. (8%)	Which two represent valid JSP expressions?	
	A.	<%= Match.random() %>
	B.	<% x %>
	C.	<% int x = “4” + “2”; %>
	D.	<% String x = “4” + “2” %>
Answer	A	

8. (8%)	Select the correct statement about the following code.
	<%@ page language="java" %>
	<html><body>
	out.print("Hello ");
	out.print("World ");
	</body></html>	

	A.	It will print Hello World in a single line
	B.	It will generate compile-time errors.
	C.	It will only print Hello in one line and world in another line.
	D.	None of above.
Answer	D	

9. (10%)	Which deployment description snippet would you use to declare the use of a tag library?	
	A.	<taglib> <uri>http://jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </taglib>
	B.	<taglib> <taglib-uri>http:// jsp_prj.com/tablib.tld</taglib-uri> <taglib-location>/WEB-INF/tablib.tld</taglib-location> </taglib>
	C.	<tag-lib> <uri>http:// jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </tag-lib>
	D.	<tag-lib> <taglib-uri>http://jsp_prj.com /taglib.tld </taglib-uri> <taglib-location>/WEB-INF/taglib.tld</taglib-location> </tag-lib>
Answer	B	

10. (10%)	Exhibit:
	1. public class ABean {
	2. private int count;
	3. public void setCount(int count) {
	4. this.count = count;
	5. }
	6. public int getCount() {
	7. return count;
	8. }
	9. }
	Given:
	1. <html>
	2. <body>
	3. <jsp:useBean id=”myBean” class=”ABean”>
	4.
	5. </jsp:useBean>
	6. </body>
	7. </html>
	Which of the following answer inserted individually at line 4, will initialize the count property of the newly created ABean myBean?	

	A.	<% myBean.count =1; %>
	B.	<% ABean.count=1; %>
	C.	<jsp:setProperty name=”myBean” property=”count” value=”1” />
	D.	<jsp:init property=”count” value=”1” />
Answer	C	

11. (8%)	Which of the following lines would you use to include the output of DataServlet into any other servlet?	
	A.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(response);
	B.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", request, response);
	C.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", response);
	D.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(request, response);
Answer	D	

12. (8%)	Given this fragment from a Web application deployment descriptor? <context-param> <param-name>user</param-name> <param-value>tessking</param-value> </context-param> From within a servlet's doPost method, which retrieves the value of the user parameter?	
	A.	getServletConfig().getAttribute("user");
	B.	getServletContext().getAttribute("user");
	C.	getServletConfig().getInitParameter("user");
	D.	getServletContext().getInitParameter("user");
Answer	D	

J2EE Web Component Development

Training Course

Chau Keng Fong
Adegboyega Ojo

e-Macao Report 24

Version 1.0, November 2005

Table of Contents

1. Overview

The Java 2 Enterprise Edition (J2EE) platform is a standard technology for building Internet applications and particularly Enterprise Applications. J2EE is a suite of Application Programming Interfaces (APIs), a distributed computing architecture, and the method of packaging distributable components for deployment [4]. Enterprise Applications are essential for safe storage, retrieval and manipulations of business data. They are characterised by multiple user interfaces, both web- and desktop-oriented, communication between remote systems and data coordination on different machines.

Enterprise applications are multi-tier applications consisting of client, web, business and enterprise tiers. J2EE provides the necessary APIs and services to develop these tiers, with Web and Business Components implementing web and business tiers respectively.

This course introduces the J2EE Technologies, focusing mainly on the Web Component Technologies. It starts by introducing the J2EE Platform including its origin, architecture and components. Next, the course teaches the core technologies for developing web components: how to develop controllers as Servlets, how to view contents using Java Server Pages and how to use Filters for processing requests and responses. Later, support for horizontal technologies like exception handling, database connectivity, security and internationalization are briefly discussed.

The rest of this document explains the objectives, prerequisites and methodology for teaching the course in Sections 2, 3 and 4 respectively. The content of the course is introduced in some detail in Section 5. The assessment and organization of the course are explained in Sections 6 and 7. Following references, Appendix A includes the complete set of slides and Appendix B contains two sets of assessment questions with answers.

2. Objectives

The course has three main objectives:

1) To introduce the J2EE Technology to students.
2) To equip students with essential skills for developing enterprise applications using three J2EE Web Components technologies:
    a) Servlets
    b) JavaServer Pages
    c) Filters
3) To teach techniques for developing multi-lingual, secure web applications.

3. Prerequisites

The course requires that students have a working knowledge of the Java Programming Language. Basic understanding of the TCP/IP network protocol is also essential. In addition, the knowledge of XML and HTML are assumed.

4. Methodology

The course has been designed based on the following didactic principles:

- *Depth versus Breadth* - As foundation, attempt is made to cover the various aspects of web services without loss of depth.
- *Academic Orientation* – A body of concepts is defined rigorously and incrementally to establish a proper foundation for understanding and use of technology.
- *From Definitions to Demonstrations* – All major concepts introduced during the course are illustrated with small-size examples which are also demonstrated on the computer, whenever possible.
- *From Demonstrations to Assignments* – On the basis of demonstrations, students are asked to perform different tasks with increasing level of difficulty and independence.

5. Content

The course consists of 490 slides organized into four major sections: J2EE Introduction, Vertical Concepts, Horizontal Concepts and Case Study. These sections are described below.

5.1. J2EE Introduction

This section comprises the slides 1 through 45. It presents an overview of the Java 2 Enterprise Edition (J2EE). The presentation covers the origin, architecture and design goal of the J2EE platform. The concepts of components, containers and application servers are introduced. Later in the section, standard services and platform roles defined by the J2EE specification are introduced. Finally, setting up the Apache Tomcat Web Server is explained.

5.2. Vertical Concepts

This section comprises the slides 46 through 372. It teaches three major J2EE Web Components technologies: (i) Servlet, (ii) JavaServer Pages (JSP) and (iii) Filter. The three different types of Web Components are presented as follows:

1) *Servlet* – The basic concepts of the architecture and lifecycle of Servlets are introduced. The HTTP protocol is explained before presenting how HTTPServlets are developed and deployed. Communication between Servlet, Client tier and Container are also explained.

2) *JavaServer Pages (JSP)* – The architecture and life cycle of JSPs are introduced. The use of scripting elements for writing JSP is explained. The usage of implicit objects and standard JSP actions like forward, include and useBeans are presented. The J2.0 Expression Language is introduced. Finally, standard and custom tags are discussed.

3) *Filter* - Filters and Filter Chains are presented and their use of explained. Also, request and response wrappers are discussed.

The lifecycles of all components are presented and compared.

5.3. Horizontal Concepts

This section consists of the slides 373 through 483. It presents the supporting technologies for J2EE applications: exception handling, database connectivity, security and internationalization. Each of these topics is explained below:

1) *Exception* – Exceptions in J2EE can be handled in different manners. This section first explains how to develop JSPs and Servlets to handle exceptions thrown by a web page. Subsequently, methods to intercept and handle exceptions thrown by Containers are discussed. The usage of error objects for retrieving error information is also explained. An illustration involving Java Mail to send out error message is presented. Finally, the concept of information logging is introduced.

2) *Database Connectivity* – The concept of data source to establish database connection is introduced. Next, the section introduces connection pools. Finally, configurations for data sources and connection pools are demonstrated.

3) *Security* - The technique for role-based and programmatic authentication in J2EE applications is presented. The role-based security in Apache Tomcat server is demonstrated. Configuration for providing secured communication through HTTPS protocol in Apache Tomcat is introduced as well. In addition, the section describes the programmatic security technique supported in the J2EE environment.

4) *Internationalization* – The concept of internationalisation is introduced, followed by a discussion of difficulties in developing multi-lingual web applications. The development of a multi-lingual website through the use of the Resource Bundle file is demonstrated. Tools for generating the Resource Bundle are presented as well.

5.4. Case Study

This section comprises the slides from 484 through 499. It presents a complete case study involving the development and deployment of a multi-lingual, secure website using the J2EE Web Components Technology.

6. Assessment

The course finishes with an assessment. This comprises 15 multiple-choice questions which cover all major sections and concepts taught.

Two sets of 15 assessment questions and answers are given in Appendices B.1 and B.2. The two sets are different permutation of the same collection of questions. The assessment complements the tasks provided in the various sections.

7. Organization

The course consists of lectures and demonstrations:

- *lectures* – The lectures mainly present the concepts and the use of the J2EE Web Components Technologies.
- *demonstrations* - Demonstrations illustrate the concepts introduced during the lectures with running code and examples. Some examples only provide skeleton codes and require students to complete them by applying the technologies discussed in the lectures.

The full course has been taught for 7 days with 6 hours of lectures per day. A shorter version of the course has also been taught over four days.

References

1. e-Macao Project, The State of Electronic Government in Macao, Volume 2: Agencies, 2005
2. Hans Bergsten, JavaServer Pages, 3rd edition, O'Reilly, 2003
3. Jayson Falkner and Kevin Jones, Servlets and JavaServer Pages: the J2EE Technology Web Tier, Addison-Wesley, 2003
4. James L. Weaver, Kevin Mukhar and Jim Crume, Beginning J2EE 1.4 – From Novice to Professional, Apress, 2004

Appendix

A. Slides

A.1. Introduction

J2EE Web Component Development

Milton, Chau Keng Fong
INESC-Macau

e-Macao-16-6-2

The Course

1) objectives - what do we intend to achieve?
2) outline - what content will be taught?
3) resources - what teaching resources will be available?
4) organization - duration, major activities, daily schedule

e-Macao-16-6-3

Course Objectives

1) explain the concept of J2EE
   a) origin
   b) architecture

2) present the core J2EE Web Components technologies
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) present the techniques to develop a multi-lingual, secured web site

e-Macao-16-6-4

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) database connectivity
   c) security
   d) internationalization

4) case study

e-Macao-16-6-5

Outline: J2EE Introduction

An overview of J2EE:

1) origin of J2EE
2) architecture of J2EE

e-Macao-16-6-6

Outline: Vertical Concepts

The main concepts about different types of web components:

1) introduction to Servlets, JavaServer Pages (JSP) and Filters
2) life cycle of different web components
3) development of different types of web components
4) how to deploy a web application
5) criteria for the usage of different web components

e-Macao-16-6-7

Outline: Horizontal Concepts

Supporting technologies to develop web applications:

1) different techniques to handle exceptions and produce logging
2) various strategies to build secure web sites
3) different ways to connect to databases
4) procedures to develop a multi-lingual web site

e-Macao-16-6-8

Outline: Case Study

Build a web site utilizing the J2EE Web Component technologies:

1) enforce the MVC pattern with Filters
2) multi-lingual support with resource bundles
3) utilizing declarative security
4) adopt standard tag libraries in building JSPs

e-Macao-16-6-9

Course Resources

1) Books
   a) JavaServer Pages, Hans Bergsten, 3rd edition, O'Reilly, 2003
   b) Servlets and JavaServer Pages: the J2EE Technology Web Tier, Jayson Falkner, Kevin Jones, Addison-Wesley, 2003

2) Articles
   Links available from the website http://www.emacao.gov.mo.

3) Tools
   a) JDK 1.5.0_01
   b) Eclipse IDE 3.0.1
   c) Jakarta Tomcat 5.5.7

e-Macao-16-6-10

Course Logistics

1) duration - 42 hours
2) activities – lectures and development
3) timing
   a) Monday 09:00–13:00 14:30–17:45
   b) Tuesday 09:00–13:00 14:30–17:45
   c) Wednesday 09:00–13:00
   d) Thursday 09:00–13:00 14:30–17:45
   e) Friday 09:00–13:00
4) sessions - 7 morning, 4 afternoon
5) style - interactive and tutorial

e-Macao-16-6-11

Course Prerequisites

1) basic Java
2) basic understanding of TCP/IP networking concepts
3) basic understanding of XML
4) basic understanding of HTML

A.1.1. J2EE Introduction

J2EE Introduction

e-Macao-16-2-13

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) security
   c) internationalization
   d) database connectivity

4) case study

e-Macao-16-2-14

J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

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Background

The Java platform was first introduced in 1995 to address the programming needs for networks and cross-platform programming.

In order to address different needs, Sun Microsystems soon split the Java Technologies into three editions:

1) Java 2 Platform Micro Edition (J2ME)
2) Java 2 Platform Standard Edition (J2SE)
3) Java 2 Platform Enterprise Edition (J2EE)

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Needs

In recent years, the needs for distributed computing in an enterprise made n-tier applications a popular program model.

The needs facing the developers:

a) simplifying the complexity of building n-tier applications
b) easily achieving :
   - availability
   - reliability
   - performance
   - scalability
   - reusability
   - interoperability
c) using a standardized API between components and application servers

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J2EE Origin

Sun Microsystems, together with partners such as IBM, designed J2EE to define a multi-tier architecture for developing enterprise information systems (EIS) to answer the needs from the industry.

Goals:

a) reduce the cost and complexity of development
b) allow J2EE applications to be rapidly deployed and easily enhanced

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J2EE Major Elements 1

J2EE consists of the following elements to pursue its design goals:

1) J2EE Platform – a standard platform for hosting J2EE applications.

2) J2EE Compatibility Test Suite (CTS) – all J2EE application servers have to pass the CTS test to carry the Java Compatible, Enterprise Edition logo.

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J2EE Major Elements 2

3) J2EE Reference Implementation – a reference implementation and operational definition of the J2EE platform.

   A binary version can be downloaded as J2EE Software Development Kits (SDK).

4) J2EE Blue Prints – the standard programming model for developing multi-tier, thin client applications.

A.1.2. Architecture of J2EE

e-Macao-16-6-20

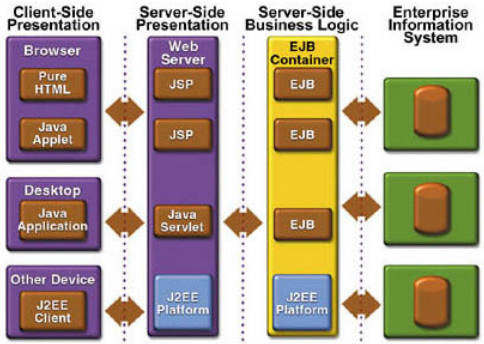
J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

e-Macao-16-6-21

J2EE Platform

J2EE platform uses a multi-tiered distributed application model.



courtesy of Sun Microsystems

e-Macao-16-6-22

J2EE Architecture

J2EE architecture is a component architecture.

A J2EE component is a self-contained functional software unit assembled into a J2EE application.

J2EE components are deployed to run on a J2EE server, which executes and manages them.

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J2EE Server

J2EE server provides the underlying services, such as:

1) transaction management
2) multithreading
3) resource pooling
4) other complex low-level services

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J2EE Containers

Containers are the interface between a component and the low-level platform.

Types of containers:

1) EJB container
2) Web container
3) Application client container
4) Applet container

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Task 1: Setup A Web Server

1) Setup and configure your `Tomcat` server for the usage in this course:
   a) copy the folder named `web_componet` to your local hard disk
   b) open the file `Tomcat.bat` and modify the path name if necessary
   c) Configure `Tomcat` to use port 80 as the default port:
      1. edit *<Catalina_Home>/conf/**server**.xml* and change the port attribute of the Connector element from 8080 to 80 as following:

```
<Connector port="80" ... maxThreads="150"
minSpareThreads="25" ...
```

This modification allows us to use the `URL` of the form `http://localhost/myServlet` instead of `http://localhost:8080/myServlet`

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Task 2: Setup Web Server

d) configure Tomcat to activate the auto-reload feature:
   1. modify the `<Catalina_Home>/conf/Context.xml` file. Change the tag `<Context>` to `<Context reloadable="true">`. This allows Tomcat to reload the servlet automatically when a modification is made to the servlet. However, this setting may degrade the performance of the server.

e) start Tomcat by runing `Tomcat.bat` bathc file

f) use a browser to access the following `URL`:

`http://localhost/`

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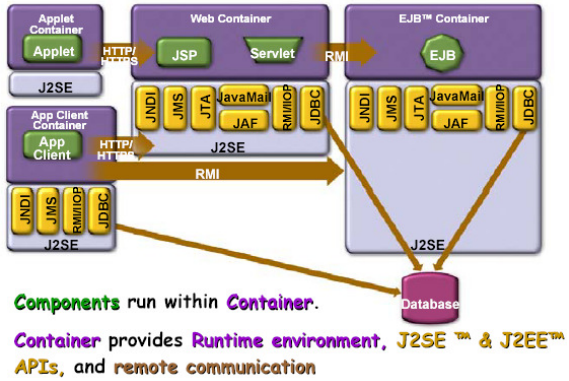
Components and Containers



courtesy of Sun Microsystems

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J2EE Components

1) Clients
   a) Web client
   b) Applet
   c) Application client
2) Web Components
   a) Servlet
   b) JavaServer Pages (JSP)
3) Business Components
   a) Enterprise Java Bean (EJB)
4) Enterprise Information System (EIS)
   a) Database

e-Macao-16-6-29

Web Components

In J2EE specification, v1.4, a web component is defined as a collection of:

a) Servlets
b) pages created with the JavaServer Pages™ technology
c) web Filters
d) web Event Listeners

In short, a web component is a software entity that runs in a web container to provide responses to external requests.

e-Macao-16-6-30

Business Components

The Enterprise Java Bean (EJB) architecture is a server-side technology for building object-oriented business application in Java.

There are three types of Enterprise Beans:

a) Session Beans
b) Entity Beans
c) Message-Driven Beans

e-Macao-16-6-31

J2EE Standard Services

J2EE standard services include the following:

- HTTP
- HTTPS
- RMI-IIOP
- JavaIDL
- Java Naming and Directory Interface (JNDI)
- JDBC API
- Java Message Service (JMS)
- Java Transaction API (JTA)
- JavaMail
- JavaBeans Activation Framework (JAF)
- Java API for XML Parsing (JAXP)
- J2EE Connector Architecture
- Security Services
- Web Services
- Management
- Deployment

Some of them are explained as follows.

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J2EE Services: JNDI

1) Java naming and directory services (`JNDI`)
   a) applications use `JNDI` to locate objects, such as environment entries, EJBs, datasources or message queues
   b) JNDI is implementation independent
   c) underlying implementation varies: `LDAP, DNS, DBMS`, etc.

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J2EE Services: JDBC

2) Java DataBase Connectivity (`JDBC`)
   a) a programming interface that lets Java applications access a database via the `SQL` language
   b) allows the development of platform-independent database applications

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J2EE Services: JMS

3) Java Message Service (JMS)
   a) provides standard APIs that Java developers can use to access the common features of an enterprise message system
   b) supports publish/subscribe and point-to-point models
   c) provides support for administration, security, error handling, optimization, distributed transactions, message ordering, message acknowledgments, and more

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J2EE Services: JTA

4) Java Transaction API (JTA)
   a) an application-level interface used to define the transaction boundaries
   b) allows applications to perform distributed transactions

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J2EE Services: JavaMail

5) JavaMail
   a) a platform-independent Java API allowing to develop email clients or servers using any of the standard email protocols

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J2EE Services: JAF

6) JavaBeans Activation Framework (JAF)
   a) used by JavaMail to convert the MIME byte streams into Java objects that can then be handled by assigned JavaBeans

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J2EE Services: JAXP

7) Java API for XML Parsing (JAXP)
   a) includes both Simple API for XML (SAX) and Document Object Model (DOM) APIs for manipulating XML documents
   b) enables Extensible Stylesheet Language Transformation (XSLT) engines to be plugged in

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J2EE Services: Connector

8) J2EE Connector Architecture
   a) integration with non-J2EE systems, such as mainframes and ERPs (Enterprise Resource Planning)
   b) standard API to access different EIS (Enterprise Information Systems)
   c) vendors implement EIS-specific resource adapters

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J2EE Services: Security

9) Security Services
   a) Java Authentication and Authorization Service (JAAS)
   b) authentication via user identification / password or digital certificates
   c) role-based authorization limits access of users to the resources (URLs, EJB methods)

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J2EE Platform Roles 1

A set of roles to carry out application development:

1) **J2EE product provider**: implements a J2EE product which provides component containers, J2EE platform APIs, and other features defined in the J2EE specification

2) **application component provider**: produces the building blocks of a J2EE application

3) **application assembler**: takes a set of components developed by application component providers and assembles them into a complete J2EE application.

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J2EE Platform Roles 2

4) **deployer**: responsible for deploying J2EE components and applications into a specific operational environment

5) **system administrator**: responsible for configuring and administrating the computing and networking infrastructure of an enterprise

6) **tool provider**: provides tools used for the development and packaging of application components.

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J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

A.1.3. Summary

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Summary 1

J2EE is designed to reduce the cost and complexity of developing distributed cross-platform enterprise applications

J2EE provides a standard platform for hosting J2EE applications

Other than the J2SE standard services, J2EE server also provides:

1) transaction management
2) multithreading
3) resource pooling
4) other low level services

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Summary 2

J2EE platform uses a multi-tiered distributed application model.

A J2EE server contains a web component container and a business component container.

Components are executed and managed by the containers.

A.2. Vertical Concepts

Vertical Concepts

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Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) database connectivity
   c) security
   d) internationalization

4) case study

A.2.1. Servlet

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary
2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Java Servlets

A servlet is a Java Technology component that executes within the servlet container.

Typically, servlets perform the following functions:

a) process the `HTTP` request
b) generate the `HTTP` response dynamically

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Servlet Container

A servlet container

1) is a special JVM (Java Virtual Machine) that is responsible for maintaining the life cycle of servlets

2) must support `HTTP` as a protocol to exchange requests and responses

3) issues threads for each request

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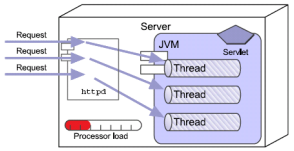
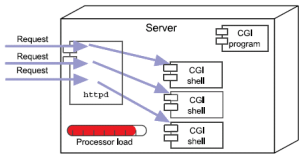
Servlets Versus CGIs

Servlets are lightweight and are scalable.



Each `CGI` is heavyweight and is not scalable.



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Servlet Interface

All servlets either:

1) implement `javax.servlet.Servlet` interface, or
2) extend a class that implements `javax.servlet.Servlet`

In the Java Servlet API, classes `GenericServlet` and `HttpServlet` implement the `Servlet` interface.

`HttpServlet` is usually extended for Servlet implementation.

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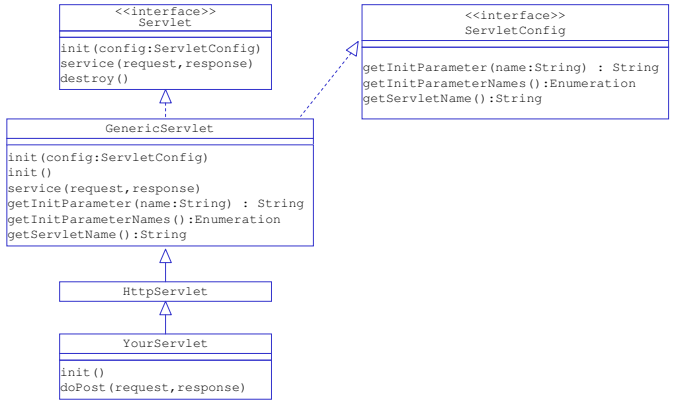
Servlet Architecture



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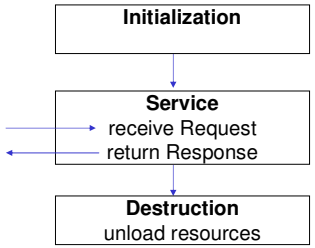
Servlet Life Cycle

Servlets follow a three-phase life cycle:

1) initialization

2) service

3) destruction



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Life Cycle: Initialization 1

A servlet container:

a) loads a servlet class during startup, or

b) when the servlet is needed for a request

After the `Servlet` class is loaded, the container will instantiate it.

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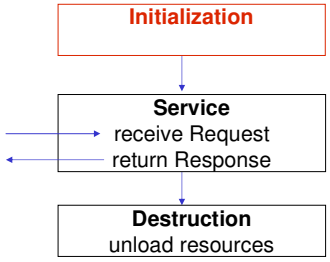
Life Cycle: Initialization 2

Initialization is performed by container before any request can be received.

Persistent data configuration, heavy resource setup (such as `JDBC` connection) and any one-time activities should be performed in this state.

The `init()` method will be called in this stage with a `ServletConfig` object as an argument.



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Life Cycle: ServletConfig Object

The `ServletConfig` object allows the servlet to access name-value initialization parameters from the deployment descriptor file using a method such as `getInitParameter(String name)`.

The object also gives access to the `ServletContext` object which contains information about the runtime environment.

`ServletContext` object is obtained by calling to the `getServletContext()` method.

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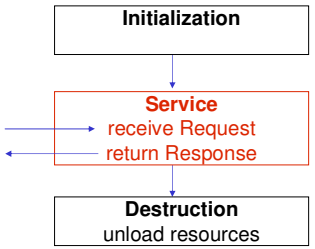
Life Cycle: Service 1

The service method is defined for handling client request.

The Container of a servlet will call this method every time a request for that specific servlet is received.



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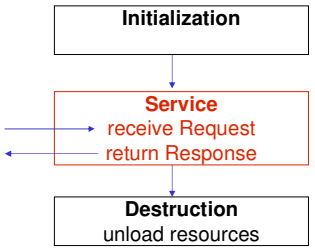
Life Cycle: Service 2

The Container generally handles concurrent requests with multi-threads.

All interactions to response to requests will occur within this phase until the servlet is destroyed.



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Life Cycle: Service Method

The `service()` method is invoked to every request and is responsible for generating the response to that request.

The `service()` method takes two parameters:

```
javax.servlet.ServletRequest
javax.servlet.ServletResponse

 public void service(ServletRequest request,
 ServletResponse response)throws IOException {
 . . .
}
```

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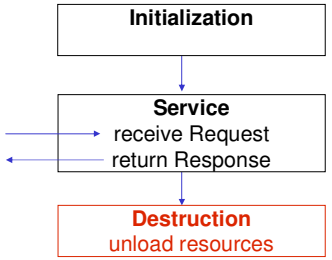
Life Cycle: Destruction

When the servlet container determines that the servlet should be removed, it calls the `destroy` method of the servlet.

The servlet container waits until all threads running in the `service` method have been completed or time out before calling the `destroy` method.



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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary
2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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HTTPServlet

A general servlet knows nothing about the `HyperText Transfer Protocol (HTTP)`, which is the major protocol used for Internet.

A special kind of servlet, `HTTPServlet`, is needed to handle requests from `HTTP` clients such as web browsers.

`HTTPServlet` is included in the package `javax.servlet.http` as a subclass of `GenericServlet`.

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Hypertext Transfer Protocol

`Hypertext Transfer Protocol (HTTP)` is the network protocol that underpins the World Wide Web.

For example:

a) when a user enters a `URL` in a Web browser, the browser issues an `HTTP GET` request to the Web server
b) the `HTTP GET` method is used by the server to retrieve a document
c) the Web server then responds with the requested `HTML` document

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HTTP Methods

Useful for Web applications:

`GET` - request information from a server

`POST` - sends an unlimited amount of information over a socket connection as part of the `HTTP` request

Not useful for Web applications:

`PUT` - place documents directly to a server

`TRACE` - debugging

`DELETE` - remove documents from a server

`OPTIONS` - ask a server what methods and other options the server supports for the requested resource

`HEAD` - requests the header of a response

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Get Versus Post

`GET` request :	`POST` request :
provides a limited amount of information in the form of a query string which is normally up to 255 characters	sends an unlimited amount of information
visible in a `URL`	does not appear as part of a `URL`
must only be used to execute queries in a Web application	able to update data in a Web application

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HTTP Request

A valid `HTTP` request may look like this:

```
GET /index.html HTTP/1.0
```

`GET`: is a method defined by `HTTP` to ask a server for a specific resource

`/index.html`: is the resource being requested from the server

`HTTP/1.0`: is the version of `HTTP` being used

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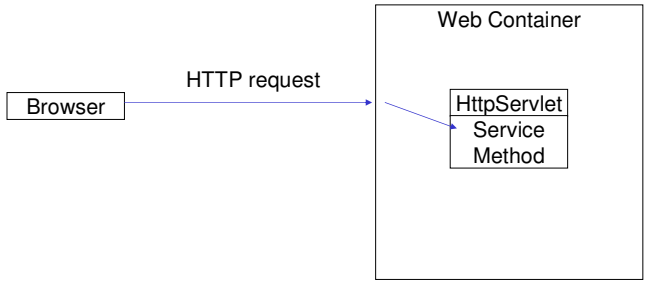
Handling HTTP Requests

A Web container processes `HTTP` requests by executing the `service` method on an `HttpServlet` object.



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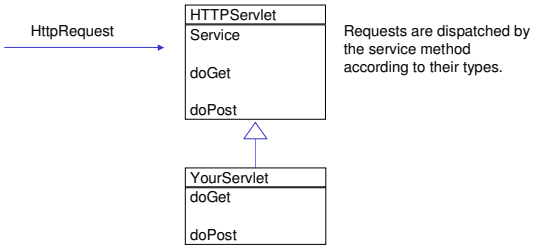
Dispatching HTTP Requests

In the `HttpServlet` class, the `service` method dispatches requests to corresponding methods based on the `HTTP` method such as `Get` or `Post`.

A servlet should extend the `HttpServlet` class and overrides the `doGet()` and/or `doPost()` methods.



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HTTP Response

After a request is handled, information should be send back to the client.

In the HTTP protocol, an HTTP server takes a request from a client and generates a response consisting of

a) a response line

b) headers

c) a body

The response line contains the HTTP version of the server, a response code and a reason phrase :

```
HTTP/1.1 200 OK
```

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HttpServlet Response

The HttpServletResponse object is responsible for sending information back to a client.

An output stream can be obtained by calls to:

```
1)getWriter()

2)getOutputStream()
```

For example:

```
PrintWriter out = response.getWriter();
out.println("<html>");
out.println("<head>");
out.println("<title>Hello World!</title>");
```

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Task 3: HTTP Servlet

1) Create and deploy a HelloWorld HTTP servlet executing the Get method.

a) Declare the package – com.examples

b) Import the required clases:

```
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import java.io.PrintWriter;
import java.io.IOException;
```

c) The body of the servlet may look like this:

```
public class HelloServlet extends HttpServlet {
 public void doGet(HttpServletRequest request,
 HttpServletResponse response)throws IOException {


 response.setContentType("text/html");
 PrintWriter out = response.getWriter();
```

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Task 4: HTTP Servlet

```
    //Generate the HTML response
    out.println("<HTML>");
    out.println("<HEAD>");
    out.println("<TITLE>Hello Servlet</TITLE>");
    out.println("</HEAD>");
    out.println("<BODY BGCOLOR='white'>");
    out.println("<B>Hello, World</B>");
    out.println("</BODY>");
    out.println("</HTML>");
    out.close();
  }
}
```

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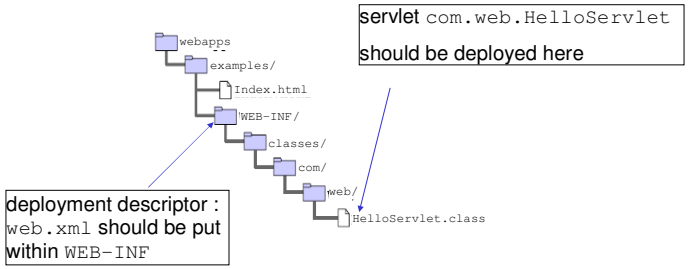
Deployment of an HTTP Servlet

The `HTTPServlet` object has to be deployed in the Web server before being used by the server.

A typical structure for deploying a servlet may look as follows:



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Deployment Descriptor

In order to deploy a servlet, we also need to put a deployment descriptor file, `web.xml`, under the directory of the `WEB-INF` directory.

Within the `web.xml` file, the definition of the servlet is contained:

1) Define a specific servlet

```
<servlet>
      <servlet-name>name</servlet-name>
      <servlet-class>full_class_name</servlet-
class>
</servlet>
```

2) Map to a `URL` pattern

```
<servlet-mapping>
      <servlet-name>name</servlet-name>
      <url-pattern>pattern</url-pattern>
</servlet-mapping>
```

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URL Patterns

There are four types of `URL` patterns:

a) Exact match:
```
<url-pattern>/dir1/dir2/name</url-pattern>
```

b) Path match:
```
<url-pattern>/dir1/dir2/*</url-pattern>
```

c) Extension match:
```
<url-pattern>*.ext</url-pattern>
```

d) Default resource:
```
<url-pattern>/</url-pattern>
```

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Mapping Rules 1

When a request is received, the mapping used will be the first servlet mapping that matches the request's path according to the following rules:

a) If the request path exactly matches the mapping, that mapping is used.

1) If the request path starts with one or more prefix mappings (not counting the mapping's trailing "/*"), then the longest matching prefix mapping is used.
For example, `"/foo/*"` will match `"/foo"`, `"/foo/"`, and `"/foo/bar"`, but not `"/foobar"`.

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Mapping Rules 2

3) If the request path ends with a given extension mapping, it will be forwarded to the specified servlet.

4) If none of the previous rules produce a match, the default mapping is used.

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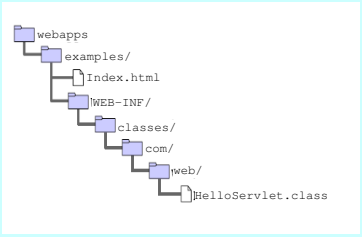
Task 5: Deploying HTTP Servlet

1) Deploy an `HTTP Servlet` in `Tomcat` server.

a) Create a directory for deployment. This directory, say `"examples"`, should be put under `<Tomcat_Home>/webapps`.



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Task 6: Deploying HTTP Servlet

b) Refer to the directory structure in previous slide, copy the servlet package to the directory `WEB-INF/classes`.

c) Create a `web.xml` file, if one does not exist, in the directory `WEB-INF`. The file may look like the following:

```
<web-app
xmlns="http://java.sun.com/xml/ns/j2ee"
  version="2.4">
<servlet>
  <servlet-name>HelloWorld</servlet-name>
  <servlet-class>
     com.web.HelloServlet
  </servlet-class>
</servlet>
```

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Task 7: Deploying HTTP Servlet

```
    <servlet-mapping>
            <servlet-name>HelloWorld</servlet-name>
            <url-pattern>/HelloWorld</url-pattern>
    </servlet-mapping>
</web-app>
```

d) Test the output of the servlet by entering the `URL` in the browser:
`http://localhost/examples/HelloWorld`

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Task 8: Deploying HTTP Servlet

2) Change the URL address of the servlet to:
   http://localhost/examples/myservelt/HelloWorld

3) Change the URL address of the servlet to:
   http://localhost/examples/Hello

4) Deploy the servlet in a different context, say *admin*.
   The URL may look like this:
   http://localhost/admin/HelloWorld

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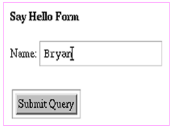
Request Parameter

Data transmitted from a browser to a servlet is considered the request parameter.

A Web browser can transmit data to a Web server through HTML form.

For example, if the submit button of the following form is pressed, the corresponding data is sent to the Web server:




```
Get /servlet/myForm?name=Bryan HTTP/1.0
. . .
```

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POST Method

By using a POST method, data may be contained in the body of the HTTP request:

```
POST /register HTTP/1.0
. . .
Accept-Charset: iso-8859-1,*,utf-8
Content-type: application/x-www-form-urlencoded
Content-length: 129
name=Bryan
```

The HTTP POST method can only be activated from a form.

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Extracting Request Parameters

Request parameters are stored as a set of name-value pairs.

ServletRequest interface provides the following methods to access the parameters:

1) getParameter(String name)
2) getParameterValues(String name)
3) getParameterNames()
4) getParameterMap()

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Task 10: Extract Parameter

1) Parameter value is sent to a servlet through an HTML form. Create a HTTP servlet to retrieve the value of the parameter.

a) Put the following HTML file in the examples folder of your web application, name it form.html and browse it.

```
<html>
 <BODY BGCOLOR='white'>
 <B>Submit this Form</B>
 <FORM ACTION='/examples/myForm' METHOD='POST'>
 Name: <INPUT TYPE='text' NAME='name'><BR><BR>
 <INPUT TYPE='submit'>
 </FORM>
 </BODY>
</html>
```

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Task 11: Extract Parameter

b) Methods of the HttpServletRequest are available for extracting parameters from different HTML forms:
String getParameter(name) – get a value from a text field
String getParameterValues(name) – get values from a multiple selection such as a checkbox

c) Create a servlet named myForm and deploy it under the examples context. The servlet will extract the parameter "name" and generate an HTML page showing the name in bold type.

Make sure that your servlet implements the correct method to respond to the request.

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Defining Initial Parameters

A servlet can have multiple initial parameters defined in the deployment descriptor (web.xml) as follows:

```
<servlet>
      <servlet-name>EnglishHello</servlet-name>
      <servlet-class>
            com.web.MultiHelloServlet
      </servlet-class>
      <init-param>
            <param-name>greetingText</param-name>
            <param-value>Welcome</param-value>
      </init-param>
      <init-param>
            <param-name>encoding</param-name>
            <param-value>UTF-8</param-value>
      </init-param>
</servlet>
```

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Getting Initial Parameter

There are different ways to obtain servlet initial parameters defined in web.xml. One is to override the init() method, which is defined in the GenericServlet class in your servlet.

The getInitParameter method of the GenericServlet class provides access to the initialization parameters for the servlet instance.

In the init() method, a greeting String may be defined as follows:

```
public void init(){
 . . .
      greeting = getInitParameter("greetingText");

 . . . }
```

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Multiple Servlet Definition

Multiple "servlet definitions" can also be defined in a given servlet class. The following could be added to `web.xml` along with the previous slide.

```
<servlet>
      <servlet-name>ChineseHello</servlet-name>
      <servlet-class>
            com.web.MultiHelloServlet
      </servlet-class>
      <init-param>
            <param-name>greetingText</param-name>
            <param-value>     </param-value>
      </init-param>
      <init-param>
            <param-name>encoding</param-name>
            <param-value>UTF-8</param-value>
      </init-param>
</servlet>
```

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Task 12: Servlet Initial Parameter

1) Modify `HelloServlet` to create a `servlet` named `MultiHelloServlet` which will pick up the initial parameters defined earlier and display them on an `HTML` Web page.

Note: Don't forget to define the servlet-mapping tag correctly. You need to define two mappings for a single servlet.

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Request Header

A servlet can access the headers of an `HTTP` request with the following methods:

1) `getHeader`

2) `getHeaders`

3) `getHeaderNames`

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Request Attributes

Attributes are objects associated with a request. They can be access through the following methods:

1) `getAttribute`

2) `getAttributeNames`

3) `setAttribute`

An attribute name can be associated with only one value.

e-Macao-16-6-94

Reserved Attributes

The following prefixes are reserved for attribute names and cannot be used:

1) `java.`
2) `javax.`
3) `sun.`
4) `com.sun.`

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Request Path 1

The request path can be obtained from this method:

`getRequestURI()`

The request path is composed of different sections.

These sections can be obtained through the following methods of the request object :

`getContextPath()`:

If the context of the servlet is the "default" root of the Web server, this call will return an empty string.

Otherwise, the string will starts with a ' / ' character but not end with a ' / ' character

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Request Path 2

`getServletPath()`:

The mapping which activates this request:

If the mapping matches with the ' /* ' pattern, returns an empty string

Otherwise, returns a string starts with a ' / ' character.

Example:

Context path: /examples
Servlet mapping :
Pattern: /lec1/ex1
Servlet: exServlet

Request Path: /examples/lec1/ex1
ContextPath: /examples
ServletPath: /lec1/ex1
PathInfo: null

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Request Path 3

`getPathInfo()`:

The extra part of the request `URI` that is not returned by the `getContextPath` or `getServletPath` method.

If no extra parts, returns null

otherwise, returns a string starts with a ' / ' character

Example:

Context path: /examples
Servlet mapping :
Pattern: /lec1/*
Servlet: exServlet

Request Path: /examples/lec1/ex/
ContextPath: /examples
ServletPath: /lec1
PathInfo: /ex/

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Request Path 4

To sum up:

```
RequestURI = ContextPath + ServletPath + PathInfo
```

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Task 13: Request Path

1) Modify the `HelloServlet` class to print out the results of the following methods:
   a) `getRequestURL()`
   b) `getRequestURI()`
   c) `getContextPath()`
   d) `getServletPath()`
   e) `getPathInfo()`

2) What is the result if entering this `URL` in the browser:
   `http://localhost/examples/HelloWorld/`

3) Modify the mapping for `HelloServlet` from `"HelloWorld"` to `"/*"` and check out the result again.

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Response Headers

`HttpServletResponse` can manipulate the `HTTP` header of a response with following methods:

```
addHeader(String name, String value)
addIntHeader(String name, int value)
addDateHeader(String name, long date)

setHeader(String name, String value)
setIntHeader(String name, String value)
setDateHeader(String name, long date)
```

For example:
You can make the client's browser cache the common graphic of your web site as following:

```
response.addHeader("Cache-Control",
"max-age=3600");
```

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
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   c) implicit objects
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   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Servlet Context

A `ServletContext` object is the runtime representation of a Web application.

A servlet has access to the servlet context object through the `getServletContext` method of the `GenericServlet` interface.

The servlet context object provides:

a) read-only access to context initialization parameters
b) read-only access to application-level file resources
c) read-write access to application-level attributes
d) write access to the application-level log file

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Context Initial Parameters 1

The application-wide servlet context parameters defined in the deployment descriptor (`web.xml`) can be retrieved through the context object.

The `web.xml` file may look like the following:

```
<web-app>
      <context-param>
            <param-name>admin email</param-name>
            <param-value>admin@servlet.com</param-value>
      </context-param>
. . .
```

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Context Initial Parameters 2

In order to obtain a context object, the following can be used:

```
ServletContext context =
getServletConfig().getServletContext();
```

After having the context object, one can access the context initial parameter like this:

```
String adminEmail =
context.getInitParameter("admin email");
```

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Access to File Resources

The `ServletContext` object provides read-only access to file resources through the `getResourceAsStream` method that returns a raw `InputStream` object.

After having the servlet context object, one can access the file resources as follows:

```
String fileName = context.getInitParameter("fileName");
InputStream is = null;
BufferedReader reader = null;
try {
is = context.getResourceAsStream(fileName);
reader = new BufferedReader(new inputStreamReader(is));
. . .
```

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Access to Attributes 1

The `ServletContext` object provides read-write access to runtime context attributes through the `getAttribute` and `setAttribute` methods.

Setting attributes:

```
ProductList catalog = new ProductList();
catalog.add(new Product("p1",10);
catalog.add(new Product ("p2",50);
context.setAttribute("catalog", catalog);
```

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Access to Attributes 2

Getting attributes:

```
catalog =
  (ProductList) context.getAttribute("catalog");
Iterator items = catalog.getProducts();
while ( items.hasNext() ) {
  Product p = (Product) items.next();
  out.println("<TR>");
  out.println("<TD>" + p.getProductCode() + "</TD>");
  out.println(" <TD>" + p.getPrice() + "</TD>");
  out.println("</TR>");
}
```

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Write Access to the Log File

The `ServletContext` object provides write access to log file through the `log` method.

The code may look as follows:

```
context.log ("This is a log record");
```

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Vertical Concepts Outline

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   e) expression language
   f) tag library
   g) summary

3) Filter
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   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Servlet Communication

When building a Web application, resource-sharing and communication between servlets are important. This can be achieved through one of the following:

a) servlet context
b) request dispatching
c) session tracking
d) event listening

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ServletContext

Servlets can access other servlets within the same servlet context through an instance of :

`javax.servlet.ServletContext`

The `ServletContext` object can be obtained from the `ServletConfig` object by calling the `getServletContext` method.

A list of all other servlets in a given servlet context can be obtained by calling the `getServletNames` method on the `ServletContext` object.

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Accessing a Servlet

The following code snippet shows how to access another servlet through the servlet context instance.

```
    ...
     BookDBServlet database = (BookDBServlet)
    getServletConfig().getServletContext().getServlet
    ("bookdb");
     //Obtain a Servlet and call its public method
    // directly
    BookDetails bd = database.getBookDetails(bookId);
       ...
  }
}
```

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Request Dispatching 1

A request may need several servlets to cooperate:

`RequestDispatcher` object can be used for redirecting a request from one servlet to another.

An object implementing the `RequestDispather` interface may be obtained from the `ServletContext` via the following methods:

`1)getRequestDispatcher`

`2)getNamedDispatcher`

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Request Dispatching 2

The `getRequestDispatcher` method takes a string argument as the path for the located resources.

The pathname must begin with a "/" and is interpreted as relative to the current context root.

The required servlet is obtained and returned as a `RequestDispatcher` object.

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Request Dispatching 3

The `getNamedDispatcher` method takes a string argument indicating the name of a servlet known to the `ServletContext`.

Servlets may be given names via server administration or via a web application deployment descriptor.

A servlet instance can be determined through its name by calling `ServletConfig.getServletName()`

If a servlet is known to the `ServletContext` by name, it is wrapped with a `RequestDispatcher` object and returned.

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Example: Request Dispatching

```
...
   RequestDispatcher dispatcher =
   getServletContext().getRequestDispatcher("/response");
         if (dispatcher != null) {
             dispatcher.include(request, response);
    }
```

Note:

1) The `RequestDispatcher` object's *include()* method dispatches the request to the "response" servlet path (/response – in the `URL` mapping).

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Using a RequestDispatcher

To use a request dispatcher, a developer needs to call either the `include` or `forward` methods of the `RequestDispatcher` interface as follows:

```
...
  dispatcher.include(request, response);
...
```

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Include Method

The `include` method of the `RequestDispatcher` interface may be called at any time.

It works like a programmatic server-side include and includes the response from the given resource (`Servlet`, `JSP` page or `HTML` page) within the caller response.

The included servlet cannot set headers or call any method that affects the headers of the response. Any attempt to do so should be ignored.

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Forward Method

The `forward` method of the `RequestDispatcher` interface may only be called by the calling servlet if no output has been committed to the client.

If output exists in the response buffer that has not been committed, it must be reset (clearing the buffer) before the target `Servlet's` service method is called.

If the response has been committed, an `IllegalStateException` must be thrown.

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Task 14: Request Dispatcher

1) Create a servlet which dispatches its request to another servlet using both the `forward` and `include` methods of the `ServletContext`.
   a) create a servlet name `TestDispatherServlet1` as follows:

```
package com.web;
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;
public class TestDispatcherServlet1 extends
  HttpServlet {
  private static final String forwardTo
    = "/DispatcherServlet2";
```

e-Macao-16-6-121

Task 15: Request Dispatcher

```
private static final String includeIn
    = "/DispatcherServlet2";

public void doGet(HttpServletRequest req,
  HttpServletResponse res)
    throws ServletException, IOException {

    res.setContentType("text/html");
    PrintWriter out = res.getWriter();
    out.print("<html><head>");
    out.print("</head><body>");
```

e-Macao-16-6-122

Task 16: Request Dispatcher

```
// Displaying Form
 out.print("<form action=\"");
 out.print( req.getRequestURI() );
 out.print("\" method=\"post\">");
 out.print("<input type=\"hidden\" name=\"mode\" ");
 out.print("value=\"forward\">");
 out.print("<input type=\"submit\" value=\" \"");
 out.print("> ");
 out.print(" Forward to another Servlet ..");
 out.print("</form>");
```

e-Macao-16-6-123

Task 17: Request Dispatcher

```
 out.print("<form action=\"");
 out.print( req.getRequestURI() );
 out.print("\" method=\"post\">");
 out.print("<input type=\"hidden\" name=\"mode\" ");
 out.print("value=\"include\">");
 out.print("<input type=\"submit\" ");
 out.print("value=\" \"> ");
 out.print(" Include another Servlet ..");
 out.print("</form>");

 out.print("</body></html>");
 out.close();
}
```

e-Macao-16-6-124

Task 18: Request Dispatcher

```
public void doPost(HttpServletRequest req,
 HttpServletResponse res)
 throws ServletException, IOException {
    res.setContentType("text/html");
    String mode = req.getParameter("mode");
    PrintWriter out = res.getWriter();
    out.print( "Begin...<br>");
    // Forwarding to Servlet2
    if(mode != null && mode.equals("forward")) {
    req.setAttribute("mode", "Forwarding Response..");
    req.getRequestDispatcher(forwardTo).forward(req,
    res);
 }
```

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Task 19: Request Dispatcher

```
    // Including response from Servlet2

    if(mode != null && mode.equals("include")) {
    req.setAttribute("mode", "Including Response..");
    req.getRequestDispatcher(includeIn).include(req,
       res);
    }
  }
}
```

b) Map the servlet at "/DispatcherServlet1" in the `web.xml` file

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Task 20: Request Dispatcher

2) Create a servlet as the target servlet built at task 14.
   a) Make sure the servlet is mapped correctly in the `web.xml` file. For instance:

```
<servlet>
  <servlet-name>DispatcherServlet2</servlet-name>
  <servlet-class>
      com.web.TestDispatcherServlet2
  </servlet-class>
 </servlet>
<servlet-mapping>
  <servlet-name>DispatcherServlet2</servlet-name>
  <url-pattern>/DispatcherServlet2</url-pattern>
</servlet-mapping>
```

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Task 21: Request Dispatcher

   b) Obtain the attribute "`mode`" of the `Request` object sent from the `TestDispatcherServlet1` and display it

3) What is the difference between `include` and `forward` methods?

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Session Tacking

`HTTP` is a stateless protocol and associating requests with a particular client is difficult.

Session tracking mechanism is used to maintain state about a series of requests from the same user.

`javax.servlet.http.HttpSession` defined in Servlet specification allows a servlet containers to use different approaches to track a user's session easily.

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HttpSession

`HttpSession` is defined in the Servlet specification for managing the state of a client.

Each `HttpSession` instance is associated with an ID and can store the client's data.

The stored data will be kept privately until the client's session is destroyed.

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Obtaining a Session

Servlets do not create sessions by default.

`getSession` method of the `HttpServletRequest` object has to be called explicitly to obtain a user's session.

For example:

```
public class CatalogServlet extends HttpServlet {
  public void doGet (HttpServletRequest request,
          HttpServletResponse response)
          throws ServletException, IOException {
      // Get the user's session
    HttpSession session = request.getSession();
     ...
      }
}
```

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HttpSession Attributes

Objects, or data, can be bound to a session as attributes.

The following methods can be used to manipulate the attributes:

1) `void setAttribute(String name, Object value)`
   - binds an object to this session, using the name specified

2) `Object getAttribute(String name)`
   - returns the object bound with the specified name in this session, or `null` if no object is bound under the name

3) `Enumeration getAttributeNames()`
   - returns an `Enumeration` of `String` objects containing the names of all objects bound to this session

4) `void removeAttribute(String name)`
   - removes the object with the specified name from this session

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Invalidating the Session

A user's session can be invalidated manually or automatically when the session timeouts.

To manually invalidate a session, the session's `invalidate` () method can be used:

```
. . .
HttpSession session = request.getSession();
. . .
// After the process, invalidate the session and clear
// the data
session.invalidate();
. . .
```

e-Macao-16-6-133

Cookies

Cookies are used to provide session ID and can be used to store information shared by the client and server.

When a session is created, an `HTTP` header, `Set-Cookie`, will be sent to the client. This cookie stores the session ID in the client until time-out.

The ID may looks like:

```
Set-Cookie:
JSESSIONID=50BAB1DB58D45F833D78D9EC1C5A10C5
```

This ID will be stored in a client and passed back to the server for each subsequent request.

```
Cookie: JSESSIONID=50BAB1DB58D45F833D78D9EC1C5A10C5
```

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Cookie Object

Other than providing session ID, cookie can be used to store information shared by both the client and server.

`javax.servlet.http.Cookie` class provides methods for manipulating the information such as:

```
setValue(String value)
getValue()
setComment(String comment)
getComment()
setMaxAge(int second)
getMaxAge()
. . .
```

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Using Cookies

A procedure for using cookies to store information in a client usually includes:

1) instantiating a cookie object
2) setting any attributes
3) sending the cookie

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Instantiating a Cookie Object

```
public void doGet (HttpServletRequest request,
  HttpServletResponse response)
  throws ServletException, IOException {

     String bookId = request.getParameter("Buy");

     if (bookId != null) {
        Cookie Book = new

    Cookie("book_purchased",bookId);
          ...
     }
}
```

e-Macao-16-6-137

Setting Attributes

```
  . . .
    Cookie Book = new

     Cookie("book_purchased",bookId);

     Book.setComment ("Book sold" );
  . . .
}
```

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Sending a Cookie

```
  . . .
  Cookie Book = new

     Cookie("book_purchased",bookId);

          Book.setComment ("Book sold" );

     response.addCookie(Book);
  . . .
}
```

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Retrieving Information

A procedure to retrieve information from a cookie:

1) retrieve all cookies from the user's request
2) find the cookie or cookies with specific names
3) get the values of the cookies found

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Retrieving a Cookie 1

```
public void doGet (HttpServletRequest request,
  HttpServletResponse response) throws ServletException,
  IOException { ...

  String bookId = request.getParameter("Remove");
  ...
  if (bookId != null) {
    // Find the cookie that pertains to that book
       Cookie[] cookies = request.getCookies();
```

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Retrieving a Cookie 2

```
      for(i=0; i < cookies.length; i++) {
          Cookie thisCookie = cookie[i];
          if (thisCookie.getName().equals

                        ("book_purchased") &&

thisCookie.getValue().equals(bookId)) {
          // Delete the cookie by setting its
          //  maximum age to zero

                thisCookie.setMaxAge(0);
                response.addCookie(thisCookie);
      }
```

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Task 22: Cookie

1) Create a servlet that stores the last time the client visits this servlet within the session.
   a) `java.util.Date` could be used to obtain the time-stamp.
   b) The time-stamp should be stored as a cookie.
   c) A message similar to the following should be shown:
   ```
   Your last visit time is Fri Apr 01 14:37:48 CST 2005
   ```

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URL Rewriting

If a client does not support cookies, URL rewriting could be used as a mechanism for session tracking.

While using this method, session ID is added to the URL of each page generated.

For example, after a session ID 123456 is generated, the rewritten URL might look like:

```
http://localhost/ServletTest/index.html;jsessionid=123456
```

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Methods for URL Rewriting

The `HttpServletResponse` object provides methods for appending a session ID to a URL address string:

```
String encodeURL(java.lang.String url)
```

Encodes the specified URL by including the session ID in it, or, if encoding is not needed, returns the URL unchanged.

```
String encodeRedirectURL(String url)
```

Encodes the specified URL for use in the `sendRedirect` method or, if encoding is not needed, returns the URL unchanged.

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Task 23: URL Rewriting

1) Investigate the usage of URL rewriting.
   a) Create a servlet, named "`URLRewrite`", which shows the following information on a web page:
      – request `URL` (`request.getURL()`)
      – request `URI` (`request.getURI()`)
      – servlet path (`request.getServletPath()`)
      – path info (`request.getPathInfo()`)
      – session id (`request.getSession().getId()`)
      – a hyperlink pointing to another servlet named "`DisplayURL`"
   b) Create a servlet `DisplayURL` which shows the session id.

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Task 24: URL Rewriting

c) Make sure that the browser accepts cookies.

d) Browse the `URLRewrite` servlet and click on the link to the `DisplayURL` servlet. What is the session id displayed on both page?

e) Configure the browser to disable the cookies.

f) Repeat step d and observe the result.

g) Modify the `URLRewrite` servlet and call the `response.encodeURL` method to modify the hyperlink pointing to the`DisplayURL` servlet.

h) What is the result now and what is the conclusion?

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Servlet Event Listener

Information about container-managed life cycle events, such as initialization of a web application or loading of a database could be useful.

Servlet event listener provides a mechanism to obtain these information.

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Event Listener Interfaces

Interfaces of different event listeners:

```
javax.servlet.ServletRequestListener
javax.servlet.ServletRequestAttributeListener
javax.servlet.ServletContextListener
javax.servlet.ServletContextAttributeListener
javax.servlet.http.HttpSessionListener
javax.servlet.http.HttpSessionAttributeListener
```

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Example of a Listener

A listener can be used in different situations and here is one of the examples:

1) When a web application starts up, the listener class is notified by the container and prepares the connection to the database.
2) When the application is closed and removed from the web server, the listener class is notified and the database connection is closed.

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Task 24: Servlet Event Listener

1) Create `HttpSessionListener` which counts the number of users connected to the server concurrently.
   a) Create a class named `UserCounter` which implements the `HttpSessionListener`.
   b) Define a static integer variable "`counter`" for counting the users.
   c) Find out which methods are needed to implement the `HttpSessionListener` interface.
   d) Within which method should you add or deduct the number of users?
   e) Provide a static method `getUserCounted` to return the number of users connecting currently.

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Task 25: Servlet Event Listener

2) Deploy the listener developed in Task 23.
   a) Modify the `web.xml` file as follows to deploy the listener:

```
<listener>
   <listener-class>
      FULL_CLASS_NAME_OF_THE_LISTENER
   </listener-class>
</listener>
```

3) Create a servlet `DisplayUser` which displays the number of connected user by calling the `getUserCount` method of the `UserCounter` class.

4) What can be observed when establishing more connections to the `DisplayUser` servlet?

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   c) filter dispatcher
   d) wrapper
   e) summary

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Servlet Summary 1

The most commonly used servlet extends the `HttpServlet` class.

The life cycle of a servlet include initialization, service and destruction.

The web container dispatches the requests to the corresponding methods according to their types such as `Get` or `Post`.

The `URL` of a servlet could be mapped as part of the `web.xml` file.

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Servlet Summary 2

Data transmitted from a browser to a servlet is considered a request parameter.

`ServletRequest` interface provides methods such as `getParameter()` for accessing the request parameters.

Initial parameters for a servlet could be assigned in the `web.xml` file and extracted within the `init()` method of a servlet using the `getInitParameter` method.

`HttpServletRequest` interface also provides methods for accessing different attributes of an `HTTP` request such as header, `URI`, etc.

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Servlet Summary 3

`ServletContext` object is the runtime representation of a web application.

The servlet context object provides:

a) read-only access to context initialization parameters
b) read-only access to application-level file resources
c) read-write access to application-level attributes
d) write access to the application-level log file

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Servlet Summary 4

Information and resources can be shared between servlets and the container.

Different approaches could be used:

a) servlet context
b) request dispatching
c) session tracking
d) event listening

A.2.2. JavaServer Pages

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Vertical Concepts Outline

1) Servlet
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   e) summary

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What is JavaServer Pages

`JavaServer Pages` is a `J2EE` technology for building web applications.

A `JSP` page is a textual document that describes how to create a dynamic response to a request.

`JSP` technology builds on:

1) template, or static, content
2) dynamic data
3) encapsulation of functionality through JavaBeans and tag libraries

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Goals of JSP

While keeping the benefits of Java Servlet, JSP supports separation of presentation and business logic:

a) web designers can design and update pages without learning Java programming language

b) programmers for Java platform can write codes without dealing with web page design

How to achieve this?

JSP allows web designer to write standard HTML pages containing **tags** that run powerful programs based on Java technology.

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Benefits of JSP

1) platform independent
2) roles separation
3) reuse of components and tag libraries
4) separation of dynamic and static content
5) encapsulation of functionality
6) integral parts of J2EE

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Simple JSP Example 1

A JSP file may look as follows:

```
<%! private static final String GREETING = "HELLO"; %>
<HTML>
      <HEAD>
            <TITLE>Hello JavaServer Pages</TITLE>
      </HEAD>
<%
  String name = request.getParameter("name");
      if ( (name == null) || (name.length() == 0) ) {
        name = "DEFAULT_NAME";
  }
%>
```

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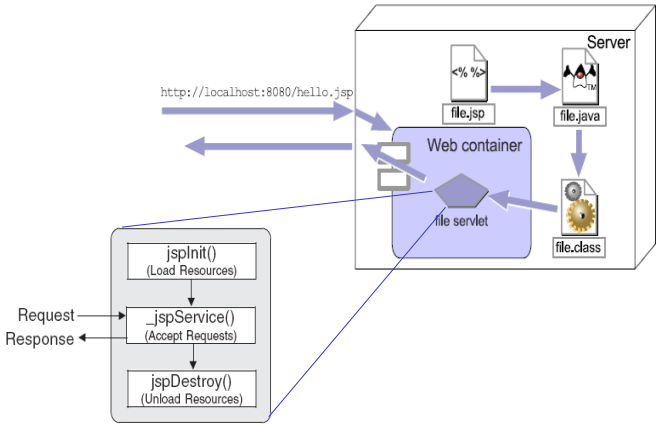
Simple JSP Example 2

```
<%-- THE FOLLOWING IS STANDARD HTML --%>
            <BODY BGCOLOR='white'>
            <B><%= GREETING %>, <%= name %></B>
      </BODY>
</HTML>
```

e-Macao-16-6-163

Life Cycle



e-Macao-16-6-164

Life Cycle Process

1) Web client transmits a request to the web container asking for a `JSP` page.
2) As this `JSP` page is accessed by the first time, it is translated into servlet code.
3) The servlet code is compiled into class file and loaded into the web container.
4) What is followed is similar to the working cycle of a normal servlet:
   a) The web container creates an instance of the servlet class for the `JSP` page and executes the `jspInit` method.
   b) The web container calls the `_jspService` method on the servlet instance for that `JSP` page. the result is sent back to the user.

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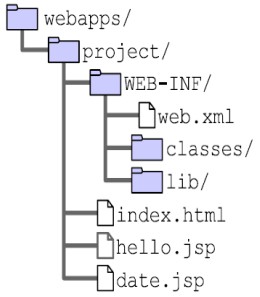
Deployment

`JSP` files can be placed under the deployment directory together with the main `HTML` files.

This allows the `JSP` files to be accessed as the main `HTML` files.

`JSP` files can also be mapped to specific `URLs` in the `web.xml` file.



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Deployment Descriptor

The configuration information for `JSP` pages is described in the `web.xml` file rooted on the `<jsp-config>` element.

configuration elements may include:

`<taglib>` - element in mapping of tag libraries

`<jsp-property-group>` - properties of collections of `JSP` files, such as page encoding or automatic includes before and after pages, etc

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Example: Deployment Descriptor

Common header and footer for JSP file can de defined in the web.xml file as follows:

```
<jsp-config>
     <jsp-property-group>
        <url-pattern>*.jsp</url-pattern>
        <include-prelude>/header.jsp</include-prelude>
        <include-coda>/footer.jsp</include-coda>
     </jsp-property-group>
</jsp-config>
```

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Mapping JSP to a URL

Like a servlet, a JSP page can be mapped to a specific URL by modifying the web.xml file.

For example, mapping a JSP page named "ShowHello.jsp in deployment directory to "/Hello" may as follows:

```
<servlet>
     <servlet-name>ShowHello</servlet-name>
     <jsp-file>/ShowHello.jsp</jsp-file>
</servlet>

<servlet-mapping>
     <servlet-name>ShowHello</servlet-name>
     <url-pattern>/Hello</url-pattern>
</servlet-mapping>
```

full path name such as /WEB-INF/classes/com/ShowHello.jsp

e-Macao-16-6-169

Task 26: Mapping JSP

1) Investigate the mapping mechanism for JSP files.
   a) create a JSP file
   b) put it under the directory: <Your_Web_Context>/WEB-INF/classes/
   c) map this page with a name: myPage
   d) browse it with a web browser

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Scripting Elements

Five kinds of scripting elements are defined in JavaServer Pages:

1) declarations <%! %>
2) scriptlets <% %>
3) expressions <%= %>
4) directives <%@ %>
5) comments <%-- --%>;<% /** **/%>;<!-- -->

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Declarations

Declaration tag is used for declaring variables or methods.

Codes generated are outside of the `_jspService()` method.
Syntax: `<%! declaration %>`

Examples:

declaring a variable

```
<%! int i = 0; %>
```

declaring a method

```
<%! public String foo(int i)
        { if (i<3) return("small");
        }
%>
```

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Scriptlets

The Java code within the scriptlet tag will be included in the `_jspService` method.

Syntax: <% *scriptlet* %>

Examples :

```
<% int time = 0; %>
<% if (time < 12) { %>
        Good Morning
<% } else { %>
        Good Afternoon
<% } ;%>
```

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Expressions

The expression represents a runtime value which is generated for a response.

Syntax: <% *expression* %>

Examples :

```
<B>Thank you</B>, <I> <%= name %> </I>, for registering
```

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Directives

Directives are used to define page attributes and do not output to a client.

Syntax: *<%@ directive {attribute="value"} *%>*

Directives can be as follows:

1) page
2) include
3) taglib

e-Macao-16-6-176

Directive: page

Provides page-specific information to a JSP container.

Syntax: `<%@ page %>`

The attributes include:

- language
- extends
- import
- session
- buffer
- autoFlush
- isThreadSafe
- isErrorPage
- errorPage
- contentType
- pageEncoding
- isScriptingEnabled
- isELEnabled

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Directive: include

Includes text and/or code at translation time of a JSP.

Syntax: `<%@ include file="relativeURL" %>`

Example:

```
<%@ include file="header.jsp" %>
This is a page with predefined header and footer by
means of the include directive
<%@ include file="footer.jsp" %>
```

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Task 27: Directive include

1) Create a JSP file named `header.jsp`.
   a) use declaration directive to declare an integer variable `"count"` for the page
   b) use declaration directive to declare a method `addCount()` which add the variable `"count"` by 1 for every call
   c) use scriptlet to call the `addCount` method
   d) append the following `HTML` code to the end of `header.jsp` which use the expression to display the dynamic content of `"count"`

```
<html>
   <body>
     <center>
        This page has been viewed <%= count %> times
     </center>
   <br>
```

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Task 28: Directives include

2) Create a JSP file named footer.jsp.
   a) put HTML code to display the word "Welcome"
   b) append to the HTML code to the file

```
</body>
   </html>
```

3) Create a JSP file named body.jsp.
   1) use directive include to include the header.jsp at the beginning
   2) put a static statement
   3) use directive include to include the footer.jsp at the end

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Directive: taglib

used to declare which markup on the page should be considered custom code and what code the markup links to

Syntax: `<%@ taglib uri="uri" prefix="prefixOfTag"%>`

This directive will be discussed in more detail in the session for tag library.

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Comments

JSP file can use two different types of comments:

1) JSP document comment
   Examples:
   `<%-- comments ... --%>`, or
   `<% /** comments too ... **/ %>`
2) Comments send back to users as a response
   Examples:
   `<!-- comments ... -->`, or
   `<!-- comments <%=expression %> ... -->`

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Guideline for Using Scripting

Overuse of scripting code can make JavaServer Pages confusing and difficult to maintain.

Scripting code will mix the business and presentation logic together.

Scripting code may reduce the reusability of JSP.

Scripting code should only be used when it is necessary.

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
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   e) expression language
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   g) summary
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   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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JSP Implicit Objects

In servlet, objects such as `HttpServletResquest` or `HttpServletResponse` can be accessed directly.

In `JSP`, some objects are automatically declared by the web container and can be accessed directly by scripting elements. These objects are called implicit objects.

Examples:

`application`	`pageContext`
`config`	`page`
`session`	`out`
`request`	`exception`
`response`	

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Implicit Objects: Servlet Equivalent

The following implicit objects have `Servlet` equivalents:

`application` – `javax.servlet.ServletContext`

`config` – `javax.servlet.ServletConfig`

`session` – `javax.servlet.http.HTTPSession`

`request` – `javax.servlet.http.HTTPRequest`

`response` – `javax.servlet.http.HTTPResponse`

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Implicit Objects: JSP Specific

`JSP` defines some implicit objects as follows:

`pageContext` – an instance of `javax.servlet.jsp.PageContext` object
e.g. `pageContext.include("header.jsp");`

`page` – synonym for the "`this`" operator.

`out` – an instance of `javax.servlet.jsp.JspWriter` object

`exception` – an instance of `java.lang.Throwable` object

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Example: Using Implicit Objects

The following JSP codes use the implicit object "request" to get information of the HTTP header and display it on a web page.

```
<%
 Enumeration enum = request.getHeaderNames();
 while (enum.hasMoreElements()) {
 String headerName = (String) enum.nextElement();
 String headerValue = request.getHeader(headerName);
%>
<b><%= headerName %></b>: <%= headerValue %><br>
<% } %>
```

can be used without declaring

e-Macao-16-6-188

Task 29: Implicit Objects

1) Investigate the usage of implicit objects.
   a) Referring to task 12, initial parameter was defined for a servlet in the web.xml file.
   b) Do the same setting for initial parameter in a JSP file named ShowHello.jsp.
   c) Call the getInitParameter() method of the implicit object "config" to get the initial parameter.
   d) Make ShowHello.jsp to display the greeting statement on the web page.

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Vertical Concepts Outline

1) Servlet
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   e) expression language
   f) tag library
   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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JSP Actions

JSP Actions have functions identical to that of scripting elements but allow abstraction of Java codes for JSP file.

JSP Actions have two types:

1) standard
2) custom

Syntax:

```
<prefix:element {attribute = "value"}* />
```

e-Macao-16-6-191

Standard JSP Actions

`Standard JSP Actions` are completely specified by the `JSP` specification and are available for use with any `JSP` container by default.

Include functionality that is commonly used with `JSP`.

A standard `JSP Action` generally use **`jsp`** as prefix.

Examples:
1) including resources (`<jsp:include/>`)
2) manipulating JavaBeans (`<jsp:useBean/>`)
3) forwarding requests (`<jsp:forward/>`)

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Commonly used Standard Actions

Some of the commonly used standard actions will be discussed in this section:

1) `<jsp:include/>`
2) `<jsp:forward/>`
3) `<jsp:param/>`
4) `<jsp:useBean/>`
5) `<jsp:setProperties/>`
6) `<jsp:getProperties/>`

e-Macao-16-6-193

<jsp:include/>

include resources during **runtime**

Syntax:

```
<jsp:include page="urlSpec" flush="true|false"/>
```

Example:

```
<jsp:include page="include_page" flush="true"/>
```

e-Macao-16-6-194

<jsp:include/>: Attribute Flush

Attribute flush indicates whether any existing buffer should be flushed before reading in the included content.

The attribute flush is required in JSP 1.1 and should be set to `true`.

In JSP 1.2 and up, the flush attribute defaults to false and can be left off.

e-Macao-16-6-195

Task 30: <jsp:include/>

1) Investigate the operation of action `include`.
   a) With the `header.jsp` and `footer.jsp` developed in task 27 and task 28, create a `JSP` file named `actionBody.jsp` as follows:

```
<jsp:include page="header.jsp" />
This is a page with predefined header and footer by
means of the include action.
<jsp:include page="footer.jsp" />
```

   b) Browse the `actionBody.jsp` a few times.
   c) Modify the `footer.jsp` to add some text to it.
   d) Refresh the web pages.
   e) What observation did you have?

e-Macao-16-6-196

Task 31: <jsp:include/>

2) Compare with the result from using directive include.
   a) Browse the `body.jsp` developed in task 27 and 28 a few times.
   b) Repeat steps c and d in task 30.
   c) What is the difference comparing to the results of task 30.

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<jsp:forward/>

Equivalent to call the `RequestDispather.forwared()` method.

This action forwards a request to a new resource and clears any content that might have previously been sent to the output buffer by the current `JSP`.

Example:

```
<jsp:forward page="relative_URL" />
```

e-Macao-16-6-198

<jsp:forward/>: Parameters

Both the `JSP` forward and include actions can optionally include parameters.

Example:

```
<jsp:forward page="examplePage.jsp">
<jsp:param name="para_1" value="val"/>
<jsp:param name="para_2" value="<%= aVal %>"/>
</jsp:forward>
```

The value can be represented by an expression.

If the parameter specified by the `param` action were exist, the existing is replaced.

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JavaBean Actions

The Actions used with the JavaBean:

1) `<jsp:useBean/>`
2) `<jsp:setProperty/>`
3) `<jsp:getProperty/>`

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JavaBeans

A JavaBean is a Java class with at least the following features:

1) accessors and mutators (get and set methods) are used to define the properties of the bean
2) has a default constructor
3) no public instance variables
4) not an `Enterprise JavaBeans (EJB)`

e-Macao-16-6-201

<jsp:useBean/>

Declares a JavaBean for use in a `JSP`.

Syntax:

```
<jsp:useBean id="name" class="full_class_name"
  scope="scope" />
```

Examples:

```
<jsp:useBean id="guestBean"
  class="com.web.GuestBean" scope="request"/>
<%
  guestBean.setName(request.getParameter("name"));
guestBean.setEmail(request.getParameter("email"));
%>
  </jsp:useBean>
```

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<jsp:useBean/>: Usage

Action

```
<html>
<head>
<title>
      with useBean
</title>
</head>
<body>
<jsp:useBean id="date"
  class="java.util.Date"
/>
The date/time is
  <%= date %>
</body>
</html>
```

Scriptlet

```
<html>
<head>
<title>
      with Scriptlet
</title>
</head>
<body>
<% java.util.Date date =
  new java.util.Date();
%>
The date/time is
  <%= date %>
  </body>
  </html>
```

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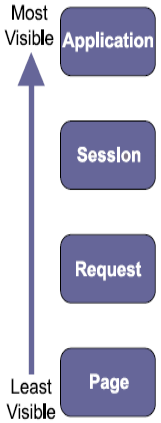
<jsp:useBean/>: Valid Scope 1

application

session

request

page



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<jsp:useBean/>: Valid Scope 2

page:

1) The JavaBean will be available by calling the `getAttribute()` method of the `PageContext`.
2) The JavaBean is discarded upon completion of the current request.

request:

1) The JavaBean is available by calling the `getAttribute()` from the current page's `ServletRequest` object.
2) The JavaBean is discarded upon completion of the current request.

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<jsp:useBean/>: Valid Scope 3

session:

1) The JavaBean is available by calling the `getAttribute()` from the current page's `HttpSession` object.
2) The JavaBean automatically persists until the session is invalidated.

application:

1) The JavaBean is available by calling the `getAttribute()` of the web application's `ServletContext` object.

e-Macao-16-6-206

<jsp:setProperty/>

The `jsp:setProperty` Action is used to initialize the JavaBean instead of using the scriptlet.

Exmaples:

```
<jsp:useBean id="guestBean"
      class="com.web.GuestBean" scope="request">
<jsp:setProperty name="guestBeam"
      property="name" value="Guest1">
<jsp:setProperty name="guestBean"
      property="email" />
</jsp:useBean>
```

`jsp:setProperty` Action can be used outside of the `jsp:useBean` Action.

e-Macao-16-6-207

<jsp:setProperty>: Attributes

To initialize the bean properties, the following settings can be used:

```
<jsp:useBean id="guestBean"
      class="com.web.GuestBean" scope="request">
<jsp:setProperty name="guestBean" property="*" />
<jsp:setProperty name="guestBean"
property="username" param="user"/>
<jsp:setProperty name="guestBean"
property="username" value="<%=user%>" />
</jsp:useBean>
```

when `property="*"` is used, the request parameters will be iterated to find the matched parameters.

e-Macao-16-6-208

<jsp:getProperty>

The `jsp:getProperty` Action is used to extract the value of an attribute of a JavaBean:

Example:

```
<jsp:getProperty name="guestBean"
      property="username"/>
```

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Task 32: <jsp:useBean/>

1) Investigate the usage of `useBean` Action.
   a) Develop a Java class named `User.java`.
   b) The class has two instance variables, `"name"` and `"password"`.
   c) Provide getter and setter for these two variables.
   d) Create a `JSP` file which shows an `HTML` form for user to input username and password.
   e) Information submitted from d) will be stored in an instance of `User` class.
   f) Create another `JSP` file named `displayeInfo.jsp` which displays the information of the `User` bean.
   g) Use `useBean`, `setProperty` and `getProperty` Actions in the `JSP` file.
   h) What is the difference applying different scopes for the useBean Action?

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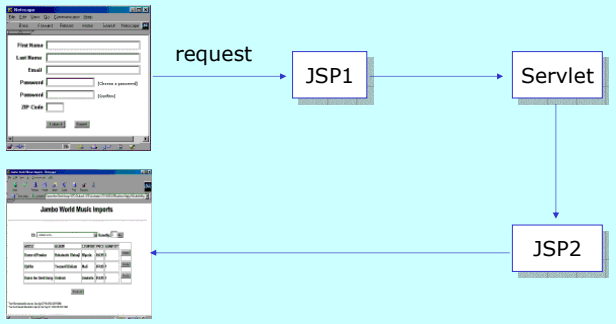
Task 33: <jsp:useBean/>

2) Use the useBean Action to perform request chaining. In this task, the following scenario is performed by modifying task 32.



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Task 34: <jsp:useBean/>

a) Modify the `HTML` file in task 32 to show a form for entering user information.

b) Create a Java bean named `FormBean` for storing the information.

c) When the submit button of the form is pressed, the data is transmitted to a `JSP` file, say `Jsp1.jsp`.

d) `Jsp1` will instantiate the `FormBean`, using the `useBean` action with a scope of `request`.

e) Information from the request parameter is stored in the `FormBean` by calling the `jsp:setProperty` Action.

f) Use attribute `property="*"` to populate the data to the `FormBean`.

g) Request is then forwarded to the servlet, Servlet1, through the `jsp:forward` Action.

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Task 35: <jsp:useBean/>

h) The controller servlet, Servlet1 extracts the bean passed to it from the attribute of the request as follows:

```
public void doPost (HttpServletRequest request,
HttpServletResponse response) {
  try {
    FormBean f = (FormBean)
                 request.getAttribute ("fBean");
  . . .
```

i) Modify the values of `UserBean` by calling the setter methods of the bean.

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Task 36: <jsp:useBean/>

j) Forward the request to the `JSP` page, say `Jsp2.jsp` for rendering the output:

```
getServletConfig().getServletContext().
getRequestDispatcher("/Jsp2.jsp").forward(request,
response);
```

k) Extract the `UserBean` information by calling the `getProperty` action.

l) Display the user info on a web page.

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Vertical Concepts Outline

1) Servlet
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   e) expression language
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   c) filter dispatcher
   d) wrapper
   e) summary

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JSP 2.0 Expression Language

JSP-specific expression language(`JSP EL`), is defined in JSP 2.0 specification.

JSP EL provides a cleaner syntax and is designed specially for JSP.

e-Macao-16-6-216

JSP EL Examples

A variable can be accessed as:

${variable_name}

The property of a bean can be accessed as:

${aBean.name}

Expression can be accessed as:

```
<c:if test="${aBean.age < 20}">
  . . .
</c:if>
```

e-Macao-16-6-217

JSP EL: Syntax

In `JSP EL`, expressions are always enclosed by the ${ } characters.

Any values not begin with **${** is literal.

Literal value contains the **${** has to be escaped with "\" character.

e-Macao-16-6-218

JSP EL: Attributes

Attributes are accessed by name, with an optional scope.

Members, getter methods, and array items are all accessed with a "**.**"

Examples:

a member b in object a → `${a.b}`
a member in an array a[b] → `${a.b} or ${a["b"]}`

e-Macao-16-6-219

JSP EL: Literals

`Boolean: true / false`
`Long:` as `long` values defined by Java

`Float:` as `float` values defined by Java

`String:` identical as in Java

`Null:` identical as in Java

e-Macao-16-6-220

JSP EL: Operators

```
[]
()
-
*, /, div, %, mod
+, -
<, >, <=, >=, lt, gt, le, ge
&&, and
||, or
```

Note: order of preference from top to bottom, left to right

e-Macao-16-6-221

JSP EL: Reserved Words

The following words are reserved and cannot be used in `JSP EL` expression:

and	true
or	false
not	instanceof
eq	empty
gt	null
lt	div
ge	mod
ne	
le	

e-Macao-16-6-222

JSP EL: Implicit Objects 1

A set of implicit objects is defined to match the `JSP` equivalents:

1) `pageContext:` the context for the `JSP` page

Through `pageContext`, the following implicit objects can be accessed:

a) `context`
b) `session`
c) `request`

For example, the context path can be accessed as:

```
${pageContext.request.contextPath}
```

e-Macao-16-6-223

JSP EL: Implicit Objects 2

2) `param`

a) maps name of parameter to a single string value

b) same as `ServletRequest.getParameter(String name)`

`e.g. ${param.name}`

3) `paramValues`

a) map name of parameter to an array of string objects

b) same as `ServletRequest.getParameterValues(String name)`

`e.g. ${paramValues.name}`

e-Macao-16-6-224

JSP EL: Implicit Objects 3

4) `header`

a) maps a request header name to a single string header value

b) same as `ServletRequest.getHeader(String name)`

`e.g. ${header.name}`

5) `headerValues`

a) map request header names to an array of string objects

b) same as `ServletRequest.getParameterValues(String name)`

`e.g. ${headerValues.name}`

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JSP EL: Implicit Objects 4

Additional implicit objects are available for accessing scope attributes:

1) `pageScope`

2) `requestScope`

3) `sessionScope`

4) `applicationScope`

For example:

`${sessionScope.user.userid}`

e-Macao-16-6-226

JSP EL: Implicit Objects 5

5) `headerValues`

a) maps all the header values

b) same as `ServletRequest.getHeaders()`

6) `cookie`

a) maps the single cookie objects that are available by invoking `HttpServletRequest getCookies()`

b) If there are multiple cookies with the same name, only the first one encountered is placed in the Map

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JSP EL: Defining EL Functions 1

Static methods in a Java class can be used as JSP EL functions.

The name and signature of the function can be defined as follows:

<function> element in the Tag Library Descriptor file (TLD) is used for setting up the linkage

```
<taglib>
...
 <function>
    <name>myFunction</name>
    <function-class>
          com.functions.MyFunction
    </function-class>
```

e-Macao-16-6-228

JSP EL: Defining EL Functions 2

```
      <function-signature>
            String bar(String)
      </function-signature>
   </function>
</taglib>
```

The static method, bar(), defined in the class com.functions.MyFunction is now mapped in the JSP EL as a function named myFunction.

e-Macao-16-6-229

JSP EL: Using EL Functions

The previous EL functions can be used as following:

```
${bar('hello')}
```

If the function is defined in a non-default namespace, the prefix must be declared explicitly.

For example:

If bar function is declared in a tag library with a prefix f, the function may be declared as :

```
${f:bar('hello')}
```

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JSP EL Compatibility

Using JSP EL may cause compatibility problems with JSP 1.2 and earlier code.

JSP EL is disabled by default if Servlet 2.3 defined web.xml file is used.

Applications uses the Servlet 2.4 defined web.xml file will enable JSP EL automatically.

e-Macao-16-6-231

Enabling / Disabling JSP EL

JSP page can use the isScriptingEnabled page directive to enable or disable JSP EL.

For example:

```
<%@ page isScriptingEnabled="true" %>
```

Element scripting-enabled in the web.xml is used to configure an application-wide usability.

For example:

```
. . .
<jsp-property-group>
    <scripting-enabled>true</scripting-enabled>
 . . .
```

e-Macao-16-6-232

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Standard Tag Library

JavaServer Pages Standard Tag Library (JSTL) is an extended set of JSP standard actions includes the following tags:

1) Iteration and conditional
2) Expression Language
3) URL manipulation
4) Internationalization-capable text formatting
5) XML manipulation
6) Database access

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Problems with JSP Scriptlet Tags

1) Java code is embedded within scriptlet tags.
2) Non-Java developer cannot understand the embedded Java code.
3) Java code within JSP scriptlets cannot be reused by other JSP pages.
4) Casting to the object's class is required when retrieving objects out of HTTP request and session.

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Advantage of JSTL

1) JSTL tags are in XML format and can be cleanly and uniformly blended into a page's HTML markup tags.

2) JSTL tag libraries are organized into four libraries which include most functionality required for a JSP page and are easier for non-programmers to use

3) JSTL tags encapsulate reusable logic and allow to be reused.

4) No casting is requiring while using JSTL tags for referencing objects in the request and session.

5) JSP's EL (Expression Language) allows using dot notation to access the attributes of Java objects.

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Disadvantage of JSTL

1) JSTL may add processing overhead to the server:

   like JSP scriplet, tag libraries are also compiled into a resulting servlet and then executed by the servlet container

2) JSTL tags only provide the typical operations but not all:

   scriptlets may be needed if the JSP pages need to do everything

e-Macao-16-6-237

Example: JSTL 1

1) Without JSTL, some scriptlets may look as follows:

```
<%
   List addresses =
   (List)request.getAttribute("addresses");
   Iterator addressIter = addresses.iterator();
    while(addressIter.hasNext()) {
      AddressVO address =
      (AddressVO)addressIter.next();
      if((address != null) {
%>
<%=address.getLastName()%><br/>
```

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Example: JSTL 2

```
 <%
       }
       else {
 %>
       N/A<br/>
<%
       }
    }
%>
```

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Example: JSTL 3

1) With JSTL, the previous may look as follows:

```
<%@ taglib prefix="c"
  uri="http://java.sun.com/jsp/jstl/core" %>
<c:forEach item=${addresses} var="address" >
  <c:choose>
    <c:when test="${address != null}" >
      <c:out value="${address.lastName}"/><br/>
    <c:otherwise>
       N/A<br/>
    </c:otherwise>
  </c:choose>
</c:forEach>
```

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Using JSTL

JSTL is standardized, but not a standard part of JSP 1.2 or 2.0.

JSTL must be downloaded and installed separately before being used.

e-Macao-16-6-241

Task 37: Installing the JSTL

1) The JSTL will be installed and setup for used.
   a) Dowonload the library from this URL:
      http://www.apache.org/dist/jakarta/taglibs/standard/
   b) Unpack the file and two jar files are inside the /lib directory:
      a) jstl.jar
      b) standard.jar

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Task 38: Installing the JSTL

   c) Copy the jar file from step b to the following directory: <Tomcat_Home>/common/lib.
   d) the jar files can also be copied to the /WEB-INF/lib directory under your application context.
   e) In the JSP page, the following tags can be used to refer to the installed JSTL:

```
<%@ taglib
uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
```

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Organization of JSTL

The JSTL tags are organized into four libraries:

Library features	Recommended prefix
Core (control flow, URLs, variable access)	c
Text formatting	fmt
XML manipulation	x
Database access	sql

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JSTL: Core Tags 1

The core tags can be subdivided into a few categories:

1) General-purpose
   a) out
   b) set
   c) catch
   d) remove
2) Flow control
   a) forEach
   b) forTokens

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JSTL: Core Tags 2

3) conditional
   a) if
   b) choose
   c) when
   d) otherwise

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JSTL: Core Tags 3

4) URL management
   a) url
   b) import
   c) redirect
   d) param

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JSTL Tags: <c:out>

This tag evaluates the JSTL expression and send output to the page's current JspWriter object.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
<html><head><title>&lt;c:out&gt;</title></head>
  <body>
   <c:out value="${'<tag> , &'}"/>
   <br>
   <c:out value='<tag> , &' escapeXml="false"/>
  </body>
</html>
```

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Attributes of <c:out> tag

1) **value:** expression to be evaluated and send
2) **escapeXml:** default is true and characters <,>,&,' and " result in <, >, and &, ', and "
3) **default:** defines the default value to be used in case the expression fails or results in null

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Task 39: <c:out> tag

1) Investigate the result of using different attributes of <c:out> tag.
   a) Follow the previous example to test the output.
   b) View the source of the web page to see the actual output of the page.
   c) What is the difference with different values of the attribute escapeXml?

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JSTL Tags: <c:set>

This tag evaluates an expression and uses the results to set a scoped variable, a JavaBean or a java.util.Map object.

Examples:

```
<c:set value="expression" target="target object"
property="name of property" />

<c:set value="value" var="varName"/>
```

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Attributes of <c:set> tag1

1) **value:** expression to be evaluated
2) **var:** the name of the result variable representing the evaluated result from value attribute
3) **scope:** scope of the object named by the var attribute including:
    1) page (default)
    2) request
    3) session
    4) application

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Attributes of <c:set> tag 2

4) **target:** a JavaBean of a java.util.Map object whose property will be set
5) **property:** the name of the property of the target object which will be set by the value attribute

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Usage of <c:set> tag

1) set a scoped variable for use later

   for example:

```
<c:set value="100" var="totalCost"
scope="session"/>
```

2) set the property of a JavaBean or Map object

```
<c:set value="pass" target="student_A"
property="grade"/>
```

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JSTL Tags: <c:catch>

This tag provides a complement to the JSP error page mechanism.

It works as a try-catch statement.

Code surrounded by a catch tag will never cause the error page mechanism to be invoked.

If a var attribute is set, the exception will be stored in the variable identified by the var attribute.

The var attribute always has page scope.

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JSTL Tags: <c:remove>

This tag is used to remove a scoped variable

For example:

```
<c:remove var="cart" scope="session"/>
```

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JSTL Tags: <c:forEach>

This tag provides iteration over a collection of objects.

supports iteration over an array, `java.util.Collection`, `java.util.Iterator`, `java.util.Enumeration`, or a `java.util.Map`

Example:

```
<c:forEach var="name" varStatus="status"
      begin="expression" end="expression"
      step="expression">

      body content

</c:forEach>
```

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Attributes of <c:forEach> tag1

`var:` defines the name of the current object, or primitive, exposed to the body of the tag during iteration

`items:` attribute defines the collection of items to iterate over

`varStatus:` defines the name of the scope variable that provides the status of the iteration

Properties of `varStatus` may be:

```
current
index
count
first
begin
end
step
```

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Attributes of <c:forEach> tag 2

`begin:` an int value that sets where the iteration should begin

`end:` The end attribute is an int value that determines inclusively where the iteration is to stop

`step:` The step attribute is an int value that determines the “step” to use when iterating

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Example: <c:forEach> tag 1

1) This example displays the `varStatus` value in a loop.

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
  prefix="c" %>
<H2>froEach varStatus</H2>
<UL>
<c:forEach var="count" begin="0" end="10" step="2"
  varStatus="status">
<LI><c:out value="${count}<br>"
  escapeXml="false"/>
<c:out value="current: ${status.current}<br>"
  escapeXml="false"/>
<c:out value="index: ${status.index}<br>"
  escapeXml="false"/>
```

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Example: <c:forEach> tag 2

```
<c:out value="count: ${status.count}<br>"
  escapeXml="false"/>
<c:out value="first: ${status.first}<br>"
  escapeXml="false"/>
<c:out value="begin: ${status.begin}<br>"
  escapeXml="false"/>
<c:out value="end: ${status.end}<br>"
  escapeXml="false"/>
<c:out value="step: ${status.step}<br>"
  escapeXml="false"/>
</c:forEach>
</UL>
```

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Example: <c:forEach> tag 3

2) This example uses the `<c:forEach>` tag to loop through an array and display on the web page.

```
<% String[] words = { "foo", "bar", "baz"};
pageContext.setAttribute("words", words); %>
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
  prefix="c" %>
<html>
<head>
<H2>Key Words:</H2>
</head>
<body>
<UL>
```

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Example: <c:forEach> tag 4

```
  <c:forEach var="word" items="${words}">
  <LI><c:out value="${word}"/>
  </c:forEach>
</UL>
<H2>Values of the test Parameter:</H2>
 <c:forEach var="val" items="${paramValues.test}">
   <LI><c:out value="${val}"/>
 </c:forEach>
</body>
</html>
```

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JSTL Tags: <c:forTokens>

This tag parses a `String` into tokens based on a given delimiter.

It works similar to the `forEach` tag with an extra attribute `delime` specifying a token delimiter.

Example:

```
<c:forTokens var="name" delime=","
items="Bryan,Frank,Gab">
 <c:out value="${name}"/>
</c:forTokens>
```

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JSTL Tags: <c:if>

This tag works similar to a Java `if` and `switch`.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
. . .
<c:if test="${user == null}">
<form>
  Name: <input name="name">
  Pass: <input name="pass">
</form>
</c:if>
. . .
```

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Attributes of <c:if> tag

`test`: the condition for testing

`var`: an optional attribute that defines the name of a scoped variable

`scope`: defines the scope of the var attribute.
(page, request, session or application)

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JSTL Tags: <c:choose> 1

for more than one options, use the `<c:choose>`, `<c:when>` and `<otherwise>` tag

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
. . .
<c:choose>
  <c:when test="${user == null}">
    <form>
     Name: <input name="name">
     Pass: <input name="pass">
    </form>
```

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JSTL Tags: <c:choose> 2

```
    </c:when>
    <c:otherwise>
       Welcome ${user.name}
    </c:otherwise>
 </c:choose>
. . .
</body>
</html>
```

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Task 40: <c:choose> tag

1) Use tags `<c:choose>`, `<c:when>` and `<c:otherwise>` to develop a `JSP` page which generates the follows:

```
1  (small)
2  (small)
3  (small)
4  (medium)
5  (medium)
6  (medium)
7  (medium)
8  (large)
9  (large)
10 (large)
```

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JSTL Tags: <c:url>

This tag provides automatically encoded `URLs`.

Session information and parameters are encoded with a `URL`.

This tag is used when client does not support cookies.

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Attributes of <c:url> tag

`value:` provides the `URL` to be processed

`context:` defines the name of the context

`var:` exports the encoded `URL` to a scoped variable

`scope:` defines the scope of the `var` object

For example:

```
<c:url var="thisURL" value="newPage.jsp">
<c:param name="aVariable" value="${v.id}"/>
<c:param name="aString" value="Simple String"/>
</c:url>
<a href="<c:out value="${thisURL}"/>">Next</a>
```

The above generates a `URL` as follows:

```
newPage.jsp?aVariable=24&aString=Simple+String
```

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JSTL Tags: <c:redirect>

This tag provides the functionality to call the `HttpServletResponse.sendRedirect` method.

It can have attributes as follows:

`url`: the `URL` the client should be redirected to

`context`: the context of the `URL` specified by the `url` attribute

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JSTL Tags: <c:import>

This tag provides all of the functionality of the `include` Action.

It allows for inclusion of absolute `URLs`, e.g. the content from a different web site.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
<c:import url="http://www.yahoo.com" />
```

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JSTL Tags: <c:param>

This tag is used within the body of `<c:import>` tag to set `URL` parameters.

Examples:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
<c:import url="http://search.yahoo.com/search"
var="yahoo">
<c:param name="p" value="java" />
</c:import>
<c:out value="${yahoo}" escapeXml="false" />
```

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Other Tags

Other than the core tags, there are tags for different purposes such as :

database tags:
`<sql:setDataSource>,<sql:query>,<sql:update>. . .`

formatting tags:
`<fmt:formatNumber>,<fmt:parseNumber> . . .`

internationalization tags:
`<fmt:setLocale>,<fmt:setBundle>. . .`

`XML` manipulation tags:
`<x:parse>,<x:if>,<x:choose>,<x:transform>. . .`

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Custom Tags

Like HTML, custom tags abstract code behind markup and provide a clean separation between logic and content.

Custom tags are designed to be used easily for a non-programmer.

Unlike scriptlet, custom tags can be packaged into a JAR file and deployed across web applications.

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When to Use Custom Tags

Custom tags can be used to embedded dynamic functionality in a JSP.

Examples:

1) support the View partition in a MVC (Model-View-Controller) design pattern
2) support multi-lingual site
3) produce different formats of output to different clients such as web browser, PDA or web application
4) complement to the JSTL to provide full support for conditionals and iterations

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Simple JSP 2.0 Custom Tags

introduced in JSP 2.0 with a simple life cycle

easier to write and use than the classic custom tag handlers

based on the javax.servlet.jsp.SimpleTag interface

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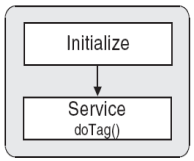
Life Cycle

Has only two parts:

1) Initialization
   a) set the parent and body
   b) set by the JSP container
2) Service – doTag()
   a) implemented by the custom tag developer



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SimpleTag Interface 1

All `SimpleTag` classes should implement the `javax.servlet.jsp.tagext.SimpleTag` interface

The interface defines the following methods:

`doTag()` – implemented by the tag developer and invoked by a `JSP` container during execution

`getParent()` – returns the custom tag surrounding this tag

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SimpleTag Interface 2

`setJspBody(javax.servlets.jsp.JspFragment)` – invoked by a JSP container during runtime before the `doTag()` method

`setJspContext(javax.servlets.jsp.JspContext)` – invoked by a JSP container during runtime before the `doTag()` method

`setParent(javax.servlets.jsp.JspTag` – invoked by a `JSP` container during runtime to set the current parent tag

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How to Develop Simple Tags

The `javax.servlet.jsp.tagext.SimpleTagSupport` class is the base implementation of the `SimpleTag` interface.

A custom tag can extend `SimpleTagSupport` and override the `doTag()` method.

e-Macao-16-6-282

Task 41: Simple Custom Tag

1) Develop a simple tag.
   a) Create a class named `HelloSimpleTag`.
   b) This class should be a subclass of `SimpleTagSupport` class.
   c) Allow the tag output a string in the `doTag()` method.
   d) The class may look like the follows:

```
package web.jsp;
import javax.servlet.jsp.tagext.SimpleTagSupport;
import javax.servlet.jsp.*;
import java.io.IOException;
public class HelloSimpleTag extends
SimpleTagSupport{
```

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Task 42: Simple Custom Tag

```
  public void doTag() throws JspException,
  IOException {
    JspWriter out = getJspContext().getOut();
    out.println("Hello World!");
  }
}
```

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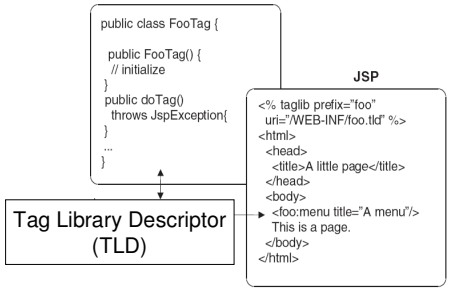
How to Use Custom Tags

A collection of custom tags designed for a common goal can be packaged into a library.

The custom tags within the library can be used by a JSP as described by a `Tag Library Descriptor` (`TLD`) file.



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Tag Library Descriptor 1

Tag Library Descriptor is an `XML` file with "`tld`" extension or a `JAR` file used to bind the custom tags to the markup appears in a `JSP` file.

For example, following `TLD` file will bind the `CountTag` to a `JSP` with a name "`count`":

```
<taglib xmlns="http://java.sun.com/xml/ns/j2ee"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
 http://java.sun.com/xml/ns/j2ee/
 web jsptaglibrary_2_0.xsd" version="2.0">
  <tlib-version>1.0</tlib-version>
  <jsp-version>2.0</jsp-version>
  <short-name>Example TLD</short-name>
```

e-Macao-16-6-286

Tag Library Descriptor 2

```
    <tag>
      <name>count</name>
      <tag-class>com.web.CountTag</tag-class>
      <body-content>empty</body-content>
  </tag>
</taglib>
```

e-Macao-16-6-287

TLD: Tag Elements 1

All tag definitions must be nested inside the `<taglib>` element.

The following tags are mandatory and should appear only once:

```
<tlib-version>1.0</tlib-version>
<jsp-version>2.0</jsp-version>
<short-name>Example TLD</short-name>
```

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TLD: Tag Elements 2

Each tag is defined by a `<tag>` element.

Within the `<tag>` element, the following attribute tags could be defined:

`<name>`: unique element name of the custom tag

`<tag-class>`: full class name for the tag class

`<body-content>`: types of code allowed to be inserted into the body of the custom tag when used by a `JSP`:

1) `empty` – tag body should be empty
2) `JSP` – tag body may be empty or containing scripting elements
3) `scriptless` – no scripting elements allowed
4) `tagdependent` – the body may contain `non-JSP` content like `SQL` statements

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Task 43: Custom Tag Library

1) Follow the example to create a custom tag library which defines the `HelloSimpleTag` with a name "`hello`".
   a) Modify the name element.
   b) Save the file as `example.tld` in the `WEB-INF` directory.

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Using Tag Library

A tag library can be referenced and used in a `JSP` by different methods.

Two of them are:

1) define a relative `URI` in `JSP` file
2) define a web application-wide `URI`

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TLD: Relative URI

A relative URI can be defined in JSP file without a protocol and host.

For example:

```
<%@ taglib uri="/WEB-INF/example.tld" prefix="ex" %>
<html>
  . . .
  <ex:hello/>
  . . .
```

Note:

A root-relative URI should start with a "/", while a non-root-relative URI has no leading "/"

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TLD: Application-Wide URI 1

An abstract URI can be defined by an entry in the web.xml file.

Example:

in web.xml file:

```
<taglib>
  <taglib-uri>
      http://www.example.com/example
  </taglib-uri>
  <taglib-location>
      /WEB-INF/example.tld
  </taglib-location>
</taglib>
```

e-Macao-16-6-293

TLD: Application-Wide URI 2

in JSP file:

```
<%@ tablib uri="http://www.exmple.com/example"
prefix="ex" %>
. . .
<ex:hello/>
```

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Summary 1

JSP can produce dynamic content using scriptlet or tags.

While keeping the benefit of Servlet, JSP also provides separation between business and presentation logic for a web application.

Using tags in JSP allows the separation to be achieved easily.

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Summary 2

The life cycle of a JSP is similar to that of a Servlet except a JSP file has to be compiled into a Servlet class before being used.

Five kinds of scripting elements can be used in JavaServer Pages:

1) declarations <%! %>
2) scriptlets <% %>
3) expressions <%= %>
4) directives <%@ %>
5) comments <%-- --%>;<% /** **/%>;<!-- -->

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Summary 3

The following implicit objects are defined in JSP and can be used without declaration:

application	pageContext
config	page
session	out
request	exception
response	

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Summary 4

JSP 2.0 specification defines Expression Language which provides a cleaner syntax then scriptlet.

JSP Actions can cooperate with JSP EL to provide a clean abstraction of Java codes making the JSP file easier to be maintained.

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Summary 5

JavaServer Pages Standard Tag Library (JSTL) is an extended set of JSP standard Actions. Tags are available for the follows:

1) Iteration and conditional
2) Expression Language
3) URL manipulation
4) i18n-capable text formatting
5) XML manipulation
6) Database access

JSP 2.0 define a Simple Custom Tags which can be developed easily.

Tag Library Descriptor file is used to bind custom tag library to a JSP file.

A.2.3. Filters

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Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary
2) JavaServer Pages
   a) basic concepts
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   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Filter: Basic Concepts

`Filter` is a new feature in the servlet 2.3 specification.

`Filter` usually acts as a components between a request and a resource in a web application.

`Filters` can:

1) read request data
2) wrap request data
3) redirect a request
4) manipulate response data
5) generate its own response
6) wrap a response
7) return errors to the client

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Filter: Advantages

Layers of `Filters` can be added for pre-processing and post-processing to a request and response.

`Filters` can perform similar functionality as `Servlets` and request dispatcher.

Unlike `Servlet` which had to be programmed differently for chaining, applying `Filters` to existing web application resources is easier.

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Filter: Sample Applications

1) Access Control
   a) authentication, logging, auditing
   b) role-based security
   c) MIME-type redirection
2) Content Manipulation
   a) modify headers (request and response)
   b) data transformation
      - encryption, compression
      - `XSLT`, conversion

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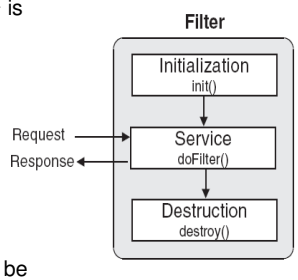
Filter: Life Cycle

`Filter's` life cycle mimics that of a `Servlet`:

1) initialization
   a) occurs only once when the `Filter` is first loaded
2) service
   a) occurs every time the `Filter` is accessed
3) destruction
   a) invoked after web application has finished using the `Filter`
   b) all resources of the `Filter` should be terminated



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Filter: Interface

`javax.servlet.Filter`

a) For initialization:
```
public void init(FilterConfig config)
  throws ServletException
```
b) For service:
```
public void doFilter(ServletRequest request,
ServletResponse response, FilterChain chain)
  throws java.io.IOException, ServletException
```
c) For destruction:
```
public void destroy()
```

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Filter: FilterConfig Object

`FilterConfig` object is used for `Filter` configuration.

`<init-param>` elements is used in the `web.xml` file, as for a servlet, to define custom initialization parameters

methods available:

```
String getFilterName()
String getInitParameter(String parameterName)
Enumeration getInitParameterNames()
ServletContext getServletContext()
```

e-Macao-16-6-307

Filter: FilterChain Object

`FilterChain` object is for invoking next `Filter` in chain (if any) or requested resource.

A method `doFilter` is defined for this purpose.

Methods available:

```
public void doFilter(ServletRequest request,
ServletResponse response)
throws java.io.IOException, ServletException
```

e-Macao-16-6-308

Filter: Deployment

`Filter` is deployed in a servlet container like a `servlet`.

Web application deployment descriptor file (`web.xml`) is also used for configuring a `Filter`.

`Filter` is defined via `<filter>` element in the `web.xml` file:

```
<filter>
        <filter-name>name</filter-name>
        <filter-class>class</filter-class>
        <init-param>
              <param-name>name</param-name>
              <param-value>value</param-value>
        </init-param>
        . . .
  </filter>
```

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Filter: Mapping

Mapping of `Filter` is defined via `<filter-mapping>` element and has two forms:

a) Map to a specific `servlet` as follows:

```
<filter-mapping>
      <filter-name>name</filter-name>
      <servlet-name>name</servlet-name>
</filter-mapping>
```

b) Map to a `URL` pattern as follows:

```
<filter-mapping>
      <filter-name>name</filter-name>
      <url-pattern>pattern</url-pattern>
</filter-mapping>
```

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Task 44: Simple Filter

1) A `Filter` can work as a normal Servlet. Try to build a simple `HelloWorld` Filter, deploy and test it.
   a) Create a `Filter` named "`FilterHelloWorld.java`". Note that `Filter` has to implement the `javax.servlet.Filter` interface.
   b) implement the init, `doFilter` and destroy methods. Don't do anything for init and destroy methods at this stage. Just try to implement `doFilter` to generate an `HTML` page showing a `String` "`HelloWorld`".
   c) Deploy your Filter at `Tomcat` and add the followings to the `web.xml` file:

```
<filter>
  <filter-name>FilterHelloWorld</filter-name>
  <filter-class>
        com.web.FilterHelloWorld
  </filter-class>
</filter>
```

e-Macao-16-6-311

Task 45: Simple Filter

```
<filter-mapping>
    <filter-name>FilterHelloWorld</filter-name>
    <url-pattern>/FilterHelloWorld</url-pattern>
</filter-mapping>
```

2) A `Filter` can do what a `Servlet` can. What is the difference between the `doFilter` method of a `Filter` and the service method of a `javax.servlet.Servlet` interface?

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Vertical Concepts Outline

1) Servlet
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   d) communication between servlets
   e) summary
2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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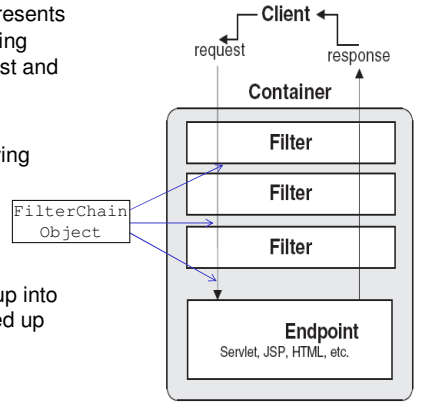
FilterChain Object

The `FilterChain` object represents the possible stack of Filters being executed on a particular request and response.

A mechanism for cleanly applying layers of functionality to a `ServletRequest` and `ServletResponse`.

Functionality is easily divided up into many logical layers and stacked up as desired.



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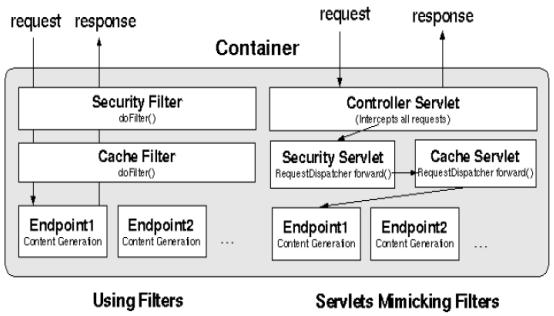
Filter Versus Servlet



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Defining a Filter Chain 1

To define a `filter` chain, put two or more filter declarations into the configuration file and supply appropriate values for the `<url-pattern>` elements .

For example, in the `web.xml` file, the following entries is set:

```
...
<filter>
      <filter-name>FilterAllRequests</filter-name>
      <filter-class>mypackage1.FilterOne</filter-class>
</filter>
<filter-mapping>
      <filter-name>FilterAllRequests</filter-name>
      <url-pattern>/*</url-pattern>
</filter-mapping>
```

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Defining a Filter Chain 2

```
<filter>
      <filter-name>FilterMyDocs</filter-name>
      <filter-class>mypackage1.FilterTwo</filter-class>
</filter>
<filter-mapping>
      <filter-name>FilterMyDocs</filter-name>
      <url-pattern>/mydocs/*</url-pattern>
</filter-mapping>
...
```

If a request for a resource like `http://127.0.0.1:8080/mydocs/foo.html` is received, the container will apply `FilterAllRequests` and `FilterMyDocs` according to their order appearing in the `web.xml` file.

e-Macao-16-6-317

Invoking Filter Chain

A `Filter` can invoke another Filter by calling the `doFilter` method of the `FilterChain` object.
For example: `chain.doFilter();`

The ordering of `Filter` execution matches the ascending order of filter-mapping elements defined in `web.xml` file.

```
public void doFilter(ServletRequest req, ServletResponse
res, FilterChain chain) throws IOException,
ServletException
{
      . . .
      chain.doFilter();
}
```

e-Macao-16-6-318

Task 46: Filter Chain

1) Add a hit counter `Filter` to a simple `hello.html` file.
   a) Create an `HTML` file as follows:

```
<html>
   <head>
      <title>HTML Page</title>
   </head>
   <body bgcolor="#FFFFFF">
            Hello World!
   </body>
</html>
```

e-Macao-16-6-319

Task 47: Filter Chain

b) Create a `Filter` for counting the hit rate for the `hello.html` page.
   1. This `Filter` has to implements `javax.servlet.Filter` interface.
   2. Declare a static integer variable count for counting the hit.
   3. Declare a `FilterConfig` object for the reference received from the init methods.
   4. There are three methods needed to be implemented: `init`, `doFilter` and `destroy`.
   5. Implement the `init` method. What type of argument should be received?
   6. Define an initial parameter named count in the `web.xml` file. Its initial value should be 0. Use corresponding method to get this initial parameter in the Filter.

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Task 48: Filter Chain

7. Implements the `doFilter` method. The major task for the `doFilter` is add one to the counter and add a message to the response. The message may look like this: "The page has been viewed 3 times". You have your response object from the argument of the method and try to get a `PrintWriter` from there and write the message out to the response.
8. After modify the response, call the `doFilter` method of the `FilterChain` object received from the method's argument. this will pass the control to next filter or the end resource if no more filter exists.
9. Implement the destroy method to clear the `FilterConfig` object.

e-Macao-16-6-321

Task 49: Filter Chain

c) Deploy the web application correctly. In the `web.xml` file, define the `Filter` as follows:

```
. . .
 <filter>
    <filter-name>CounterFilter</filter-name>
    <filter-lass>
      your_filter_full_class_name
   </filter-class>
    <init-param>
       <param-name>Counter</param-name>
        <param-value>0</param-value>
     </init-param>
```

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Task 50: Filter Chain

```
    </filter>

    <filter-mapping>
       <filter-name>CounterFilter</filter-name>
       <url-pattern>maping_pattern</url-pattern>
    </filter-mapping>
```

d) Change the value of `<url-pattern>` tag to allow `CounterFilter` to work for all `HTML` files.

e) Try access the `hello.html` and check out the result. Make sure to turn off the cache option of the browser.

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Task 51: Filter Chain

2) Stack another `Filter` on top of the hit counter and named it `AuthenticationFilter`. This `Filter` is simplified for this exercise.

The functionality of the `Filter` is as follows:

When the client want to access the `hello.html` page, the `AuthenticationFilter` will check if the user has been login or not. A login page may show up if the user has not been login. Once the user pass the login process, a permission will be granted and the request will pass to the hit counter filter, followed by the `hello.html` page.

Please be noted that by using `Filter`, no change is made to the target resource, `hello.html`, at all.

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Task 52: Filter Chain

a) The `AuthenticationFilter` may look as follows:

```
package com.web;
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.*;
 import javax.servlet.http.*;
 public class AuthenticationFilter implements Filter {
         private FilterConfig config;

         public AuthenticationFilter() {
         super();
 }
```

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Task 53: Filter Chain

```
// initialize the FilterConfig object.
// we are not using this object in this filter
public void init(FilterConfig config) throws
   ServletException {
         // TODO Auto-generated method stub
         this.config = config;
}
public void doFilter(
         ServletRequest req,
         ServletResponse res,
         FilterChain chain) throws IOException,
         ServletException {
```

e-Macao-16-6-326

Task 54: Filter Chain

```
String nextPage;
  HttpServletRequest request=(HttpServletRequest)req;
  HttpServletResponse response
   =(HttpServletResponse)res;
HttpSession = request.getSession();
String userName = request.getParameter("username");
String passWord = request.getParameter("password");
String login = (String)session.getAttribute("login");
```

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Task 55: Filter Chain

```
// if the user has login already, pass to next filter
// make sure that you check if it is null
if (login!= null && (login.equals("true")) )
      chain.doFilter( req,res);
}
// print out the login in form, you may dispatch to
// other login page
else{
```

e-Macao-16-6-328

Task 56: Filter Chain

```
res.setContentType("text/html");
PrintWriter out = res.getWriter();
out.println ("<form action="+uri+" method='POST'>") ;
out.println ( "<table>");
out.println ( " <tr><td>User:</td><td><input
  type='text' name='username'></td></tr>");
out.println ( "<tr><td>Password:</td><td><input
  type='password' name='password'></td></tr>");
```

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Task 57: Filter Chain

```
    out.println ( " <tr><td colspan='2'><input
      type=submit></td></tr>");
    out.println ( " </table>");
    out.println ("</form>");
    }
   }
  }
 public void destroy() {
 }
}
```

e-Macao-16-6-330

Task 58: Filter Chain

b) Modify the `web.xml` file to stack the `AuthenticationFilter` on top of the `CounterFilter` as follows:

```
. . .

<filter>
   <filter-name>AuthFilter</filter-name>
   <filter-
   class>com.web.AuthenticationFilter</filter-class>
</filter>
```

e-Macao-16-6-331

Task 59: Filter Chain

```
<!-- the AuthenticationFilter is applied to all html
   files
-->
<filter-mapping>
   <filter-name>AuthFilter</filter-name>
   <url-pattern>*.html</url-pattern>
</filter-mapping>
. . .
```

e-Macao-16-6-332

Task 60: Filter Chain

b) Try to access the `hello.html` again.

c) Try to enter a wrong user name or password.

d) Try to use “user” as user name and “pass” as password to login in. What is the difference between this and step c?

e) Try to access the `hello.html` couple times and check the output. Make sure to disable the cache option of the browser.

e-Macao-16-6-333

Task 61: Filter Chain

f) Set up the `Tomcat` server to make session expire after 1 minute. Put the following statement to the `web.xml` file:

```
<session-config>
      <session-timeout>
          1 <!--minute-->
      </session-timeout>
</session-config>
```

g) Wait for a minute and try to access the `hello.html` again.

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Vertical Concepts Outline

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   g) summary
3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

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Filter Dispatcher

By default, Filters will only handle a request made by a client.

Request dispatched using either the `forward()` or `include()` methods of the `RequestDispatcher` object will not be handled.

This can be re-configured via `web.xml` file by using the `<dispatcher>` element as follows:

```
<filter-mapping>
 <filter-name>AuthenticationFilter</filter-name>
 <url-pattern>/*</url-pattern>
 <dispatcher>INCLUDE</dispatcher>
</filter-mapping>
```

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Filter Dispatcher Elements

There are four types of dispatcher elements:

1) `REQUEST`
2) `INCLUDE`
3) `FORWARD`
4) `ERROR`

More than one dispatcher elements can be used as the same time such as:

```
. . .
      <dispatcher>INCLUDE</dispatcher>
      <dispatcher>REQUEST</dispatcher>
. . .
```

Noted that if the dispatcher elements used, only the declared dispatcher call will be handled.

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Vertical Concepts Outline

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   e) summary

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Filter: Wrapper

`Wrapper` is a new feature of `Filters` introduce in `Servlet` 2.3 specification.

A request or response can be wrapped inside a customized one.

Custom coding can then be used to manipulate the wrapped request and response.

Request and response are wrapped differently.

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Invocating Wrappers in Filter

`Wrappers` are invocated within the `doFilter` method of a `Filter`:

```
public void doFilter(ServletRequest request,
   ServletResponse response FilterChain chain)
   throws java.io.IOException, ServletException {

     // Process request
     // Wrap request and/or response
     chain.doFilter(request or wrappedRequest,
              response or wrappedResponse);
     // Process (wrapped) response
   }
```

e-Macao-16-6-340

ServletRequest Wrapper

For `ServletRequest`, a corresponding `ServletRequestWrapper` is available for sublcassing as a wrapper:

```
javax.servlet.ServletRequestWrapper implements
ServletRequest
```

Constructor:

```
public ServletRequestWrapper(ServletRequest req)
```

e-Macao-16-6-341

HttpServletRequest Wrapper

For `HttpServletRequest`, a corresponding `HttpServletRequestWrapper` is provided for sublcassing as wrapper:

```
javax.servlet.HttpServletRequestWrapper extends
          ServletRequestWrapper implements
HttpServletRequest
```

Constructor:

```
public HttpServletRequestWrapper(HttpServletRequest
   req)
```

e-Macao-16-6-342

Task 62: Request Wrappers

1) Use a `Filter` to change the request headers before a `servlet` or `JSP` receives the request. A request wrapper is used to wrapped the request and pass it to the `FilterChain.doFilter( )` method, instead of the original request destination.

a) Create a class that extends `HttpServletRequestWrapper`.

```
import javax.servlet.http.HttpServletRequestWrapper;
import javax.servlet.http.HttpServletRequest;
import java.util.*;
public class RequestWrapper extends
 HttpServletRequestWrapper{
   public RequestWrapper(HttpServletRequest request){
      super(request);
   }
```

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Task 63: Request Wrappers

```
    public Locale getLocale(){
        return new Locale("English", "Canada");
    }
}
```

b) Create a `Filter` name `RequestFilter` which uses the `RequestWrapper` to wrapped the `ServletRequest` and passes it to the target.

```
import javax.servlet.*;
import javax.servlet.http.*;
public class RequestFilter implements Filter {
```

e-Macao-16-6-344

Task 64: Request Wrappers

```
    private FilterConfig config;
   public RequestFilter( ) {}
    public void  init(FilterConfig filterConfig)
    throws ServletException{
             this.config = filterConfig;
     }
     public void  doFilter(ServletRequest request,
     ServletResponse response, FilterChain chain)
      throws java.io.IOException,ServletException {
```

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Task 65: Request Wrappers

```
    RequestWrapper wrapper = null;
     ServletContext context = null;
      if (request instanceof HttpServletRequest)
         wrapper = new
          RequestWrapper((HttpServletRequest)request);
          if (wrapper != null)
             chain.doFilter(wrapper,response);
      else
             chain.doFilter(request,response);
}
   public void destroy( ){}
}
```

e-Macao-16-6-346

Task 66: Request Wrappers

c) Modify the `web.xml` file as follows:

```
<servlet>
      <servlet-name>requestjsp</servlet-name>
      <jsp-file>/request.jsp</jsp-file>
</servlet>
<servlet-mapping>
      <servlet-name>requestjsp</servlet-name>
      <url-pattern>/requestjsp</url-pattern>
</servlet-mapping>
```

e-Macao-16-6-347

Task 67: Request Wrappers

```
<filter>
   <filter-name>RequestFilter</filter-name>
   <filter-class>com.web.RequestFilter</filter-class>
</filter>
<filter-mapping>
   <filter-name>RequestFilter</filter-name>
   <url-pattern>/requestjsp</url-pattern>
</filter-mapping>
```

d) Deploy the files and try to browse the file `/requestjsp` under the application context. Try to browse the file through `/request.jsp` under the application context. What is the difference?

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Servlet Response Wrapper

Similar to request wrapper, there are `ServletResponseWrapper` and `httpServletResponseWrapper` availabe for subclassing to create the corresponding wrappers.

```
javax.servlet.ServletResponseWrapper implements
      ServletResponse
```

Constructor :

```
public ServletResponseWrapper(ServletResponse res)
```

e-Macao-16-6-349

HttpServlet Response Wrapper

For `HttpServletResponseWrapper`:

```
javax.servlet.http.HttpServletResponseWrapper
   extends ServletResponseWrapper
   implements HttpServletResponse
```

Constructor:

```
public HttpServletResponseWrapper
(HttpServletResponse response)
```

e-Macao-16-6-350

Task 68: Response Wrapper

1) Use `Filter` and `Wrapper` to compress the content requested by a client. A `Filter` is used to intercept the request for a web page and a response wrapper is used to capture the response and pass it through a `GZIPOutputStream` to compress the data before sending it to the client.
   a) Write a class named `GZIPResponseStream` extending the standard `ServletOutputStream`, which is used to send output to the client. Methods in the `ServletOutputStream` are overridden to write compressed response data out to the client. The header of the response should also be modified adding an entry "`Content-Encoding`". The skeleton code may look as follows:

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Task 69: Response Wrapper

```
import java.io.*;
import java.util.zip.GZIPOutputStream;
import javax.servlet.*;
import javax.servlet.http.*;
public class GZIPResponseStream extends
  ServletOutputStream {
//declare variables
protected ByteArrayOutputStream baos = null;
protected GZIPOutputStream gzipstream = null;
protected boolean closed = false;
protected HttpServletResponse response = null;
protected ServletOutputStream output = null;
```

e-Macao-16-6-352

Task 70: Response Wrapper

```
// A constructor that receive the original response and
// replace the output stream with a GZIPOutputStream

public GZIPResponseStream(HttpServletResponse response)
throws IOException {
    super();
    closed = false;
    this.response = response;
    this.output = response.getOutputStream();
    baos = new ByteArrayOutputStream();
    gzipstream = new GZIPOutputStream(baos);
}
```

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Task 71: Response Wrapper

```
// Override the close method that will modify the header
// entries such as "Content-Length" and
// "Content-Encoding" before closing the stream.
public void close() throws IOException {
    if (!closed) {
        throw new IOException("Stream closed"); }
    gzipstream.finish();
    byte[] bytes = baos.toByteArray();
    response.addHeader("Content-Length",
    Integer.toString(bytes.length));
    response.addHeader("Content-Encoding", "gzip");
    output.write(bytes);
```

e-Macao-16-6-354

Task 72: Response Wrapper

```
    output.flush();
    output.close();
    closed = true;
}

// Override the flush() and various write methods to
// use the gzipstream instead of the original stream

public void flush() throws IOException {
if (closed) {
      throw new IOException("Fail to flush"); }
   gzipstream.flush();
}
```

e-Macao-16-6-355

Task 73: Response Wrapper

```
public void write(int b) throws IOException {
  if (closed) {
      throw new IOException("Cannot write to a closed
       output stream");
  }
      gzipstream.write((byte)b);
      }
  flush();
  close();
}
```

e-Macao-16-6-356

Task 74: Response Wrapper

```
public void write(byte b[]) throws IOException {
  if (closed) {
  throw new IOException("Cannot write to a closed output
  stream"); }
  gzipstream.write(b, 0, b.length);
  flush();
  close();
}
```

e-Macao-16-6-357

Task 75: Response Wrapper

```
public void write(byte b[], int off, int len) throws
      IOException {
  System.out.println("writing...");
  if (closed) {
  throw new IOException("Cannot write to a closed output
  stream"); }
  gzipstream.write(b, off, len);
  flush();
  close();
}
}
```

e-Macao-16-6-358

Task 76: Response Wrapper

b) Write a class named `GZIPResponseWrapper` extends the `HttpServletResponseWrapper`. The main function of this wrapper is to replace the original `OutputStream` with a `GZIPResponseStream` that we defined in previous steps. The `getWriter()` is also overridden to obtain a writer from the `GZIPResponseStream`.
The skeleton code may look as follows:

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

e-Macao-16-6-359

Task 77: Response Wrapper

```
public class GZIPResponseWrapper extends
   HttpServletResponseWrapper {
   protected HttpServletResponse origResponse = null;
   protected ServletOutputStream stream = null;
   protected PrintWriter writer = null;
// Constructor
public GZIPResponseWrapper
   (HttpServletResponse response) {
         super(response);
         origResponse = response;
}
```

e-Macao-16-6-360

Task 78: Response Wrapper

```
// Create a GZIPResponseStream from the original
   Response
public ServletOutputStream createOutputStream()
   throws IOException {
      return (new GZIPResponseStream(origResponse));
}
```

e-Macao-16-6-361

Task 79: Response Wrapper

```
// Overridden the getOutputStream and replace the
// ServletOutputStream with GZIPResponseStream
public ServletOutputStream getOutputStream() throws
IOException {
   if (writer != null) {
         throw new IllegalStateException(
         "getWriter() has already been called!");
   }
   if (stream == null)
         stream = createOutputStream();
   return (stream);
}
```

e-Macao-16-6-362

Task 80: Response Wrapper

```
// Overridden the getWriter and piped
// writer from the GZIPResponseStream
public PrintWriter getWriter() throws IOException {
   if (writer != null) {
         return (writer);
   }
   if (stream != null) {
    throw new IllegalStateException(
    "getOutputStream() has alreadybeen called!");
   }
```

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Task 81: Response Wrapper

```
      stream = createOutputStream();
      writer = new PrintWriter
      (new OutputStreamWriter(stream, "UTF-8"));
      return (writer);
   }
}
```

e-Macao-16-6-364

Task 82: Response Wrapper

c) Write a class named `GZIPFilter` implements the `javax.servlet.Filter` interface. This `Filter` will check whether the client will accept gzip format. If so, the `Filter` will wrap the response with the `GZIPResponseWrapper` and let it compress the data. Otherwise, the ordinary response will be returned.
The skeleton code may look as follows:

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;
public class GZIPFilter implements Filter {
   public void init(FilterConfig filterConfig) {
     //no implementation needed
}
```

e-Macao-16-6-365

Task 83: Response Wrapper

```
public void doFilter(ServletRequest req,
   ServletResponse res,FilterChain chain) throws
   IOException, ServletException {
   if (req instanceof HttpServletRequest) {
    HttpServletRequest request =
         (HttpServletRequest) req;
    HttpServletResponse response =
         (HttpServletResponse) res;
    String ae = request.getHeader("accept-encoding");
    if (ae != null && ae.indexOf("gzip") != -1) {
         System.out.println
         ("GZIP supported, compressing.");
```

e-Macao-16-6-366

Task 84: Response Wrapper

```
            GZIPResponseWrapper wrappedResponse = new
            GZIPResponseWrapper(response);
            chain.doFilter(req, wrappedResponse);
            return;
          }
          chain.doFilter(req, res);
    }
}
```

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Task 85: Response Wrapper

d) In order to test the `Filter`, download a web page such as `www.yahoo.com/index.html` and save it under your web application context, e.g. `<TOMCAT_HOME>/webapps/FilterTest/`

e) Modify the `web.xml` file to apply the `GZIPFilter` to the downloaded page.

f) Browse the downloaded page and check the output from the console of `Tomcat`.

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Vertical Concepts Outline

e-Macao-16-6-369

Filter: Summary 1

`Filter` is a new feature in the `servlet` 2.3 specification.

Filters are usually used for:
1) read request data
2) wrap request data
3) redirect a request
4) manipulate response data
5) generate its own response
6) wrap a response
7) return errors to the client

e-Macao-16-6-370

Filter: Summary 2

`Filter` can stack up as a `Filter chain` to provide layers of functionality to requested and response.

Functionality is easily divided up into many logical layers.

e-Macao-16-6-371

Filter: Summary 3

`Filters` do not handle dispatched request by default.

`<dispatcher>` element is used in the `web.xml` file to configure a `Filter` to handle dispatched requests.

e-Macao-16-6-372

Filter: Summary 4

`Wrapper` is a new feature of `Filters` introduce in `Servlet` 2.3 specification.

`Wrappers` are used to wrap and modify requests or responses.

Requests and responses are wrapped with different objects.

A.3. Horizontal Concepts

Horizontal Concepts

e-Macao-16-6-374

Course Outline

1) introduction

2) vertical concepts
   a) servlet
   b) java server page
   c) filters

3) horizontal concepts
   a) exception
   b) database connectivity
   c) security
   d) internationalization

4) case study

A.3.1. Exceptions

e-Macao-16-6-375

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

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Exception

If an exception is thrown from a `Servlets` or a `JSP`, it is passes to the container and the reactions will be depending on the container.

Create a `JSP` as follows and check out what is the response of the `Tomcat` server.

```
<%
if (true)
throw new Exception("An Exception thrown by JSP!");
%>
```

e-Macao-16-6-377

Handling Exception

Exceptions can be handled in following ways:

1) use `try-catch-finally` statements
2) forward the `HTTP` request to a `JSP` error page
3) forward the `HTTP` request to a `Servlet` to handle the error
4) declare error pages for specific error codes and allow the container to forward to these pages

e-Macao-16-6-378

Declaring Error Page

In `JSP`, the following directive forwards the request to "`myErrorPage.jsp`" when exception is thrown:

```
<%@page errorPage="myErrorPage.jsp" %>
```

The error can also be forward to a `Servlet` for handling the exception.

e-Macao-16-6-379

JSP Error Page

In `JSP`, the directive `<%@ page isErrorPage="true" %>` is used to declare that the file for exception handling.

Implicit object "`exception`" can be used in the error page to provide exception messages.

```
<%@ page isErrorPage="true" %>
<html>
. . .
<body>
This is the error message :<br>
"<%=exception.getMessage()%>"
</body>
</html>
```

Used to declarr that this is the error handling page

e-Macao-16-6-380

Task 86: JSP Error Handling

1) Test the error handling using a `JSP` error page.
   a) Define an application-wide parameter "`admin email`" in the `web.xml` file with a value "`admin@servlet.com`".
   b) Create a `JSP` page which will throw an error message as in the previous example. Remember to use the "`page`" directive with attribute "`errorPage`" correctly.
   c) Create an error handling page to catch the exception thrown by the `JSP` page at (b). The page needed to show the error message from the implicit object "exception" and the admin email address.
   d) What will happen when the "`isErroPage`" attribute is missing?

e-Macao-16-6-381

Task 87: JSP Error Handling

2) Test the error handling using a Servlet error page.
   a) Create a Servlet named "ErrorServlet".
   b) Within this Servlet, get the initial parameter "admin email" defined in the web.xml file.
   c) Within this Servlet, you can retrieve the Exception through the request object as following :

```
Exception e =
    (Exception)request.getAttribute
      ("javax.servlet.jsp.jspException");
```

   d) Modify the previous ThrowError.jsp as following to test the output:

```
<%@ page errorPage="ErrorServlet" %>
  <% if (true)  throw new Exception
     ("An Exception!");
  %>
```

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Handling Specific Error

Error handling pages for specific exception can be declared in the web.xml file with the tag <error-page>.

Container will redirect the request to the specific page according to the exception occurred.

For example, in the web.xml file, error page can be defined as follows:

```
<error-page>
   <exception-type>java.lang.Exception</exception-type>
   <location>/Errorjsg.jsp</location>
</error-page>
<error-page>
   <error-code>404</error-code>
   <location>/Errorjsg.jsp</location>
</error-page>
```

Throwable

HTTP response code

e-Macao-16-6-383

Error Objects

The Servlet specification defines some attributes which can be retrieved from the request object for debugging:

javax.servlet.error.status_code
javax.servlet.error.exception_type
javax.servlet.error.message
javax.servlet.error.exception
javax.servlet.error.request_uri
javax.servlet.error.servlet_name

e-Macao-16-6-384

Task 88: Error Object

1) Create a JSP page which will send an email after receiving an error. The email will contain messages extracted from the error. The container will be configured to handle the forwarding operation.
   a) Download two packages from SUN and put inside the folder "<Tomcat_home>/common/lib":

      JavaMail: http://java.sun.com/products/javamail/

      JavaBeans Activation Framework(JAF) : http://java.sun.com/products/javabeans/glasgow/jaf.html

   b) Create a JSP named EmailErrorPage.jsp as follows:

```
<%@page isErrorPage="true" import="java.util.*,
 javax.mail.*, javax.mail.internet.*" %>
<%
Properties props = new Properties();
```

e-Macao-16-6-385

Task 89: Error Object

```
props.put("mail.smtp.host","smtp.macau.ctm.net")
;
Session msession =
 Session.getInstance(props,null);
String email =
 application.getInitParameter("lecturer email");
MimeMessage message= new MimeMessage(msession);
message.setSubject("[Application Error]");
message.setFrom(new InternetAddress(email));
message.addRecipient(Message.RecipientType.TO,
 new InternetAddress(email));
String debug = "";
```

e-Macao-16-6-386

Task 90: Error Object

```
Integer status_code
=(Integer)request.getAttribute
   ("javax.servlet.error.status_code");
if (status_code != null) {
 debug += "status_code: "+status_code.toString()
      + "\n";
}
 Class exception_type=
 (Class)request.getAttribute
   ("javax.servlet.error.exception_type");
if (exception_type != null) {
 debug += "exception_type:
   "+exception_type.getName() + "\n";
}
```

e-Macao-16-6-387

Task 91: Error Object

```
 String m=
(String)request.getAttribute
    ("javax.servlet.error.message");
if (m != null) {
    debug += "message: "+m + "\n";
 }

 Throwable e =(Throwable)
   request.getAttribute
    ("javax.servlet.error.exception");
if (e != null) {
  debug += "exception: "+ e.toString() + "\n";
 }
```

e-Macao-16-6-388

Task 92: Error Object

```
String request_uri =
 (String)request.getAttribute
    ("javax.servlet.error.request_uri");
if (request_uri != null) {
  debug += "request_uri: "+request_uri + "\n";
 }
String servlet_name=
 (String)request.getAttribute
    ("javax.servlet.error.servlet_name");
if (servlet_name != null) {
    debug += "servlet_name: "+servlet_name;
 }
```

e-Macao-16-6-389

Task 93: Error Object

```
message.setText(debug);
 Transport.send(message);
 %>
<html><head><title>EmailErrorPage</title></head>
<body>
   <h3>An Error Has Occurred</h3>
 This site is unavailable! requested.
   <br>Please send a description of the
   problem to:
 <a href="mailto:<%=email%>"><%=email%></a>.
</body>
</html>
```

e-Macao-16-6-390

Task 94: Error Object

c) Add a tag `<error-page>` to the `web.xml` file as follows:

```
<error-page>
   <error-code>404</error-code>
   <location>/EmailErrorPage.jsp</location>
 </error-page>
```

d) In the `EmailErrorPage.jsg` file, "`lecturer email`" is used as the email address for the sender and receiver for the email. Try to modify this to use different email addresses. However, the real email address is defined in the `web.xml` file as an initial parameter as follows:

```
<context-param>
    <param-name>lecturer email</param-name>
    <param-value>miltongm@gmail.com</param-value>
 </context-param>
```

Modify this to your own email address

e-Macao-16-6-391

Logging

Logging is used to keep a record of important information in some serialized form such as text file or information printed to `System.err` or `System.out`.

For constantly log information, a more robust logging API will be prefer than `System.out.println()` method.

Some Logging API:

1) `java.util.logging` package
2) `Log4J` (`jakarta.apache.org/log4j`)

e-Macao-16-6-392

Example: Logger 1

The following example shows the basic logging functionality of the `javax.util.logging` package.

```
<%@ page import="java.util.logging.*"%>
<% Logger logger = Logger.getLogger("example");
<% logger.setLevel(Level.ALL);
logger.addHandler(new FileHandler("/log.txt"));
 String info = request.getParameter("info");
 if (info != null && !info.equals("")) {
 logger.info(info);
 }
%>
```

e-Macao-16-6-393

Example: Logger 2

```
<html>
<head>
<title>A Simple Logger</title>
</head>
<body>
Logging examples
<form>
Information to log:<input name="info"><br>
<input type="submit">
</form>
</body>
</html>
```

e-Macao-16-6-394

Loggers and Levels

A Logger object is used to log messages for a specific system of application components.

`java.util.logging.Level` object is used to manage different types of logged information.

Types can be:

1) SEVERE
2) WARNING
3) INFO
4) CONFIG
5) FINE,FINNER AND FINNEST
6) OFF
7) ALL

e-Macao-16-6-395

Handlers

`java.util.logging` packages defines some `Handlers` for handling information.

1) `StreamHandler`: logged information is exported to a `java.io.OutputStream`.
2) `MemoryHandler`: `LogRecord` objects are kept in memory.
3) `SocketHandler`: information is logged using a network socket.
4) `FileHandler`: information is logged to a local file.

A.3.2. Database Connectivity

e-Macao-16-6-396

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

e-Macao-16-6-397

JDBC Review 1

JDBC allows data stored in different databases to be accessed using a common Java API.

In general, Java applications that use a database almost always use JDBC to communicate with it.

e-Macao-16-6-398

JDBC Review 2

Important interfaces and classes:

`javax.sql.DataSource`–interface for obtaining connections to a database

`java.sql.Statement`–interface for executing `SQL` statements on a database

`java.sql.Connection`–object represents a physical connection with a database and is governed by underlying `JDBC` driver

`java.sql.ResultSet`–object returned as the results of an `SQL` statement

e-Macao-16-6-399

JDBC Review: DriverManger 1

Early version of `JDBC` may use an object called `DriverManger` to obtain the connection of a database as following:

```
String url = "jdbc:hsqldb:" + dbDir +"/my_database";
String user = "sa"; // hsqldb default
String password = ""; // hsqldb default
Class.forName("org.hsqldb.jdbcDriver");
Connection conn =
DriverManager.getConnection(url, user, password);
```

e-Macao-16-6-400

JDBC Review: DriverManger 1

The previous example has two problems:

1) The code is vendor specific.
2) The `DriverManager` is not an interface but a class and cannot be optimized by a Vendor easily.

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DataSource

`DataSource` can solve the previous mentioned problems easily because `DataSource` is an interface which allows vendors' optimizations.

`DataSource` objects can be managed by container for higher efficiency.

Disadvantage:

`DataSource` needed to be configured in a container-dependent method.

e-Macao-16-6-402

Configuring DataSource 1

The following example shows the procedure for creating a datasource connecting a MySQL database to Tomcat server.

1) A database "dbTest" is assumed to have been created in MySQL already.
2) Downloaded and installed the required library as follows:
   a) Download the MySQL connector/J from www.mysql.com.

      file: mysql-connector-java-3.1.7.zip

      URL for download:
      http://dev.mysql.com/downloads/connector/j/3.1.html
   b) Extract the zip file and copy the file, mysql-connector-java-3.1.7-bin.jar, to <TOMCAT_HOME>/common/lib.

e-Macao-16-6-403

Configuring DataSource 2

The following steps will configure Tomcat with the DataSource connected to MySQL:

a) modify the <TOMCAT_HOME>/conf/server.xml by adding the following code segment within the tag <GlobalNamingResources>:

```
<Resource name="jdbc/Testdb"
            auth="Container"
            type="javax.sql.DataSource"
            driverClassName="com.mysql.jdbc.Driver"
 url="jdbc:mysql://localhost:3306/dbTest"
                  username="root"
                  password="1234"/>
```

e-Macao-16-6-404

Configuring DataSource 3

b) modify the <TOMCAT_HOME>/conf/context.xml by adding the following code segment within the tag <Context>:

```
<ResourceLink
      global="jdbc/Testdb"
      name="jdbc/Testdb"
      type="javax.sql.DataSource"/>
```

e-Macao-16-6-405

Configuring DataSource 4

c) The setting in step 2 can also be done as follows:

   Create a file META-INF/context.xml under the context of the web application. If the context of the web application is "dbTest", the context.xml may look as follows:

```
<Context docBace="dbTest" path="/dbTest"
  reloadable="true">
<ResourceLink global="jdbc/Testdb" name="jdbc/Testdb"
  type="javax.sql.DataSource"/>
</Context>
```

d) Restart Tomcat server and a DataSource is ready for connection.

e-Macao-16-6-406

Task 95: Connecting DataBase

1) Examine different ways, with and without `DataSource`, for connecting a database. A database named "`dbTest`" with a table "`testdata`" is assumed to have been created in a running `MySQL` server.
   a) Deploy the following Servlet, which extracts data from the database connected through `DriverManger`:

```
import java.sql.*;
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
public class DatabaseServlet extends HttpServlet
{
```

e-Macao-16-6-407

Task 96: Connecting DataBase

```
public void doGet(HttpServletRequest request,
    HttpServletResponse response) throws
    ServletException, java.io.IOException {
String sql = "select * from testdata";
Connection conn = null;
Statement stmt = null;
ResultSet rs = null;
ResultSetMetaData rsm = null;
response.setContentType("text/html");
PrintWriter out = response.getWriter( );
out.println("<html><head><title>Servlet
Database  Access</title></head><body>");
```

e-Macao-16-6-408

Task 97: Connecting DataBase

```
try{
//load the database driver
  Class.forName ("com.mysql.jdbc.Driver");
//The JDBC URL for database
  String url =
    "jdbc:mysql://127.0.0.1:3306/dbTest";
// Create the java.sql.Connection to the
// database  using DriverManager
  conn =
    DriverManager.getConnection(url,"root",
    "1234");
//Create a statement for executing some SQL
      stmt = conn.createStatement( );
```

e-Macao-16-6-409

Task 98: Connecting DataBase

```
//Execute the SQL statement
     rs = stmt.executeQuery(sql);

//Get info from the ResultSetMetaData object
  rsm = rs.getMetaData( );
// Display the data
 int colCount =  rsm.getColumnCount( );
  for (int i = 1; i <=colCount; ++i){
  out.println("<th>" + rsm.getColumnName(i) +
  "</th>");}          }
  out.println("</tr>");
  while( rs.next( )){
    out.println("<tr>");
```

e-Macao-16-6-410

Task 99: Connecting DataBase

```
          for (int i = 1;  i <=colCount; ++i)
                  out.println("<td>" + rs.getString(i)
                  + "</td>");
                 out.println("</tr>");}
        } catch (Exception e){
           throw new ServletException(e.getMessage( ));
        } finally {
            try{
                  if(stmt != null)
                    stmt.close( );
                if (conn != null)
                    conn.close( );
             } catch (SQLException sqle){ }
        }
```

e-Macao-16-6-411

Task 100: Connecting DataBase

```
          out.println("</table><br><br></body></html>");

      } //doGet
}
```

b) Modify the previous `Servlet` and make it use a `DataSource` to create a database connection. The set up for connection may look as follows:

```
Context ctx = new InitialContext();
DataSource ds=
(DataSource)ctx.lookup("java:/comp/env/jdbc/Testdb");
 conn = ds.getConnection();
```

e-Macao-16-6-412

Connection Pooling

Connection pooling is a technique of creating and managing a pool of connections that are ready for use by any thread that needs them.

Connection pooling allows a thread to get connection from a pool and return it to the pool when the work is done.

The connection may either be a new, or already-existing connection.

e-Macao-16-6-413

Advantages

Connection pooling can greatly increase the performance of Java application, while reducing overall resource usage.

The main advantages are:

a) Reduced connection creation time - the overhead for creating connection will be avoided if connections are "recycled."

b) Simplified programming model – Only simple `JDBC` programming techniques is required.

c) Controlled resource usage – The resource is controlled by the container effectively.

e-Macao-16-6-414

Tomcat Implementation

Sun has standardized the concept of connection pooling in JDBC through the JDBC-2.0 Optional Package API.

As in previous example, Tomcat has implemented the APIs with MySQL Connector/J.

For Tomcat 5.0, install the following libraries in <Tomcat_HOME>/common/lib:

a) Jakarta-Commons DBCP 1.0

b) Jakarta-Commons Collections 2.0

c) Jakarta-Commons Pool 1.0

For Tomcat 5.5, the required libraries are located in a single JAR at <TOMCAT_HOME>/common/lib/naming-factory-dbcp.jar

e-Macao-16-6-415

Tomcat Configuration

For Tomcat, the following attributes can be added to the Resource element in the server.xml file between the </GlobalNamingResources> tag:

maxActive: Maximum number of connections in connection pool. Make sure the mysqld max_connections is large enough to handle all of the connections. A value of 0 represents "no limit".

maxIdle: Maximum number of idle connections to retain in pool. Set to -1 for no limit.

maxWait: Maximum time to wait for a connection to become available in millisecond. Set to -1 to wait indefinitely.

e-Macao-16-6-416

Connection pool leaks

While using connection pooling, a web application has to explicitly close ResultSet, Statement, and Connection or they will never being available for reuse causing a connection pool leak.

The Jakarta-Commons DBCP can be configured to prevent this problem while adding the attributes to the Resource configuration for your DBCP DataSource as follows:

```
removeAbandoned="true"
removeAbandonedTimeout="60"
```

e-Macao-16-6-417

Example: Connection Pool 1

After setting up the connection pool configuration, the server.xml file of the Tomcat server may look as follows:

```
. . .
<GlobalNamingResources>
 . . .
   <Resource  name="jdbc/Testdb"
              auth="Container"
              type="javax.sql.DataSource"
              driverClassName="com.mysql.jdbc.Driver"
              url="jdbc:mysql://localhost:3306/dbTest"
              username="root"
              password="1234"
```

e-Macao-16-6-418

Example: Connection Pool 2

```
            maxActive="20"
            maxIdle="10"
            maxWait="-1"
            removeAbandoned="true"
            removeAbandonedTimeout="60"
/>
```

A.3.3. Security

e-Macao-16-6-419

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

e-Macao-16-6-420

Servlet / JSPs Security

Problem to address:

1) Authentication, Authorization and Access Control (AAA)
2) Secure Encrypted Communication

e-Macao-16-6-421

Security Features

Authentication, Authorization and Access Control

1) Declarative Security:
   a) access control configuration is separated from the `Servlet` and `JSP` code
   b) no security-related code is written
   c) static security that runtime condition can not be checked

2) Programmatic Security:
   a) flexible but need more work
   b) run-time condition such as client's credit limit can be considered

e-Macao-16-6-422

Role-Based Security 1

Role-Based Security

The `servlet` specification only specifies that roles should exist and a container must recognize them. How to assign a user to a role is not specified.

In `Tomcat`, the `<TOMCAT_HOME>/conf/tomcat-users.xml` file is used to define the mapping for a user. Its default content may look as follows:

```
<tomcat-users>
  <role rolename="tomcat"/>
  <role rolename="role1"/>
  <role rolename="manager"/>
```

e-Macao-16-6-423

Role-Based Security 2

```
  <role rolename="admin"/>
  <user username="tomcat" password="tomcat"
          roles="tomcat"/>
  <user username="role1" password="tomcat"
          roles="role1"/>
  <user username="both" password="tomcat"
          roles="tomcat,role1"/>
  <user username="admin" password=""
          roles="admin,manager"/>
</tomcat-users>
```

e-Macao-16-6-424

Applying Role-Based Security 1

The `web.xml` file is used to applied the role-based security to certain web applications. The tag `<security-constraint>` is used as follows:

```
<web-app>
...
 <security-constraint>
      <web-resource-collection>
            <web-resource-name>
                  SecuredWebPage
            </web-resource-name>
            <url-pattern>/secured/*</url-pattern>
            <http-method>GET</http-method>
            <http-method>POST</http-method>
```

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Applying Role-Based Security 2

```
            </web-resource-collection>
            <auth-constraint>
                  <role-name>role1</role-name>
            </auth-constraint>
      </security-constraint>
      <login-config>
            <auth-method>BASIC</auth-method>
      </login-config>
...
```

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Task 101: Role-Based Security

1) Follow the previous example to test the role-based security feature of `Tomcat`.
   a) Create a secured directory under your Web application context.
   b) Use the default users setting in `Tomcat's tomcat-users.xml` file.
   c) Put two web pages under the secured directory.
   d) Try to access one of the secured web pages.
   e) What will happen when a wrong user name or password is received?
   f) Try to access the secured web page with correct user name and password (user name: role1, password: tomcat).
   g) Can all web pages under the secured directory be accessed?

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Authentication 1

`HTTP` supports two built-in authentication schemes:

`1)basic`

a) user name and password are essentially sent as plain text
b) password could be spoofed by a malicious server
c) once authentication is issued, the client will have authentication for a given subset of server resources
d) only used over an encrypted and with strong server authentication link

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Authentication 2

`2)digest`

a) Introduced in `HTTP 1.1` to improve the basic authentication.
b) Not the password but an encrypted digest of the password is sent and it cannot be determined by sniffing the network.
c) Most but not all browser support.
d) Access may be gained by just working with the digest of the password.
e) Note: using `SSL` is still a better choice for securing important content.

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Form-Based Authentication 1

Custom design authentication form can be used for authentication.
Modification of the `web.xml` file is needed as follows:

```
<web-app>
. . .
  <security-constraint>
. . .
  </security-constraint>
 <login-config>
      <auth-method>FORM</auth-method>
      <form-login-config>
```

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Form-Based Authentication 2

```
      <form-login-page>/login.html</form-login-page>
     <form-error-page>/loginError.jsp</form-error-page>
   </form-login-config>
 </login-config>
. . .
</web-app>
```

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Form-Based Authentication 3

The login form may look as follows:

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0
 Transitional//EN">
<html>
<head>
    <title>Login Form</title>
</head>
<body bgcolor="#ffffff">
<h2>Please Login to the Application</h2>
<!-- The value of action is mandatory -->
<form method="POST"  action="j_security_check">
```

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Form-Based Authentication 4

```
<table border="0"><tr>
<td>Enter the username: </td><td>
<!-- The value of the text name is mandatory -->
<input type="text" name="j_username" size="15">
</td>
</tr>
<tr>
<td>Enter the password: </td><td>
<!-- The value of the password name is mandatory -->
<input type="password" name="j_password" size="15">
```

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Form-Based Authentication 5

```
</td>
</tr>
<tr>
<td> <input type="submit" value="Submit"> </td>
</tr>
</table>
</form>
</body>
</html>
```

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Form-Based Authentication 6

The `loginError.jsp` file may look as follows:

```
<html>
<head>
    <title>Login Error</title>
</head>
 <body bgcolor="#ffffff">
 <h2>Authentication Fail</h2><br>
 . . .
 </body>
</html>
```

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Form-Based Authentication 7

Once the user is authorized, the container will maintain the login session with a cookie containing the session-id and send it back to the user for subsequent requests.

If the role of the user is not allowed for certain resources, a "`403 Access Denied`" response will be received by the user.

Note:

a) still not a strong authentication
b) session tracking and `URL` redirecting is difficult.
c) cookie must be enabled

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Programmatic Security

Problems with role-based security:

Role-based security cannot deal with runtime based checking such as the user's credit limit.

It cannot filter resources by the role of the user.

`HttpServletRequest` object provides methods to perform different logics based on the runtime information about the user.

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HttpServletRquest 1

The following methods are available from the `HttpServletRequest` object for security checking purpose:

`String getAuthType()`:
returns the name of the authentication scheme for determining how form information was submitted

`boolean isUserInRole(java.lang.String role)`:

To check if a user is in the given role.

`String getProtocol()`:

returns the protocol that was used to send the request for checking if a secure protocol was used

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HttpServletRquest 2

`boolean isSecure()`:

a boolean value representing if a `HTTPS` request was made.

`Principle getUserPrinciple()`:

returns a `java.security.Principle` object that contains the name of the current authenticated user.

`String getRemoteUser()`:

If the user is not authenticated, `null` will be return.

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Example: Programmatic Security 1

1) The following `Servlet` checks the user's role and generates different content according to the role.

```
if (request.isUserInRole("manager")) {
        out.println("<B>Hello Manager");
            out.println (request.getRemoteUser());
            out.println ("</B></br>");
 }
   else if (request.isUserInRole("role1")) {
        out.println("<B>Hello User");
        out.println (request.getRemoteUser());
        out.println ("</B></br>");
    }
```

e-Macao-16-6-440

Example: Programmatic Security 2

```
else {
       throw new IOException("User does not have
       access!");
 }
```

e-Macao-16-6-441

Task 102: Programmatic Security

1) After logged in through a form-based authentication, access right will last within the same session. Try to access another secured page under the same context.
2) Try to delete the cookie stored in the browser from a sender "`localhost`". Browse to the same secured page again. What happen?
3) Create a page to allow the user to logout. The page should perform the follows:
   a) Check if the user was authenticated.
   b) Find out if the user were under a specific role.
   c) Logout the user by invalidate the session.
4) The skeleton code may look as follows:

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Task 103: Programmatic Security

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
public class LogoutServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
   HttpServletResponse response)
    throws ServletException, java.io.IOException {
   HttpSession session = request.getSession( );
   response.setContentType("text/html");
   PrintWriter out = response.getWriter( );
   out.println("<html><head><title>Logout Authenticated
      User</title></head><body>");
```

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Task 104: Programmatic Security

```
out.println("request.getRemoteUser( ) returns: ");
 //get the logged-in user's name
  String userName = request.getRemoteUser( );
 //If request.getRemoteUser( ) return null then the
  //user is not authenticated
  out.println(userName == null ? "Not authenticated." :
 userName + "<br>" );
  out.println("request.isUserInRole(\"admin\")  returns:
 ");
 //Find out whether the user is in the admin role
  out.println(isInRole + + "<br>" );
```

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Task 105: Programmatic Security

```
   //log out the user by invalidating the HttpSession
     session.invalidate( );
     out.println("</body></html>");
  }
  . . .
}
```

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Secured Communication

Other than controlling the access to certain resources, encrypting the transmitted data to provide secured communication is equally important.

The level of security can be configured with the `web.xml` file by the `<transport-guarantee>` element within the tag `<user-data-constraint>`.

The `<transport-guarantee>` element has three levels of security:

`NONE` – default and requires no security

`INTEGRAL` – container must ensure the integrity of information

`CONFIDENTIAL` – information sent must be both private and unchanged

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Security Configuration: Tomcat 1

`Tomcat` needs specific configuration to provide secured communication.

a) In `<TOMCAT_HOME>/conf/server.xml`, find the following entry and modify the redirect attribute to "443", the default port `HTTPS` :

```
<Connector
  port="80" maxThreads="150"
   minSpareThreads="25"
   maxSpareThreads="75"
   enableLookups="false"
   redirectPort="443"
   acceptCount="100"
   connectionTimeout="20000"
   disableUploadTimeout="true"
/>
```

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Security Configuration: Tomcat 2

b) In `<TOMCAT_HOME>/conf/server.xml`, uncomment the following entry and add a keypass attribute representing the password used for the keystore:

```
<!-- Define a SSL HTTP/1.1 Connector on port 8443 -->
<Connector port="443"
     maxThreads="150" minSpareThreads="25"
     maxSpareThreads="75" enableLookups="true"
     disableUploadTimeout="true"
     acceptCount="100" scheme="https" secure="true"
     clientAuth="false" sslProtocol="TLS"
     keypass="123456"
/>
```

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Tomcat Configuration 3

c) Generate a self certified keystore:

```
%JAVA_HOME%/bin/keytool  -genkey -keystore
  mystore.keystore -alias tomcat -keyalg RSA
```

d) Put the keystore file generated to the home directory of `Tomcat`.

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Task 106: Using HTTPS

1) Test the secure communication function provided by `Tomcat` server.
   a) Follow previous slides to configure your `Tomcat` and restart it.
   b) Modify the `web.xml` file to add the `<transport-guarantee>` element for a protected resource. Put a value "`CONFIDENTIAL`" for this element.
   c) Access the protected resource. Is there any changes to the protocol used?

A.3.4. Internationalization

e-Macao-16-6-450

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

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Introduction: Internationalization 1

Internationalization is also known as i18n representing the process of designing an application supporting multi-lingual without engineering changes.

e-Macao-16-6-452

Introduction: Internationalization 2

An internationalized program has the following characteristics:

1) With the addition of localization data, the same executable can run worldwide.
2) Textual elements, such as status messages and the `GUI` component labels, are not hardcoded in the program. Instead they are stored outside the source code and retrieved dynamically.
3) Support for new languages does not require recompilation.
4) Culturally-dependent data, such as dates and currencies, appear in formats that conform to the end user's region and language.
5) It can be localized quickly.

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Problems with Encoding

When designing a web application, character encoding is a major problem for internationalization:

1) The default character encoding of `HTTP` is `ISO-8859-1(Latin-1).`
2) `ISO-8859-1` uses only 8 bits and cannot be extended easily.

Java uses Unicode as default character encoding.

`UTF-8` is a common way to use Unicode which encoding Unicode characters using a varying number of bytes depending on the character set.

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Clients' Encoding

When invoking a method such as `getParameter()` to obtain data from client, sometimes the returned `String` may not be encoded properly. The following code snippet can avoid this situation:

```
String value = request.getParameter("param");
value = new String(value.getBytes(),
   request.getCharacterEncoding());
```

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Specifying Encoding

While sending information to client, the encoding can be specified by manipulating the `content-type` header :

```
response.setContentType("text/html; charset=UTF-8");
ServletOutputStream sos = response.getOutputStream();
PrintWriter out =
new PrintWriter(new OutputStreamWriter(sos,"UTF-8"),
true);
response.setLocale("","");
out.println("<html>");
```

By substituting the `UTF-8` with specific encoding, different encoding can be specified.

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i18n Implementation 1

Different ways can be done to provide multi-lingual support for a web site.

The following example illustrates one of the ways which uses a mechanism called resource bundle to provide i18n support.

Assume a simple web page, `welcome.html`, as follows:

```
<html>
<head>
<title>Hello!</title>
</head>
```

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i18n Implementation 2

```
<body>
   <cr>Welcome to the multi-language page<br/>
   <i>multi-language page</i></cr>
</body>
</html>
```

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Resource Bundle Files

In order to provide multi-lingual support, resource bundles can be used to store the content information in different languages.

The resource bundle files for various languages may look like as follows:

For English:

```
title=Welcome!
welcome=<b>Welcome</b>
```

For Chinese:

```
title=    !
welcome=<b>    </b>
```

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Naming of Resource Bundles

Each resource bundle file is just a simple property text file containing key/value pairs information.

Each resource bundle file has a name starting with the base name, appending with "_" and a two-digit language code. An extension ".properties" should be used for this file.

For example, if the base name for resource bundle is "resource", the locale-specific property file will then be "`resource_en.properties`" for English client. The name can also be extend with country code like `_zh_TW` and `_zh_CN` representing Taiwan and China respectively.

The resource bundle files should be placed under the WEB-INF/classes directory or any sub-directory of it.

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ResourceBundle Object

`java.util.ResourceBundle` provides static methods which takes base name and Locale object to return a resource bundle with proper values.

For example:

```
Locale locale = request.getLocale();
ResourceBundle rb = ResourceBundle.getBundle("resource",
 locale);
```

This code will check the `Locale` of the client and if, for example, it were `zh_TW`, the values of the `resource_zh_TW.properties` file would be loaded.

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List of Country Code

The following link lists the country code used for the Resource Bundle file:

`http://www.iso.ch/iso/en/prods-services/iso3166ma/02iso-3166-code-lists/list-en1.html`

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Loading Resource Bundles 1

A JavaBean may be used as a façade for loading the content of the resource bundle object. `Getter` and `Setter` methods should be defined in this JavaBean.

For example:

```
package com.web;
public class Welcome {
protected String title = null;
protected String welcome = null;
public String getTitle() {
        return title;
}
```

e-Macao-16-6-463

Loading Resource Bundles 2

```
   public void setTitle(String title) {
      this.title = title;
   }
   public String getWelcome() {
      return welcome;
   }
   public void setWelcome(String welcome) {
      this.welcome = welcome;
   }
}
```

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Using Resource Bundles 1

In JSP file, scriptlets may be used to extract the values from the resource bundle as follows:

```
<%@ page import="java.util, com.web.Resource"%>
<%
Locale locale = request.getLocale();
ResourceBundle rb = ResourceBundle.getBundle("resource",
locale);
Welcome content = new Welcome();
content.setTitle(rb.getString("title"));
content.setWelcome(rb.getString("welcome"));
request.setAttribute("content", content);
%>
```

e-Macao-16-6-465

Using Resource Bundles 2

```
<%@ taglib uri="http://java.sun.com/jstl/core_rt"
prefix="c" %>
<html>
<head>
<title>${content.title}</title>
</head>
<body>
${content.welcome}
</body>
</html>
```

e-Macao-16-6-466

JSTL i18n Tags 1

`JSTL` provides a set of `i18n` tags for supporting internationalization.

The following example illustrates how to use the tag message:

```
<%@ taglib uri="http://java.sun.com/jstl/fmt" prefix="fmt"%>
<fmt:bundle basename="resource">
```

e-Macao-16-6-467

JSTL i18n Tags 2

```
<html>
<head>
<title><fmt:message key="title"/></title>
</head>
<body>
<fmt:message key="welcome"/>
</body>
</html>
</fmt:bundle>
```

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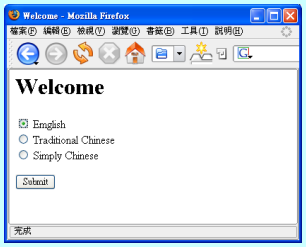
Task 107: i18n

1) Create three `ResourceBundle` files for a web page: one for English, one for Traditional Chinese and one for Simplified Chinese. A `JSP` page with a form for selecting different languages is used to display the content with different languages. The output may look as follows:



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Task 108: i18n

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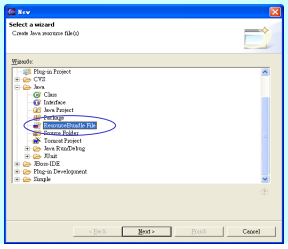
Task 109: i18n

a) Tools for creating the `ResourceBundle` files can be used. There is a free plugin, named `Jinto`, for `Eclipse` which converts input into unicode and generates `ResourceBundle` files. This plugin can be downloaded at :
`http://www.guh-software.de/jinto_en.html`

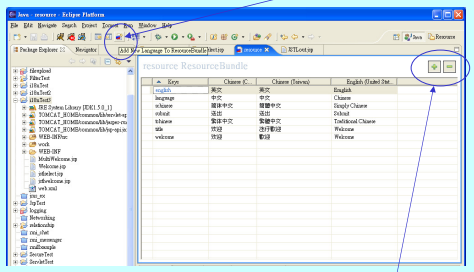
b) After installed this plugin, create a new resource bundle file at `Eclipse: File` → `New` → `Others` → `Java` → `ResourceBundle File`



e-Macao-16-6-471

Task 110: i18n

c) For adding a new language, just press this **button**



d) For adding or deleting an entry, press these **buttons**.

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Task 111: i18n

d) While using JSTL tags for the JSP file, the JSP file may look like the following in order to produce the required effect:

```
<%@ page contentType="text/html" pageEncoding="UTF-
   8"%>
<%@ taglib  uri="http://java.sun.com/jsp/jstl/core"
   prefix="c" %>
<%@ taglib  uri="http://java.sun.com/jsp/jstl/fmt"
   prefix="fmt" %>

<c:if test="${param.language == 'en'}">
  <fmt:setLocale value="en" />
</c:if>
```

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Task 112: i18n

```
<c:if test="${param.language == 'zh_TW'}">
  <fmt:setLocale value="zh_TW" />
</c:if>
<c:if test="${param.language == 'zh_CN'}">
  <fmt:setLocale value="zh_CN" />
</c:if>
<fmt:bundle basename="resource" >
<fmt:setBundle basename="resource" var="currLang"/>
<html>
  <head>
    <title>
      <fmt:message key="title" />
    </title>
```

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Task 113: i18n

```
</head>
  <body bgcolor="white">
    <h1>
      <fmt:message key="welcome" />
    </h1>

    <form action="jstlselect.jsp">
      <p>
      <input type="radio" name="language" value="en"
        ${currLang == 'en' ? 'checked' : ''}>
      <fmt:message key="english" /><br>
      <input type="radio" name="language"
   value="zh_TW"
        ${currLang == 'zh_TW' ? 'checked' : ''}>
```

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Task 114: i18n

```
<fmt:message key="tchinese" /><br>
      <input type="radio" name="language"
   value="zh_CN"
        ${currLang == 'zh_CN' ? 'checked' : ''}>
      <fmt:message key="schinese" /><br>
      <p>
      <input type="submit" value="<fmt:message
   key="submit" />" >
      </form>
  </body>
</html>
</fmt:bundle>
```

A.3.5. Summary

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Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging
2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling
1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication
2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles
3) Summary

e-Macao-16-6-477

Summary

1) In this section, the following supporting technologies are presented:
   a) Exception handling
   b) Database Connectivity
   c) Internationalization
   d) Security

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Summary: Exception Handling 1

1) Directive `<%@page errorPage="myErrorPage.jsp"%>` indicates a page for handling the exception.

2) Directive `<%@ page isErrorPage="true"%>` indicateds that the current page can handle exception.

3) `Servlet` can also be used for handling exception.

4) A specific page can be declared within the `web.xml` file to handle specific error

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Summary: Exception Handling 2

1) Error Objects are defined by the Servlet specification to provide useful information for debugging such as:
   a) status code
   b) exception type
   c) exception
   d) request uri

e-Macao-16-6-480

Summary: Exception Handling 2

Logging is used to keep record of important information.

The `java.util.logging` package provides a standard API for logging.

The following logging handlers are defined for handling different logged information:

a) `SteramHandler`
b) `MemoryHandler`
c) `SocketHandler`
d) `FileHandler`

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Summary: Database Connectivity

`DataSource` is used for connecting database with high efficency.

`DataSource` is managed by container but needed to be configured for different server.

Connection Pooling create and manage a pool of connections and can be accessed and managed easily through `DataSource`.

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Summary: Security

The security of a web site can be enforced through role-based or programmatic authentication.

Role-Based security can be set up easily in Tomcat server but is lack of flexibility.

Programmatic security can provide runtime checking and provide a more flexible access control.

Programmatic involves more work.

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Summary: Internationalization

Internationalization is also known as i18n and aim to provide multi-lingual support for a web site.

One of the ways to provide multi-lingual web site is through the usage of `ResouceBundle` file.

A.4. Case Study

Case Study

e-Macao-16-6-485

Course Outline

1) J2EE introduction
2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters
3) horizontal concepts
   a) exceptions
   b) security
   c) internationalization
   d) database connectivity
4) case study

e-Macao-16-6-486

Case Study Outline

1) hands-on practice

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Task 115: Hands-On Practice

1) Develop a portion of a web site to review the technology and techniques discussed in this course.
   a) Create a multi-lingual supported web site which can detect the locale of the client's browser to provide corresponding contents.
   b) Use `DataSource` to connect to a database and make use of the default connection pooling.
   c) `Filter` is used to provide a hit counter of the web site.

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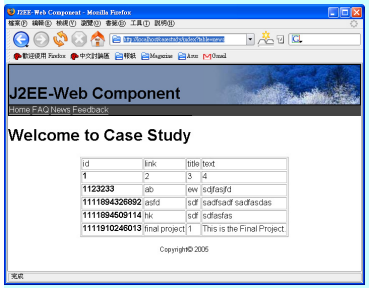
Task 116: Hands-On Practice

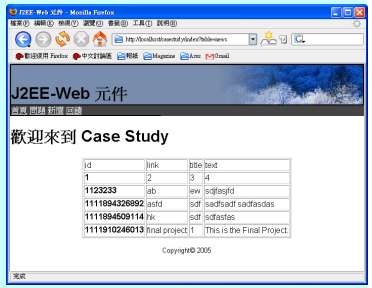
d) "Page not found" (404) exception should be handled by the container to redirect the client to the default web page of the site.

e) Basic security should be set up to protected the content of a specific directory.

e-Macao-16-6-489

Task 117: Hands-On Practice





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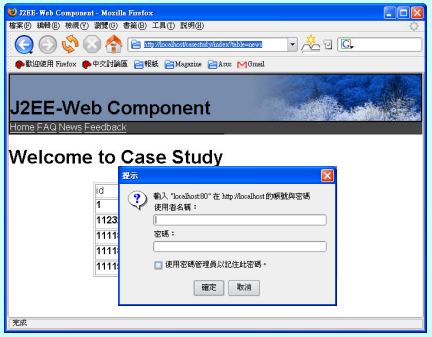
Task 118: Hands-On Practice



B. Assessment

B.1. Set 1

1. (8%)	In a JSP page you are required to insert a JSP fragment called insert.jsp, where this JSP fragment requires an additional request parameter called title. What is necessary to perform this insertion?	
	A.	<%@ include file='insert.jsp' title='Web Wonk'%>
	B.	<jsp:include page="insert,jsp' title="Web Wonk"/>
	C.	<%@ include file='insert.jsp' %>Web Wonk<%@include%>
	D.	<jsp:include page='insert.jsp'> <jsp:param name='title' value='Web Wonk'/> </jsp:include>
Answer	D	

2. (10%)	Which deployment description snippet would you use to declare the use of a tag library?	
	A.	<taglib> <uri>http://jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </taglib>
	B.	<taglib> <taglib-uri>http:// jsp_prj.com/tablib.tld</taglib-uri> <taglib-location>/WEB-INF/tablib.tld</taglib-location> </taglib>
	C.	<tag-lib> <uri>http:// jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </tag-lib>
	D.	<tag-lib> <taglib-uri>http://jsp_prj.com /taglib.tld </taglib-uri> <taglib-location>/WEB-INF/taglib.tld</taglib-location> </tag-lib>
Answer	B	

3. (8%)	Where is the following declared JavaBean accessible? <jsp:useBean id=”ABean” class=”com.examples.ABean”/>	
	A.	Throughout the remainder of the JSP page.
	B.	Within other servlets or JSP pages in the same Web application.
	C.	Within other servlets or JSP pages in the same servlet context.
	D.	Throughout all future invocations of the JSP page, until the session expires.
Answer	A	

4. (10%)	Exhibit:
	1. public class ABean {
	2. private int count;
	3. public void setCount(int count) {
	4. this.count = count;
	5. }
	6. public int getCount() {
	7. return count;
	8. }
	9. }
	Given:
	1. <html>
	2. <body>
	3. <jsp:useBean id=”myBean” class=”ABean”>
	4.
	5. </jsp:useBean>
	6. </body>
	7. </html>
	Which of the following answer inserted individually at line 4, will initialize the count property of the newly created ABean myBean?	

	A.	<% myBean.count =1; %>
	B.	<% ABean.count=1; %>
	C.	<jsp:setProperty name=”myBean” property=”count” value=”1” />
	D.	<jsp:init property=”count” value=”1” />
Answer	C	

5. (8%)	Given servlet A:
	1. public class A extends HttpServlet {
	2. public void doPost(HttpServletRequest req,
	HttpServletResponse resp)
	throws ServletException {
	3. String id = "aString";
	4.
	5. }
	6. }
	Servlet A and servlet B share the same active session.
	Which, inserted at line 4, will allow servlet B to access the value "aString" in subsequent POST requests to servlet B?	

	A.	req.getSession().put("ID",id);
	B.	req.getSession().setValue("ID"),id)
	C.	req.getSession().putAttribute("ID",id);
	D.	req.getSession().setAttribute("ID",id);
Answer	D	

6. (8%)	Which method in the HttpServlet class services the HTTP POST request?	
	A.	doPost(ServletRequest, ServletResponse)
	B.	doPOST(ServletRequest, ServletResponse)
	C.	servicePost(HttpServletRequest, HttpServletResponse)
	D.	doPost(HttpServletRequest, HttpServletResponse)
Answer	D	

7. (8%)	Which method is required for using the URL rewriting mechanism of implementing session support?	
	A.	HttpServletRequest.encodeURL()
	B.	HttpServletRequest.rewriteURL()
	C.	HttpServletResponse.encodeURL()
	D.	HttpServletResponse.rewriteURL()
Answer	C	

8. (8%)	Which of the following implicit objects can be used to store attributes that need to be accessed from all the sessions of a web application?	
	A.	application
	B.	session
	C.	request
	D.	page
Answer	A	

9. (8%)	Select the correct statement about the following code.
	<%@ page language="java" %>
	<html><body>
	out.print("Hello ");
	out.print("World ");
	</body></html>	

	A.	It will print Hello World in a single line
	B.	It will generate compile-time errors.
	C.	It will only print Hello in one line and world in another line.
	D.	None of above.
Answer	D	

10. (8%)	Which of the following lines would you use to include the output of DataServlet into any other servlet?	
	A.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(response);
	B.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", request, response);
	C.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", response);
	D.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(request, response);
Answer	D	

11. (8%)	Which of the following code types cannot be used within a scriptlet tag?	
	A.	if block
	B.	while block
	C.	Code block
	D.	Static block
Answer	D	

12. (8%)	For a FilterChain object, chain, which of the following method can be called to invoke another Filter?	
	A.	chain.next();
	B.	chain.doNext();
	C.	chain.doFilter();
	D.	None of the above.
Answer	C	

B.2. Set 2

1. (8%)	Which method is required for using the URL rewriting mechanism of implementing session support?	
	A.	HttpServletRequest.encodeURL()
	B.	HttpServletRequest.rewriteURL()
	C.	HttpServletResponse.encodeURL()
	D.	HttpServletResponse.rewriteURL()
Answer	C	

2. (8%)	Where is the following declared JavaBean accessible? <jsp:useBean id=”ABean” class=”com.examples.ABean”/>	
	A.	Throughout the remainder of the JSP page.
	B.	Within other servlets or JSP pages in the same Web application.
	C.	Within other servlets or JSP pages in the same servlet context.
	D.	Throughout all future invocations of the JSP page, until the session expires.
Answer	A	

3. (8%)	Given servlet A:
	1. public class A extends HttpServlet {
	2. public void doPost(HttpServletRequest req,
	HttpServletResponse resp)
	throws ServletException {
	3. String id = “aString”;
	4.
	5. }
	6. }
	Servlet A and servlet B share the same active session.
	Which, inserted at line 4, will allow servlet B to access the value “aString” in subsequent POST requests to servlet B?	

	A.	req.getSession().put(“ID”,id);
	B.	req.getSession().setValue(“ID”),id)
	C.	req.getSession().putAttribute(“ID”,id);
	D.	req.getSession().setAttribute(“ID”,id);
Answer	D	

4. (8%)	For a FilterChain object, chain, which of the following method can be called to invoke another Filter?	
	A.	chain.next();
	B.	chain.doNext();
	C.	chain.doFilter();
	D.	None of the above.
Answer	C	

5. (8%)	Which of the following implicit objects can be used to store attributes that need to be accessed from all the sessions of a web application?	
	A.	application
	B.	session
	C.	request
	D.	page
Answer	A	

6. (8%)	In a JSP page you are required to insert a JSP fragment called insert.jsp, where this JSP fragment requires an additional request parameter called title. What is necessary to perform this insertion?	
	A.	<%@ include file='insert.jsp' title='Web Wonk'%>
	B.	<jsp:include page="insert,jsp' title="Web Wonk"/>
	C.	<%@ include file='insert.jsp' %>Web Wonk<%@include%>
	D.	<jsp:include page='insert.jsp'> <jsp:param name='title' value='Web Wonk'/> </jsp:include>
Answer	D	

7. (8%)	Which two represent valid JSP expressions?	
	A.	<%= Match.random() %>
	B.	<% x %>
	C.	<% int x = “4” + “2”; %>
	D.	<% String x = “4” + “2” %>
Answer	A	

8. (8%)	Select the correct statement about the following code.
	<%@ page language="java" %>
	<html><body>
	out.print("Hello ");
	out.print("World ");
	</body></html>	

	A.	It will print Hello World in a single line
	B.	It will generate compile-time errors.
	C.	It will only print Hello in one line and world in another line.
	D.	None of above.
Answer	D	

9. (10%)	Which deployment description snippet would you use to declare the use of a tag library?	
	A.	<taglib> <uri>http://jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </taglib>
	B.	<taglib> <taglib-uri>http:// jsp_prj.com/tablib.tld</taglib-uri> <taglib-location>/WEB-INF/tablib.tld</taglib-location> </taglib>
	C.	<tag-lib> <uri>http:// jsp_prj.com/taglib.tld</uri> <location>/WEB-INF/taglib.tld</location> </tag-lib>
	D.	<tag-lib> <taglib-uri>http://jsp_prj.com /taglib.tld </taglib-uri> <taglib-location>/WEB-INF/taglib.tld</taglib-location> </tag-lib>
Answer	B	

10. (10%)	Exhibit:
	1. public class ABean {
	2. private int count;
	3. public void setCount(int count) {
	4. this.count = count;
	5. }
	6. public int getCount() {
	7. return count;
	8. }
	9. }
	Given:
	1. <html>
	2. <body>
	3. <jsp:useBean id=”myBean” class=”ABean”>
	4.
	5. </jsp:useBean>
	6. </body>
	7. </html>
	Which of the following answer inserted individually at line 4, will initialize the count property of the newly created ABean myBean?	

	A.	<% myBean.count =1; %>
	B.	<% ABean.count=1; %>
	C.	<jsp:setProperty name=”myBean” property=”count” value=”1” />
	D.	<jsp:init property=”count” value=”1” />
Answer	C	

11. (8%)	Which of the following lines would you use to include the output of DataServlet into any other servlet?	
	A.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(response);
	B.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", request, response);
	C.	RequestDispatcher rd = request.getRequestDispatcher(); rd.include("/servlet/DataServlet", response);
	D.	RequestDispatcher rd = request.getRequestDispatcher("/servlet/DataServlet"); rd.include(request, response);
Answer	D	

12. (8%)	Given this fragment from a Web application deployment descriptor? <context-param> <param-name>user</param-name> <param-value>tessking</param-value> </context-param> From within a servlet's doPost method, which retrieves the value of the user parameter?	
	A.	getServletConfig().getAttribute("user");
	B.	getServletContext().getAttribute("user");
	C.	getServletConfig().getInitParameter("user");
	D.	getServletContext().getInitParameter("user");
Answer	D	

J2EE Web Component Development

Milton, Chau Keng Fong
INESC-Macau

The Course

1) objectives - what do we intend to achieve?
2) outline - what content will be taught?
3) resources - what teaching resources will be available?
4) organization - duration, major activities, daily schedule

Course Objectives

1) explain the concept of J2EE
   a) origin
   b) architecture

2) present the core J2EE Web Components technologies
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) present the techniques to develop a multi-lingual, secured web site

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) database connectivity
   c) security
   d) internationalization

4) case study

Outline: J2EE Introduction

An overview of J2EE:

1) origin of J2EE
2) architecture of J2EE

Outline: Vertical Concepts

The main concepts about different types of web components:

1) introduction to Servlets, JavaServer Pages (JSP) and Filters
2) life cycle of different web components
3) development of different types of web components
4) how to deploy a web application
5) criteria for the usage of different web components

Outline: Horizontal Concepts

Supporting technologies to develop web applications:

1) different techniques to handle exceptions and produce logging
2) various strategies to build secure web sites
3) different ways to connect to databases
4) procedures to develop a multi-lingual web site

Outline: Case Study

Build a web site utilizing the J2EE Web Component technologies:

1) enforce the MVC pattern with Filters
2) multi-lingual support with resource bundles
3) utilizing declarative security
4) adopt standard tag libraries in building JSPs

Course Resources

1) Books
   a) JavaServer Pages, Hans Bergsten, 3rd edition, O'Reilly, 2003
   b) Servlets and JavaServer Pages: the J2EE Technology Web Tier, Jayson Falkner, Kevin Jones, Addison-Wesley, 2003

2) Articles

   Links available from the website http://www.emacao.gov.mo.

3) Tools
   a) JDK 1.5.0_01
   b) Eclipse IDE 3.0.1
   c) Jakarta Tomcat 5.5.7

Course Logistics

1) duration - 42 hours
2) activities – lectures and development
3) timing
   a) Monday 09:00–13:00 14:30–17:45
   b) Tuesday 09:00–13:00 14:30–17:45
   c) Wednesday 09:00–13:00
   d) Thursday 09:00–13:00 14:30–17:45
   e) Friday 09:00–13:00
4) sessions - 7 morning, 4 afternoon
5) style - interactive and tutorial

Course Prerequisites

1) basic Java
2) basic understanding of TCP/IP networking concepts
3) basic understanding of XML
4) basic understanding of HTML

J2EE Introduction

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) security
   c) internationalization
   d) database connectivity

4) case study

J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

Background

The Java platform was first introduced in 1995 to address the programming needs for networks and cross-platform programming.

In order to address different needs, Sun Microsystems soon split the Java Technologies into three editions:

1) Java 2 Platform Micro Edition (J2ME)

2) Java 2 Platform Standard Edition (J2SE)

3) Java 2 Platform Enterprise Edition (J2EE)

Needs

In recent years, the needs for distributed computing in an enterprise made n-tier applications a popular program model.

The needs facing the developers:

a) simplifying the complexity of building n-tier applications

b) easily achieving :

- availability
- reliability
- performance
- scalability
- reusability
- interoperability

c) using a standardized API between components and application servers

J2EE Origin

Sun Microsystems, together with partners such as IBM, designed J2EE to define a multi-tier architecture for developing enterprise information systems (EIS) to answer the needs from the industry.

Goals:

a) reduce the cost and complexity of development

b) allow J2EE applications to be rapidly deployed and easily enhanced

J2EE Major Elements 1

J2EE consists of the following elements to pursue its design goals:

1) J2EE Platform – a standard platform for hosting J2EE applications.

2) J2EE Compatibility Test Suite (CTS) – all J2EE application servers have to pass the CTS test to carry the Java Compatible, Enterprise Edition logo.

J2EE Major Elements 2

3) J2EE Reference Implementation – a reference implementation and operational definition of the J2EE platform.

   A binary version can be downloaded as J2EE Software Development Kits (SDK).

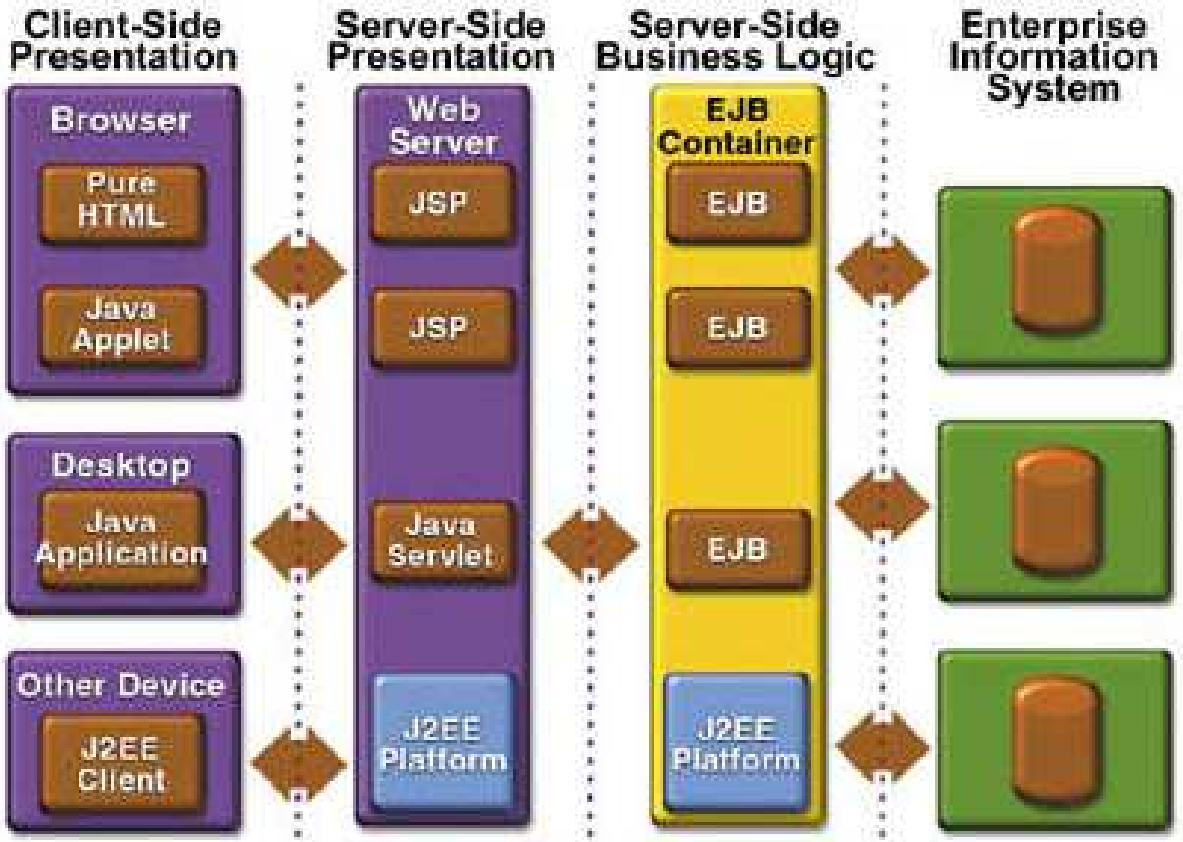
4) J2EE Blue Prints – the standard programming model for developing multi-tier, thin client applications.

J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

J2EE Platform

J2EE platform uses a multi-tiered distributed application model.



courtesy of Sun Microsystems

J2EE Architecture

J2EE architecture is a component architecture.

A J2EE component is a self-contained functional software unit assembled into a J2EE application.

J2EE components are deployed to run on a J2EE server, which executes and manages them.

J2EE Server

J2EE server provides the underlying services, such as:

1) transaction management
2) multithreading
3) resource pooling
4) other complex low-level services

J2EE Containers

Containers are the interface between a component and the low-level platform.

Types of containers:

1) EJB container
2) Web container
3) Application client container
4) Applet container

Task 1: Setup A Web Server

1) Setup and configure your `Tomcat` server for the usage in this course:
   a) copy the folder named `web_componet` to your local hard disk
   b) open the file `Tomcat.bat` and modify the path name if necessary
   c) Configure `Tomcat` to use port 80 as the default port:
      1. edit *<Catalina_Home>/conf/**server**.xml* and change the port attribute of the Connector element from 8080 to 80 as following:

```
<Connector port="80" ... maxThreads="150"
minSpareThreads="25" ...
```

This modification allows us to use the `URL` of the form `http://localhost/myServlet` instead of `http://localhost:8080/myServlet`

Task 2: Setup Web Server

d) configure Tomcat to activate the auto-reload feature:

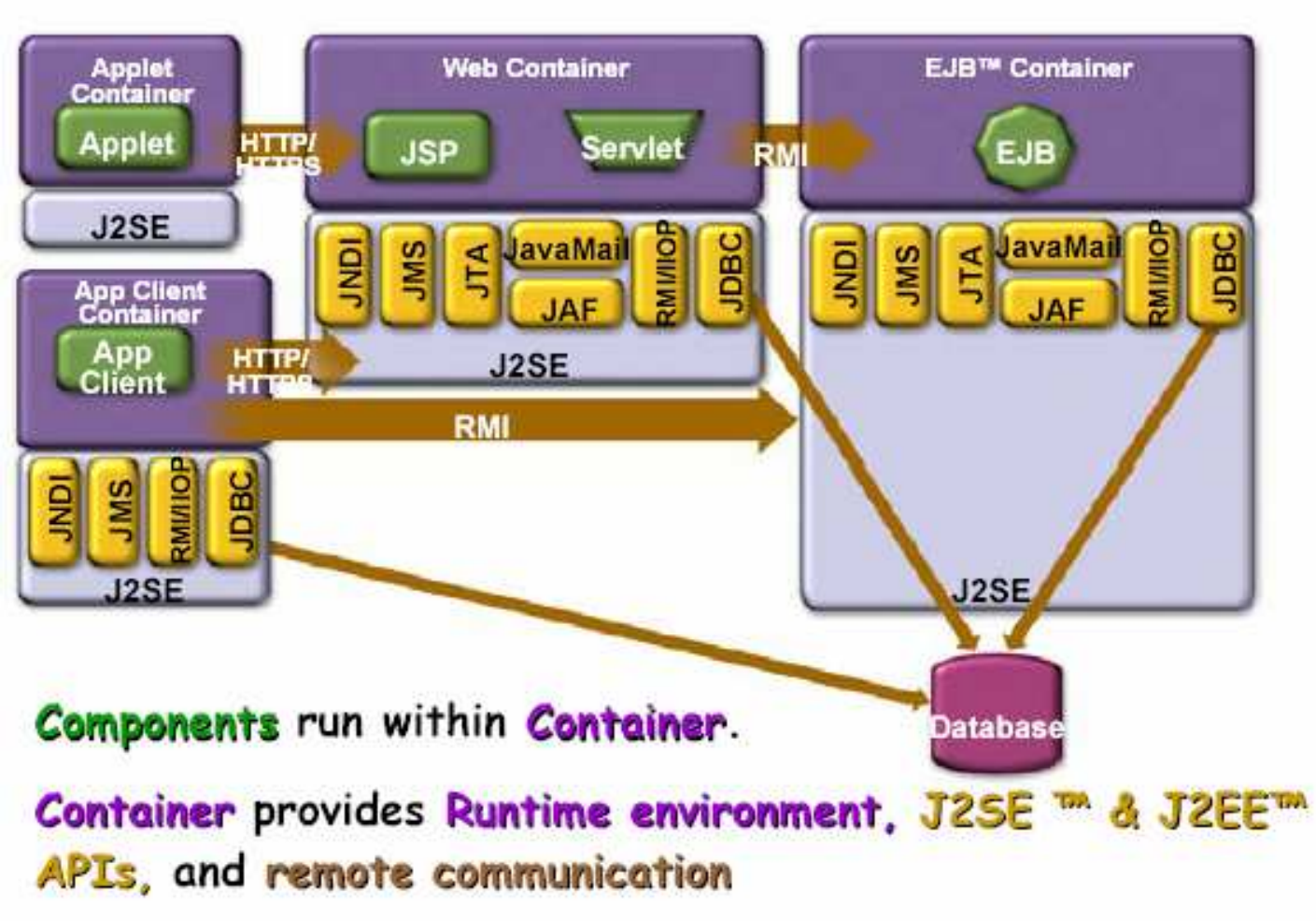
   1. modify the `<Catalina_Home>/conf/Context.xml` file. Change the tag `<Context>` to `<Context reloadable="true">`. This allows Tomcat to reload the servlet automatically when a modification is made to the servlet. However, this setting may degrade the performance of the server.

e) start Tomcat by runing `Tomcat.bat` bathc file

f) use a browser to access the following `URL`:

   `http://localhost/`

Components and Containers



courtesy of Sun Microsystems

J2EE Components

1) Clients
   a) Web client
   b) Applet
   c) Application client
2) Web Components
   a) Servlet
   b) JavaServer Pages (JSP)
3) Business Components
   a) Enterprise Java Bean (EJB)
4) Enterprise Information System (EIS)
   a) Database

Web Components

In J2EE specification, v1.4, a web component is defined as a collection of:

a) Servlets

b) pages created with the JavaServer Pages™ technology

c) web Filters

d) web Event Listeners

In short, a web component is a software entity that runs in a web container to provide responses to external requests.

Business Components

The Enterprise Java Bean (EJB) architecture is a server-side technology for building object-oriented business application in Java.

There are three types of Enterprise Beans:

a) Session Beans

b) Entity Beans

c) Message-Driven Beans

J2EE Standard Services

J2EE standard services include the following:

- HTTP
- HTTPS
- RMI-IIOP
- JavaIDL
- Java Naming and Directory Interface (JNDI)
- JDBC API
- Java Message Service (JMS)
- Java Transaction API (JTA)
- JavaMail
- JavaBeans Activation Framework (JAF)
- Java API for XML Parsing (JAXP)
- J2EE Connector Architecture
- Security Services
- Web Services
- Management
- Deployment

Some of them are explained as follows.

J2EE Services: JNDI

1) Java naming and directory services (JNDI)

   a) applications use JNDI to locate objects, such as environment entries, EJBs, datasources or message queues

   b) JNDI is implementation independent

   c) underlying implementation varies: LDAP, DNS, DBMS, etc.

J2EE Services: JDBC

2) Java DataBase Connectivity (JDBC)

   a) a programming interface that lets Java applications access a database via the SQL language

   b) allows the development of platform-independent database applications

J2EE Services: JMS

3) Java Message Service (JMS)

   a) provides standard APIs that Java developers can use to access the common features of an enterprise message system

   b) supports publish/subscribe and point-to-point models

   c) provides support for administration, security, error handling, optimization, distributed transactions, message ordering, message acknowledgments, and more

J2EE Services: JTA

4) Java Transaction API (JTA)

   a) an application-level interface used to define the transaction boundaries

   b) allows applications to perform distributed transactions

J2EE Services: JavaMail

5) JavaMail

   a) a platform-independent Java API allowing to develop email clients or servers using any of the standard email protocols

J2EE Services: JAF

6) JavaBeans Activation Framework (JAF)

   a) used by JavaMail to convert the MIME byte streams into Java objects that can then be handled by assigned JavaBeans

J2EE Services: JAXP

7) Java API for XML Parsing (JAXP)

   a) includes both Simple API for XML (SAX) and Document Object Model (DOM) APIs for manipulating XML documents

   b) enables Extensible Stylesheet Language Transformation (XSLT) engines to be plugged in

J2EE Services: Connector

8) J2EE Connector Architecture

a) integration with non-J2EE systems, such as mainframes and ERPs (Enterprise Resource Planning)

b) standard API to access different EIS (Enterprise Information Systems)

c) vendors implement EIS-specific resource adapters

J2EE Services: Security

9) Security Services

a) Java Authentication and Authorization Service (JAAS)

b) authentication via user identification / password or digital certificates

c) role-based authorization limits access of users to the resources (URLs, EJB methods)

J2EE Platform Roles 1

A set of roles to carry out application development:

1) **J2EE product provider**: implements a J2EE product which provides component containers, J2EE platform APIs, and other features defined in the J2EE specification

2) **application component provider**: produces the building blocks of a J2EE application

3) **application assembler**: takes a set of components developed by application component providers and assembles them into a complete J2EE application.

J2EE Platform Roles 2

4) **deployer**: responsible for deploying J2EE components and applications into a specific operational environment

5) **system administrator**: responsible for configuring and administrating the computing and networking infrastructure of an enterprise

6) **tool provider**: provides tools used for the development and packaging of application components.

J2EE Introduction Outline

1) Origin of J2EE
2) Architecture of J2EE
3) Summary

Summary 1

J2EE is designed to reduce the cost and complexity of developing distributed cross-platform enterprise applications

J2EE provides a standard platform for hosting J2EE applications

Other than the J2SE standard services, J2EE server also provides:

1) transaction management
2) multithreading
3) resource pooling
4) other low level services

Summary 2

J2EE platform uses a multi-tiered distributed application model.

A J2EE server contains a web component container and a business component container.

Components are executed and managed by the containers.

Vertical Concepts

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) database connectivity
   c) security
   d) internationalization

4) case study

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Java Servlets

A servlet is a Java Technology component that executes within the servlet container.

Typically, servlets perform the following functions:

a) process the `HTTP` request

b) generate the `HTTP` response dynamically

Servlet Container

A servlet container

1) is a special JVM (Java Virtual Machine) that is responsible for maintaining the life cycle of servlets

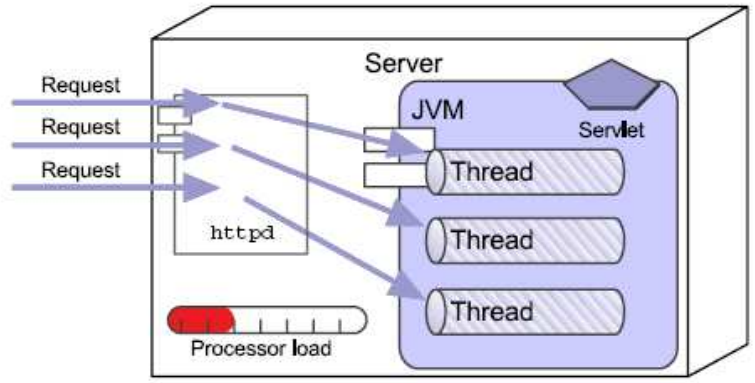
2) must support `HTTP` as a protocol to exchange requests and responses

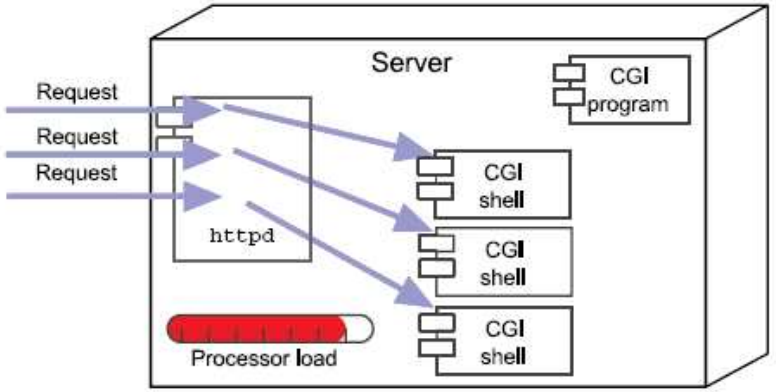
3) issues threads for each request

Servlets Versus CGIs

Servlets are lightweight and are scalable.

Each `CGI` is heavyweight and is not scalable.





Servlet Interface

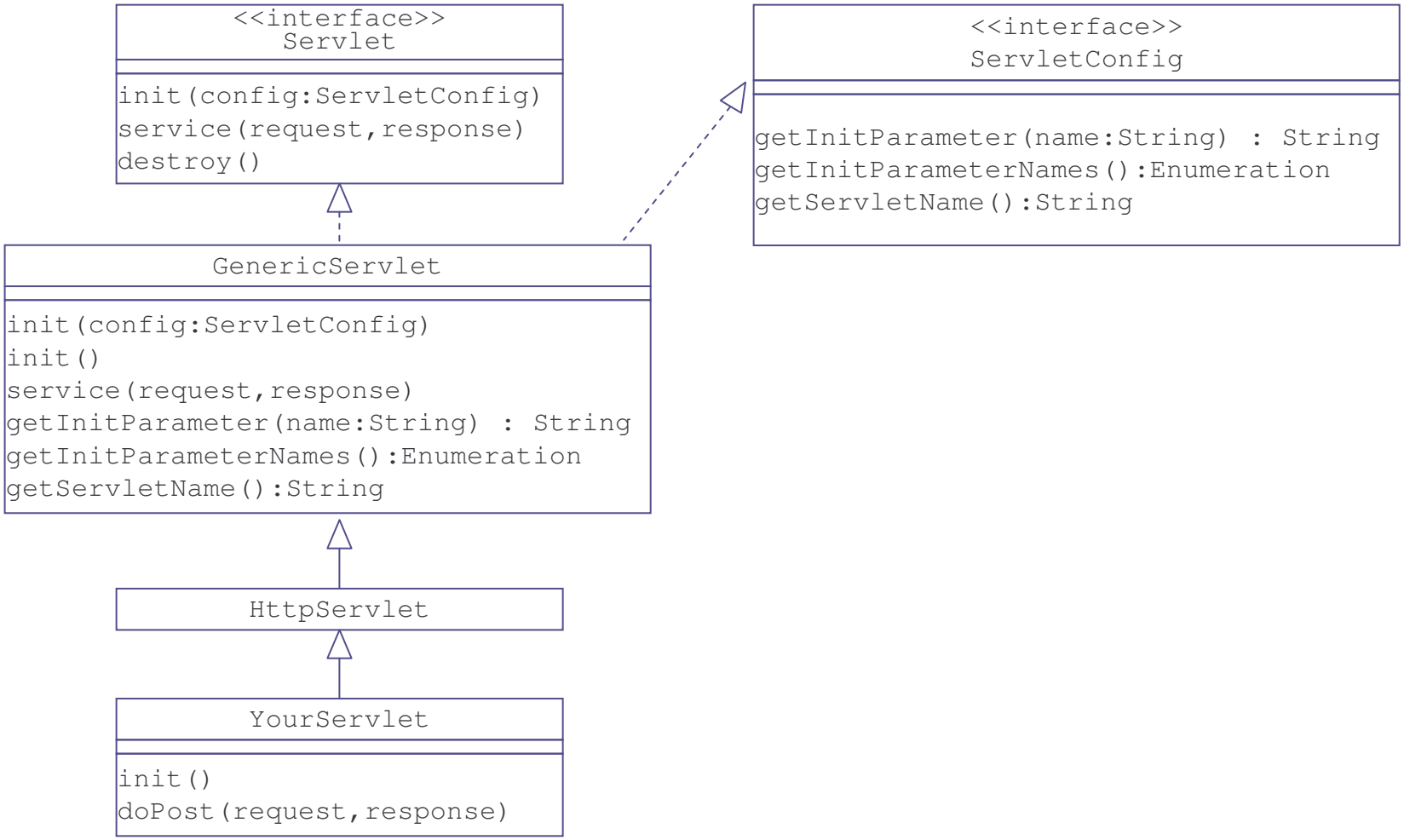
All servlets either:

1) implement `javax.servlet.Servlet` interface, or
2) extend a class that implements `javax.servlet.Servlet`

In the Java Servlet API, classes `GenericServlet` and `HttpServlet` implement the `Servlet` interface.

`HttpServlet` is usually extended for Servlet implementation.

Servlet Architecture



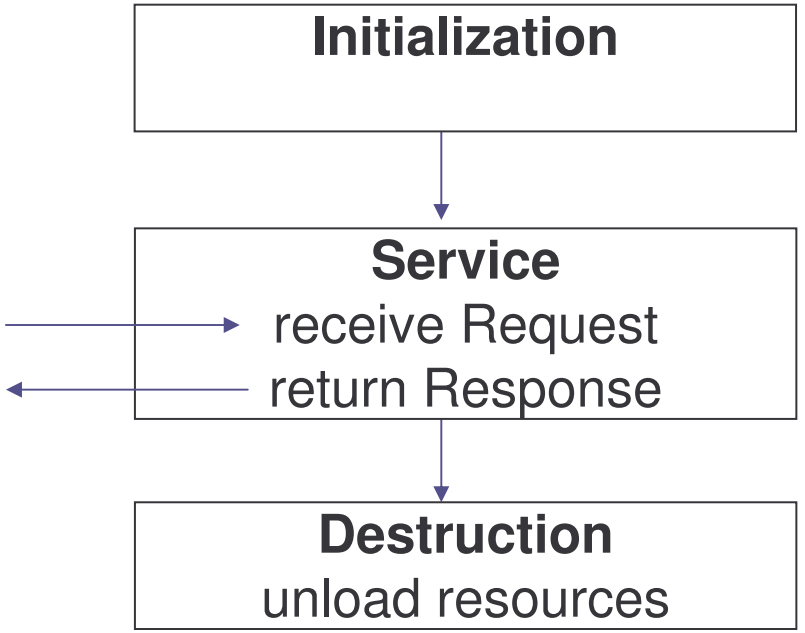
Servlet Life Cycle

Servlets follow a three-phase life cycle:

1) initialization

2) service

3) destruction



Life Cycle: Initialization 1

A servlet container:

a) loads a servlet class during startup, or

b) when the servlet is needed for a request

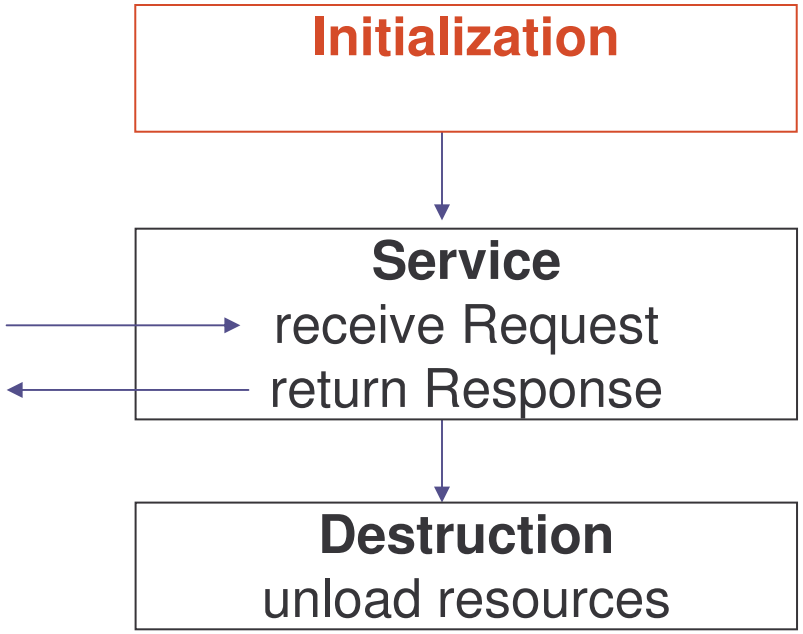
After the `Servlet` class is loaded, the container will instantiate it.

Life Cycle: Initialization 2

Initialization is performed by container before any request can be received.

Persistent data configuration, heavy resource setup (such as `JDBC` connection) and any one-time activities should be performed in this state.

The `init()` method will be called in this stage with a `ServletConfig` object as an argument.



Life Cycle: ServletConfig Object

The `ServletConfig` object allows the servlet to access name-value initialization parameters from the deployment descriptor file using a method such as `getInitParameter(String name)`.

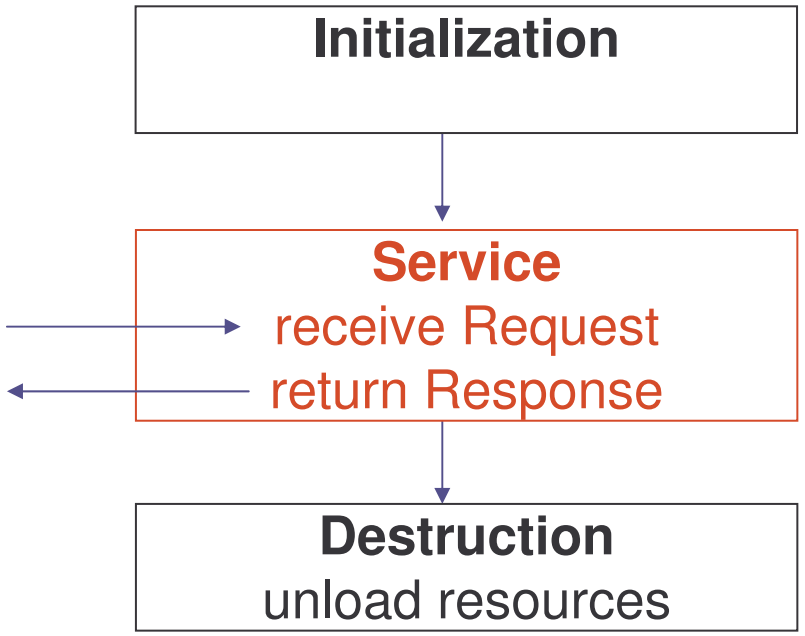
The object also gives access to the `ServletContext` object which contains information about the runtime environment.

`ServletContext` object is obtained by calling to the `getServletContext()` method.

Life Cycle: Service 1

The service method is defined for handling client request.

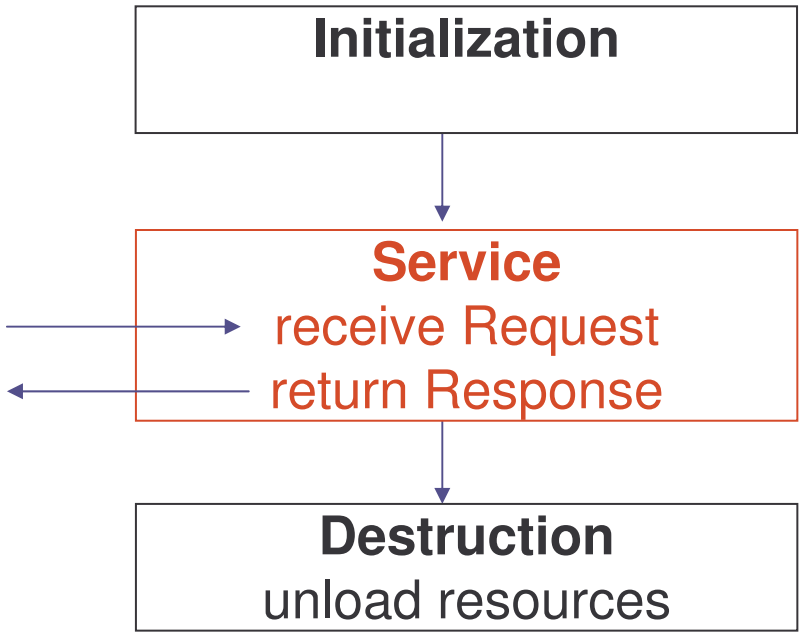
The Container of a servlet will call this method every time a request for that specific servlet is received.



Life Cycle: Service 2

The Container generally handles concurrent requests with multi-threads.

All interactions to response to requests will occur within this phase until the servlet is destroyed.



Life Cycle: Service Method

The `service()` method is invoked to every request and is responsible for generating the response to that request.

The `service()` method takes two parameters:

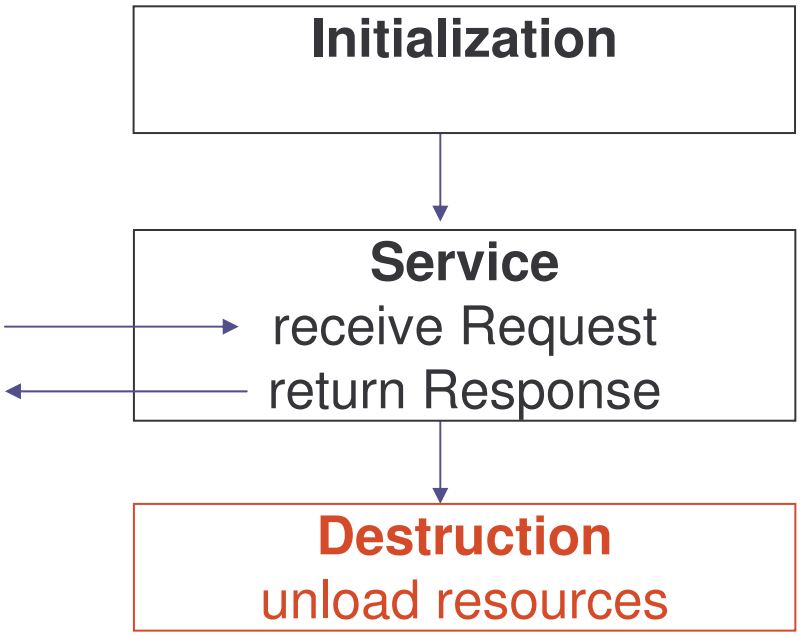
```
javax.servlet.ServletRequest
javax.servlet.ServletResponse

 public void service(ServletRequest request,
  ServletResponse response)throws IOException {
  . . .
}
```

Life Cycle: Destruction

When the servlet container determines that the servlet should be removed, it calls the `destroy` method of the servlet.

The servlet container waits until all threads running in the `service` method have been completed or time out before calling the `destroy` method.



Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

HTTPServlet

A general servlet knows nothing about the `HyperText Transfer Protocol` (`HTTP`), which is the major protocol used for Internet.

A special kind of servlet, `HTTPServlet`, is needed to handle requests from `HTTP` clients such as web browsers.

`HTTPServlet` is included in the package `javax.servlet.http` as a subclass of `GenericServlet`.

Hypertext Transfer Protocol

`Hypertext Transfer Protocol (HTTP)` is the network protocol that underpins the World Wide Web.

For example:

a) when a user enters a `URL` in a Web browser, the browser issues an `HTTP GET` request to the Web server

b) the `HTTP GET` method is used by the server to retrieve a document

c) the Web server then responds with the requested `HTML` document

HTTP Methods

Useful for Web applications:

`GET` - request information from a server

`POST` - sends an unlimited amount of information over a socket connection as part of the `HTTP` request

Not useful for Web applications:

`PUT` - place documents directly to a server

`TRACE` - debugging

`DELETE` - remove documents from a server

`OPTIONS` - ask a server what methods and other options the server supports for the requested resource

`HEAD` - requests the header of a response

Get Versus Post

`GET` request :	`POST` request :
provides a limited amount of information in the form of a query string which is normally up to 255 characters	sends an unlimited amount of information
visible in a `URL`	does not appear as part of a `URL`
must only be used to execute queries in a Web application	able to update data in a Web application

HTTP Request

A valid `HTTP` request may look like this:

```
GET /index.html HTTP/1.0
```

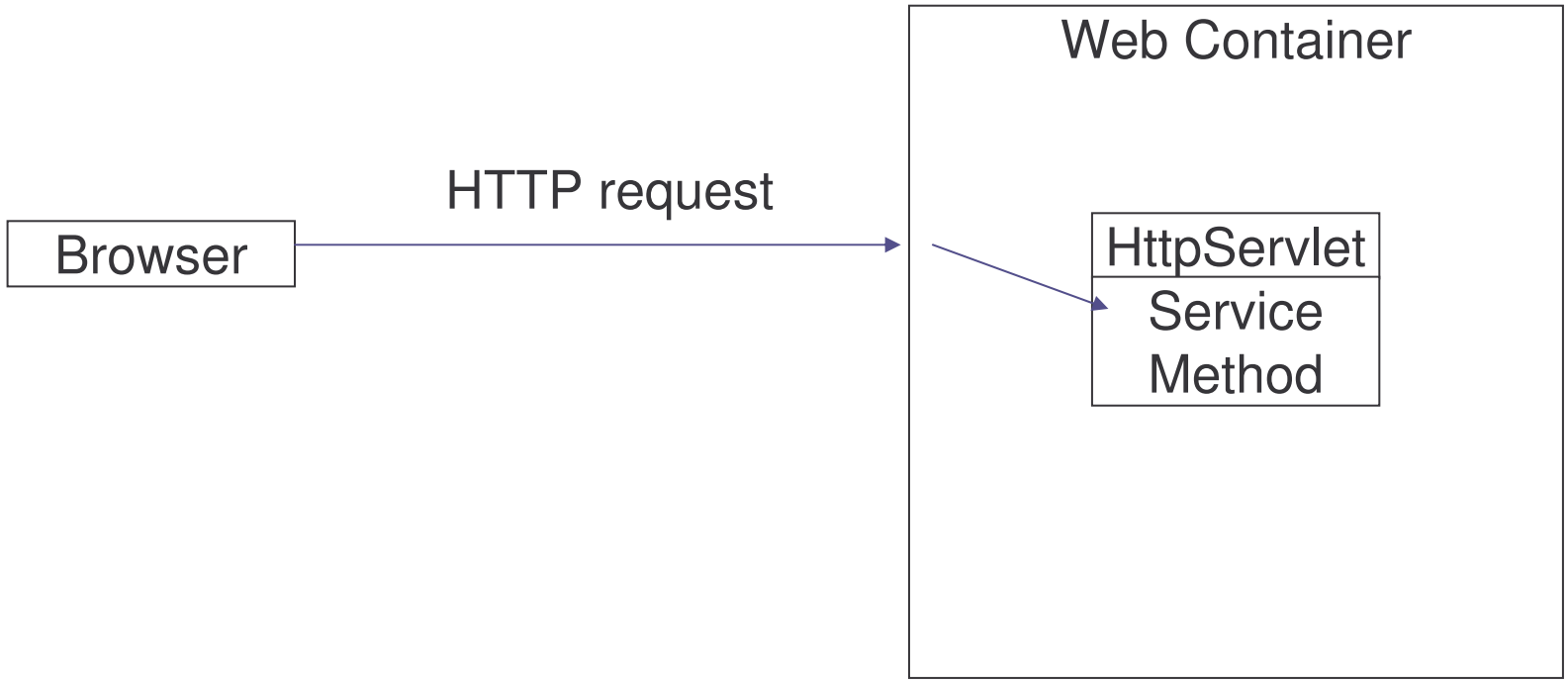
`GET`: is a method defined by `HTTP` to ask a server for a specific resource

`/index.html`: is the resource being requested from the server

`HTTP/1.0`: is the version of `HTTP` being used

Handling HTTP Requests

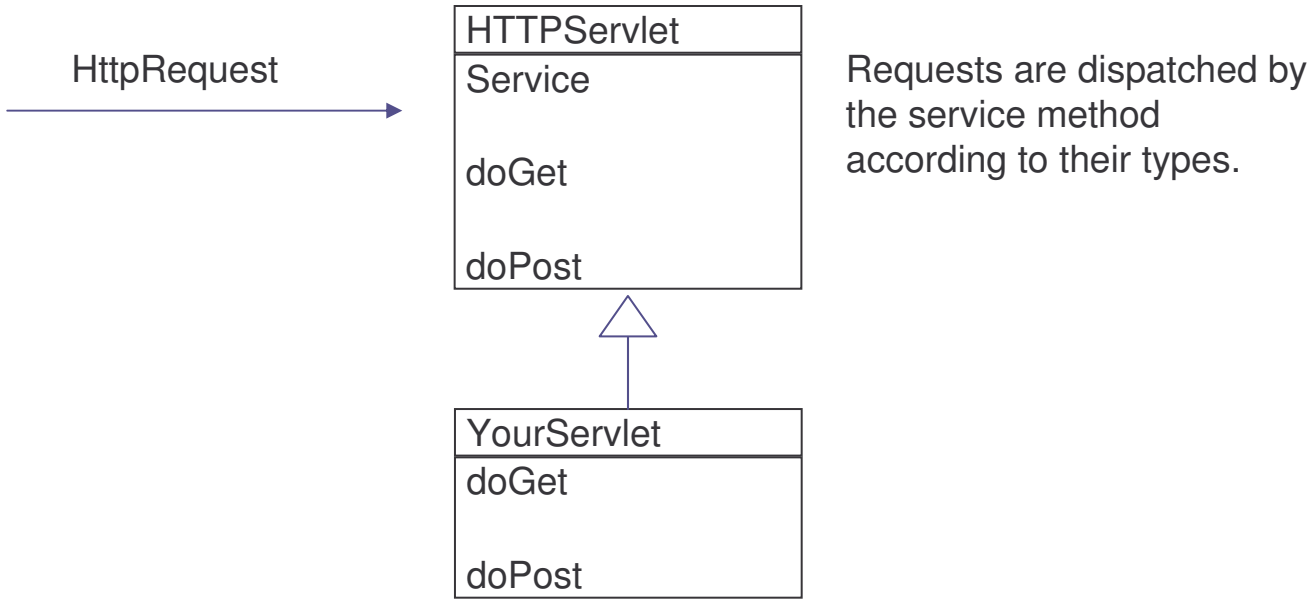
A Web container processes `HTTP` requests by executing the `service` method on an `HttpServlet` object.



Dispatching HTTP Requests

In the `HttpServlet` class, the `service` method dispatches requests to corresponding methods based on the `HTTP` method such as `Get or Post`.

A servlet should extend the `HttpServlet` class and overrides the `doGet()` and/or `doPost()` methods.



HTTP Response

After a request is handled, information should be send back to the client.

In the `HTTP` protocol, an `HTTP` server takes a request from a client and generates a response consisting of

a) a response line

b) headers

c) a body

The response line contains the `HTTP` version of the server, a response code and a reason phrase :

```
HTTP/1.1 200 OK
```

HttpServlet Response

The `HttpServletResponse` object is responsible for sending information back to a client.

An output stream can be obtained by calls to:

`1)getWriter()`

`2)getOutputStream()`

For example:

```
PrintWriter out = response.getWriter();
out.println("<html>");
out.println("<head>");
out.println("<title>Hello World!</title>");
```

Task 3: HTTP Servlet

1) Create and deploy a `HelloWorld HTTP servlet` executing the Get method.
   a) Declare the package – `com.examples`
   b) Import the required clases:

```
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import java.io.PrintWriter;
import java.io.IOException;
```

   c) The body of the servlet may look like this:

```
public class HelloServlet extends HttpServlet {
 public void doGet(HttpServletRequest request,
 HttpServletResponse response)throws IOException {


 response.setContentType("text/html");
 PrintWriter out = response.getWriter();
```

Task 4: HTTP Servlet

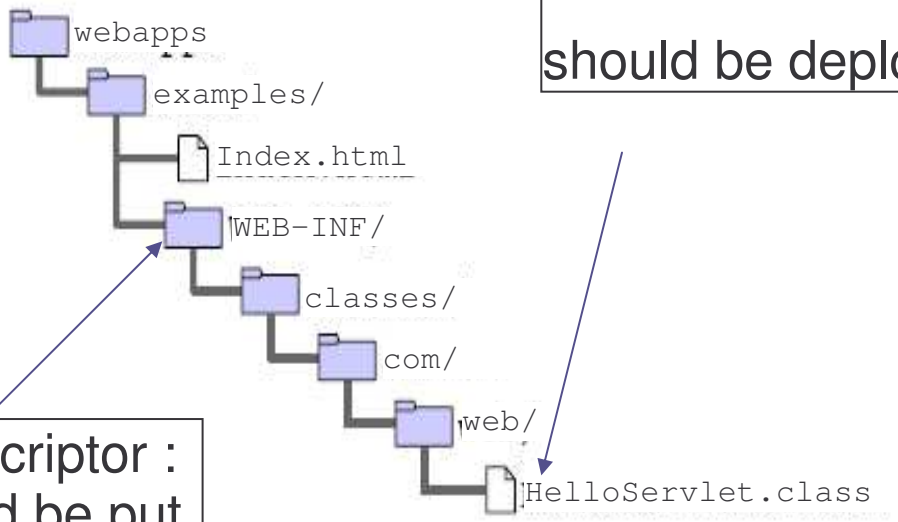
```
        //Generate the HTML response
        out.println("<HTML>");
        out.println("<HEAD>");
        out.println("<TITLE>Hello Servlet</TITLE>");
        out.println("</HEAD>");
        out.println("<BODY BGCOLOR='white'>");
        out.println("<B>Hello, World</B>");
        out.println("</BODY>");
        out.println("</HTML>");
        out.close();
    }
}
```

Deployment of an HTTP Servlet

The `HTTPServlet` object has to be deployed in the Web server before being used by the server.

A typical structure for deploying a servlet may look as follows:

servlet `com.web.HelloServlet` should be deployed here



deployment descriptor : `web.xml` should be put within `WEB-INF`

Deployment Descriptor

In order to deploy a servlet, we also need to put a deployment descriptor file, `web.xml`, under the directory of the `WEB-INF` directory.

Within the `web.xml` file, the definition of the servlet is contained:

1) Define a specific servlet

```
<servlet>
        <servlet-name>name</servlet-name>
        <servlet-class>full_class_name</servlet-
class>
</servlet>
```

2) Map to a `URL` pattern

```
<servlet-mapping>
        <servlet-name>name</servlet-name>
        <url-pattern>pattern</url-pattern>
</servlet-mapping>
```

URL Patterns

There are four types of `URL` patterns:

a) Exact match:
```
<url-pattern>/dir1/dir2/name</url-pattern>
```

b) Path match:
```
<url-pattern>/dir1/dir2/*</url-pattern>
```

c) Extension match:
```
<url-pattern>*.ext</url-pattern>
```

d) Default resource:
```
<url-pattern>/</url-pattern>
```

Mapping Rules 1

When a request is received, the mapping used will be the first servlet mapping that matches the request's path according to the following rules:

a) If the request path exactly matches the mapping, that mapping is used.

1) If the request path starts with one or more prefix mappings (not counting the mapping's trailing "/*"), then the longest matching prefix mapping is used.
For example, `"/foo/*"` will match `"/foo"`, `"/foo/"`, and `"/foo/bar"`, but not `"/foobar"`.

Mapping Rules 2

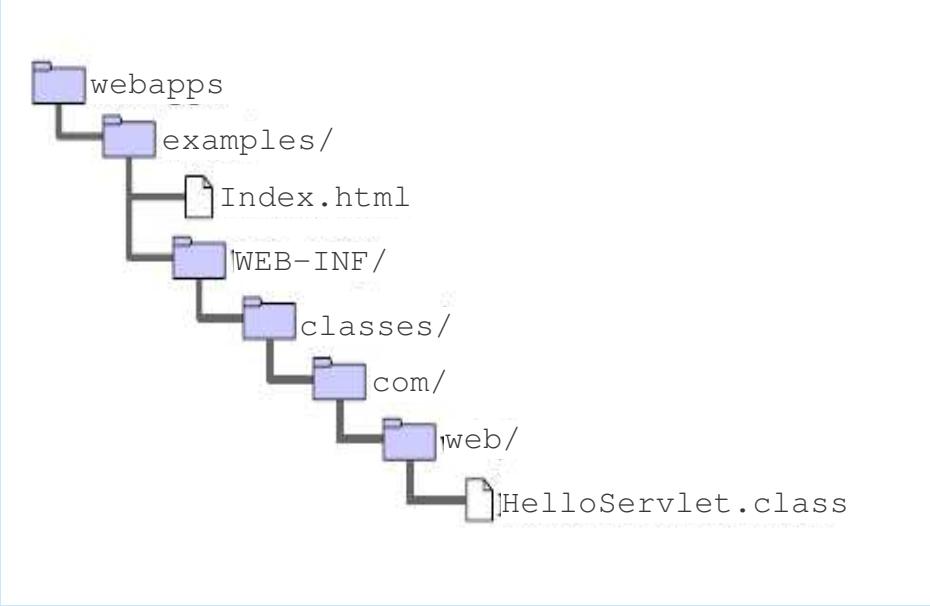
3) If the request path ends with a given extension mapping, it will be forwarded to the specified servlet.

4) If none of the previous rules produce a match, the default mapping is used.

Task 5: Deploying HTTP Servlet

1) Deploy an `HTTP Servlet` in `Tomcat` server.

   a) Create a directory for deployment. This directory, say `"examples"`, should be put under `<Tomcat_Home>/webapps`.



Task 6: Deploying HTTP Servlet

b) Refer to the directory structure in previous slide, copy the servlet package to the directory `WEB-INF/classes`.

c) Create a `web.xml` file, if one does not exist, in the directory `WEB-INF`. The file may look like the following:

```
<web-app
xmlns="http://java.sun.com/xml/ns/j2ee"
  version="2.4">

<servlet>

  <servlet-name>HelloWorld</servlet-name>

  <servlet-class>

     com.web.HelloServlet

  </servlet-class>

</servlet>
```

Task 7: Deploying HTTP Servlet

```
        <servlet-mapping>
                <servlet-name>HelloWorld</servlet-name>
                <url-pattern>/HelloWorld</url-pattern>
        </servlet-mapping>
    </web-app>
```

d) Test the output of the servlet by entering the `URL` in the browser:
`http://localhost/examples/HelloWorld`

Task 8: Deploying HTTP Servlet

2) Change the `URL` address of the servlet to:
   `http://localhost/examples/myservelt/HelloWorld`

3) Change the `URL` address of the servlet to:
   `http://localhost/examples/Hello`

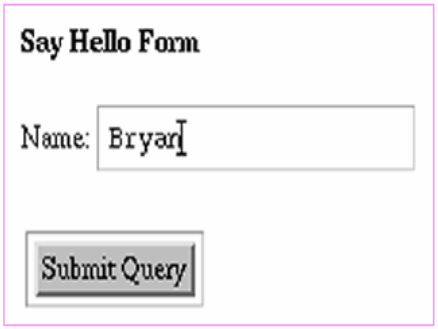
4) Deploy the servlet in a different context, say *`admin`*.
   The `URL` may look like this:
   `http://localhost/admin/HelloWorld`

Request Parameter

Data transmitted from a browser to a servlet is considered the request parameter.

A Web browser can transmit data to a Web server through `HTML` form.

For example, if the submit button of the following form is pressed, the corresponding data is sent to the Web server:




```
Get /servlet/myForm?name=Bryan HTTP/1.0
. . .
```

POST Method

By using a `POST` method, data may be contained in the body of the `HTTP` request:

```
POST /register HTTP/1.0
. . .

Accept-Charset: iso-8859-1,*,utf-8

Content-type: application/x-www-form-urlencoded

Content-length: 129

name=Bryan
```

The `HTTP POST` method can only be activated from a form.

Extracting Request Parameters

Request parameters are stored as a set of name-value pairs.

`ServletRequest` interface provides the following methods to access the parameters:

1) `getParameter(String name)`

2) `getParameterValues(String name)`

3) `getParameterNames()`

4) `getParameterMap()`

Task 10: Extract Parameter

1) Parameter value is sent to a servlet through an HTML form. Create a HTTP servlet to retrieve the value of the parameter.

   a) Put the following HTML file in the examples folder of your web application, name it form.html and browse it.

```
<html>
 <BODY BGCOLOR='white'>

 <B>Submit this Form</B>
 <FORM ACTION='/examples/myForm' METHOD='POST'>
 Name: <INPUT TYPE='text' NAME='name'><BR><BR>
 <INPUT TYPE='submit'>
 </FORM>

 </BODY>

</html>
```

Task 11: Extract Parameter

b) Methods of the `HttpServletRequest` are available for extracting parameters from different `HTML` forms:
`String getParameter(name)` – get a value from a text field
`String getParameterValues(name)` – get values from a multiple selection such as a checkbox

c) Create a servlet named `myForm` and deploy it under the `examples` context. The servlet will extract the parameter "name" and generate an HTML page showing the name in bold type.

Make sure that your servlet implements the correct method to respond to the request.

Defining Initial Parameters

A servlet can have multiple initial parameters defined in the deployment descriptor (`web.xml`) as follows:

```
<servlet>
      <servlet-name>EnglishHello</servlet-name>
      <servlet-class>
            com.web.MultiHelloServlet
      </servlet-class>
      <init-param>
            <param-name>greetingText</param-name>
            <param-value>Welcome</param-value>
      </init-param>
      <init-param>
            <param-name>encoding</param-name>
            <param-value>UTF-8</param-value>
      </init-param>
</servlet>
```

Getting Initial Parameter

There are different ways to obtain servlet initial parameters defined in `web.xml`. One is to override the `init()` method, which is defined in the `GenericServlet` class in your servlet.

The `getInitParameter` method of the `GenericServlet` class provides access to the initialization parameters for the servlet instance.

In the `init()` method, a greeting `String` may be defined as follows:

```
public void init(){
  . . .
       greeting = getInitParameter("greetingText");

  . . . }
```

Multiple Servlet Definition

Multiple “servlet definitions” can also be defined in a given servlet class. The following could be added to `web.xml` along with the previous slide.

```
<servlet>
        <servlet-name>ChineseHello</servlet-name>
        <servlet-class>
                com.web.MultiHelloServlet
        </servlet-class>
        <init-param>
                <param-name>greetingText</param-name>
                <param-value>歡迎你</param-value>
        </init-param>
        <init-param>
                <param-name>encoding</param-name>
                <param-value>UTF-8</param-value>
        </init-param>
</servlet>
```

Task 12: Servlet Initial Parameter

1) Modify `HelloServlet` to create a `servlet` named `MultiHelloServlet` which will pick up the initial parameters defined earlier and display them on an `HTML` Web page.

   Note: Don't forget to define the servlet-mapping tag correctly. You need to define two mappings for a single servlet.

Request Header

A servlet can access the headers of an `HTTP` request with the following methods:

1) `getHeader`

2) `getHeaders`

3) `getHeaderNames`

Request Attributes

Attributes are objects associated with a request. They can be access through the following methods:

1) `getAttribute`

2) `getAttributeNames`

3) `setAttribute`

An attribute name can be associated with only one value.

Reserved Attributes

The following prefixes are reserved for attribute names and cannot be used:

1) `java.`

2) `javax.`

3) `sun.`

4) `com.sun.`

Request Path 1

The request path can be obtained from this method:

```
getRequestURI()
```

The request path is composed of different sections.

These sections can be obtained through the following methods of the request object :

`getContextPath()`:

> If the context of the servlet is the "default" root of the Web server, this call will return an empty string.
>
> Otherwise, the string will starts with a ' / ' character but not end with a ' / ' character

Request Path 2

`getServletPath()`:

The mapping which activates this request:

If the mapping matches with the ' /* ' pattern, returns an empty string

Otherwise, returns a string starts with a ' / ' character.

Example:

Context path: /examples
Servlet mapping :
Pattern: /lec1/ex1
Servlet: exServlet

Request Path: /examples/lec1/ex1
ContextPath: /examples
ServletPath: /lec1/ex1
PathInfo: null

Request Path 3

`getPathInfo()`:

The extra part of the request `URI` that is not returned by the `getContextPath` or `getServletPath` method.

If no extra parts, returns null

otherwise, returns a string starts with a ' / ' character

Example:

Context path: /examples
Servlet mapping :
Pattern: /lec1/*
Servlet: exServlet

Request Path: /examples/lec1/ex/
ContextPath: /examples
ServletPath: /lec1
PathInfo: /ex/

Request Path 4

To sum up:

```
RequestURI = ContextPath + ServletPath + PathInfo
```

Task 13: Request Path

1) Modify the `HelloServlet` class to print out the results of the following methods:
   a) `getRequestURL()`
   b) `getRequestURI()`
   c) `getContextPath()`
   d) `getServletPath()`
   e) `getPathInfo()`

2) What is the result if entering this `URL` in the browser:
   `http://localhost/examples/HelloWorld/`

3) Modify the mapping for `HelloServlet` from `"HelloWorld"` to `"/*"` and check out the result again.

Response Headers

`HttpServletResponse` can manipulate the `HTTP` header of a response with following methods:

```
addHeader(String name, String value)
addIntHeader(String name, int value)
addDateHeader(String name, long date)

setHeader(String name, String value)
setIntHeader(String name, String value)
setDateHeader(String name, long date)
```

For example:
You can make the client's browser cache the common graphic of your web site as following:

```
response.addHeader("Cache-Control",
"max-age=3600");
```

Vertical Concepts Outline

1) Servlet
   a) basic concepts
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   d) communication between servlets
   e) summary

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   b) scripting elements
   c) implicit objects
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   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Servlet Context

A `ServletContext` object is the runtime representation of a Web application.

A servlet has access to the servlet context object through the `getServletContext` method of the `GenericServlet` interface.

The servlet context object provides:

a) read-only access to context initialization parameters

b) read-only access to application-level file resources

c) read-write access to application-level attributes

d) write access to the application-level log file

Context Initial Parameters 1

The application-wide servlet context parameters defined in the deployment descriptor (`web.xml`) can be retrieved through the context object.

The `web.xml` file may look like the following:

```
<web-app>
      <context-param>
            <param-name>admin email</param-name>
            <param-value>admin@servlet.com</param-value>
      </context-param>
. . .
```

Context Initial Parameters 2

In order to obtain a context object, the following can be used:

```
ServletContext context =
getServletConfig().getServletContext();
```

After having the context object, one can access the context initial parameter like this:

```
String adminEmail =
context.getInitParameter("admin email");
```

Access to File Resources

The `ServletContext` object provides read-only access to file resources through the `getResourceAsStream` method that returns a raw `InputStream` object.

After having the servlet context object, one can access the file resources as follows:

```
String fileName = context.getInitParameter("fileName");
InputStream is = null;
BufferedReader reader = null;
try {
is = context.getResourceAsStream(fileName);
reader = new BufferedReader(new inputStreamReader(is));
. . .
```

Access to Attributes 1

The `ServletContext` object provides read-write access to runtime context attributes through the `getAttribute` and `setAttribute` methods.

Setting attributes:

```
ProductList catalog = new ProductList();
catalog.add(new Product(“p1”,10);
catalog.add(new Product (“p2”,50);
context.setAttribute(“catalog”, catalog);
```

Access to Attributes 2

Getting attributes:

```
catalog =
  (ProductList) context.getAttribute("catalog");
Iterator items = catalog.getProducts();
while ( items.hasNext() ) {
   Product p = (Product) items.next();
   out.println("<TR>");
   out.println("<TD>" + p.getProductCode() + "</TD>");
   out.println(" <TD>" + p.getPrice() + "</TD>");
   out.println("</TR>");
}
```

Write Access to the Log File

The `ServletContext` object provides write access to log file through the `log` method.

The code may look as follows:

```
context.log ("This is a log record");
```

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   g) summary

3) Filter
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   b) filter chain
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   d) wrapper
   e) summary

Servlet Communication

When building a Web application, resource-sharing and communication between servlets are important. This can be achieved through one of the following:

a) servlet context

b) request dispatching

c) session tracking

d) event listening

ServletContext

Servlets can access other servlets within the same servlet context through an instance of :

`javax.servlet.ServletContext`

The `ServletContext` object can be obtained from the `ServletConfig` object by calling the `getServletContext` method.

A list of all other servlets in a given servlet context can be obtained by calling the `getServletNames` method on the `ServletContext` object.

Accessing a Servlet

The following code snippet shows how to access another servlet through the servlet context instance.

```
        ...
         BookDBServlet database = (BookDBServlet)
        getServletConfig().getServletContext().getServlet
        ("bookdb");
         //Obtain a Servlet and call its public method
        // directly
        BookDetails bd = database.getBookDetails(bookId);
           ...
    }
}
```

Request Dispatching 1

A request may need several servlets to cooperate:

`RequestDispatcher` object can be used for redirecting a request from one servlet to another.

An object implementing the `RequestDispather` interface may be obtained from the `ServletContext` via the following methods:

1) `getRequestDispatcher`

2) `getNamedDispatcher`

Request Dispatching 2

The `getRequestDispatcher` method takes a string argument as the path for the located resources.

The pathname must begin with a "/" and is interpreted as relative to the current context root.

The required servlet is obtained and returned as a `RequestDispatcher` object.

Request Dispatching 3

The `getNamedDispatcher` method takes a string argument indicating the name of a servlet known to the `ServletContext`.

Servlets may be given names via server administration or via a web application deployment descriptor.

A servlet instance can be determined through its name by calling `ServletConfig.getServletName()`

If a servlet is known to the `ServletContext` by name, it is wrapped with a `RequestDispatcher` object and returned.

Example: Request Dispatching

```
...
   RequestDispatcher dispatcher =
   getServletContext().getRequestDispatcher("/response");
         if (dispatcher != null) {
             dispatcher.include(request, response);
    }
```

Note:

1) The `RequestDispatcher` object's *include()* method dispatches the request to the "response" servlet path (/response – in the `URL` mapping).

Using a RequestDispatcher

To use a request dispatcher, a developer needs to call either the `include` or `forward` methods of the `RequestDispatcher` interface as follows:

```
...
  dispatcher.include(request, response);
...
```

Include Method

The `include` method of the `RequestDispatcher` interface may be called at any time.

It works like a programmatic server-side include and includes the response from the given resource (`Servlet`, `JSP` page or `HTML` page) within the caller response.

The included servlet cannot set headers or call any method that affects the headers of the response. Any attempt to do so should be ignored.

Forward Method

The `forward` method of the `RequestDispatcher` interface may only be called by the calling servlet if no output has been committed to the client.

If output exists in the response buffer that has not been committed, it must be reset (clearing the buffer) before the target `Servlet's` service method is called.

If the response has been committed, an `IllegalStateException` must be thrown.

Task 14: Request Dispatcher

1) Create a servlet which dispatches its request to another servlet using both the `forward` and `include` methods of the `ServletContext`.
   a) create a servlet name `TestDispatherServlet1` as follows:

```
package com.web;

import java.io.*;

import javax.servlet.*;

import javax.servlet.http.*;

public class TestDispatcherServlet1 extends
   HttpServlet {

   private static final String forwardTo

      = "/DispatcherServlet2";
```

Task 15: Request Dispatcher

```
private static final String includeIn
     = "/DispatcherServlet2";


public void doGet(HttpServletRequest req,
   HttpServletResponse res)
     throws ServletException, IOException {


     res.setContentType("text/html");
     PrintWriter out = res.getWriter();
     out.print("<html><head>");
     out.print("</head><body>");
```

Task 16: Request Dispatcher

```
// Displaying Form
out.print("<form action=\"");
out.print( req.getRequestURI() );
out.print("\" method=\"post\">");
out.print("<input type=\"hidden\" name=\"mode\" ");
out.print("value=\"forward\">");
out.print("<input type=\"submit\" value=\" \"");
out.print("> ");
out.print(" Forward to another Servlet ..");
out.print("</form>");
```

Task 17: Request Dispatcher

```
out.print("<form action=\"");
out.print( req.getRequestURI() );
out.print("\" method=\"post\">");
out.print("<input type=\"hidden\" name=\"mode\" ");
out.print("value=\"include\">");
out.print("<input type=\"submit\" ");
out.print("value=\" \"> ");
out.print(" Include another Servlet ..");
out.print("</form>");


out.print("</body></html>");
out.close();
}
```

Task 18: Request Dispatcher

```
public void doPost(HttpServletRequest req,
 HttpServletResponse res)
 throws ServletException, IOException {
    res.setContentType("text/html");
    String mode = req.getParameter("mode");
    PrintWriter out = res.getWriter();
    out.print( "Begin...<br>");
    // Forwarding to Servlet2
    if(mode != null && mode.equals("forward")) {
    req.setAttribute("mode", "Forwarding Response..");
    req.getRequestDispatcher(forwardTo).forward(req,
    res);
 }
```

Task 19: Request Dispatcher

```
        // Including response from Servlet2


        if(mode != null && mode.equals("include")) {
        req.setAttribute("mode", "Including Response..");
        req.getRequestDispatcher(includeIn).include(req,
           res);
        }
    }
}
```

b) Map the servlet at "/DispatcherServlet1" in the `web.xml` file

Task 20: Request Dispatcher

2) Create a servlet as the target servlet built at task 14.
   a) Make sure the servlet is mapped correctly in the `web.xml` file. For instance:

```
<servlet>
  <servlet-name>DispatcherServlet2</servlet-name>
  <servlet-class>
      com.web.TestDispatcherServlet2
  </servlet-class>
 </servlet>
<servlet-mapping>
  <servlet-name>DispatcherServlet2</servlet-name>
  <url-pattern>/DispatcherServlet2</url-pattern>
</servlet-mapping>
```

Task 21: Request Dispatcher

b) Obtain the attribute "`mode`" of the `Request` object sent from the `TestDispatcherServlet1` and display it

3) What is the difference between `include` and `forward` methods?

Session Tacking

`HTTP` is a stateless protocol and associating requests with a particular client is difficult.

Session tracking mechanism is used to maintain state about a series of requests from the same user.

`javax.servlet.http.HttpSession` defined in Servlet specification allows a servlet containers to use different approaches to track a user's session easily.

HttpSession

`HttpSession` is defined in the Servlet specification for managing the state of a client.

Each `HttpSession` instance is associated with an ID and can store the client's data.

The stored data will be kept privately until the client's session is destroyed.

Obtaining a Session

Servlets do not create sessions by default.

`getSession` method of the `HttpServletRequest` object has to be called explicitly to obtain a user's session.

For example:

```
public class CatalogServlet extends HttpServlet {

  public void doGet (HttpServletRequest request,
          HttpServletResponse response)
          throws ServletException, IOException {

      // Get the user's session

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

HttpSession Attributes

Objects, or data, can be bound to a session as attributes.

The following methods can be used to manipulate the attributes:

1) `void setAttribute(String name, Object value)`
   - binds an object to this session, using the name specified

2) `Object getAttribute(String name)`
   - returns the object bound with the specified name in this session, or `null` if no object is bound under the name

3) `Enumeration getAttributeNames()`
   - returns an `Enumeration` of `String` objects containing the names of all objects bound to this session

4) `void removeAttribute(String name)`
   - removes the object with the specified name from this session

Invalidating the Session

A user's session can be invalidated manually or automatically when the session timeouts.

To manually invalidate a session, the session's `invalidate` () method can be used:

```
. . .
HttpSession session = request.getSession();
. . .
// After the process, invalidate the session and clear
// the data
session.invalidate();
. . .
```

Cookies

Cookies are used to provide session ID and can be used to store information shared by the client and server.

When a session is created, an `HTTP` header, `Set-Cookie,` will be sent to the client. This cookie stores the session ID in the client until time-out.

The ID may looks like:

```
Set-Cookie:
JSESSIONID=50BAB1DB58D45F833D78D9EC1C5A10C5
```

This ID will be stored in a client and passed back to the server for each subsequent request.

```
Cookie: JSESSIONID=50BAB1DB58D45F833D78D9EC1C5A10C5
```

Cookie Object

Other than providing session ID, cookie can be used to store information shared by both the client and server.

`javax.servlet.http.Cookie` class provides methods for manipulating the information such as:

```
setValue(String value)
getValue()
setComment(String comment)
getComment()
setMaxAge(int second)
getMaxAge()
. . .
```

Using Cookies

A procedure for using cookies to store information in a client usually includes:

1) instantiating a cookie object
2) setting any attributes
3) sending the cookie

Instantiating a Cookie Object

```
public void doGet (HttpServletRequest request,
  HttpServletResponse response)
  throws ServletException, IOException {

      String bookId = request.getParameter("Buy");

      if (bookId != null) {
         Cookie Book = new

      Cookie("book_purchased",bookId);
            ...
      }
}
```

Setting Attributes

```
  . . .
     Cookie Book = new

      Cookie("book_purchased",bookId);

      Book.setComment ("Book sold" );
  . . .
}
```

Sending a Cookie

```
  . . .
  Cookie Book = new
      Cookie("book_purchased",bookId);
           Book.setComment ("Book sold" );
      response.addCookie(Book);
  . . .
}
```

Retrieving Information

A procedure to retrieve information from a cookie:

1) retrieve all cookies from the user's request
2) find the cookie or cookies with specific names
3) get the values of the cookies found

Retrieving a Cookie 1

```
public void doGet (HttpServletRequest request,
   HttpServletResponse response) throws ServletException,
   IOException { ...


  String bookId = request.getParameter("Remove");
   ...
   if (bookId != null) {
     // Find the cookie that pertains to that book

         Cookie[] cookies = request.getCookies();
```

Retrieving a Cookie 2

```
        for(i=0; i < cookies.length; i++) {
            Cookie thisCookie = cookie[i];
            if (thisCookie.getName().equals

                                ("book_purchased") &&


  thisCookie.getValue().equals(bookId)) {
             // Delete the cookie by setting its
            //  maximum age to zero

                    thisCookie.setMaxAge(0);
                    response.addCookie(thisCookie);
        }
```

Task 22: Cookie

1) Create a servlet that stores the last time the client visits this servlet within the session.
   a) `java.util.Date` could be used to obtain the time-stamp.
   b) The time-stamp should be stored as a cookie.
   c) A message similar to the following should be shown:
      ```
      Your last visit time is Fri Apr 01 14:37:48 CST 2005
      ```

URL Rewriting

If a client does not support cookies, URL rewriting could be used as a mechanism for session tracking.

While using this method, session ID is added to the URL of each page generated.

For example, after a session ID 123456 is generated, the rewritten URL might look like:

```
http://localhost/ServletTest/index.html;jsessionid=123456
```

Methods for URL Rewriting

The `HttpServletResponse` object provides methods for appending a session ID to a URL address string:

```
String encodeURL(java.lang.String url)
```

Encodes the specified URL by including the session ID in it, or, if encoding is not needed, returns the URL unchanged.

```
String encodeRedirectURL(String url)
```

Encodes the specified URL for use in the `sendRedirect` method or, if encoding is not needed, returns the URL unchanged.

Task 23: URL Rewriting

1) Investigate the usage of URL rewriting.
   a) Create a servlet, named "`URLRewrite`", which shows the following information on a web page:
      - request `URL` (`request.getURL()`)
      - request `URI` (`request.getURI()`)
      - servlet path (`request.getServletPath()`)
      - path info (`request.getPathInfo()`)
      - session id (`request.getSession().getId()`)
      - a hyperlink pointing to another servlet named "`DisplayURL`"
   b) Create a servlet `DisplayURL` which shows the session id.

Task 24: URL Rewriting

c) Make sure that the browser accepts cookies.

d) Browse the `URLRewrite` servlet and click on the link to the `DisplayURL` servlet. What is the session id displayed on both page?

e) Configure the browser to disable the cookies.

f) Repeat step d and observe the result.

g) Modify the `URLRewrite` servlet and call the `response.encodeURL` method to modify the hyperlink pointing to the`DisplayURL` servlet.

h) What is the result now and what is the conclusion?

Servlet Event Listener

Information about container-managed life cycle events, such as initialization of a web application or loading of a database could be useful.

Servlet event listener provides a mechanism to obtain these information.

Event Listener Interfaces

Interfaces of different event listeners:

```
javax.servlet.ServletRequestListener
javax.servlet.ServletRequestAttributeListener
javax.servlet.ServletContextListener
javax.servlet.ServletContextAttributeListener
javax.servlet.http.HttpSessionListener
javax.servlet.http.HttpSessionAttributeListener
```

Example of a Listener

A listener can be used in different situations and here is one of the examples:

1) When a web application starts up, the listener class is notified by the container and prepares the connection to the database.
2) When the application is closed and removed from the web server, the listener class is notified and the database connection is closed.

Task 24: Servlet Event Listener

1) Create `HttpSessionListener` which counts the number of users connected to the server concurrently.
   a) Create a class named `UserCounter` which implements the `HttpSessionListener`.
   b) Define a static integer variable "`counter`" for counting the users.
   c) Find out which methods are needed to implement the `HttpSessionListener` interface.
   d) Within which method should you add or deduct the number of users?
   e) Provide a static method `getUserCounted` to return the number of users connecting currently.

Task 25: Servlet Event Listener

2) Deploy the listener developed in Task 23.
   a) Modify the `web.xml` file as follows to deploy the listener:

```
<listener>
   <listener-class>
      FULL_CLASS_NAME_OF_THE_LISTENER
   </listener-class>
</listener>
```

3) Create a servlet `DisplayUser` which displays the number of connected user by calling the `getUserCount` method of the `UserCounter` class.

4) What can be observed when establishing more connections to the `DisplayUser` servlet?

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   d) actions
   e) expression language
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3) Filter
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   d) wrapper
   e) summary

Servlet Summary 1

The most commonly used servlet extends the `HttpServlet` class.

The life cycle of a servlet include initialization, service and destruction.

The web container dispatches the requests to the corresponding methods according to their types such as `Get` or `Post`.

The `URL` of a servlet could be mapped as part of the `web.xml` file.

Servlet Summary 2

Data transmitted from a browser to a servlet is considered a request parameter.

`ServletRequest` interface provides methods such as `getParameter()` for accessing the request parameters.

Initial parameters for a servlet could be assigned in the `web.xml` file and extracted within the `init()` method of a servlet using the `getInitParameter` method.

`HttpServletRequest` interface also provides methods for accessing different attributes of an `HTTP` request such as header, `URI`, etc.

Servlet Summary 3

`ServletContext` object is the runtime representation of a web application.

The servlet context object provides:

a) read-only access to context initialization parameters

b) read-only access to application-level file resources

c) read-write access to application-level attributes

d) write access to the application-level log file

Servlet Summary 4

Information and resources can be shared between servlets and the container.

Different approaches could be used:

a) servlet context

b) request dispatching

c) session tracking

d) event listening

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What is JavaServer Pages

JavaServer Pages is a J2EE technology for building web applications.

A JSP page is a textual document that describes how to create a dynamic response to a request.

JSP technology builds on:

1) template, or static, content

2) dynamic data

3) encapsulation of functionality through JavaBeans and tag libraries

Goals of JSP

While keeping the benefits of `Java Servlet`, `JSP` supports separation of presentation and business logic:

a) web designers can design and update pages without learning Java programming language

b) programmers for Java platform can write codes without dealing with web page design

How to achieve this?

`JSP` allows web designer to write standard `HTML` pages containing **tags** that run powerful programs based on Java technology.

Benefits of JSP

1) platform independent
2) roles separation
3) reuse of components and tag libraries
4) separation of dynamic and static content
5) encapsulation of functionality
6) integral parts of `J2EE`

Simple JSP Example 1

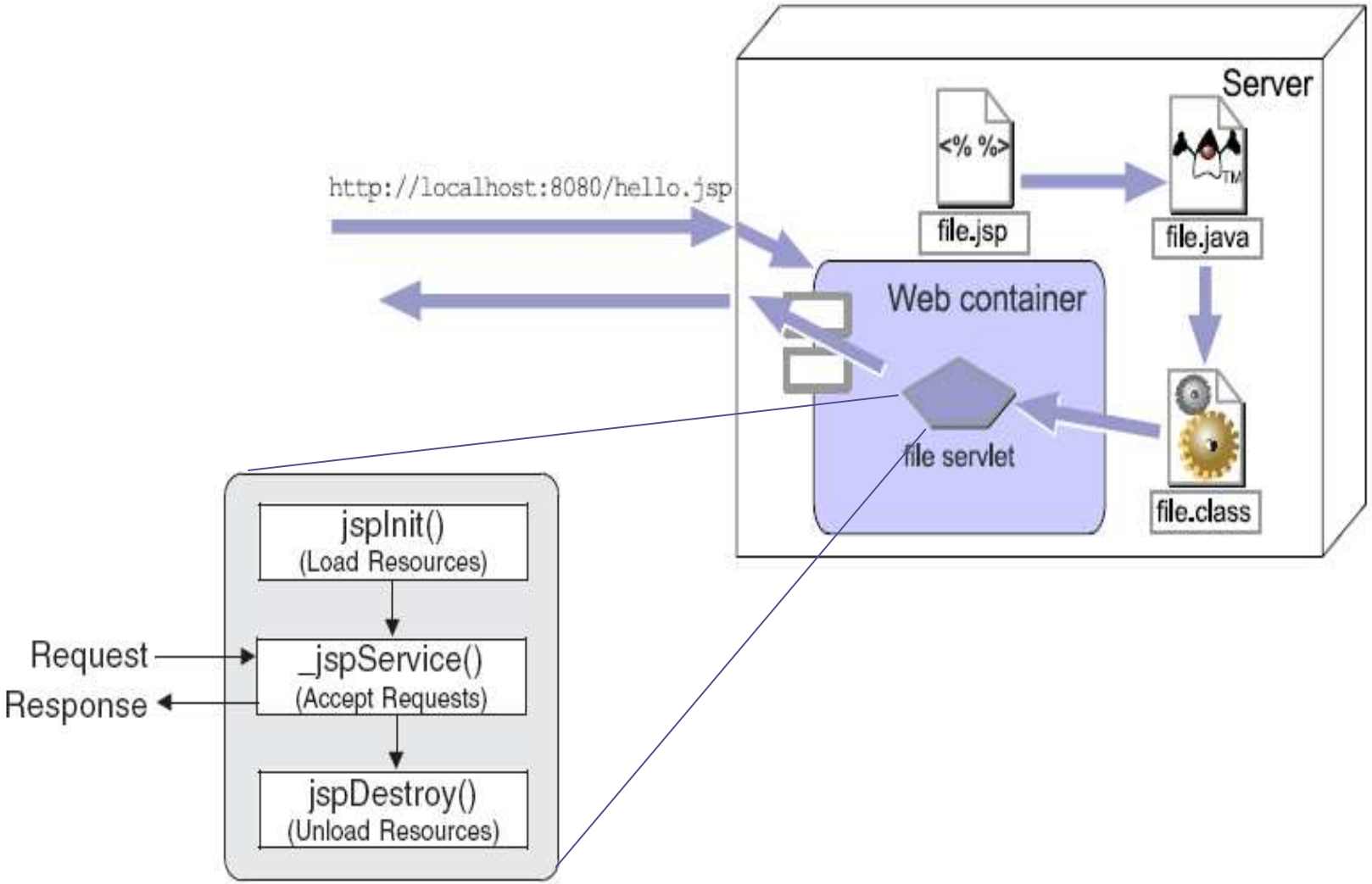
A JSP file may look as follows:

```
<%! private static final String GREETING = “HELLO”; %>
<HTML>
      <HEAD>
            <TITLE>Hello JavaServer Pages</TITLE>
      </HEAD>
<%
  String name = request.getParameter(“name”);
      if ( (name == null) || (name.length() == 0) ) {
        name = "DEFAULT_NAME";
  }
%>
```

Simple JSP Example 2

```
<%-- THE FOLLOWING IS STANDARD HTML --%>
            <BODY BGCOLOR='white'>
            <B><%= GREETING %>, <%= name %></B>
      </BODY>
</HTML>
```

Life Cycle


Server
http://localhost:8080/hello.jsp
<% %>
file.jsp
file.java
Web container
file servlet
file.class
jspInit()
(Load Resources)
Request
Response
_jspService()
(Accept Requests)
jspDestroy()
(Unload Resources)

Life Cycle Process

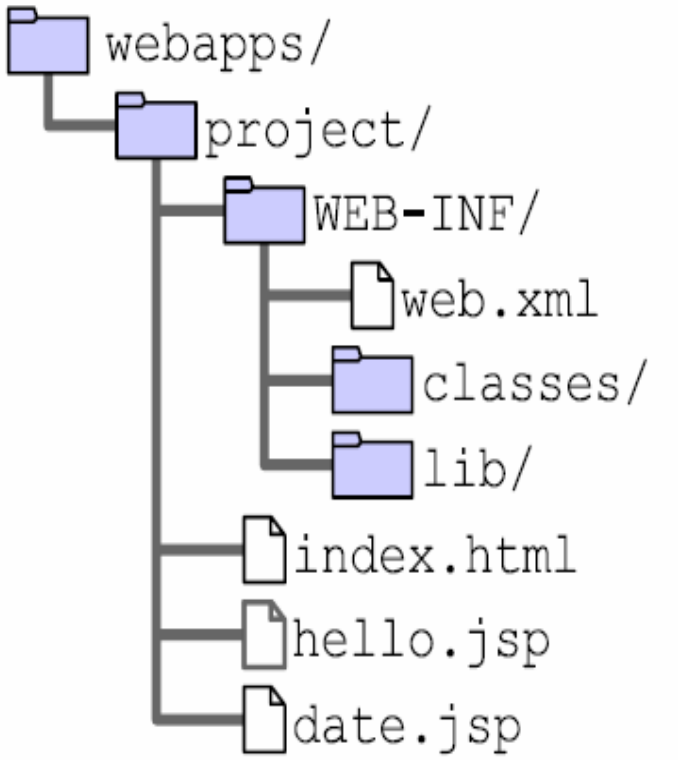
1) Web client transmits a request to the web container asking for a `JSP` page.
2) As this `JSP` page is accessed by the first time, it is translated into servlet code.
3) The servlet code is compiled into class file and loaded into the web container.
4) What is followed is similar to the working cycle of a normal servlet:
    a) The web container creates an instance of the servlet class for the `JSP` page and executes the `jspInit` method.
    b) The web container calls the `_jspService` method on the servlet instance for that `JSP` page. the result is sent back to the user.

Deployment

`JSP` files can be placed under the deployment directory together with the main `HTML` files.

This allows the `JSP` files to be accessed as the main `HTML` files.

`JSP` files can also be mapped to specific `URLs` in the `web.xml` file.



Deployment Descriptor

The configuration information for `JSP` pages is described in the `web.xml` file rooted on the `<jsp-config>` element.

configuration elements may include:

`<taglib>` - element in mapping of tag libraries

`<jsp-property-group>` - properties of collections of `JSP` files, such as page encoding or automatic includes before and after pages, etc

Example: Deployment Descriptor

Common header and footer for `JSP` file can de defined in the `web.xml` file as follows:

```
<jsp-config>
     <jsp-property-group>
        <url-pattern>*.jsp</url-pattern>
        <include-prelude>/header.jsp</include-prelude>
        <include-coda>/footer.jsp</include-coda>
     </jsp-property-group>
</jsp-config>
```

Mapping JSP to a URL

Like a servlet, a JSP page can be mapped to a specific URL by modifying the web.xml file.

For example, mapping a JSP page named "ShowHello.jsp in deployment directory to "/Hello" may as follows:

```
<servlet>
      <servlet-name>ShowHello</servlet-name>
      <jsp-file>/ShowHello.jsp</jsp-file>
</servlet>

<servlet-mapping>
      <servlet-name>ShowHello</servlet-name>
      <url-pattern>/Hello</url-pattern>
</servlet-mapping>
```

full path name such as

/WEB-INF/classes/com/ShowHello.jsp

Task 26: Mapping JSP

1) Investigate the mapping mechanism for `JSP` files.
   a) create a `JSP` file
   b) put it under the directory:
      `<Your_Web_Context>/WEB-INF/classes/`
   c) map this page with a name: `myPage`
   d) browse it with a web browser

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   g) summary

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Scripting Elements

Five kinds of scripting elements are defined in JavaServer Pages:

1)	declarations	<%!	%>
2)	scriptlets	<%	%>
3)	expressions	<%=	%>
4)	directives	<%@	%>
5)	comments	<%--	--%>;<% /** **/%>;<!-- -->

Declarations

Declaration tag is used for declaring variables or methods.

Codes generated are outside of the `_jspService()` method.

Syntax: `<%!  declaration  %>`

Examples:

declaring a variable

```
<%! int i = 0; %>
```

declaring a method

```
<%! public String foo(int i)
        { if (i<3) return(“small”);
        }
%>
```

Scriptlets

The Java code within the scriptlet tag will be included in the `_jspService` method.

Syntax: <% *scriptlet* %>

Examples :

```
<% int time = 0; %>
<% if (time < 12) { %>
        Good Morning
<% } else { %>
        Good Afternoon
<% } ;%>
```

Expressions

The expression represents a runtime value which is generated for a response.

Syntax: <% *expression* %>

Examples :

```
<B>Thank you</B>, <I> <%= name %> </I>, for registering
```

Directives

Directives are used to define page attributes and do not output to a client.

Syntax: *<%@ directive {attribute="value"} * %>*

Directives can be as follows:

1) `page`
2) `include`
3) `taglib`

Directive: page

Provides page-specific information to a `JSP` container.

Syntax: `<%@ page %>`

The attributes include:

- `language`
- `extends`
- `import`
- `session`
- `buffer`
- `autoFlush`
- `isThreadSafe`
- `isErrorPage`
- `errorPage`
- `contentType`
- `pageEncoding`
- `isScriptingEnabled`
- `isELEnabled`

Directive: include

Includes text and/or code at translation time of a `JSP`.

Syntax: `<%@ include file="relativeURL" %>`

Example:

```
<%@ include file="header.jsp" %>
This is a page with predefined header and footer by
means of the include directive
<%@ include file="footer.jsp" %>
```

Task 27: Directive include

1) Create a JSP file named header.jsp.
   a) use declaration directive to declare an integer variable "count" for the page
   b) use declaration directive to declare a method addCount() which add the variable "count" by 1 for every call
   c) use scriptlet to call the addCount method
   d) append the following HTML code to the end of header.jsp which use the expression to display the dynamic content of "count"

```
<html>
    <body>
      <center>
         This page has been viewed <%= count %> times
      </center>
    <br>
```

Task 28: Directives include

2) Create a `JSP` file named `footer.jsp`.
   a) put `HTML` code to display the word "`Welcome`"
   b) append to the `HTML` code to the file

```
</body>
   </html>
```

3) Create a `JSP` file named `body.jsp`.
   1) use directive `include` to include the `header.jsp` at the beginning
   2) put a static statement
   3) use directive `include` to include the `footer.jsp` at the end

Directive: taglib

used to declare which markup on the page should be considered custom code and what code the markup links to

Syntax: `<%@ taglib uri="uri" prefix="prefixOfTag"%>`

This directive will be discussed in more detail in the session for tag library.

Comments

JSP file can use two different types of comments:

1) JSP document comment

   Examples:

   <%-- comments ... --%>, or

   <% /** comments too ... **/ %>

2) Comments send back to users as a response

   Examples:

   <!-- comments ... -->, or

   <!-- comments <%=expression %> ... -->

Guideline for Using Scripting

Overuse of scripting code can make JavaServer Pages confusing and difficult to maintain.

Scripting code will mix the business and presentation logic together.

Scripting code may reduce the reusability of `JSP`.

Scripting code should only be used when it is necessary.

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JSP Implicit Objects

In servlet, objects such as `HttpServletResquest` or `HttpServletResponse` can be accessed directly.

In `JSP`, some objects are automatically declared by the web container and can be accessed directly by scripting elements. These objects are called implicit objects.

Examples:

- `application`
- `config`
- `session`
- `request`
- `response`
- `pageContext`
- `page`
- `out`
- `exception`

Implicit Objects: Servlet Equivalent

The following implicit objects have `Servlet` equivalents:

`application` – `javax.servlet.ServletContext`

`config` – `javax.servlet.ServletConfig`

`session` – `javax.servlet.http.HTTPSession`

`request` – `javax.servlet.http.HTTPRequest`

`response` – `javax.servlet.http.HTTPResponse`

Implicit Objects: JSP Specific

`JSP` defines some implicit objects as follows:

`pageContext` – an instance of `javax.servlet.jsp.PageContext` object
e.g. `pageContext.include("header.jsp");`

`page` – synonym for the "`this`" operator.

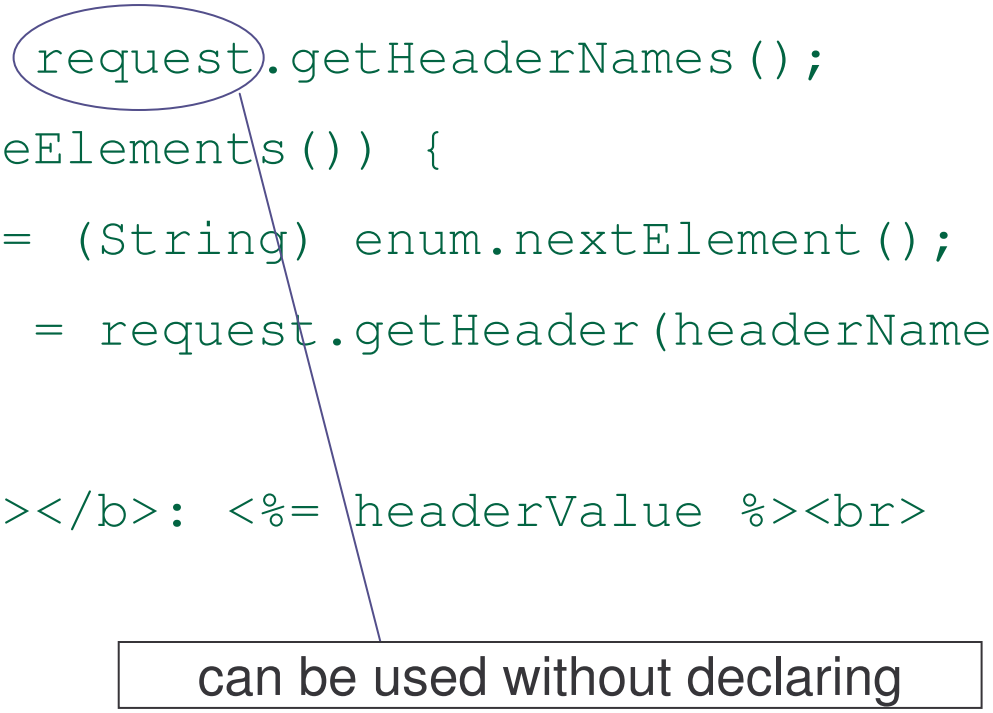
`out` – an instance of `javax.servlet.jsp.JspWriter` object

`exception` – an instance of `java.lang.Throwable` object

Example: Using Implicit Objects

The following JSP codes use the implicit object "request" to get information of the HTTP header and display it on a web page.

```
<%
 Enumeration enum = request.getHeaderNames();
 while (enum.hasMoreElements()) {
 String headerName = (String) enum.nextElement();
 String headerValue = request.getHeader(headerName);
%>
<b><%= headerName %></b>: <%= headerValue %><br>
<% } %>
```



Task 29: Implicit Objects

1) Investigate the usage of implicit objects.
   a) Referring to task 12, initial parameter was defined for a servlet in the `web.xml` file.
   b) Do the same setting for initial parameter in a `JSP` file named `ShowHello.jsp`.
   c) Call the `getInitParameter()` method of the implicit object "`config`" to get the initial parameter.
   d) Make `ShowHello.jsp` to display the greeting statement on the web page.

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JSP Actions

`JSP Actions` have functions identical to that of scripting elements but allow abstraction of Java codes for `JSP` file.

`JSP Actions` have two types:

1) standard
2) custom

Syntax:

```
<prefix:element {attribute = "value"}* />
```

Standard JSP Actions

`Standard JSP Actions` are completely specified by the `JSP` specification and are available for use with any `JSP` container by default.

Include functionality that is commonly used with `JSP`.

A standard `JSP Action` generally use **`jsp`** as prefix.

Examples:

1) including resources (`<jsp:include/>`)
2) manipulating JavaBeans (`<jsp:useBean/>`)
3) forwarding requests (`<jsp:forward/>`)

Commonly used Standard Actions

Some of the commonly used standard actions will be discussed in this section:

1) `<jsp:include/>`
2) `<jsp:forward/>`
3) `<jsp:param/>`
4) `<jsp:useBean/>`
5) `<jsp:setProperties/>`
6) `<jsp:getProperties/>`

<jsp:include/>

include resources during **runtime**

Syntax:

```
<jsp:include page="urlSpec" flush="true|false"/>
```

Example:

```
<jsp:include page="include_page" flush="true"/>
```

<jsp:include/>: Attribute Flush

Attribute flush indicates whether any existing buffer should be flushed before reading in the included content.

The attribute flush is required in JSP 1.1 and should be set to `true`.

In JSP 1.2 and up, the flush attribute defaults to false and can be left off.

Task 30: <jsp:include/>

1) Investigate the operation of action `include`.
   a) With the `header.jsp` and `footer.jsp` developed in task 27 and task 28, create a `JSP` file named `actionBody.jsp` as follows:

```
<jsp:include page="header.jsp" />
This is a page with predefined header and footer by
means of the include action.
<jsp:include page="footer.jsp" />
```

   b) Browse the `actionBody.jsp` a few times.
   c) Modify the `footer.jsp` to add some text to it.
   d) Refresh the web pages.
   e) What observation did you have?

Task 31: <jsp:include/>

2) Compare with the result from using directive include.
   a) Browse the `body.jsp` developed in task 27 and 28 a few times.
   b) Repeat steps c and d in task 30.
   c) What is the difference comparing to the results of task 30.

<jsp:forward/>

Equivalent to call the `RequestDispather.forwared()` method.

This action forwards a request to a new resource and clears any content that might have previously been sent to the output buffer by the current `JSP`.

Example:

```
<jsp:forward page="relative_URL" />
```

<jsp:forward/>: Parameters

Both the JSP forward and include actions can optionally include parameters.

Example:

```
<jsp:forward page="examplePage.jsp">
<jsp:param name="para_1" value="val"/>
<jsp:param name="para_2" value="<%= aVal %>"/>
</jsp:forward>
```

The value can be represented by an expression.

If the parameter specified by the param action were exist, the existing is replaced.

JavaBean Actions

The Actions used with the JavaBean:

1) `<jsp:useBean/>`
2) `<jsp:setProperty/>`
3) `<jsp:getProperty/>`

JavaBeans

A JavaBean is a Java class with at least the following features:

1) accessors and mutators (get and set methods) are used to define the properties of the bean
2) has a default constructor
3) no public instance variables
4) not an `Enterprise JavaBeans (EJB)`

<jsp:useBean/>

Declares a JavaBean for use in a JSP.

Syntax:

```
<jsp:useBean id="name" class="full_class_name"
   scope="scope" />
```

Examples:

```
<jsp:useBean id="guestBean"
   class="com.web.GuestBean" scope="request"/>
<%
   guestBean.setName(request.getParameter("name"));
guestBean.setEmail(request.getParameter("email"));
%>
   </jsp:useBean>
```

<jsp:useBean/>: Usage

Action

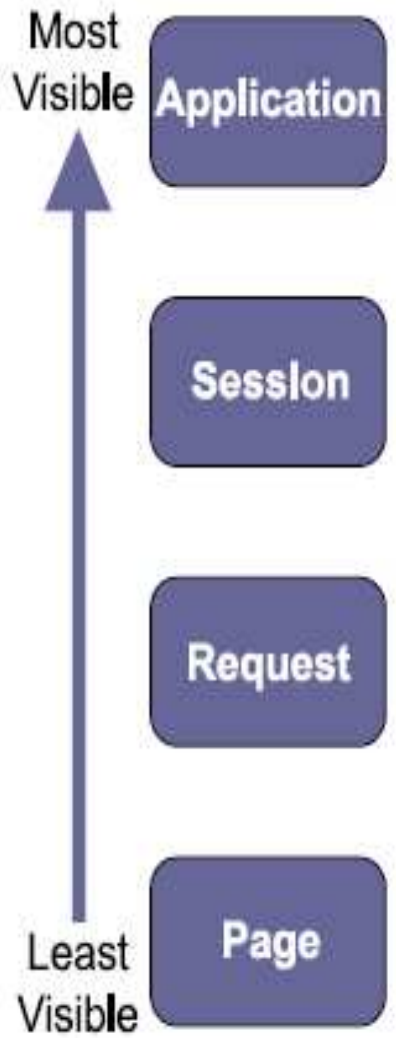
```
<html>
<head>
<title>
      with useBean
</title>
</head>
<body>
<jsp:useBean id="date"
  class="java.util.Date"
/>
The date/time is
  <%= date %>
</body>
</html>
```

Scriptlet

```
<html>
<head>
<title>
      with Scriptlet
</title>
</head>
<body>
<% java.util.Date date =
  new java.util.Date();
%>
The date/time is
  <%= date %>
  </body>
  </html>
```

<jsp:useBean/>: Valid Scope 1

- **application**
- **session**
- **request**
- **page**



<jsp:useBean/>: Valid Scope 2

page:

1) The JavaBean will be available by calling the `getAttribute()` method of the `PageContext`.
2) The JavaBean is discarded upon completion of the current request.

request:

1) The JavaBean is available by calling the `getAttribute()` from the current page's `ServletRequest` object.
2) The JavaBean is discarded upon completion of the current request.

<jsp:useBean/>: Valid Scope 3

session:

1) The JavaBean is available by calling the `getAttribute()` from the current page's `HttpSession` object.
2) The JavaBean automatically persists until the session is invalidated.

application:

1) The JavaBean is available by calling the `getAttribute()` of the web application's `ServletContext` object.

<jsp:setProperty/>

The `jsp:setProperty` Action is used to initialize the JavaBean instead of using the scriptlet.

Exmaples:

```
<jsp:useBean id="guestBean"
      class="com.web.GuestBean" scope="request">
<jsp:setProperty name="guestBeam"
      property="name" value="Guest1">
<jsp:setProperty name="guestBean"
      property="email" />
</jsp:useBean>
```

`jsp:setProperty` Action can be used outside of the `jsp:useBean` Action.

<jsp:setProperty>: Attributes

To initialize the bean properties, the following settings can be used:

```
<jsp:useBean id="guestBean"
      class="com.web.GuestBean" scope="request">
<jsp:setProperty name="guestBean" property="*" />
<jsp:setProperty name="guestBean"
property="username" param="user"/>
<jsp:setProperty name="guestBean"
property="username" value="<%=user%>" />
</jsp:useBean>
```

when `property="*"` is used, the request parameters will be iterated to find the matched parameters.

<jsp:getProperty>

The `jsp:getProperty` Action is used to extract the value of an attribute of a JavaBean:

Example:

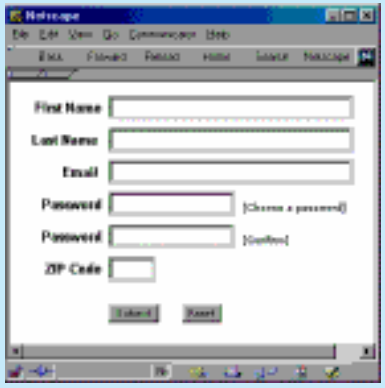
```
<jsp:getProperty name="guestBean"
      property="username"/>
```

Task 32: <jsp:useBean/>

1) Investigate the usage of `useBean` Action.
   a) Develop a Java class named `User.java`.
   b) The class has two instance variables, `"name"` and `"password"`.
   c) Provide getter and setter for these two variables.
   d) Create a `JSP` file which shows an `HTML` form for user to input username and password.
   e) Information submitted from d) will be stored in an instance of `User` class.
   f) Create another `JSP` file named `displayeInfo.jsp` which displays the information of the `User` bean.
   g) Use `useBean`, `setProperty` and `getProperty` Actions in the `JSP` file.
   h) What is the difference applying different scopes for the useBean Action?

Task 33: <jsp:useBean/>

2) Use the useBean Action to perform request chaining. In this task, the following scenario is performed by modifying task 32.



request

JSP1

Servlet

JSP2

Task 34: <jsp:useBean/>

a) Modify the `HTML` file in task 32 to show a form for entering user information.

b) Create a Java bean named `FormBean` for storing the information.

c) When the submit button of the form is pressed, the data is transmitted to a `JSP` file, say `Jsp1.jsp`.

d) `Jsp1` will instantiate the `FormBean`, using the `useBean` action with a scope of `request`.

e) Information from the request parameter is stored in the `FormBean` by calling the `jsp:setProperty` Action.

f) Use attribute `property="*"` to populate the data to the `FormBean`.

g) Request is then forwarded to the servlet, Servlet1, through the `jsp:forward` Action.

Task 35: <jsp:useBean/>

h) The controller servlet, Servlet1 extracts the bean passed to it from the attribute of the request as follows:

```
public void doPost (HttpServletRequest request,
HttpServletResponse response) {
  try {
    FormBean f = (FormBean)
                 request.getAttribute ("fBean");

  . . .
```

i) Modify the values of `UserBean` by calling the setter methods of the bean.

Task 36: <jsp:useBean/>

j) Forward the request to the `JSP` page, say `Jsp2.jsp` for rendering the output:

```
getServletConfig().getServletContext().
getRequestDispatcher("/Jsp2.jsp").forward(request,
response);
```

k) Extract the `UserBean` information by calling the `getProperty` action.

l) Display the user info on a web page.

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

JSP 2.0 Expression Language

JSP-specific expression language(`JSP EL`), is defined in JSP 2.0 specification.

JSP EL provides a cleaner syntax and is designed specially for JSP.

JSP EL Examples

A variable can be accessed as:

${variable_name}

The property of a bean can be accessed as:

${aBean.name}

Expression can be accessed as:

```
<c:if test="${aBean.age < 20}">
   . . .
</c:if>
```

JSP EL: Syntax

In `JSP EL`, expressions are always enclosed by the ${ } characters.

Any values not begin with **${** is literal.

Literal value contains the **${** has to be escaped with “\” character.

JSP EL: Attributes

Attributes are accessed by name, with an optional scope.

Members, getter methods, and array items are all accessed with a "."

Examples:

a member b in object a → `${a.b}`
a member in an array a[b] → `${a.b} or ${a["b"]}`

JSP EL: Literals

`Boolean:` `true / false`

`Long:` as `long` values defined by Java

`Float:` as `float` values defined by Java

`String:` identical as in Java

`Null:` identical as in Java

JSP EL: Operators

```
[]
()
-
*, /, div, %, mod
+, -
<, >, <=, >=, lt, gt, le, ge
&&, and
||, or
```

Note: order of preference from top to bottom, left to right

JSP EL: Reserved Words

The following words are reserved and cannot be used in `JSP EL` expression:

`and`	`true`
`or`	`false`
`not`	`instanceof`
`eq`	`empty`
`gt`	`null`
`lt`	`div`
`ge`	`mod`
`ne`	
`le`	

JSP EL: Implicit Objects 1

A set of implicit objects is defined to match the JSP equivalents:

1) pageContext: the context for the JSP page

Through pageContext, the following implicit objects can be accessed:

a) context
b) session
c) request

For example, the context path can be accessed as:

```
${pageContext.request.contextPath}
```

JSP EL: Implicit Objects 2

2) `param`

   a) maps name of parameter to a single string value

   b) same as `ServletRequest.getParameter(String name)`

   `e.g. ${param.name}`

3) `paramValues`

   a) map name of parameter to an array of string objects

   b) same as `ServletRequest.getParameterValues(String name)`

   `e.g. ${paramValues.name}`

JSP EL: Implicit Objects 3

4) `header`

a) maps a request header name to a single string header value

b) same as `ServletRequest.getHeader(String name)`

`e.g. ${header.name}`

5) `headerValues`

a) map request header names to an array of string objects

b) same as `ServletRequest.getParameterValues(String name)`

`e.g. ${headerValues.name}`

JSP EL: Implicit Objects 4

Additional implicit objects are available for accessing scope attributes:

1) `pageScope`
2) `requestScope`
3) `sessionScope`
4) `applicationScope`

For example:

```
${sessionScope.user.userid}
```

JSP EL: Implicit Objects 5

5) `headerValues`

   a) maps all the header values

   b) same as `ServletRequest.getHeaders()`

6) `cookie`

   a) maps the single cookie objects that are available by invoking `HttpServletRequest getCookies()`

   b) If there are multiple cookies with the same name, only the first one encountered is placed in the Map

JSP EL: Defining EL Functions 1

`Static` methods in a Java class can be used as `JSP EL` functions.

The name and signature of the function can be defined as follows:

`<function> element` in the `Tag Library Descriptor file (TLD)` is used for setting up the linkage

```
<taglib>
...
 <function>
    <name>myFunction</name>
    <function-class>
          com.functions.MyFunction
    </function-class>
```

JSP EL: Defining EL Functions 2

```
        <function-signature>
              String bar(String)
        </function-signature>
    </function>
</taglib>
```

The static method, `bar()`, defined in the class `com.functions.MyFunction` is now mapped in the `JSP EL` as a function named `myFunction`.

JSP EL: Using EL Functions

The previous EL functions can be used as following:

```
${bar('hello')}
```

If the function is defined in a non-default namespace, the prefix must be declared explicitly.

For example:

If bar function is declared in a tag library with a prefix `f`, the function may be declared as :

```
${f:bar('hello')}
```

JSP EL Compatibility

Using `JSP EL` may cause compatibility problems with `JSP 1.2` and earlier code.

`JSP EL` is disabled by default if Servlet 2.3 defined `web.xml` file is used.

Applications uses the Servlet 2.4 defined `web.xml` file will enable `JSP EL` automatically.

Enabling / Disabling JSP EL

JSP page can use the isScriptingEnabled page directive to enable or disable JSP EL.

For example:

```
<%@ page isScriptingEnabled="true" %>
```

Element scripting-enabled in the web.xml is used to configure an application-wide usability.

For example:

```
. . .
<jsp-property-group>
    <scripting-enabled>true</scripting-enabled>
 . . .
```

Vertical Concepts Outline

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   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Standard Tag Library

JavaServer Pages Standard Tag Library (JSTL) is an extended set of JSP standard actions includes the following tags:

1) Iteration and conditional
2) Expression Language
3) URL manipulation
4) Internationalization-capable text formatting
5) XML manipulation
6) Database access

Problems with JSP Scriptlet Tags

1) Java code is embedded within scriptlet tags.

2) Non-Java developer cannot understand the embedded Java code.

3) Java code within `JSP` scriptlets cannot be reused by other `JSP` pages.

4) Casting to the object's class is required when retrieving objects out of `HTTP request` and `session`.

Advantage of JSTL

1) JSTL tags are in XML format and can be cleanly and uniformly blended into a page's HTML markup tags.

2) JSTL tag libraries are organized into four libraries which include most functionality required for a JSP page and are easier for non-programmers to use

3) JSTL tags encapsulate reusable logic and allow to be reused.

4) No casting is requiring while using JSTL tags for referencing objects in the request and session.

5) JSP's EL (Expression Language) allows using dot notation to access the attributes of Java objects.

Disadvantage of JSTL

1) JSTL may add processing overhead to the server:

   like JSP scriplet, tag libraries are also compiled into a resulting servlet and then executed by the servlet container

2) JSTL tags only provide the typical operations but not all:

   scriptlets may be needed if the JSP pages need to do everything

Example: JSTL 1

1) Without JSTL, some scriptlets may look as follows:

```
<%
    List addresses =
   (List)request.getAttribute("addresses");
    Iterator addressIter = addresses.iterator();
     while(addressIter.hasNext()) {
       AddressVO address =
       (AddressVO)addressIter.next();
       if((address != null) {
%>
<%=address.getLastName()%><br/>
```

Example: JSTL 2

```
<%
        }
        else {
%>
        N/A<br/>
<%
        }
    }
%>
```

Example: JSTL 3

1) With JSTL, the previous may look as follows:

```
<%@ taglib prefix="c"
   uri="http://java.sun.com/jsp/jstl/core" %>
<c:forEach item=${addresses} var="address" >
   <c:choose>
     <c:when test="${address != null}" >
       <c:out value="${address.lastName}"/><br/>
     <c:otherwise>
        N/A<br/>
     </c:otherwise>
   </c:choose>
</c:forEach>
```

Using JSTL

`JSTL` is standardized, but not a standard part of JSP 1.2 or 2.0.

`JSTL` must be downloaded and installed separately before being used.

Task 37: Installing the JSTL

1) The `JSTL` will be installed and setup for used.
   a) Dowonload the library from this `URL`:
      `http://www.apache.org/dist/jakarta/taglibs/standard/`
   b) Unpack the file and two `jar` files are inside the `/lib` directory:
      a) `jstl.jar`
      b) `standard.jar`

Task 38: Installing the JSTL

c) Copy the `jar` file from step b to the following directory: `<Tomcat_Home>/common/lib`.

d) the `jar` files can also be copied to the `/WEB-INF/lib` directory under your application context.

e) In the `JSP` page, the following tags can be used to refer to the installed `JSTL`:

```
<%@ taglib
uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
```

Organization of JSTL

The `JSTL` tags are organized into four libraries:

Library features	Recommended prefix
Core (control flow, URLs, variable access)	`c`
Text formatting	`fmt`
XML manipulation	`x`
Database access	`sql`

JSTL: Core Tags 1

The core tags can be subdivided into a few categories:

1) General-purpose
    a) `out`
    b) `set`
    c) `catch`
    d) `remove`
2) Flow control
    a) `forEach`
    b) `forTokens`

JSTL: Core Tags 2

3) conditional
    a) `if`
    b) `choose`
    c) `when`
    d) `otherwise`

JSTL: Core Tags 3

4) URL management

a) url

b) import

c) redirect

d) param

JSTL Tags: <c:out>

This tag evaluates the `JSTL` expression and send output to the page's current `JspWriter` object.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>

<html><head><title>&lt;c:out&gt;</title></head>

  <body>

   <c:out value="${'<tag> , &'}"/>
   <br>
   <c:out value='<tag> , &' escapeXml="false"/>
  </body>
</html>
```

Attributes of <c:out> tag

1) **`value`**: expression to be evaluated and send
2) **`escapeXml`**: default is true and characters `<,>,&,'` and `"` result in `<, >, and &, &#039;, and &#034;`
3) **`default`**: defines the default value to be used in case the expression fails or results in null

Task 39: <c:out> tag

1) Investigate the result of using different attributes of `<c:out>` tag.
    a) Follow the previous example to test the output.
    b) View the source of the web page to see the actual output of the page.
    c) What is the difference with different values of the attribute `escapeXml`?

JSTL Tags: <c:set>

This tag evaluates an expression and uses the results to set a scoped variable, a `JavaBean` or a `java.util.Map` object.

Examples:

```
<c:set value="expression" target="target object"
property="name of property" />

<c:set value="value" var="varName"/>
```

Attributes of <c:set> tag1

1) **`value:`** expression to be evaluated
2) **`var:`** the name of the result variable representing the evaluated result from `value` attribute
3) **`scope:`** scope of the object named by the `var` attribute including:
    1) `page` (default)
    2) `request`
    3) `session`
    4) `application`

Attributes of <c:set> tag 2

4) **`target:`** a `JavaBean` of a `java.util.Map` object whose property will be set

5) **`property:`** the name of the property of the target object which will be set by the value attribute

Usage of <c:set> tag

1) set a scoped variable for use later

   for example:

```
<c:set value="100" var="totalCost"
scope="session"/>
```

2) set the property of a `JavaBean` or `Map` object

```
<c:set value="pass" target="student_A"
property="grade"/>
```

JSTL Tags: <c:catch>

This tag provides a complement to the `JSP` error page mechanism.

It works as a `try-catch` statement.

Code surrounded by a catch tag will never cause the error page mechanism to be invoked.

If a `var` attribute is set, the exception will be stored in the variable identified by the `var` attribute.

The `var` attribute always has `page` scope.

JSTL Tags: <c:remove>

This tag is used to remove a scoped variable

For example:

```
<c:remove var="cart" scope="session"/>
```

JSTL Tags: <c:forEach>

This tag provides iteration over a collection of objects.

supports iteration over an array, `java.util.Collection`, `java.util.Iterator`, `java.util.Enumeration`, or a `java.util.Map`

Example:

```
<c:forEach var="name" varStatus="status"
      begin="expression" end="expression"
      step="expression">

      body content

</c:forEach>
```

Attributes of <c:forEach> tag1

`var:` defines the name of the current object, or primitive, exposed to the body of the tag during iteration

`items:` attribute defines the collection of items to iterate over

`varStatus:` defines the name of the scope variable that provides the status of the iteration

Properties of `varStatus` may be:

```
current
index
count
first
begin
end
step
```

Attributes of <c:forEach> tag 2

`begin:` an int value that sets where the iteration should begin

`end:` The end attribute is an int value that determines inclusively where the iteration is to stop

`step:` The step attribute is an int value that determines the “step” to use when iterating

Example: <c:forEach> tag 1

1) This example displays the `varStatus` value in a loop.

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
  prefix="c" %>

<H2>froEach varStatus</H2>

<UL>

<c:forEach var="count" begin="0" end="10" step="2"
  varStatus="status">

<LI><c:out value="${count}<br>"
  escapeXml="false"/>

<c:out value="current: ${status.current}<br>"
  escapeXml="false"/>

<c:out value="index: ${status.index}<br>"
  escapeXml="false"/>
```

Example: <c:forEach> tag 2

```
<c:out value="count: ${status.count}<br>"
  escapeXml="false"/>

<c:out value="first: ${status.first}<br>"
  escapeXml="false"/>

<c:out value="begin: ${status.begin}<br>"
  escapeXml="false"/>

<c:out value="end: ${status.end}<br>"
  escapeXml="false"/>

<c:out value="step: ${status.step}<br>"
  escapeXml="false"/>

</c:forEach>

</UL>
```

Example: <c:forEach> tag 3

2) This example uses the `<c:forEach>` tag to loop through an array and display on the web page.

```
<% String[] words = { "foo", "bar", "baz"};
pageContext.setAttribute("words", words); %>
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
  prefix="c" %>
<html>
<head>
<H2>Key Words:</H2>
</head>
<body>
<UL>
```

Example: <c:forEach> tag 4

```
    <c:forEach var="word" items="${words}">
    <LI><c:out value="${word}"/>
    </c:forEach>
</UL>
<H2>Values of the test Parameter:</H2>
 <c:forEach var="val" items="${paramValues.test}">
     <LI><c:out value="${val}"/>
 </c:forEach>
</body>
</html>
```

JSTL Tags: <c:forTokens>

This tag parses a `String` into tokens based on a given delimiter.

It works similar to the `forEach` tag with an extra attribute `delime` specifying a token delimiter.

Example:

```
<c:forTokens var="name" delime="," 
items="Bryan,Frank,Gab">
 <c:out value="${name}"/>
</c:forTokens>
```

JSTL Tags: <c:if>

This tag works similar to a Java `if` and `switch`.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
. . .
<c:if test="${user == null}">
<form>
  Name: <input name="name">
  Pass: <input name="pass">
</form>
</c:if>
. . .
```

Attributes of <c:if> tag

`test:` the condition for testing

`var:` an optional attribute that defines the name of a scoped variable

`scope:` defines the scope of the var attribute.
(page, request, session or application)

JSTL Tags: <c:choose> 1

for more than one options, use the `<c:choose>`, `<c:when>` and `<otherwise>` tag

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
. . .
<c:choose>
  <c:when test="${user == null}">
    <form>
     Name: <input name="name">
     Pass: <input name="pass">
    </form>
```

JSTL Tags: <c:choose> 2

```
    </c:when>
    <c:otherwise>
       Welcome ${user.name}
    </c:otherwise>
 </c:choose>
. . .
</body>
</html>
```

Task 40: <c:choose> tag

1) Use tags `<c:choose>`,`<c:when>` and `<c:otherwise>` to develop a `JSP` page which generates the follows:

```
1  (small)
2  (small)
3  (small)
4  (medium)
5  (medium)
6  (medium)
7  (medium)
8  (large)
9  (large)
10 (large)
```

JSTL Tags: <c:url>

This tag provides automatically encoded `URLs`.

Session information and parameters are encoded with a `URL`.

This tag is used when client does not support cookies.

Attributes of <c:url> tag

value: provides the URL to be processed

context: defines the name of the context

var: exports the encoded URL to a scoped variable

scope: defines the scope of the var object

For example:

```
<c:url var="thisURL" value="newPage.jsp">
<c:param name="aVariable" value="${v.id}"/>
<c:param name="aString" value="Simple String"/>
</c:url>
<a href="<c:out value="${thisURL}"/>">Next</a>
```

The above generates a URL as follows:

```
newPage.jsp?aVariable=24&aString=Simple+String
```

JSTL Tags: <c:redirect>

This tag provides the functionality to call the `HttpServletResponse.sendRedirect` method.

It can have attributes as follows:

`url`: the `URL` the client should be redirected to

`context`: the context of the `URL` specified by the `url` attribute

JSTL Tags: <c:import>

This tag provides all of the functionality of the `include` Action.

It allows for inclusion of absolute `URLs`, e.g. the content from a different web site.

Example:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>
<c:import url="http://www.yahoo.com" />
```

JSTL Tags: <c:param>

This tag is used within the body of `<c:import>` tag to set `URL` parameters.

Examples:

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core"
prefix="c" %>

<c:import url="http://search.yahoo.com/search"
var="yahoo">

<c:param name="p" value="java" />

</c:import>

<c:out value="${yahoo}" escapeXml="false" />
```

Other Tags

Other than the core tags, there are tags for different purposes such as :

database tags:
`<sql:setDataSource>,<sql:query>,<sql:update>. . .`

formatting tags:
`<fmt:formatNumber>,<fmt:parseNumber> . . .`

internationalization tags:
`<fmt:setLocale>,<fmt:setBundle>. . .`

XML manipulation tags:
`<x:parse>,<x:if>,<x:choose>,<x:transform>. . .`

Custom Tags

Like HTML, custom tags abstract code behind markup and provide a clean separation between logic and content.

Custom tags are designed to be used easily for a non-programmer.

Unlike scriptlet, custom tags can be packaged into a JAR file and deployed across web applications.

When to Use Custom Tags

Custom tags can be used to embedded dynamic functionality in a JSP.

Examples:

1) support the View partition in a MVC (Model-View-Controller) design pattern
2) support multi-lingual site
3) produce different formats of output to different clients such as web browser, PDA or web application
4) complement to the JSTL to provide full support for conditionals and iterations

Simple JSP 2.0 Custom Tags

introduced in `JSP` 2.0 with a simple life cycle

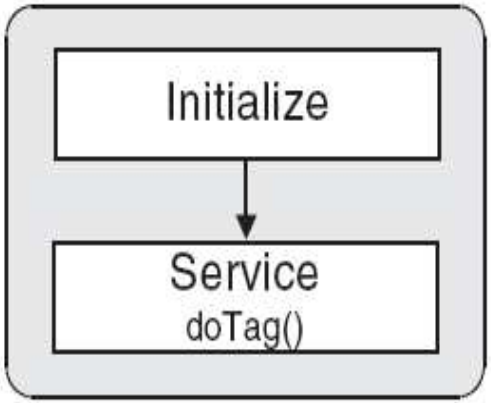
easier to write and use than the classic custom tag handlers

based on the `javax.servlet.jsp.SimpleTag` interface

Life Cycle

Has only two parts:

1) Initialization
   a) set the parent and body
   b) set by the `JSP` container
2) Service – `doTag()`
   a) implemented by the custom tag developer



SimpleTag Interface 1

All `SimpleTag` classes should implement the `javax.servlet.jsp.tagext.SimpleTag` interface

The interface defines the following methods:

`doTag()` – implemented by the tag developer and invoked by a `JSP` container during execution

`getParent()` – returns the custom tag surrounding this tag

SimpleTag Interface 2

`setJspBody(javax.servlets.jsp.JspFragment)` – invoked by a JSP container during runtime before the `doTag()` method

`setJspContext(javax.servlets.jsp.JspContext)` – invoked by a JSP container during runtime before the `doTag()` method

`setParent(javax.servlets.jsp.JspTag` – invoked by a `JSP` container during runtime to set the current parent tag

How to Develop Simple Tags

The `javax.servlet.jsp.tagext.SimpleTagSupport` class is the base implementation of the `SimpleTag` interface.

A custom tag can extend `SimpleTagSupport` and override the `doTag()` method.

Task 41: Simple Custom Tag

1) Develop a simple tag.
   a) Create a class named `HelloSimpleTag`.
   b) This class should be a subclass of `SimpleTagSupport` class.
   c) Allow the tag output a string in the `doTag()` method.
   d) The class may look like the follows:

```
package web.jsp;
import javax.servlet.jsp.tagext.SimpleTagSupport;
import javax.servlet.jsp.*;
import java.io.IOException;
public class HelloSimpleTag extends
SimpleTagSupport{
```

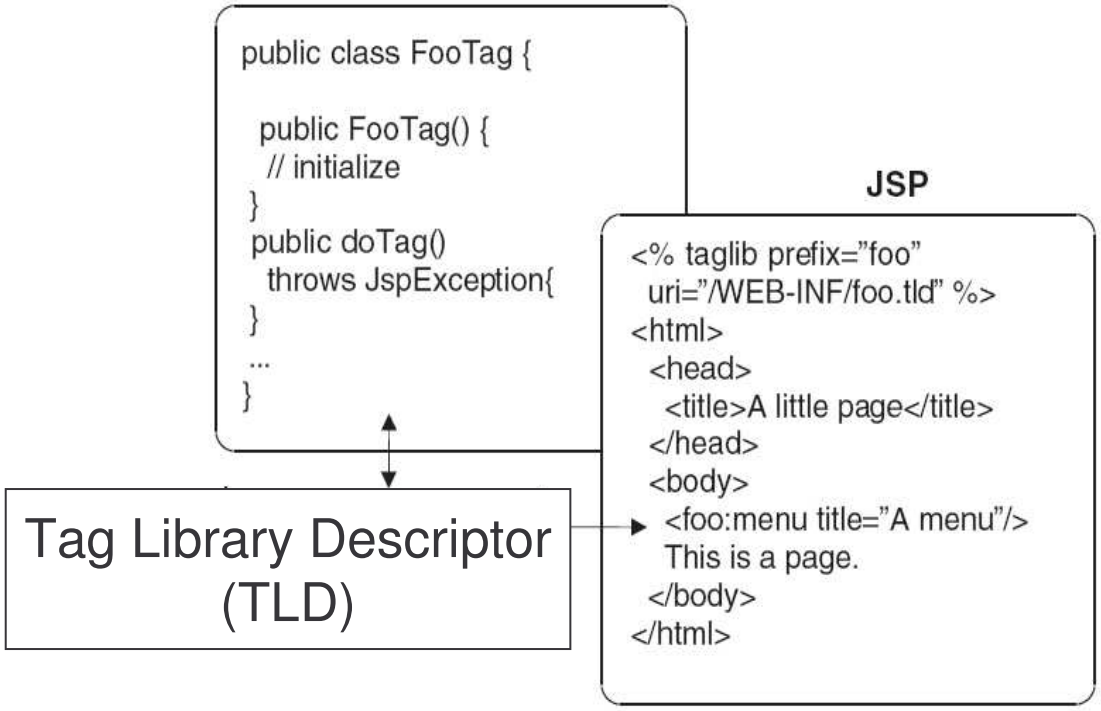
Task 42: Simple Custom Tag

```
  public void doTag() throws JspException,
  IOException {
    JspWriter out = getJspContext().getOut();
    out.println("Hello World!");
  }
}
```

How to Use Custom Tags

A collection of custom tags designed for a common goal can be packaged into a library.

The custom tags within the library can be used by a JSP as described by a `Tag Library Descriptor` (`TLD`) file.



Tag Library Descriptor 1

Tag Library Descriptor is an XML file with "tld" extension or a JAR file used to bind the custom tags to the markup appears in a JSP file.

For example, following TLD file will bind the CountTag to a JSP with a name "count":

```
<taglib xmlns="http://java.sun.com/xml/ns/j2ee"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
 http://java.sun.com/xml/ns/j2ee/
 web jsptaglibrary_2_0.xsd" version="2.0">
  <tlib-version>1.0</tlib-version>
  <jsp-version>2.0</jsp-version>
  <short-name>Example TLD</short-name>
```

Tag Library Descriptor 2

```
    <tag>
      <name>count</name>
      <tag-class>com.web.CountTag</tag-class>
      <body-content>empty</body-content>
  </tag>
</taglib>
```

TLD: Tag Elements 1

All tag definitions must be nested inside the `<taglib>` element.

The following tags are mandatory and should appear only once:

```
<tlib-version>1.0</tlib-version>
<jsp-version>2.0</jsp-version>
<short-name>Example TLD</short-name>
```

TLD: Tag Elements 2

Each tag is defined by a <tag> element.

Within the <tag> element, the following attribute tags could be defined:

<name>: unique element name of the custom tag

<tag-class>: full class name for the tag class

<body-content>: types of code allowed to be inserted into the body of the custom tag when used by a JSP:

1) empty – tag body should be empty
2) JSP – tag body may be empty or containing scripting elements
3) scriptless – no scripting elements allowed
4) tagdependent – the body may contain non-JSP content like SQL statements

Task 43: Custom Tag Library

1) Follow the example to create a custom tag library which defines the `HelloSimpleTag` with a name "`hello`".
   a) Modify the name element.
   b) Save the file as `example.tld` in the `WEB-INF` directory.

Using Tag Library

A tag library can be referenced and used in a `JSP` by different methods.

Two of them are:

1) define a relative `URI` in `JSP` file
2) define a web application-wide `URI`

TLD: Relative URI

A relative URI can be defined in JSP file without a protocol and host.

For example:

```
<%@ taglib uri="/WEB-INF/example.tld" prefix="ex" %>
<html>
  . . .
  <ex:hello/>
  . . .
```

Note:

A root-relative URI should start with a "/", while a non-root-relative URI has no leading "/"

TLD: Application-Wide URI 1

An abstract `URI` can be defined by an entry in the `web.xml` file.

Example:

in `web.xml` file:

```
<taglib>
  <taglib-uri>
      http://www.example.com/example
  </taglib-uri>
  <taglib-location>
      /WEB-INF/example.tld
  </taglib-location>
</taglib>
```

TLD: Application-Wide URI 2

in JSP file:

```
<%@ tablib uri="http://www.exmple.com/example"
prefix="ex" %>

. . .

<ex:hello/>
```

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Summary 1

`JSP` can produce dynamic content using scriptlet or tags.

While keeping the benefit of `Servlet`, `JSP` also provides separation between business and presentation logic for a web application.

Using tags in `JSP` allows the separation to be achieved easily.

Summary 2

The life cycle of a `JSP` is similar to that of a Servlet except a `JSP` file has to be compiled into a `Servlet` class before being used.

Five kinds of scripting elements can be used in JavaServer Pages:

1) declarations `<%!` `%>`
2) scriptlets `<%` `%>`
3) expressions `<%=` `%>`
4) directives `<%@` `%>`
5) comments `<%--` `--%>;<%` `/**` `**/%>;<!--` `-->`

Summary 3

The following implicit objects are defined in `JSP` and can be used without declaration:

`application`	`pageContext`
`config`	`page`
`session`	`out`
`request`	`exception`
`response`	

Summary 4

JSP 2.0 specification defines Expression Language which provides a cleaner syntax then scriptlet.

JSP Actions can cooperate with JSP EL to provide a clean abstraction of Java codes making the JSP file easier to be maintained.

Summary 5

JavaServer Pages Standard Tag Library (JSTL) is an extended set of JSP standard Actions. Tags are available for the follows:

1) Iteration and conditional
2) Expression Language
3) URL manipulation
4) i18n-capable text formatting
5) XML manipulation
6) Database access

JSP 2.0 define a Simple Custom Tags which can be developed easily.

Tag Library Descriptor file is used to bind custom tag library to a JSP file.

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Filter: Basic Concepts

`Filter` is a new feature in the servlet 2.3 specification.

`Filter` usually acts as a components between a request and a resource in a web application.

`Filters` can:

1) read request data
2) wrap request data
3) redirect a request
4) manipulate response data
5) generate its own response
6) wrap a response
7) return errors to the client

Filter: Advantages

Layers of `Filters` can be added for pre-processing and post-processing to a request and response.

`Filters` can perform similar functionality as `Servlets` and request dispatcher.

Unlike `Servlet` which had to be programmed differently for chaining, applying `Filters` to existing web application resources is easier.

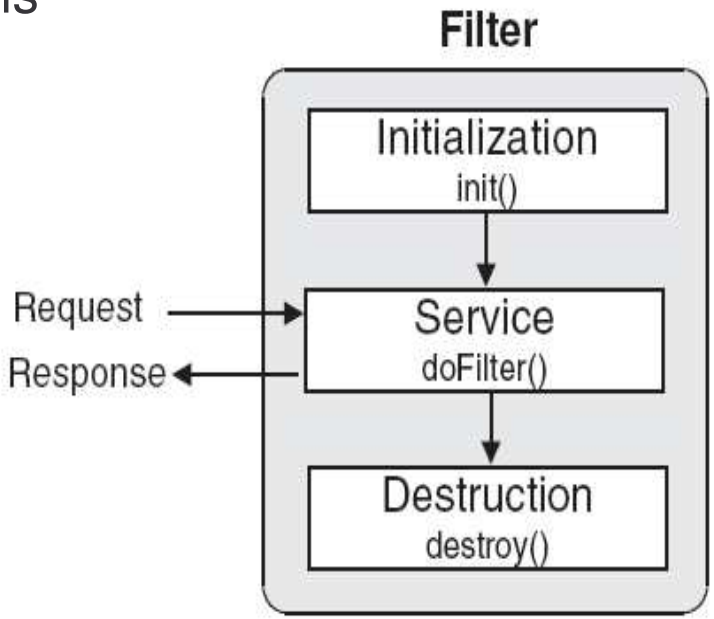
Filter: Sample Applications

1) Access Control
    a) authentication, logging, auditing
    b) role-based security
    c) MIME-type redirection
2) Content Manipulation
    a) modify headers (request and response)
    b) data transformation
        - encryption, compression
        - `XSLT`, conversion

Filter: Life Cycle

`Filter's` life cycle mimics that of a `Servlet`:

1) initialization
    a) occurs only once when the `Filter` is first loaded
2) service
    a) occurs every time the `Filter` is accessed
3) destruction
    a) invoked after web application has finished using the `Filter`
    b) all resources of the `Filter` should be terminated



Filter: Interface

`javax.servlet.Filter`

a) For initialization:

```
public void init(FilterConfig config)
  throws ServletException
```

b) For service:

```
public void doFilter(ServletRequest request,
ServletResponse response, FilterChain chain)
  throws java.io.IOException, ServletException
```

c) For destruction:

```
public void destroy()
```

Filter: FilterConfig Object

`FilterConfig` object is used for `Filter` configuration.

`<init-param>` elements is used in the `web.xml` file, as for a servlet, to define custom initialization parameters

methods available:

```
String getFilterName()
String getInitParameter(String parameterName)
Enumeration getInitParameterNames()
ServletContext getServletContext()
```

Filter: FilterChain Object

`FilterChain` object is for invoking next `Filter` in chain (if any) or requested resource.

A method `doFilter` is defined for this purpose.

Methods available:

```
public void doFilter(ServletRequest request,
ServletResponse response)
throws java.io.IOException, ServletException
```

Filter: Deployment

`Filter` is deployed in a servlet container like a `servlet`.

Web application deployment descriptor file (`web.xml`) is also used for configuring a `Filter`.

`Filter` is defined via `<filter>` element in the `web.xml` file:

```
<filter>
        <filter-name>name</filter-name>
        <filter-class>class</filter-class>
        <init-param>
              <param-name>name</param-name>
              <param-value>value</param-value>
        </init-param>
        . . .
</filter>
```

Filter: Mapping

Mapping of `Filter` is defined via `<filter-mapping>` element and has two forms:

a) Map to a specific `servlet` as follows:

```
<filter-mapping>
        <filter-name>name</filter-name>
        <servlet-name>name</servlet-name>
</filter-mapping>
```

b) Map to a `URL` pattern as follows:

```
<filter-mapping>
        <filter-name>name</filter-name>
        <url-pattern>pattern</url-pattern>
</filter-mapping>
```

Task 44: Simple Filter

1) A `Filter` can work as a normal Servlet. Try to build a simple `HelloWorld` Filter, deploy and test it.
   a) Create a `Filter` named "`FilterHelloWorld.java`". Note that `Filter` has to implement the `javax.servlet.Filter` interface.
   b) implement the init, `doFilter` and destroy methods. Don't do anything for init and destroy methods at this stage. Just try to implement `doFilter` to generate an `HTML` page showing a `String` "`HelloWorld`".
   c) Deploy your Filter at `Tomcat` and add the followings to the `web.xml` file:

```
<filter>
  <filter-name>FilterHelloWorld</filter-name>
  <filter-class>
        com.web.FilterHelloWorld
  </filter-class>
</filter>
```

Task 45: Simple Filter

```
    <filter-mapping>
        <filter-name>FilterHelloWorld</filter-name>
        <url-pattern>/FilterHelloWorld</url-pattern>
    </filter-mapping>
```

2) A `Filter` can do what a `Servlet` can. What is the difference between the `doFilter` method of a `Filter` and the service method of a `javax.servlet.Servlet` interface?

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   g) summary

3) Filter
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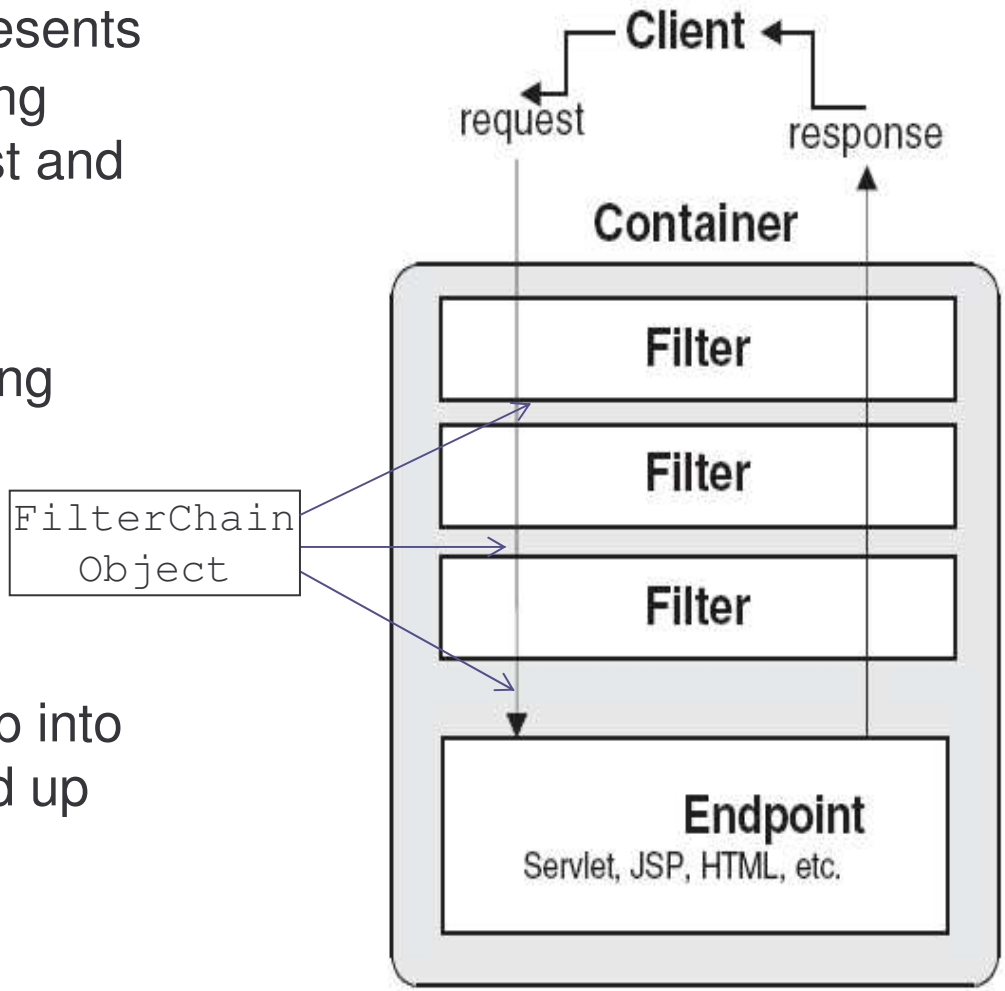
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

FilterChain Object

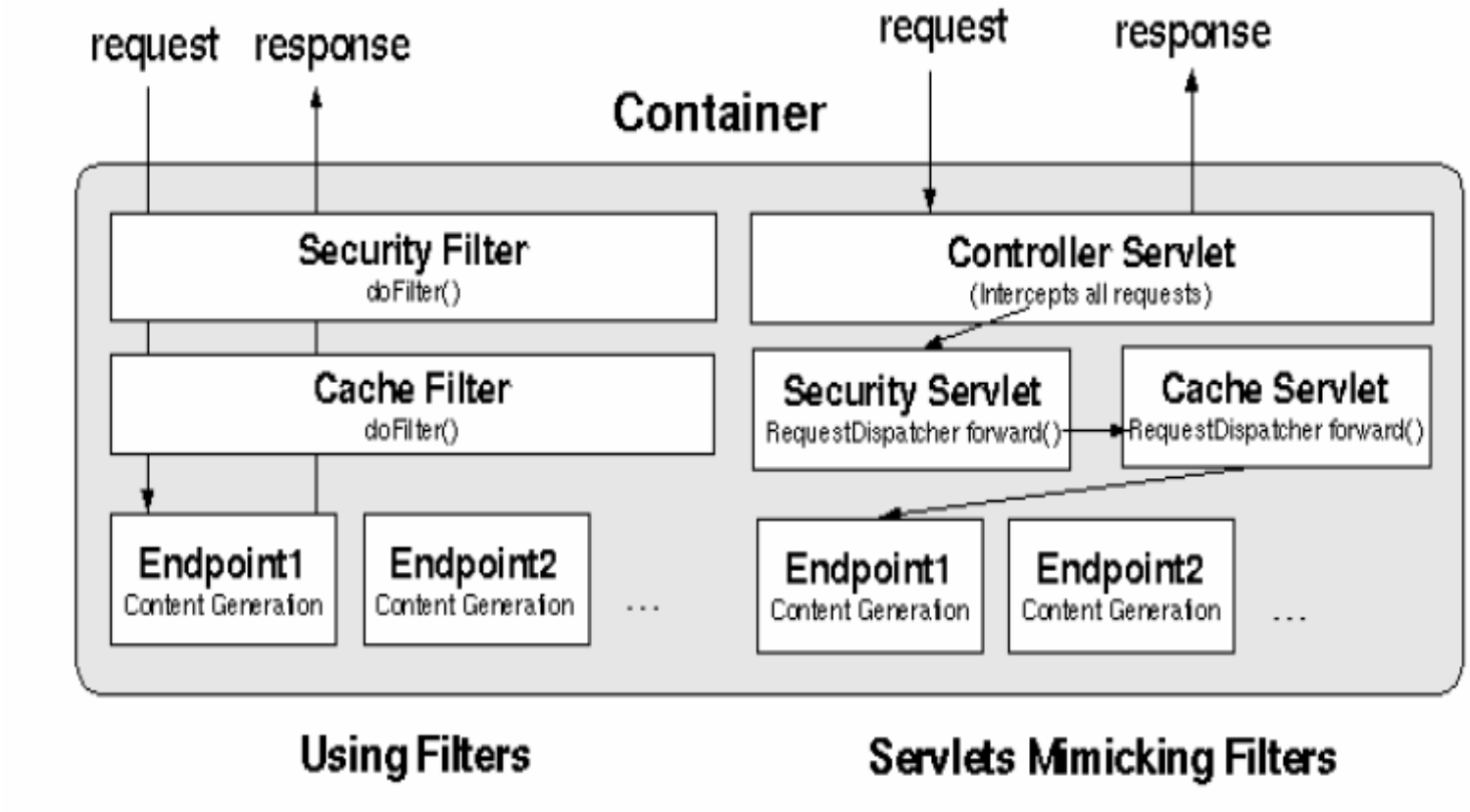
The `FilterChain` object represents the possible stack of Filters being executed on a particular request and response.

A mechanism for cleanly applying layers of functionality to a `ServletRequest` and `ServletResponse`.

Functionality is easily divided up into many logical layers and stacked up as desired.



Filter Versus Servlet



Defining a Filter Chain 1

To define a `filter` chain, put two or more filter declarations into the configuration file and supply appropriate values for the `<url-pattern>` elements .

For example, in the `web.xml` file, the following entries is set:

```
...
<filter>
      <filter-name>FilterAllRequests</filter-name>
      <filter-class>mypackage1.FilterOne</filter-class>
</filter>
<filter-mapping>
      <filter-name>FilterAllRequests</filter-name>
      <url-pattern>/*</url-pattern>
</filter-mapping>
```

Defining a Filter Chain 2

```
<filter>
      <filter-name>FilterMyDocs</filter-name>
      <filter-class>mypackage1.FilterTwo</filter-class>
</filter>
<filter-mapping>
      <filter-name>FilterMyDocs</filter-name>
      <url-pattern>/mydocs/*</url-pattern>
</filter-mapping>

...
```

If a request for a resource like `http://127.0.0.1:8080/mydocs/foo.html` is received, the container will apply `FilterAllRequests` and `FilterMyDocs` according to their order appearing in the `web.xml` file.

Invoking Filter Chain

A `Filter` can invoke another Filter by calling the `doFilter` method of the `FilterChain` object.
For example: `chain.doFilter();`

The ordering of `Filter` execution matches the ascending order of filter-mapping elements defined in `web.xml` file.

```
public void doFilter(ServletRequest req, ServletResponse
res, FilterChain chain) throws IOException,
ServletException
{
      . . .
      chain.doFilter();
}
```

Task 46: Filter Chain

1) Add a hit counter `Filter` to a simple `hello.html` file.
   a) Create an `HTML` file as follows:

```
<html>
   <head>
      <title>HTML Page</title>
   </head>
   <body bgcolor="#FFFFFF">
            Hello World!
   </body>
</html>
```

Task 47: Filter Chain

b) Create a `Filter` for counting the hit rate for the `hello.html` page.

1. This `Filter` has to implements `javax.servlet.Filter` interface.
2. Declare a static integer variable count for counting the hit.
3. Declare a `FilterConfig` object for the reference received from the init methods.
4. There are three methods needed to be implemented: `init`, `doFilter` and `destroy`.
5. Implement the `init` method. What type of argument should be received?
6. Define an initial parameter named count in the `web.xml` file. Its initial value should be 0. Use corresponding method to get this initial parameter in the Filter.

Task 48: Filter Chain

7. Implements the `doFilter` method. The major task for the `doFilter` is add one to the counter and add a message to the response. The message may look like this: "The page has been viewed 3 times". You have your response object from the argument of the method and try to get a `PrintWriter` from there and write the message out to the response.
8. After modify the response, call the `doFilter` method of the `FilterChain` object received from the method's argument. this will pass the control to next filter or the end resource if no more filter exists.
9. Implement the destroy method to clear the `FilterConfig` object.

Task 49: Filter Chain

c) Deploy the web application correctly. In the `web.xml` file, define the `Filter` as follows:

```
. . .
 <filter>
    <filter-name>CounterFilter</filter-name>
    <filter-lass>
      your_filter_full_class_name
   </filter-class>
    <init-param>
        <param-name>Counter</param-name>
         <param-value>0</param-value>
     </init-param>
```

Task 50: Filter Chain

```
    </filter>


    <filter-mapping>
       <filter-name>CounterFilter</filter-name>
       <url-pattern>maping_pattern</url-pattern>
    </filter-mapping>
```

d) Change the value of `<url-pattern>` tag to allow `CounterFilter` to work for all `HTML` files.

e) Try access the `hello.html` and check out the result. Make sure to turn off the cache option of the browser.

Task 51: Filter Chain

2) Stack another `Filter` on top of the hit counter and named it `AuthenticationFilter`. This `Filter` is simplified for this exercise.

   The functionality of the `Filter` is as follows:

   When the client want to access the `hello.html` page, the `AuthenticationFilter` will check if the user has been login or not. A login page may show up if the user has not been login. Once the user pass the login process, a permission will be granted and the request will pass to the hit counter filter, followed by the `hello.html` page.

   Please be noted that by using `Filter`, no change is made to the target resource, `hello.html`, at all.

Task 52: Filter Chain

a) The `AuthenticationFilter` may look as follows:

```
package com.web;
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.*;
 import javax.servlet.http.*;
 public class AuthenticationFilter implements Filter {
         private FilterConfig config;

         public AuthenticationFilter() {
         super();
 }
```

Task 53: Filter Chain

```
// initialize the FilterConfig object.
// we are not using this object in this filter
public void init(FilterConfig config) throws
   ServletException {
        // TODO Auto-generated method stub
        this.config = config;
}
public void doFilter(
        ServletRequest req,
        ServletResponse res,
        FilterChain chain) throws IOException,
        ServletException {
```

Task 54: Filter Chain

```
String nextPage;
  HttpServletRequest request=(HttpServletRequest)req;
  HttpServletResponse response
   =(HttpServletResponse)res;
HttpSession = request.getSession();
String userName = request.getParameter("username");
String passWord = request.getParameter("password");
String login = (String)session.getAttribute("login");
```

Task 55: Filter Chain

```
// if the user has login already, pass to next filter
// make sure that you check if it is null
if (login!= null && (login.equals("true")) )
      chain.doFilter( req,res);
}
// print out the login in form, you may dispatch to
// other login page
else{
```

Task 56: Filter Chain

```
res.setContentType("text/html");
PrintWriter out = res.getWriter();
out.println ("<form action="+uri+" method='POST'>") ;
out.println ( "<table>");
out.println ( " <tr><td>User:</td><td><input
  type='text' name='username'></td></tr>");
out.println ( "<tr><td>Password:</td><td><input
  type='password' name='password'></td></tr>");
```

Task 57: Filter Chain

```
        out.println ( " <tr><td colspan='2'><input
           type=submit></td></tr>");
        out.println ( " </table>");
        out.println ("</form>");
        }
      }
    }
  public void destroy() {
  }
}
```

Task 58: Filter Chain

b) Modify the `web.xml` file to stack the `AuthenticationFilter` on top of the `CounterFilter` as follows:

```
. . .

<filter>
   <filter-name>AuthFilter</filter-name>
   <filter-
   class>com.web.AuthenticationFilter</filter-class>
</filter>
```

Task 59: Filter Chain

```
<!-- the AuthenticationFilter is applied to all html
   files
-->
<filter-mapping>
   <filter-name>AuthFilter</filter-name>
   <url-pattern>*.html</url-pattern>
</filter-mapping>
. . .
```

Task 60: Filter Chain

b) Try to access the `hello.html` again.

c) Try to enter a wrong user name or password.

d) Try to use “user” as user name and “pass” as password to login in. What is the difference between this and step c?

e) Try to access the `hello.html` couple times and check the output. Make sure to disable the cache option of the browser.

Task 61: Filter Chain

f) Set up the `Tomcat` server to make session expire after 1 minute. Put the following statement to the `web.xml` file:

```
<session-config>
      <session-timeout>
          1 <!--minute-->
      </session-timeout>
</session-config>
```

g) Wait for a minute and try to access the `hello.html` again.

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Filter Dispatcher

By default, Filters will only handle a request made by a client.

Request dispatched using either the `forward()` or `include()` methods of the `RequestDispatcher` object will not be handled.

This can be re-configured via `web.xml` file by using the `<dispatcher>` element as follows:

```
<filter-mapping>
 <filter-name>AuthenticationFilter</filter-name>
 <url-pattern>/*</url-pattern>
 <dispatcher>INCLUDE</dispatcher>
</filter-mapping>
```

Filter Dispatcher Elements

There are four types of dispatcher elements:

1) REQUEST

2) INCLUDE

3) FORWARD

4) ERROR

More than one dispatcher elements can be used as the same time such as:

```
. . .
      <dispatcher>INCLUDE</dispatcher>
      <dispatcher>REQUEST</dispatcher>
 . . .
```

Noted that if the dispatcher elements used, only the declared dispatcher call will be handled.

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Filter: Wrapper

`Wrapper` is a new feature of `Filters` introduce in `Servlet` 2.3 specification.

A request or response can be wrapped inside a customized one.

Custom coding can then be used to manipulate the wrapped request and response.

Request and response are wrapped differently.

Invocating Wrappers in Filter

`Wrappers` are invocated within the `doFilter` method of a `Filter`:

```
public void doFilter(ServletRequest request,
   ServletResponse response FilterChain chain)
   throws java.io.IOException, ServletException {

      // Process request
      // Wrap request and/or response
      chain.doFilter(request or wrappedRequest,
                response or wrappedResponse);
      // Process (wrapped) response
   }
```

ServletRequest Wrapper

For `ServletRequest`, a corresponding `ServletRequestWrapper` is available for sublcassing as a wrapper:

```
javax.servlet.ServletRequestWrapper implements
ServletRequest
```

Constructor:

```
public ServletRequestWrapper(ServletRequest req)
```

HttpServletRequest Wrapper

For `HttpServletRequest`, a corresponding `HttpServletRequestWrapper` is provided for sublcassing as wrapper:

```
javax.servlet.HttpServletRequestWrapper extends
          ServletRequestWrapper implements
HttpServletRequest
```

Constructor:

```
public HttpServletRequestWrapper(HttpServletRequest
   req)
```

Task 62: Request Wrappers

1) Use a `Filter` to change the request headers before a `servlet` or `JSP` receives the request. A request wrapper is used to wrapped the request and pass it to the `FilterChain.doFilter( )` method, instead of the original request destination.

   a) Create a class that extends `HttpServletRequestWrapper.`

```
import javax.servlet.http.HttpServletRequestWrapper;
import javax.servlet.http.HttpServletRequest;
import java.util.*;
public class RequestWrapper extends
 HttpServletRequestWrapper{
   public RequestWrapper(HttpServletRequest request){
      super(request);
   }
```

Task 63: Request Wrappers

```
    public Locale getLocale(){
        return new Locale("English", "Canada");
    }
}
```

b) Create a `Filter` name `RequestFilter` which uses the `RequestWrapper` to wrapped the `ServletRequest` and passes it to the target.

```
import javax.servlet.*;
import javax.servlet.http.*;
public class RequestFilter implements Filter {
```

Task 64: Request Wrappers

```
private FilterConfig config;

public RequestFilter( ) {}

public void  init(FilterConfig filterConfig)
throws ServletException{

        this.config = filterConfig;

 }

 public void  doFilter(ServletRequest request,

 ServletResponse response, FilterChain chain)
  throws java.io.IOException,ServletException {
```

Task 65: Request Wrappers

```
      RequestWrapper wrapper = null;
       ServletContext context = null;
        if (request instanceof HttpServletRequest)
           wrapper = new
            RequestWrapper((HttpServletRequest)request);
            if (wrapper != null)
              chain.doFilter(wrapper,response);
        else
              chain.doFilter(request,response);
   }
      public void destroy( ){}
}
```

Task 66: Request Wrappers

c) Modify the `web.xml` file as follows:

```
<servlet>
        <servlet-name>requestjsp</servlet-name>
        <jsp-file>/request.jsp</jsp-file>
</servlet>
<servlet-mapping>
        <servlet-name>requestjsp</servlet-name>
        <url-pattern>/requestjsp</url-pattern>
</servlet-mapping>
```

Task 67: Request Wrappers

```
<filter>
   <filter-name>RequestFilter</filter-name>
   <filter-class>com.web.RequestFilter</filter-class>
</filter>
<filter-mapping>
   <filter-name>RequestFilter</filter-name>
   <url-pattern>/requestjsp</url-pattern>
</filter-mapping>
```

d) Deploy the files and try to browse the file /`requestjsp` under the application context. Try to browse the file through /`request.jsp` under the application context. What is the difference?

Servlet Response Wrapper

Similar to request wrapper, there are `ServletResponseWrapper` and `httpServletResponseWrapper` availabe for subclassing to create the corresponding wrappers.

```
javax.servlet.ServletResponseWrapper implements
      ServletResponse
```

Constructor :

```
public ServletResponseWrapper(ServletResponse res)
```

HttpServlet Response Wrapper

For `HttpServletResponseWrapper`:

```
javax.servlet.http.HttpServletResponseWrapper
   extends ServletResponseWrapper
   implements HttpServletResponse
```

Constructor:

```
   public HttpServletResponseWrapper
   (HttpServletResponse response)
```

Task 68: Response Wrapper

1) Use `Filter` and `Wrapper` to compress the content requested by a client. A `Filter` is used to intercept the request for a web page and a response wrapper is used to capture the response and pass it through a `GZIPOutputStream` to compress the data before sending it to the client.

   a) Write a class named `GZIPResponseStream` extending the standard `ServletOutputStream`, which is used to send output to the client. Methods in the `ServletOutputStream` are overridden to write compressed response data out to the client. The header of the response should also be modified adding an entry "`Content-Encoding`". The skeleton code may look as follows:

Task 69: Response Wrapper

```
import java.io.*;
import java.util.zip.GZIPOutputStream;
import javax.servlet.*;
import javax.servlet.http.*;
public class GZIPResponseStream extends
   ServletOutputStream {
//declare variables
protected ByteArrayOutputStream baos = null;
protected GZIPOutputStream gzipstream = null;
protected boolean closed = false;
protected HttpServletResponse response = null;
protected ServletOutputStream output = null;
```

Task 70: Response Wrapper

```
// A constructor that receive the original response and
// replace the output stream with a GZIPOutputStream


public GZIPResponseStream(HttpServletResponse response)
throws IOException {
    super();
    closed = false;
    this.response = response;
    this.output = response.getOutputStream();
    baos = new ByteArrayOutputStream();
    gzipstream = new GZIPOutputStream(baos);
}
```

Task 71: Response Wrapper

```
// Override the close method that will modify the header
// entries such as “Content-Length” and
// “Content-Encoding” before closing the stream.
public void close() throws IOException {
    if (!closed) {
        throw new IOException("Stream closed"); }
    gzipstream.finish();
    byte[] bytes = baos.toByteArray();
    response.addHeader("Content-Length",
    Integer.toString(bytes.length));
    response.addHeader("Content-Encoding", "gzip");
    output.write(bytes);
```

Task 72: Response Wrapper

```
    output.flush();
    output.close();
    closed = true;
}

// Override the flush() and various write methods to
// use the gzipstream instead of the original stream

public void flush() throws IOException {
if (closed) {
      throw new IOException("Fail to flush"); }
   gzipstream.flush();
}
```

Task 73: Response Wrapper

```
public void write(int b) throws IOException {
  if (closed) {
      throw new IOException("Cannot write to a closed
       output stream");
  }
      gzipstream.write((byte)b);
      }
  flush();
  close();
}
```

Task 74: Response Wrapper

```
public void write(byte b[]) throws IOException {
  if (closed) {
  throw new IOException("Cannot write to a closed output
  stream"); }
  gzipstream.write(b, 0, b.length);
  flush();
  close();
}
```

Task 75: Response Wrapper

```
public void write(byte b[], int off, int len) throws
      IOException {
  System.out.println("writing...");
  if (closed) {
  throw new IOException("Cannot write to a closed output
  stream"); }
  gzipstream.write(b, off, len);
  flush();
  close();
}
}
```

Task 76: Response Wrapper

b) Write a class named `GZIPResponseWrapper` extends the `HttpServletResponseWrapper`. The main function of this wrapper is to replace the original `OutputStream` with a `GZIPResponseStream` that we defined in previous steps. The `getWriter()` is also overridden to obtain a writer from the `GZIPResponseStream`.

The skeleton code may look as follows:

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

Task 77: Response Wrapper

```
public class GZIPResponseWrapper extends
    HttpServletResponseWrapper {
    protected HttpServletResponse origResponse = null;
    protected ServletOutputStream stream = null;
    protected PrintWriter writer = null;
// Constructor
public GZIPResponseWrapper
    (HttpServletResponse response) {
          super(response);
          origResponse = response;
}
```

Task 78: Response Wrapper

```
// Create a GZIPResponseStream from the original
   Response
public ServletOutputStream createOutputStream()
   throws IOException {
      return (new GZIPResponseStream(origResponse));
}
```

Task 79: Response Wrapper

```
// Overridden the getOutputStream and replace the
// ServletOutputStream with GZIPResponseStream
public ServletOutputStream getOutputStream() throws
IOException {
   if (writer != null) {
         throw new IllegalStateException(
         "getWriter() has already been called!");
   }
   if (stream == null)
         stream = createOutputStream();
   return (stream);
}
```

Task 80: Response Wrapper

```
// Overridden the getWriter and piped
// writer from the GZIPResponseStream
public PrintWriter getWriter() throws IOException {
   if (writer != null) {
         return (writer);
   }
   if (stream != null) {
    throw new IllegalStateException(
    "getOutputStream() has alreadybeen called!");
   }
```

Task 81: Response Wrapper

```
        stream = createOutputStream();
        writer = new PrintWriter
        (new OutputStreamWriter(stream, "UTF-8"));
        return (writer);
    }
}
```

Task 82: Response Wrapper

c) Write a class named `GZIPFilter` implements the `javax.servlet.Filter` interface. This `Filter` will check whether the client will accept gzip format. If so, the `Filter` will wrap the response with the `GZIPResponseWrapper` and let it compress the data. Otherwise, the ordinary response will be returned.
The skeleton code may look as follows:

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;
public class GZIPFilter implements Filter {
   public void init(FilterConfig filterConfig) {
     //no implementation needed
}
```

Task 83: Response Wrapper

```
public void doFilter(ServletRequest req,
    ServletResponse res,FilterChain chain) throws
    IOException, ServletException {

    if (req instanceof HttpServletRequest) {

     HttpServletRequest request =
          (HttpServletRequest) req;

     HttpServletResponse response =
          (HttpServletResponse) res;

     String ae = request.getHeader("accept-encoding");

     if (ae != null && ae.indexOf("gzip") != -1) {

          System.out.println
          ("GZIP supported, compressing.");
```

Task 84: Response Wrapper

```
                GZIPResponseWrapper wrappedResponse = new
                GZIPResponseWrapper(response);
                chain.doFilter(req, wrappedResponse);
                return;
            }
            chain.doFilter(req, res);
        }
    }
```

Task 85: Response Wrapper

d) In order to test the `Filter`, download a web page such as `www.yahoo.com/index.html` and save it under your web application context, e.g. `<TOMCAT_HOME>/webapps/FilterTest/`

e) Modify the `web.xml` file to apply the `GZIPFilter` to the downloaded page.

f) Browse the downloaded page and check the output from the console of `Tomcat`.

Vertical Concepts Outline

1) Servlet
   a) basic concepts
   b) http servlet
   c) servlet context
   d) communication between servlets
   e) summary

2) JavaServer Pages
   a) basic concepts
   b) scripting elements
   c) implicit objects
   d) actions
   e) expression language
   f) tag library
   g) summary

3) Filter
   a) basic concepts
   b) filter chain
   c) filter dispatcher
   d) wrapper
   e) summary

Filter: Summary 1

`Filter` is a new feature in the `servlet` 2.3 specification.

Filters are usually used for:

1) read request data
2) wrap request data
3) redirect a request
4) manipulate response data
5) generate its own response
6) wrap a response
7) return errors to the client

Filter: Summary 2

`Filter` can stack up as a `Filter chain` to provide layers of functionality to requested and response.

Functionality is easily divided up into many logical layers.

Filter: Summary 3

`Filters` do not handle dispatched request by default.

`<dispatcher>` element is used in the `web.xml` file to configure a `Filter` to handle dispatched requests.

Filter: Summary 4

`Wrapper` is a new feature of `Filters` introduce in `Servlet` 2.3 specification.

`Wrappers` are used to wrap and modify requests or responses.

Requests and responses are wrapped with different objects.

Horizontal Concepts

Course Outline

1) introduction

2) vertical concepts
   a) servlet
   b) java server page
   c) filters

3) horizontal concepts
   a) exception
   b) database connectivity
   c) security
   d) internationalization

4) case study

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

Exception

If an exception is thrown from a Servlets or a JSP, it is passes to the container and the reactions will be depending on the container.

Create a JSP as follows and check out what is the response of the Tomcat server.

```
<%
if (true)
throw new Exception("An Exception thrown by JSP!");
%>
```

Handling Exception

Exceptions can be handled in following ways:

1) use `try-catch-finally` statements
2) forward the `HTTP` request to a `JSP` error page
3) forward the `HTTP` request to a `Servlet` to handle the error
4) declare error pages for specific error codes and allow the container to forward to these pages

Declaring Error Page

In JSP, the following directive forwards the request to "myErrorPage.jsp" when exception is thrown:

```
<%@page errorPage="myErrorPage.jsp" %>
```

The error can also be forward to a Servlet for handling the exception.

JSP Error Page

In JSP, the directive <%@ page isErrorPage="true" %> is used to declare that the file for exception handling.

Implicit object "exception" can be used in the error page to provide exception messages.

```
<%@ page isErrorPage="true" %>
<html>
. . .
<body>
This is the error message :<br>
"<%=exception.getMessage()%>"
</body>
</html>
```

Used to declarr that this is the error handling page

Task 86: JSP Error Handling

1) Test the error handling using a `JSP` error page.
   a) Define an application-wide parameter "`admin email`" in the `web.xml` file with a value "`admin@servlet.com`".
   b) Create a `JSP` page which will throw an error message as in the previous example. Remember to use the "`page`" directive with attribute "`errorPage`" correctly.
   c) Create an error handling page to catch the exception thrown by the `JSP` page at (b). The page needed to show the error message from the implicit object "exception" and the admin email address.
   d) What will happen when the "`isErroPage`" attribute is missing?

Task 87: JSP Error Handling

2) Test the error handling using a `Servlet` error page.

a) Create a `Servlet` named "`ErrorServlet`".

b) Within this `Servlet`, get the initial parameter "`admin email`" defined in the `web.xml` file.

c) Within this `Servlet`, you can retrieve the `Exception` through the request object as following :

```
Exception e =
    (Exception)request.getAttribute
      ("javax.servlet.jsp.jspException");
```

d) Modify the previous `ThrowError.jsp` as following to test the output:

```
<%@ page errorPage="ErrorServlet" %>
  <% if (true)  throw new Exception
     ("An Exception!");
  %>
```

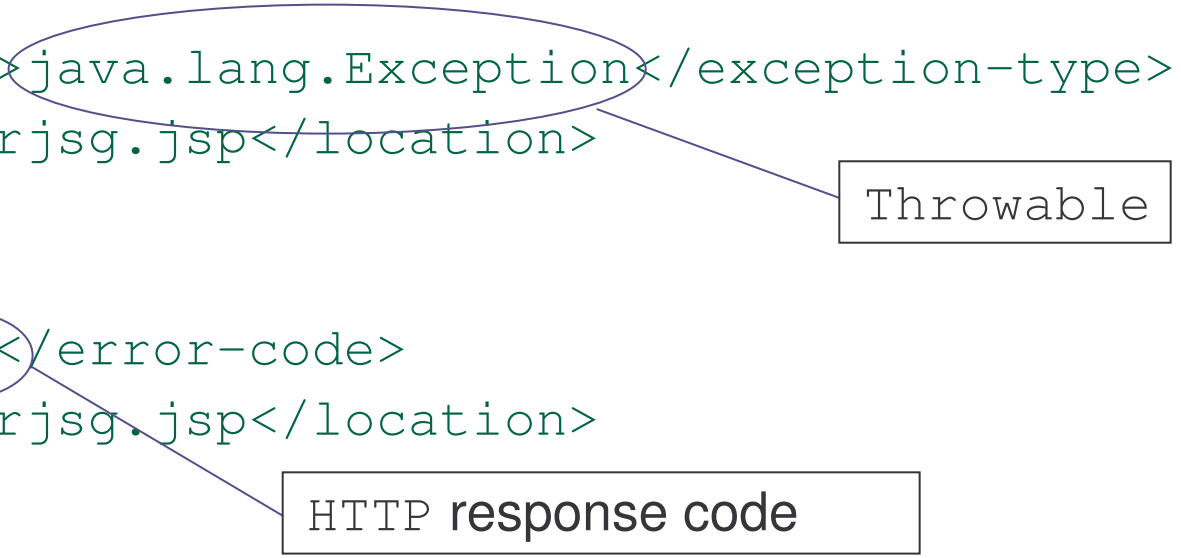
Handling Specific Error

Error handling pages for specific exception can be declared in the `web.xml` file with the tag `<error-page>`.

Container will redirect the request to the specific page according to the exception occurred.

For example, in the `web.xml` file, error page can be defined as follows:

```
<error-page>
    <exception-type>java.lang.Exception</exception-type>
    <location>/Errorjsg.jsp</location>
</error-page>
<error-page>
    <error-code>404</error-code>
    <location>/Errorjsg.jsp</location>
</error-page>
```



Error Objects

The `Servlet` specification defines some attributes which can be retrieved from the request object for debugging:

`javax.servlet.error.status_code`

`javax.servlet.error.exception_type`

`javax.servlet.error.message`

`javax.servlet.error.exception`

`javax.servlet.error.request_uri`

`javax.servlet.error.servlet_name`

Task 88: Error Object

1) Create a JSP page which will send an email after receiving an error. The email will contain messages extracted from the error. The container will be configured to handle the forwarding operation.

   a) Download two packages from SUN and put inside the folder "<Tomcat_home>/common/lib":

      JavaMail: http://java.sun.com/products/javamail/

      JavaBeans Activation Framework(JAF) : http://java.sun.com/products/javabeans/glasgow/jaf.html

   b) Create a JSP named EmailErrorPage.jsp as follows:

```
<%@page isErrorPage="true" import="java.util.*,
 javax.mail.*, javax.mail.internet.*" %>

<%

Properties props = new Properties();
```

Task 89: Error Object

```
props.put("mail.smtp.host","smtp.macau.ctm.net")
;
Session msession =
 Session.getInstance(props,null);
String email =
 application.getInitParameter("lecturer email");
MimeMessage message= new MimeMessage(msession);
message.setSubject("[Application Error]");
message.setFrom(new InternetAddress(email));
message.addRecipient(Message.RecipientType.TO,
 new InternetAddress(email));
String debug = "";
```

Task 90: Error Object

```
Integer status_code
=(Integer)request.getAttribute
   ("javax.servlet.error.status_code");
if (status_code != null) {
 debug += "status_code: "+status_code.toString()
      + "\n";
}
 Class exception_type=
 (Class)request.getAttribute
   ("javax.servlet.error.exception_type");
if (exception_type != null) {
 debug += "exception_type:
   "+exception_type.getName() + "\n";
}
```

Task 91: Error Object

```
String m=
(String)request.getAttribute
    (“javax.servlet.error.message”);
if (m != null) {
    debug += "message: "+m + "\n";
 }

 Throwable e =(Throwable)
   request.getAttribute
    ("javax.servlet.error.exception");
if (e != null) {
  debug += "exception: "+ e.toString() + "\n";
 }
```

Task 92: Error Object

```
String request_uri =
 (String)request.getAttribute
    ("javax.servlet.error.request_uri");

if (request_uri != null) {
  debug += "request_uri: "+request_uri + "\n";
 }

String servlet_name=
 (String)request.getAttribute
    ("javax.servlet.error.servlet_name");

if (servlet_name != null) {
    debug += "servlet_name: "+servlet_name;
 }
```

Task 93: Error Object

```
message.setText(debug);
 Transport.send(message);
 %>

<html><head><title>EmailErrorPage</title></head>

<body>

   <h3>An Error Has Occurred</h3>

 This site is unavailable! requested.
   <br>Please send a description of the
   problem to:

 <a href="mailto:<%=email%>"><%=email%></a>.

</body>

</html>
```

Task 94: Error Object

c) Add a tag `<error-page>` to the `web.xml` file as follows:

```
<error-page>
   <error-code>404</error-code>
   <location>/EmailErrorPage.jsp</location>
 </error-page>
```

d) In the `EmailErrorPage.jsg` file, "`lecturer email`" is used as the email address for the sender and receiver for the email. Try to modify this to use different email addresses. However, the real email address is defined in the `web.xml` file as an initial parameter as follows:

```
<context-param>
    <param-name>lecturer email</param-name>
    <param-value>miltongm@gmail.com</param-value>
 </context-param>
```

Modify this to your own email address

Logging

Logging is used to keep a record of important information in some serialized form such as text file or information printed to `System.err` or `System.out`.

For constantly log information, a more robust logging API will be prefer than `System.out.println()` method.

Some Logging API:

1) `java.util.logging` package
2) `Log4J` (`jakarta.apache.org/log4j`)

Example: Logger 1

The following example shows the basic logging functionality of the `javax.util.logging` package.

```
<%@ page import="java.util.logging.*"%>
<% Logger logger = Logger.getLogger("example");
<% logger.setLevel(Level.ALL);
logger.addHandler(new FileHandler("/log.txt"));
 String info = request.getParameter("info");
 if (info != null && !info.equals("")) {
 logger.info(info);
 }
%>
```

Example: Logger 2

```
<html>
<head>
<title>A Simple Logger</title>
</head>
<body>
Logging examples
<form>
Information to log:<input name="info"><br>
<input type="submit">
</form>
</body>
</html>
```

Loggers and Levels

A Logger object is used to log messages for a specific system of application components.

`java.util.logging.Level` object is used to manage different types of logged information.

Types can be:

1) `SEVERE`

2) `WARNING`

3) `INFO`

4) `CONFIG`

5) `FINE,FINNER AND FINNEST`

6) `OFF`

7) `ALL`

Handlers

`java.util.logging` packages defines some `Handlers` for handling information.

1) `StreamHandler:` logged information is exported to a `java.io.OutputStream.`

2) `MemoryHandler:` `LogRecord` objects are kept in memory.

3) `SocketHandler:` information is logged using a network socket.

4) `FileHandler:` information is logged to a local file.

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
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1) Security
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2) Internationalization
   a) introduction
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3) Summary

JDBC Review 1

JDBC allows data stored in different databases to be accessed using a common Java API.

In general, Java applications that use a database almost always use JDBC to communicate with it.

JDBC Review 2

Important interfaces and classes:

`javax.sql.DataSource`–interface for obtaining connections to a database

`java.sql.Statement`–interface for executing `SQL` statements on a database

`java.sql.Connection`–object represents a physical connection with a database and is governed by underlying `JDBC` driver

`java.sql.ResultSet`–object returned as the results of an `SQL` statement

JDBC Review: DriverManger 1

Early version of `JDBC` may use an object called `DriverManger` to obtain the connection of a database as following:

```
String url = "jdbc:hsqldb:" + dbDir +"/my_database";
String user = "sa"; // hsqldb default
String password = ""; // hsqldb default
Class.forName("org.hsqldb.jdbcDriver");
Connection conn =
DriverManager.getConnection(url, user, password);
```

JDBC Review: DriverManger 1

The previous example has two problems:

1) The code is vendor specific.
2) The `DriverManager` is not an interface but a class and cannot be optimized by a Vendor easily.

DataSource

`DataSource` can solve the previous mentioned problems easily because `DataSource` is an interface which allows vendors' optimizations.

`DataSource` objects can be managed by container for higher efficiency.

Disadvantage:

`DataSource` needed to be configured in a container-dependent method.

Configuring DataSource 1

The following example shows the procedure for creating a `datasource` connecting a `MySQL` database to `Tomcat` server.

1) A database "`dbTest`" is assumed to have been created in `MySQL` already.
2) Downloaded and installed the required library as follows:
   a) Download the `MySQL connector/J` from `www.mysql.com`.

      file: `mysql-connector-java-3.1.7.zip`

      `URL` for download:
      http://`dev.mysql.com/downloads/connector/j/3.1.html`
   b) Extract the zip file and copy the file, `mysql-connector-java-3.1.7-bin.jar`, to <`TOMCAT_HOME`>/`common/lib`.

Configuring DataSource 2

The following steps will configure `Tomcat` with the `DataSource` connected to `MySQL`:

a) modify the `<TOMCAT_HOME>/conf/server.xml` by adding the following code segment within the tag `<GlobalNamingResources>`:

```
<Resource name="jdbc/Testdb"
              auth="Container"
              type="javax.sql.DataSource"
              driverClassName="com.mysql.jdbc.Driver"
 url="jdbc:mysql://localhost:3306/dbTest"
                    username="root"
                    password="1234"/>
```

Configuring DataSource 3

b) modify the `<TOMCAT_HOME>/conf/context.xml` by adding the following code segment within the tag `<Context>`:

```
<ResourceLink
        global="jdbc/Testdb"
        name="jdbc/Testdb"
        type="javax.sql.DataSource"/>
```

Configuring DataSource 4

c) The setting in step 2 can also be done as follows:

Create a file `META-INF/context.xml` under the context of the web application. If the context of the web application is "`dbTest`", the `context.xml` may look as follows:

```
<Context docBace="dbTest" path="/dbTest"
   reloadable="true">
<ResourceLink global="jdbc/Testdb" name="jdbc/Testdb"
   type="javax.sql.DataSource"/>
</Context>
```

d) Restart `Tomcat` server and a `DataSource` is ready for connection.

Task 95: Connecting DataBase

1) Examine different ways, with and without `DataSource`, for connecting a database. A database named "`dbTest`" with a table "`testdata`" is assumed to have been created in a running `MySQL` server.
   a) Deploy the following Servlet, which extracts data from the database connected through `DriverManger`:

```
import java.sql.*;
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
public class DatabaseServlet extends HttpServlet
{
```

Task 96: Connecting DataBase

```
public void doGet(HttpServletRequest request,
    HttpServletResponse response) throws
    ServletException, java.io.IOException {
String sql = "select * from testdata";
Connection conn = null;
Statement stmt = null;
ResultSet rs = null;
ResultSetMetaData rsm = null;
response.setContentType("text/html");
PrintWriter out = response.getWriter( );
out.println("<html><head><title>Servlet
Database  Access</title></head><body>");
```

Task 97: Connecting DataBase

```
try{
//load the database driver
  Class.forName ("com.mysql.jdbc.Driver");
//The JDBC URL for database
  String url =
    "jdbc:mysql://127.0.0.1:3306/dbTest";
// Create the java.sql.Connection to the
// database  using DriverManager
  conn =
    DriverManager.getConnection(url,"root",
    "1234");
//Create a statement for executing some SQL
      stmt = conn.createStatement( );
```

Task 98: Connecting DataBase

```
//Execute the SQL statement
     rs = stmt.executeQuery(sql);

//Get info from the ResultSetMetaData object
  rsm = rs.getMetaData( );
// Display the data
 int colCount =  rsm.getColumnCount( );
  for (int i = 1; i <=colCount; ++i){
  out.println("<th>" + rsm.getColumnName(i) +
  "</th>");}           }
  out.println("</tr>");
  while( rs.next( )){
    out.println("<tr>");
```

Task 99: Connecting DataBase

```
        for (int i = 1;  i <=colCount; ++i)
                out.println("<td>" + rs.getString(i)
                + "</td>");
               out.println("</tr>");}
      } catch (Exception e){
         throw new ServletException(e.getMessage( ));
      } finally {
          try{
                if(stmt != null)
                  stmt.close( );
              if (conn != null)
                  conn.close( );
          } catch (SQLException sqle){ }
      }
```

Task 100: Connecting DataBase

```
        out.println("</table><br><br></body></html>");

    } //doGet
}
```

b) Modify the previous `Servlet` and make it use a `DataSource` to create a database connection. The set up for connection may look as follows:

```
Context ctx = new InitialContext();
DataSource ds=
(DataSource)ctx.lookup("java:/comp/env/jdbc/Testdb");
 conn = ds.getConnection();
```

Connection Pooling

Connection pooling is a technique of creating and managing a pool of connections that are ready for use by any thread that needs them.

Connection pooling allows a thread to get connection from a pool and return it to the pool when the work is done.

The connection may either be a new, or already-existing connection.

Advantages

Connection pooling can greatly increase the performance of Java application, while reducing overall resource usage.

The main advantages are:

a) Reduced connection creation time - the overhead for creating connection will be avoided if connections are "recycled."

b) Simplified programming model – Only simple `JDBC` programming techniques is required.

c) Controlled resource usage – The resource is controlled by the container effectively.

Tomcat Implementation

Sun has standardized the concept of connection pooling in JDBC through the JDBC-2.0 Optional Package API.

As in previous example, Tomcat has implemented the APIs with MySQL Connector/J.

For Tomcat 5.0, install the following libraries in <Tomcat_HOME>/common/lib:

a) Jakarta-Commons DBCP 1.0

b) Jakarta-Commons Collections 2.0

c) Jakarta-Commons Pool 1.0

For Tomcat 5.5, the required libraries are located in a single JAR at <TOMCAT_HOME>/common/lib/naming-factory-dbcp.jar

Tomcat Configuration

For `Tomcat`, the following attributes can be added to the `Resource` element in the `server.xml` file between the `</GlobalNamingResources>` tag:

`maxActive`: Maximum number of connections in connection pool. Make sure the mysqld `max_connections` is large enough to handle all of the connections. A value of 0 represents "no limit".

`maxIdle`: Maximum number of idle connections to retain in pool. Set to -1 for no limit.

`maxWait`: Maximum time to wait for a connection to become available in millisecond. Set to -1 to wait indefinitely.

Connection pool leaks

While using connection pooling, a web application has to explicitly close `ResultSet`, `Statement`, and `Connection` or they will never being available for reuse causing a connection pool leak.

The `Jakarta-Commons DBCP` can be configured to prevent this problem while adding the attributes to the Resource configuration for your `DBCP DataSource` as follows:

```
removeAbandoned="true"
removeAbandonedTimeout="60"
```

Example: Connection Pool 1

After setting up the connection pool configuration, the `server.xml` file of the `Tomcat` server may look as follows:

```
. . .
<GlobalNamingResources>
  . . .
    <Resource  name="jdbc/Testdb"
               auth="Container"
               type="javax.sql.DataSource"
               driverClassName="com.mysql.jdbc.Driver"
               url="jdbc:mysql://localhost:3306/dbTest"
               username="root"
               password="1234"
```

Example: Connection Pool 2

```
            maxActive="20"
            maxIdle="10"
            maxWait="-1"
            removeAbandoned="true"
            removeAbandonedTimeout="60"
/>
```

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

Servlet / JSPs Security

Problem to address:

1) Authentication, Authorization and Access Control (AAA)
2) Secure Encrypted Communication

Security Features

Authentication, Authorization and Access Control

1) Declarative Security:
   a) access control configuration is separated from the `Servlet` and `JSP` code
   b) no security-related code is written
   c) static security that runtime condition can not be checked

2) Programmatic Security:
   a) flexible but need more work
   b) run-time condition such as client's credit limit can be considered

Role-Based Security 1

Role-Based Security

The `servlet` specification only specifies that roles should exist and a container must recognize them. How to assign a user to a role is not specified.

In `Tomcat`, the `<TOMCAT_HOME>/conf/tomcat-users.xml` file is used to define the mapping for a user. Its default content may look as follows:

```
<tomcat-users>
  <role rolename="tomcat"/>
  <role rolename="role1"/>
  <role rolename="manager"/>
```

Role-Based Security 2

```
  <role rolename="admin"/>
  <user username="tomcat" password="tomcat"
            roles="tomcat"/>
  <user username="role1" password="tomcat"
            roles="role1"/>
  <user username="both" password="tomcat"
            roles="tomcat,role1"/>
  <user username="admin" password=""
            roles="admin,manager"/>
</tomcat-users>
```

Applying Role-Based Security 1

The `web.xml` file is used to applied the role-based security to certain web applications. The tag `<security-constraint>` is used as follows:

```
<web-app>

...
 <security-constraint>
       <web-resource-collection>
             <web-resource-name>
                   SecuredWebPage
             </web-resource-name>
             <url-pattern>/secured/*</url-pattern>
             <http-method>GET</http-method>
             <http-method>POST</http-method>
```

Applying Role-Based Security 2

```
            </web-resource-collection>
            <auth-constraint>
                  <role-name>role1</role-name>
            </auth-constraint>
      </security-constraint>
      <login-config>
            <auth-method>BASIC</auth-method>
      </login-config>
...
```

Task 101: Role-Based Security

1) Follow the previous example to test the role-based security feature of `Tomcat`.
   a) Create a secured directory under your Web application context.
   b) Use the default users setting in `Tomcat's tomcat-users.xml` file.
   c) Put two web pages under the secured directory.
   d) Try to access one of the secured web pages.
   e) What will happen when a wrong user name or password is received?
   f) Try to access the secured web page with correct user name and password (user name: role1, password: tomcat).
   g) Can all web pages under the secured directory be accessed?

Authentication 1

`HTTP` supports two built-in authentication schemes:

`1)basic`

a) user name and password are essentially sent as plain text

b) password could be spoofed by a malicious server

c) once authentication is issued, the client will have authentication for a given subset of server resources

d) only used over an encrypted and with strong server authentication link

Authentication 2

2) digest

a) Introduced in HTTP 1.1 to improve the basic authentication.

b) Not the password but an encrypted digest of the password is sent and it cannot be determined by sniffing the network.

c) Most but not all browser support.

d) Access may be gained by just working with the digest of the password.

e) Note: using SSL is still a better choice for securing important content.

Form-Based Authentication 1

Custom design authentication form can be used for authentication.

Modification of the `web.xml` file is needed as follows:

```
<web-app>
. . .
  <security-constraint>
. . .
  </security-constraint>
 <login-config>
      <auth-method>FORM</auth-method>
      <form-login-config>
```

Form-Based Authentication 2

```
        <form-login-page>/login.html</form-login-page>
       <form-error-page>/loginError.jsp</form-error-page>
    </form-login-config>
 </login-config>
. . .
</web-app>
```

Form-Based Authentication 3

The login form may look as follows:

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0
 Transitional//EN">
<html>
<head>
    <title>Login Form</title>
</head>
<body bgcolor="#ffffff">
<h2>Please Login to the Application</h2>
<!-- The value of action is mandatory -->
<form method="POST"  action="j_security_check">
```

Form-Based Authentication 4

```
<table border="0"><tr>
<td>Enter the username: </td><td>
<!-- The value of the text name is mandatory -->
<input type="text" name="j_username" size="15">
</td>
</tr>
<tr>
<td>Enter the password: </td><td>
<!-- The value of the password name is mandatory -->
<input type="password" name="j_password" size="15">
```

Form-Based Authentication 5

```
</td>
</tr>
<tr>
<td> <input type="submit" value="Submit"> </td>
</tr>
</table>
</form>
</body>
</html>
```

Form-Based Authentication 6

The `loginError.jsp` file may look as follows:

```
<html>
<head>
    <title>Login Error</title>
</head>
 <body bgcolor="#ffffff">
 <h2>Authentication Fail</h2><br>
 . . .
 </body>
</html>
```

Form-Based Authentication 7

Once the user is authorized, the container will maintain the login session with a cookie containing the session-id and send it back to the user for subsequent requests.

If the role of the user is not allowed for certain resources, a "`403 Access Denied`" response will be received by the user.

Note:

a) still not a strong authentication

b) session tracking and `URL` redirecting is difficult.

c) cookie must be enabled

Programmatic Security

Problems with role-based security:

Role-based security cannot deal with runtime based checking such as the user's credit limit.

It cannot filter resources by the role of the user.

`HttpServletRequest` object provides methods to perform different logics based on the runtime information about the user.

HttpServletRquest 1

The following methods are available from the `HttpServletRequest` object for security checking purpose:

`String getAuthType()`:
returns the name of the authentication scheme for determining how form information was submitted

`boolean isUserInRole(java.lang.String role)`:

To check if a user is in the given role.

`String getProtocol()`:

returns the protocol that was used to send the request for checking if a secure protocol was used

HttpServletRquest 2

`boolean isSecure()`:

a boolean value representing if a `HTTPS` request was made.

`Principle getUserPrinciple()`:

returns a `java.security.Principle` object that contains the name of the current authenticated user.

`String getRemoteUser()`:

If the user is not authenticated, `null` will be return.

Example: Programmatic Security 1

1) The following `Servlet` checks the user's role and generates different content according to the role.

```
if (request.isUserInRole("manager")) {
        out.println("<B>Hello Manager");
            out.println (request.getRemoteUser());
            out.println ("</B></br>");
 }
   else if (request.isUserInRole("role1")) {
        out.println("<B>Hello User");
        out.println (request.getRemoteUser());
        out.println ("</B></br>");
    }
```

Example: Programmatic Security 2

```
else {
        throw new IOException("User does not have
        access!");
 }
```

Task 102: Programmatic Security

1) After logged in through a form-based authentication, access right will last within the same session. Try to access another secured page under the same context.
2) Try to delete the cookie stored in the browser from a sender "`localhost`". Browse to the same secured page again. What happen?
3) Create a page to allow the user to logout. The page should perform the follows:
   a) Check if the user was authenticated.
   b) Find out if the user were under a specific role.
   c) Logout the user by invalidate the session.
4) The skeleton code may look as follows:

Task 103: Programmatic Security

```
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;
public class LogoutServlet extends HttpServlet {
  public void doGet(HttpServletRequest request,
   HttpServletResponse response)
    throws ServletException, java.io.IOException {
   HttpSession session = request.getSession( );
   response.setContentType("text/html");
   PrintWriter out = response.getWriter( );
   out.println("<html><head><title>Logout Authenticated
      User</title></head><body>");
```

Task 104: Programmatic Security

```
out.println("request.getRemoteUser( ) returns: ");
 //get the logged-in user's name
  String userName = request.getRemoteUser( );
 //If request.getRemoteUser( ) return null then the
  //user is not authenticated
  out.println(userName == null ? "Not authenticated." :
 userName + "<br>" );
  out.println("request.isUserInRole(\"admin\")
 returns: ");
 //Find out whether the user is in the admin role
 out.println(isInRole + + "<br>" );
```

Task 105: Programmatic Security

```
    //log out the user by invalidating the HttpSession
      session.invalidate( );
      out.println("</body></html>");
  }
  . . .
}
```

Secured Communication

Other than controlling the access to certain resources, encrypting the transmitted data to provide secured communication is equally important.

The level of security can be configured with the `web.xml` file by the `<transport-guarantee>` element within the tag `<user-data-constraint>`.

The `<transport-guarantee>` element has three levels of security:

`NONE` – default and requires no security

`INTEGRAL` – container must ensure the integrity of information

`CONFIDENTIAL` – information sent must be both private and unchanged

Security Configuration: Tomcat 1

Tomcat needs specific configuration to provide secured communication.

a) In <TOMCAT_HOME>/conf/server.xml, find the following entry and modify the redirect attribute to “443”, the default port HTTPS :

```
<Connector
  port="80" maxThreads="150"
   minSpareThreads="25"
   maxSpareThreads="75"
   enableLookups="false"
   redirectPort="443"
   acceptCount="100"
   connectionTimeout="20000"
   disableUploadTimeout="true"
/>
```

Security Configuration: Tomcat 2

b) In `<TOMCAT_HOME>/conf/server.xml`, uncomment the following entry and add a keypass attribute representing the password used for the keystore:

```
<!-- Define a SSL HTTP/1.1 Connector on port 8443 -->
<Connector port="443"
        maxThreads="150" minSpareThreads="25"
        maxSpareThreads="75" enableLookups="true"
        disableUploadTimeout="true"
        acceptCount="100" scheme="https" secure="true"
        clientAuth="false" sslProtocol="TLS"
        keypass="123456"
/>
```

Tomcat Configuration 3

c) Generate a self certified keystore:

```
%JAVA_HOME%/bin/keytool  -genkey -keystore
  mystore.keystore -alias tomcat -keyalg RSA
```

d) Put the keystore file generated to the home directory of `Tomcat`.

Task 106: Using HTTPS

1) Test the secure communication function provided by `Tomcat` server.
   a) Follow previous slides to configure your `Tomcat` and restart it.
   b) Modify the `web.xml` file to add the `<transport-guarantee>` element for a protected resource. Put a value "`CONFIDENTIAL`" for this element.
   c) Access the protected resource. Is there any changes to the protocol used?

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

Introduction: Internationalization 1

Internationalization is also known as i18n representing the process of designing an application supporting multi-lingual without engineering changes.

Introduction: Internationalization 2

An internationalized program has the following characteristics:

1) With the addition of localization data, the same executable can run worldwide.
2) Textual elements, such as status messages and the `GUI` component labels, are not hardcoded in the program. Instead they are stored outside the source code and retrieved dynamically.
3) Support for new languages does not require recompilation.
4) Culturally-dependent data, such as dates and currencies, appear in formats that conform to the end user's region and language.
5) It can be localized quickly.

Problems with Encoding

When designing a web application, character encoding is a major problem for internationalization:

1) The default character encoding of `HTTP` is `ISO-8859-1(Latin-1)`.

2) `ISO-8859-1` uses only 8 bits and cannot be extended easily.

Java uses Unicode as default character encoding.

`UTF-8` is a common way to use Unicode which encoding Unicode characters using a varying number of bytes depending on the character set.

Clients' Encoding

When invoking a method such as `getParameter()` to obtain data from client, sometimes the returned `String` may not be encoded properly. The following code snippet can avoid this situation:

```
String value = request.getParameter("param");
value = new String(value.getBytes(),
   request.getCharacterEncoding());
```

Specifying Encoding

While sending information to client, the encoding can be specified by manipulating the `content-type` header :

```
response.setContentType("text/html; charset=UTF-8");
ServletOutputStream sos = response.getOutputStream();
PrintWriter out =
new PrintWriter(new OutputStreamWriter(sos,"UTF-8"),
true);
response.setLocale("","");
out.println("<html>");
```

By substituting the `UTF-8` with specific encoding, different encoding can be specified.

i18n Implementation 1

Different ways can be done to provide multi-lingual support for a web site.

The following example illustrates one of the ways which uses a mechanism called resource bundle to provide i18n support.

Assume a simple web page, `welcome.html`, as follows:

```
<html>
<head>
<title>Hello!</title>
</head>
```

i18n Implementation 2

```
<body>
   <cr>Welcome to the multi-language page<br/>
   <i>multi-language page</i></cr>
</body>
</html>
```

Resource Bundle Files

In order to provide multi-lingual support, resource bundles can be used to store the content information in different languages.

The resource bundle files for various languages may look like as follows:

For English:

```
title=Welcome!
welcome=<b>Welcome</b>
```

For Chinese:

```
title=歡迎!
welcome=<b>歡迎</b>
```

Naming of Resource Bundles

Each resource bundle file is just a simple property text file containing key/value pairs information.

Each resource bundle file has a name starting with the base name, appending with "_" and a two-digit language code. An extension ".properties" should be used for this file.

For example, if the base name for resource bundle is "resource", the locale-specific property file will then be "`resource_en.properties`" for English client. The name can also be extend with country code like `_zh_TW` and `_zh_CN` representing Taiwan and China respectively.

The resource bundle files should be placed under the WEB-INF/classes directory or any sub-directory of it.

ResourceBundle Object

`java.util.ResourceBundle` provides static methods which takes base name and Locale object to return a resource bundle with proper values.

For example:

```
Locale locale = request.getLocale();
ResourceBundle rb = ResourceBundle.getBundle("resource",
 locale);
```

This code will check the `Locale` of the client and if, for example, it were `zh_TW`, the values of the `resource_zh_TW.properties` file would be loaded.

List of Country Code

The following link lists the country code used for the Resource Bundle file:

`http://www.iso.ch/iso/en/prods-services/iso3166ma/02iso-3166-code-lists/list-en1.html`

Loading Resource Bundles 1

A JavaBean may be used as a façade for loading the content of the resource bundle object. `Getter` and `Setter` methods should be defined in this JavaBean.

For example:

```
package com.web;
public class Welcome {
protected String title = null;
protected String welcome = null;
public String getTitle() {
        return title;
}
```

Loading Resource Bundles 2

```
    public void setTitle(String title) {
        this.title = title;
    }
    public String getWelcome() {
        return welcome;
    }
    public void setWelcome(String welcome) {
        this.welcome = welcome;
    }
}
```

Using Resource Bundles 1

In JSP file, scriptlets may be used to extract the values from the resource bundle as follows:

```
<%@ page import="java.util, com.web.Resource"%>
<%
Locale locale = request.getLocale();
ResourceBundle rb = ResourceBundle.getBundle("resource",
locale);
Welcome content = new Welcome();
content.setTitle(rb.getString("title"));
content.setWelcome(rb.getString("welcome"));
request.setAttribute("content", content);
%>
```

Using Resource Bundles 2

```
<%@ taglib uri="http://java.sun.com/jstl/core_rt"
prefix="c" %>

<html>

<head>

<title>${content.title}</title>

</head>

<body>

${content.welcome}

</body>

</html>
```

JSTL i18n Tags 1

`JSTL` provides a set of `i18n` tags for supporting internationalization.

The following example illustrates how to use the tag message:

```
<%@ taglib uri="http://java.sun.com/jstl/fmt" prefix="fmt"%>
<fmt:bundle basename="resource">
```

JSTL i18n Tags 2

```
<html>
<head>
<title><fmt:message key="title"/></title>
</head>
<body>
<fmt:message key="welcome"/>
</body>
</html>
</fmt:bundle>
```

Task 107: i18n

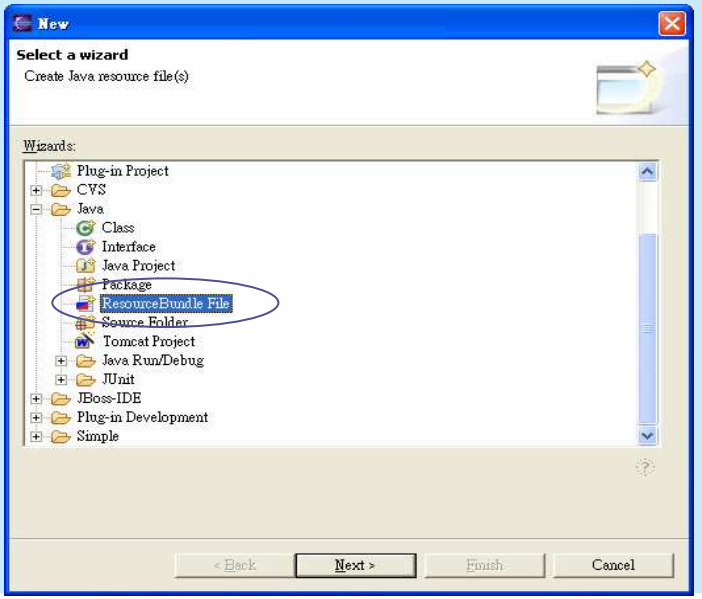
1) Create three `ResourceBundle` files for a web page: one for English, one for Traditional Chinese and one for Simplified Chinese. A `JSP` page with a form for selecting different languages is used to display the content with different languages. The output may look as follows:

Task 108: i18n

Task 109: i18n

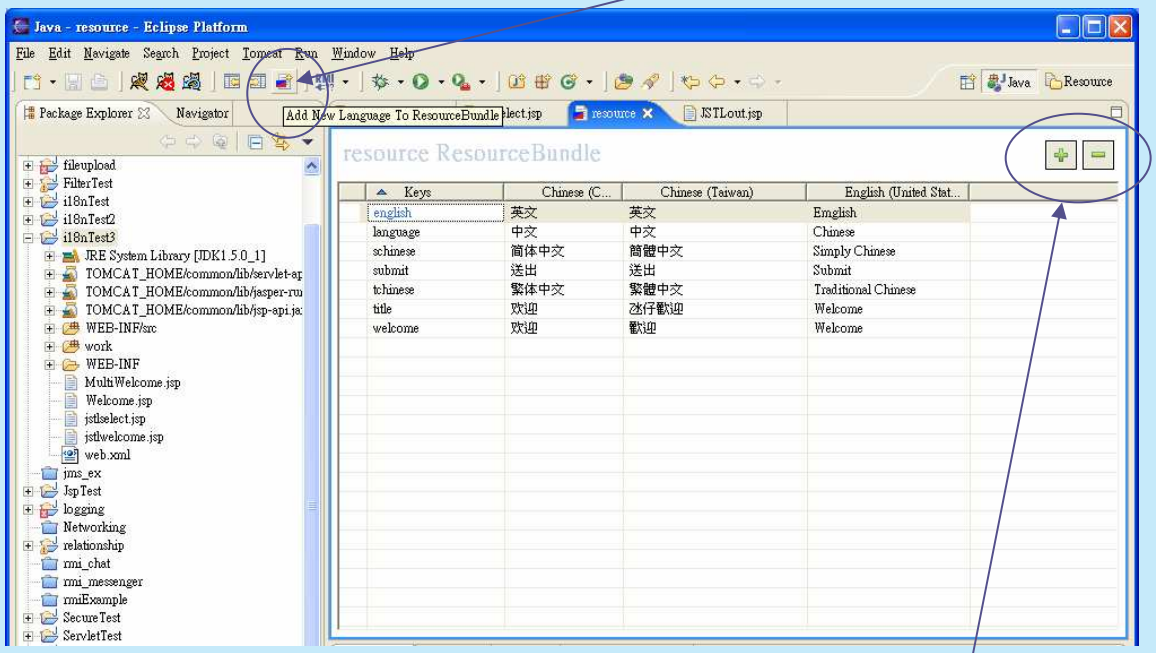
a) Tools for creating the `ResourceBundle` files can be used. There is a free plugin, named `Jinto`, for `Eclipse` which converts input into unicode and generates `ResourceBundle` files. This plugin can be downloaded at :
`http://www.guh-software.de/jinto_en.html`

b) After installed this plugin, create a new resource bundle file at `Eclipse: File → New → Others → Java → ResourceBundle File`



Task 110: i18n

c) For adding a new language, just press this **button**



d) For adding or deleting an entry, press these **buttons**.

Task 111: i18n

d) While using JSTL tags for the JSP file, the JSP file may look like the following in order to produce the required effect:

```
<%@ page contentType="text/html" pageEncoding="UTF-
   8"%>
<%@ taglib  uri="http://java.sun.com/jsp/jstl/core"
   prefix="c" %>
<%@ taglib  uri="http://java.sun.com/jsp/jstl/fmt"
   prefix="fmt" %>

<c:if test="${param.language == 'en'}">
  <fmt:setLocale value="en" />
</c:if>
```

Task 112: i18n

```
<c:if test="${param.language == 'zh_TW'}">
  <fmt:setLocale value="zh_TW" />
</c:if>
<c:if test="${param.language == 'zh_CN'}">
  <fmt:setLocale value="zh_CN" />
</c:if>
<fmt:bundle basename="resource" >
<fmt:setBundle basename="resource" var="currLang"/>
<html>
  <head>
    <title>
      <fmt:message key="title" />
    </title>
```

Task 113: i18n

```
  </head>
    <body bgcolor="white">
      <h1>
        <fmt:message key="welcome" />
      </h1>

      <form action="jstlselect.jsp">
        <p>
        <input type="radio" name="language" value="en"
          ${currLang == 'en' ? 'checked' : ''}>
        <fmt:message key="english" /><br>
        <input type="radio" name="language"
     value="zh_TW"
          ${currLang == 'zh_TW' ? 'checked' : ''}>
```

Task 114: i18n

```
<fmt:message key="tchinese" /><br>
      <input type="radio" name="language"
   value="zh_CN"
        ${currLang == 'zh_CN' ? 'checked' : ''}>
      <fmt:message key="schinese" /><br>
      <p>
      <input type="submit" value="<fmt:message
   key="submit" />" >
      </form>
  </body>
</html>
</fmt:bundle>
```

Horizontal Concepts Outline

1) Exceptions
   a) introduction
   b) error handling
   c) error objects
   d) logging

2) DataBase Connectivity
   a) jdbc review
   b) datasource
   c) connection pooling

1) Security
   a) introduction
   b) declarative security
   c) programmatic security
   d) secure communication

2) Internationalization
   a) introduction
   b) encoding
   c) resource bundles

3) Summary

Summary

1) In this section, the following supporting technologies are presented:
    a) Exception handling
    b) Database Connectivity
    c) Internationalization
    d) Security

Summary: Exception Handling 1

1) Directive `<%@page errorPage="myErrorPage.jsp"%>` indicates a page for handling the exception.

2) Directive `<%@ page isErrorPage="true"%>` indicateds that the current page can handle exception.

3) `Servlet` can also be used for handling exception.

4) A specific page can be declared within the `web.xml` file to handle specific error

Summary: Exception Handling 2

1) Error Objects are defined by the Servlet specification to provide useful information for debugging such as:
   a) status code
   b) exception type
   c) exception
   d) request uri

Summary: Exception Handling 2

Logging is used to keep record of important information.

The `java.util.logging` package provides a standard API for logging.

The following logging handlers are defined for handling different logged information:

a) `SteramHandler`

b) `MemoryHandler`

c) `SocketHandler`

d) `FileHandler`

Summary: Database Connectivity

`DataSource` is used for connecting database with high efficency.

`DataSource` is managed by container but needed to be configured for different server.

Connection Pooling create and manage a pool of connections and can be accessed and managed easily through `DataSource`.

Summary: Security

The security of a web site can be enforced through role-based or programmatic authentication.

Role-Based security can be set up easily in Tomcat server but is lack of flexibility.

Programmatic security can provide runtime checking and provide a more flexible access control.

Programmatic involves more work.

Summary: Internationalization

Internationalization is also known as i18n and aim to provide multi-lingual support for a web site.

One of the ways to provide multi-lingual web site is through the usage of `ResouceBundle` file.

Case Study

Course Outline

1) J2EE introduction

2) vertical concepts
   a) Servlets
   b) JavaServer Pages
   c) Filters

3) horizontal concepts
   a) exceptions
   b) security
   c) internationalization
   d) database connectivity

4) case study

Case Study Outline

1) hands-on practice

Task 115: Hands-On Practice

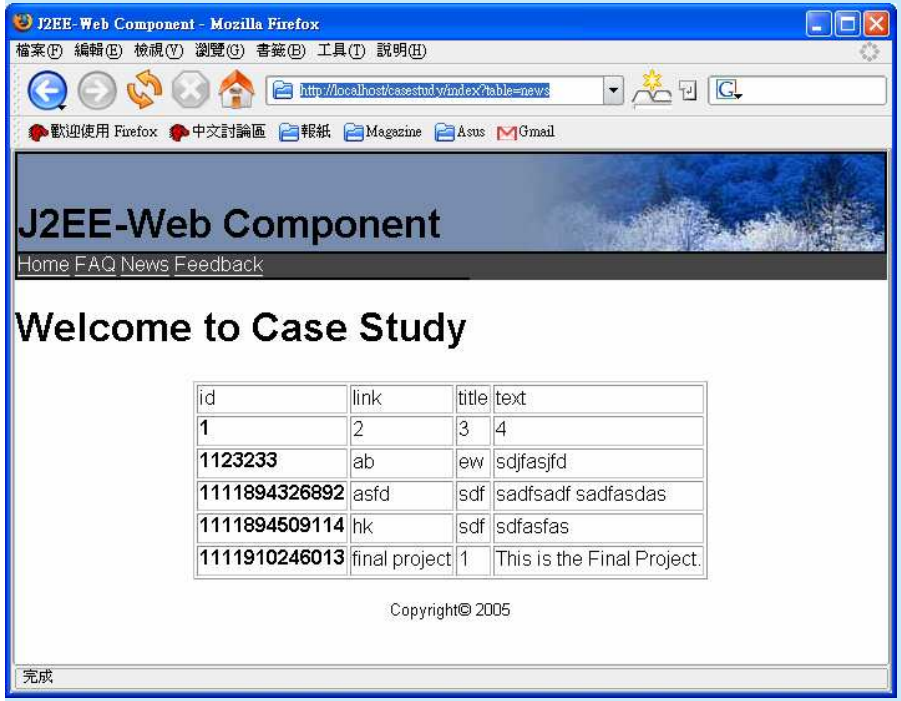
1) Develop a portion of a web site to review the technology and techniques discussed in this course.
    a) Create a multi-lingual supported web site which can detect the locale of the client's browser to provide corresponding contents.
    b) Use `DataSource` to connect to a database and make use of the default connection pooling.
    c) `Filter` is used to provide a hit counter of the web site.

Task 116: Hands-On Practice

d) "Page not found" (404) exception should be handled by the container to redirect the client to the default web page of the site.

e) Basic security should be set up to protected the content of a specific directory.

Task 117: Hands-On Practice



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1	2	3	4
1123233	ab	ew	sdjfasjfd
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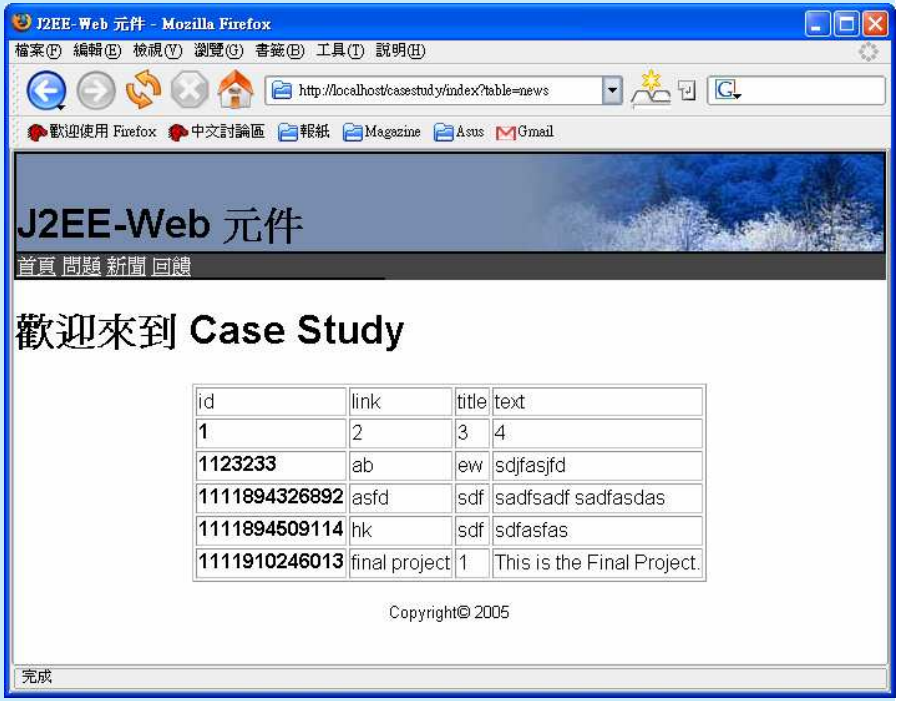
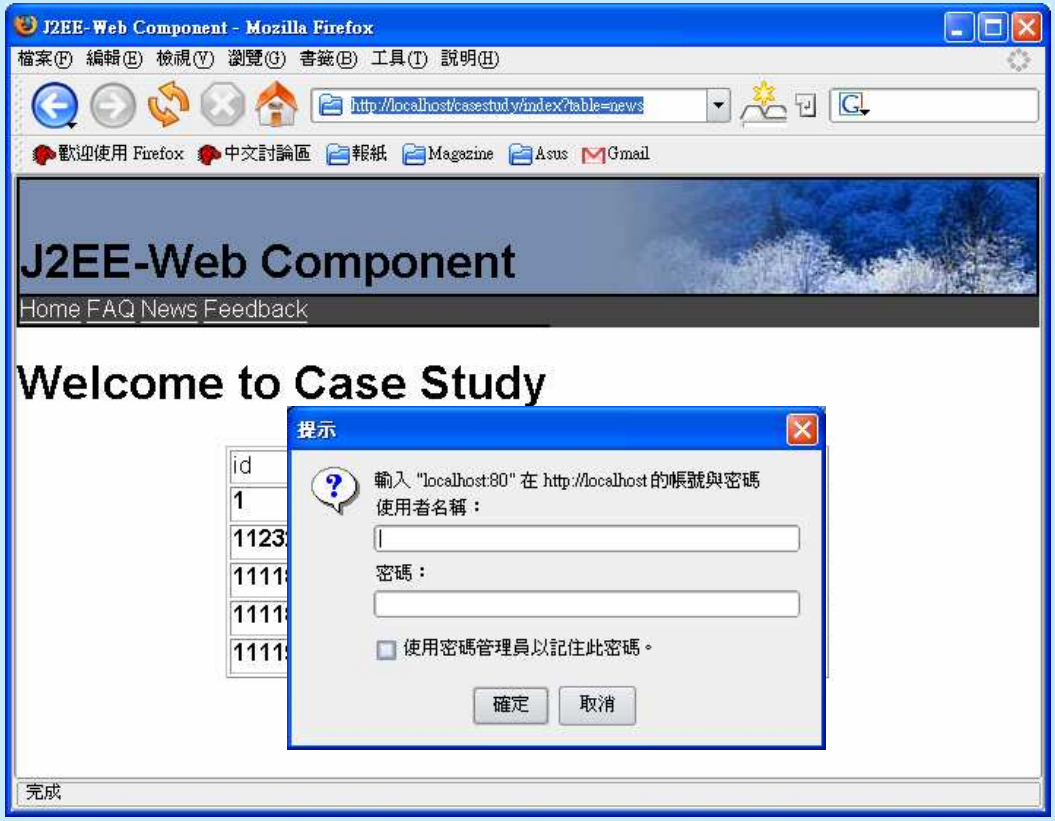
1111894509114	hk	sdf	sdfasfas
1111910246013	final project	1	This is the Final Project.



id	link	title	text
1	2	3	4
1123233	ab	ew	sdjfasjfd
1111894326892	asfd	sdf	sadfsadf sadfasdas
1111894509114	hk	sdf	sdfasfas
1111910246013	final project	1	This is the Final Project.

Task 118: Hands-On Practice



J2EE Business Component Development

Assessment

B.1. Set 1

1.	Which of the following kinds of beans would survive a server crash?	
	A.	Entity bean
	B.	State-less session bean
	C.	State-full session bean
	D.	Message-driven bean
Answer	A	
2.	Suppose you make a JNDI lookup on a JDBC connection by the following code: InitialContext ctx = new InitialContext(); DataSource dsrc = (DataSource)ctx.lookup("java:comp/env/jdbc/discountDB"); Connection con = dsrc.getConnection(); Which of the following are correct entries in the <resource-ref-name> element of the deployment descriptor?	
	A.	java:comp/env/jdbc/discountDB
	B.	env/jdbc/discountDB
	C.	jdbc/discountDB
	D.	discountDB
Answer	C	
3.	Suppose Hello is a reference to the component interface of a stateless session bean named HelloBean. Which of the following is a valid home interface of HelloBean?	
	A.	create()
	B.	create(String name)
	C.	create(String name, String date)
	D.	All of the above
Answer	A	
4.	Which of the following statements are true about locating or using the home interface of a session bean?	
	A.	Once acquired, the home interface can be used only once.
	B.	Each instance of a session bean has its own EJBHome object.
	C.	Only remote clients need to get the home interface; local clients can get the component interface directly.
	D.	None of the above
Answer	D	

5.	Which of the following statements are true about the remote component interface of a session bean?	
	A.	All methods in the remote home interface and the remote component interface are declared to throw javax.ejb.RemoteException.
	B.	All methods in the remote home interface and the remote component interface are declared to throw java.rmi.RemoteException.
	C.	A client locates the remote component interface from JNDI and then narrows it before invoking a methods on it.
	D.	A remote client can use the method remove(Object key) from the home interface to remove a state-full session bean instance.
Answer	B	
6.	Consider an entity bean with Customer as its remote component interface and CustomerHome as its remote home interface. Which of the following are legal method declarations in the home interface?	
	A.	public CustomerHome findCustomerByEmail(String email);
	B.	public Customer findCustomerByEmail(String email);
	C.	public Customer findCustomerByEmail(String email) throws FinderException, RemoteException;
	D.	public Customer findCustomerByEmail(String email) throws FinderException;
Answer	C	
7.	Which of the following are true statements about what happens when remove() method is called using the component interface of an entity bean representing a specific entity in the database?	
	A.	The entity bean instance is deleted.
	B.	The entity in the database is deleted.
	C.	Both the entity and the entity bean instance survive, but that entity bean instance does not represent that entity anymore.
	D.	Nothing happens; the container simply ignores the call.
Answer	B	
8.	Which of the following statements are true about a CMP entity bean?	
	A.	You cannot write JDBC code in the bean class to make a connection and send queries to any database.
	B.	You cannot write JDBC code in the bean class to change the values of virtual persistent fields of your bean.
	C.	You can write JDBC code and get connected to any database you want.
	D.	You can write JDBC code to read the virtual persistent fields, but you cannot change their values.
Answer	B	
9.	Which of the following are legal method declarations for an entity bean class?	
	A.	public static Collection ejbHomeListCustomers()
	B.	public Collection ejbHomeListCustomers() throws RemoteException
	C.	public Collection ejbHomeListCustomers()

	D.	public Collection EJBHomeListCustomers()
Answer	C	
10.	Which of the following statements are true for an entity bean that uses a container to manage its persistence and relationships?	
	A.	The type of a CMP field is determined by the corresponding get and set methods.
	B.	The type of a CMP field is determined from the corresponding get and set methods.
	C.	The type of a CMP field is declared in the deployment descriptor.
	D.	The type of a CMP or CMR field is declared inside the bean class in the form of a variable declaration.
Answer	A	
11.	Which of the following are valid statements about a message-driven bean?	
	A.	A message-driven bean can have only a local home interface.
	B.	The identity of a message-driven bean is hidden from the client.
	C.	You can invoke the getEJBLocalHome() method on the bean's context from inside the onMessage() method.
	D.	The container invokes the ejbActivate() method on the bean instance before invoking the onMessage() method.
Answer	B	
12.	Consider that method A() in an application sends a message. In response, the method onMessage() of an MDB is called. The onMessage() method invokes another method, B(). Method B() throws an application (checked) exception. Which of the following are the correct ways to deal with this exception in the onMessage() method?	
	A.	Throw the exception back to method A().
	B.	Handle the exception inside the method onMessage().
	C.	Throw the exception back to the container.
	D.	Throw RemoteException.
Answer	B	

B.2. Set 2

1.	Consider the following lines in the deployment descriptor: 1. <ejb-relationship-role> 2. <ejb-relationship-role-name> 3. OrderBean 4. </ejb-relationship-role-name> 5. <multiplicity>Many</multiplicity> 6. <cascade-delete/> 7. <relationship-role-source> 8. <ejb-name>OrderBean</ejb-name> 9. </relationship-role-source> 10. <cmr-field> 11. <cmr-field-name> 12. customer 13. </cmr-field-name> 14. </cmr-field> 15. </ejb-relationship-role> What does the line 6 in the above listing mean?	
	A.	If a customer is deleted, all orders related to that customer are deleted.
	B.	If a customer is deleted, all orders related to all customers are deleted.
	C.	If an order is deleted, the customer related to that order is deleted.
	D.	If all orders related to a customer are deleted, the customer is deleted.
Answer	A	
2.	Which of the following are true statements about what happens when a remove() method is called using the component interface of an entity bean representing a specific entity in the database?	
	A.	The entity bean instance is deleted.
	B.	The entity in the database is deleted.
	C.	Both the entity and the entity bean instance survive, but that entity bean instance does not represent the entity anymore.
	D.	Nothing happens; the container simply ignores the call.
Answer	B	
3.	The following bean code does a JNDI lookup on a JDBC connection: InitialContext ctx = new InitialContext(); DataSource dsrc = (DataSource)ctx.lookup("java:comp/env/jdbc/discountDB"); Connection con = dsrc.getConnection(); Which of the following are correct entries in the <resource-ref-name> element in the deployment descriptor?	
	A.	java:comp/env/jdbc/discountDB
	B.	env/jdbc/discountDB
	C.	jdbc/discountDB

	D.	discountDB
Answer	C	
4.	Which of the following statements are true about locating or using the home interface of a session bean?	
	A.	Once acquired, the home interface can be used only once.
	B.	Each instance of a session bean has its own EJBHome object.
	C.	Only remote clients need to get the home interface; local clients can get to the component interface directly.
	D.	None of the above
Answer	D	
5.	Consider an entity bean with Customer as its remote component interface and CustomerHome as its remote home interface. Which of the following are legal method declarations in the home interface?	
	A.	public CustomerHome findCustomerByEmail(String email);
	B.	public Customer findCustomerByEmail(String email);
	C.	public Customer findCustomerByEmail(String email) throws FinderException, RemoteException;
	D.	public Customer findCustomerByEmail(String email) throws FinderException;
Answer	C	
6.	Which of the following are legal method declarations for an entity bean class?	
	A.	public static Collection ejbHomeListCustomers()
	B.	public Collection ejbHomeListCustomers() throws RemoteException
	C.	public Collection ejbHomeListCustomers()
	D.	public Collection EJBHomeListCustomers()
Answer	C	
7.	Suppose Hello is a reference to the component interface of a state-less session bean named HelloBean. Which of the following is a valid home interface of HelloBean?	
	A.	create()
	B.	create(String name)
	C.	create(String name, String date)
	D.	All of the above
Answer	A	
8.	Which of the following statements are true for an entity bean that uses a container to manage its persistence and relationships?	
	A.	The type of a CMP field is determined by the corresponding get and set methods.
	B.	The type of a CMR field is determined from the corresponding get and set methods.

	C.	The type of a CMP field is declared in the deployment descriptor.
	D.	The type of a CMP or CMR field is declared inside the bean class in the form of a variable declaration.
Answer	A	
9.	Which of the following kinds of beans would survive a server crash?	
	A.	Entity beans
	B.	State-less session beans
	C.	State-full session beans
	D.	Message-driven beans
Answer	A	
10.	Which of the following statements are true about the remote component interface of a session bean?	
	A.	All methods in the remote home interface and the remote component interface are declared to throw javax.ejb.RemoteException.
	B.	All methods in the remote home interface and the remote component interface are declared to throw java.rmi.RemoteException.
	C.	A client locates the remote component interface from JNDI and then narrows it before invoking methods on it.
	D.	A remote client can use the method remove(Object key) from the home interface to remove a state-full session bean instance.
Answer	B	
11.	Which of the following are valid statements about a message-driven bean?	
	A.	A message-driven bean can have only a local home interface.
	B.	The identity of a message-driven bean is hidden from the client.
	C.	You can invoke the getEJBLocalHome() method on the bean's context from inside the onMessage() method.
	D.	The container invokes the ejbActivate() method on the bean instance before invoking the onMessage() method.
Answer	B	
12.	Consider that method A() in an application sends a message. In response, the method onMessage() of an MDB is called. The onMessage() method invokes another method, B(). Method B() throws an application (checked) exception. Which of the following are the correct ways to deal with this exception in the onMessage() method?	
	A.	Throw the exception back to method A().
	B.	Handle the exception inside the method onMessage().
	C.	Throw the exception back to the container.
	D.	Throw RemoteException.
Answer	B	

J2EE Business Component Development

Training Course

Chau Keng Fong
Adegboyega Ojo

e-Macao Tasks Report 25

Version 1.0, December 2005

Table of Contents

1. Overview

The Java 2 Enterprise Edition (J2EE) platform is a standard technology for building Internet applications and particularly Enterprise Applications. J2EE comprises: (i) a collection of Application Programming Interfaces (APIs), (ii) a distributed computing architecture and (iii) a method of packaging distributable components for deployment [4]. Enterprise Applications are essential for the safe storage, retrieval and manipulation of business data. They are characterised by: multiple user interfaces (typically graphical user interfaces operating in web and desktop environments), communication between remote systems and coordination of data residing in multiple data stores located on different machines.

Enterprise Applications are multi-tier applications consisting of client, web, business and enterprise tiers. J2EE provides the necessary APIs and services to develop these tiers. In particular, J2EE Web and Business Component Technologies consist of vertical services for developing web and business tiers respectively.

The course provides a comprehensive overview of the J2EE Business Component Technology. It teaches how enterprise applications can be developed using the core J2EE business components. The use of Session, Entity and Message-Driven Beans for developing business components is explained in detail. The course also presents supporting technologies related to local interfaces, declarative transactions and role-base security management.

The rest of this document explains the objectives, prerequisites and methodology for teaching the course in Sections 2, 3 and 4 respectively. The content of the course is introduced in some detail in Section 5. The assessment and organization of the course are explained in Sections 6 and 7. Following references, Appendix A includes the complete set of slides and Appendix B contains two sets of assessment questions with answers.

2. Objectives

This course has three main objectives:

1) To introduce the development and run-time environment for J2EE business components.
2) To equip students with essential skills in developing business components using three core technologies: Session Beans, Entity Beans and Message-Driven Beans.
3) To present various techniques for developing multi-tiered, distributed, component-based J2EE applications.

3. Prerequisites

The course requires a working knowledge of the Java Programming Language. Good understanding of distributed programming is also required. In addition, the knowledge of Extensible Markup Language (XML) and J2EE Web Component Technologies is assumed.

4. Methodology

The course has been designed based on the following didactic principles:

- *Depth versus Breadth* - As foundation, an attempt has been made to cover the various aspects of web services without much loss of depth.
- *Academic Orientation* – A body of concepts is defined rigorously and incrementally to establish a proper foundation for understanding and use of technology.
- *From Definitions to Demonstrations* – All major concepts introduced during the course are illustrated with small-size examples, many demonstrated on the computer.
- *From Demonstrations to Assignments* – On the basis of demonstrations, students are asked to perform different tasks with increasing level of difficulty and independence.

In more specific terms, emphasis is placed on the core concepts of the J2EE Business Component Technology rather than on horizontal concepts.

5. Content

The course consists of 366 slides organized into four sections: Basic Concepts, Vertical Concepts, Horizontal Concepts and Case Study. Each of these is discussed in detail below.

5.1. Basic Concepts

This section comprises the slides 1 through 54. It presents an overview of the Enterprise Java Bean (EJB) Architecture. The section starts with the basic concepts and characteristics of an EJB. Next, it discusses the development and deployment environment for an EJB and ends with a brief discussion on the benefits of EJBs.

5.2. Vertical Concepts

This section comprises the slides 55 through 272. It presents three types of business components: (i) Session Beans, (ii) Entity Beans and (iii) Message-Driven Beans. Three subsections are devoted to each of the three types:

1) *Session Beans*: The basic architectures and life-cycles of state-less and state-full session beans are described first. The activation and passivation process of a state-full session bean is explained. The difference between state-full and state-less sessions is explained next. Finally, the deployment procedure for session beans is described.

2) *Entity Beans:* The characteristics and life-cycle of entity beans is explained. Specific methods for entity beans such as `ejbCreate`, `ejbFind`, `ejbHome`, `ejbLoad`, `ejbStore` and `ejbRemove` are discussed. The concept of Bean Managed Persistence (BMP) and Container Managed Persistence (CMP) are further discussed including their development and deployment procedures. The EJB Query Language (EJB-QL) is explained at the end.

3) *Message-Driven Beans*: Basic concepts about the Java Message Service (JMS) are first presented. The procedure for setting up the JBoss Message Queue is described in detail. The life-cycle characteristics of a typical message-driven bean are also explained. Finally, the use of message driven beans with the JBoss Message Queue is explained.

5.3. Horizontal Concepts

This section comprises the slides from 273 through 358. It presents a set of selected supporting technologies, such as: local interface, Java Naming and Directory Interface (JNDI), security, and transaction management. It also discusses design patterns. The sections addressing these topics are described below:

1) *Local Interface* - EJB 2.0 allows local clients to call enterprise beans in a fast, efficient way by calling EJBs through their local objects, rather than remote objects. The technique for defining and using the local interface is presented in this section. Advantages and disadvantages of using the local interface are also discussed.

2) *Java Naming and Directory Interface (JNDI)* – JNDI is designed to provide a common interface for Java-based clients to interact with naming and directory services provided by different vendors. This section explains how JNDI can be used in the context of EJBs.

3) *Security* - EJB security can be managed declaratively using Deployment Descriptor File, or programmatically using method calls in the application. Both techniques are discussed in this section. The JBoss Application Server is used for demonstrating how EJB security can be set-up declaratively.

4) *Transaction Management* - Three different approaches to transaction management are presented: client-initiated, declarative and programmatic. EJB transaction attributes `Required`, `RequiresNew`, `Supports`, `NotSupported`, `Mandatory` and `Never` are described.

5) *Design Patterns* – These are proven techniques for designing, building and working with EJBs. These design techniques are collectively referred to as J2EE design patterns. The use of design patterns prevents pitfalls. Three popular design patterns are treated in this section: service locator, session façade and data transfer object.

5.4. Case Study

This section comprises the slides 359 through 366. It describes the task to develop and deploy an EJB application on the JBoss Application Server. This application requires the use of Session and Entity Beans to model a bank account. It also requires to correctly setup the relationship between entity beans, allowing operations like e.g. cascade delete. In addition, the task requires transaction management to be set-up declaratively, as well as the knowledge of design patterns.

6. Assessment

The course ends with assessment. This comprises 12 multiple-choice questions which cover all major sections and concepts taught.

Two sets of 12 assessment questions with answers are given in Appendices B.1 and B.2. The two sets are permutation of the same collection of questions. The assessment complements the tasks provided in the various sections.

7. Organization

The course consists of lectures and demonstrations:

- *lectures* – The lectures present the concepts and use of the J2EE Business Technology.
- *demonstrations* - Demonstrations illustrate the concepts introduced during the lectures with running code and examples. Some of the examples only provide skeleton code and require students to complete it using the technologies introduced during lectures.

The full course was taught for 7 days, 6 hours of lectures per day. A shorter version of the course was also taught over four days.

References

1. Sun Microsystems, The J2EE Tutorial, [online] http://java.sun.com/j2ee/1.4/docs /tutorial/doc/J2EETutorial.pdf, 2004.
2. Sun Microsystems, Java™ 2 Platform, Enterprise Edition (J2EE™) Specification, Version 1.4.
3. Sun Microsystems, Enterprise JavaBeans™ Specification, Version 2.1.
4. James L. Weaver, Kevin Mukhar and Jim Crume, Beginning J2EE 1.4 – From Novice to Professional, Apress, 2004.

Appendix

A. Slides

A.1. Introduction

J2EE Business Component Development

Milton, Chau Keng Fong
INESC-Macau

e-Macao-16-7-2

The Course

1) objectives - what do we intend to achieve?
2) outline - what content will be taught?
3) resources - what teaching resources will be available?
4) organization - duration, major activities, daily schedule

e-Macao-16-7-3

Course Objectives

1) Introduce the Enterprise JavaBeans development environment.

2) present the core J2EE Business Components technologies:
   a) Session Bean
   b) Entity Bean
   c) Message-Driven Bean

3) present the techniques to develop an n-tier, distributed J2EE application.

e-Macao-16-7-4

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

e-Macao-16-7-5

Outline: Basic Concepts

An overview of the Enterprise Java Bean Architecture:

1) basic concepts of Enterprise JavaBeans (EJB)
2) deployment environment of EJB
3) benefits of using EJB

e-Macao-16-7-6

Outline: Vertical Concepts

The main concepts about different types of business components:

1) introduction to Session Bean, Entity Bean and Message-Driven Bean
2) life cycle of different business components
3) development of different types of business components
4) deployment of J2EE applications

e-Macao-16-7-7

Outline: Horizontal Concepts

Supporting technologies to develop J2EE applications:

1) usage of local interface
2) usage of JNDI
3) setup for role-based security
4) transaction declaration
5) application of J2EE design patterns

e-Macao-16-7-8

Outline: Case Study

Review the J2EE technologies with a hands-on practice:

1) development of session façades using session beans
2) development of data transfer objects using session beans
3) development of container managed persistence entity beans
4) defining relationship between entity beans
5) setting up transaction control for operations

e-Macao-16-7-9

Course Resources

1) Books
   a) The J2EE Tutorial, Sun Microsystems, http://java.sun.com/j2ee/1.4/docs/tutorial/doc/J2EETutorial.pdf, 2004
2) Articles
   Links available from the website http://www.emacao.gov.mo.
3) Tools
   a) JDK 1.5
   b) Eclipse IDE
   c) Jboss 4.0.1
   d) Jboss-IDE 1.4.0

e-Macao-16-7-10

Course Logistics

1) duration - 29 hours
2) activities – lectures
3) timing
   a) Monday 09:00–13:00 14:30–17:45
   b) Tuesday 09:00–13:00 14:30–17:45
   c) Wednesday 09:00–13:00 14:30–17:45
   d) Thursday 09:00–13:00 14:30–17:45
4) sessions - 4 mornings, 4 afternoons
5) style - interactive and tutorial

e-Macao-16-7-11

Course Prerequisites

1) basic Java
2) basic understanding of TCP/IP networking concepts
3) basic understanding of XML

A.1.1. Basic Concepts

Basic Concepts

e-Macao-16-7-13

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

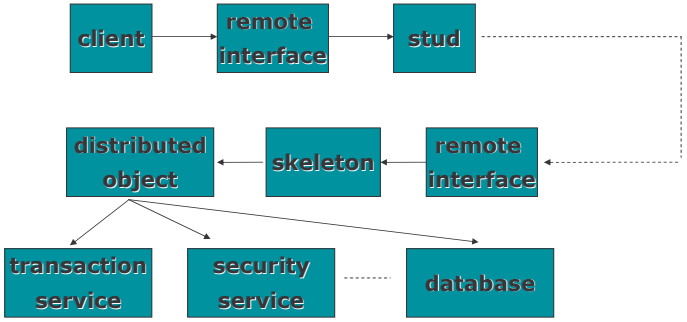
3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

e-Macao-16-7-14

Distributed Objects

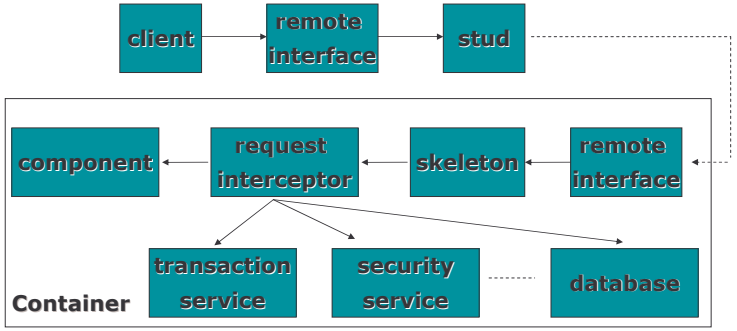
1) are objects called from remote system
2) use stubs and skeleton to hide the complexity of network communication
3) external services are invoked explicitly by user applications



e-Macao-16-7-15

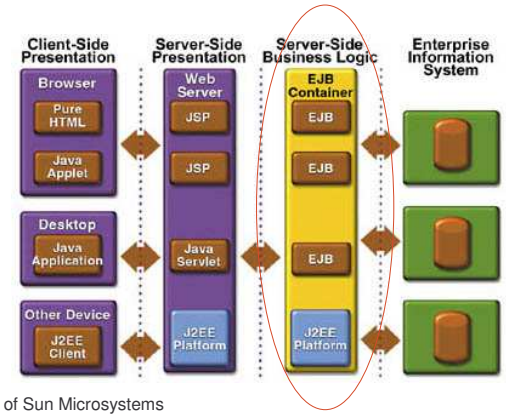
Component Objects

1) request interceptors intercepts all communications
2) components focus on business logic
3) system level services are controlled and maintained by the container and request interceptors



e-Macao-16-7-16

J2EE Platform



courtesy of Sun Microsystems

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Business Components

Enterprise JavaBeans (`EJB`)

a) is a server side component written in Java Language
b) is a standard distribuited component model
c) requires a container to function
d) allows developer concentrates on business logic
e) allows `JSPs`, `Servlets`, other `EJBs` and external applications act as clients

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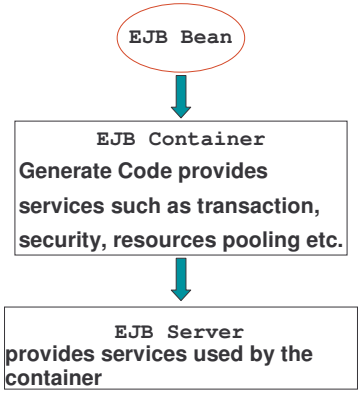
Deploying Enterprise JavaBeans



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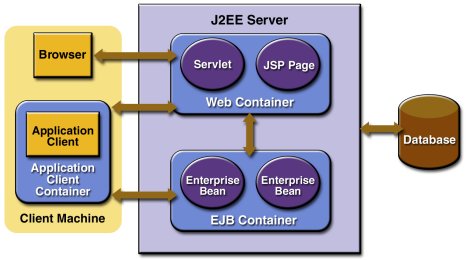
What is Application Server

Application servers enable the development of multi-tiered distributed applications. They are also called “middleware”.

An application server acts as the interface between the database(s), the web container, the EJB container and the client machines.



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Commercial Platforms

1) J2EE SDK 1.4 (Sun)
2) WebLogic (BEA Systems)
3) WebSphere (IBM)
4) iPlanet (Sun & Netscape)
5) JBoss (Open source)

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Benefits

Bean writers need not write codes for:

a) remote access protocols
b) transactional behaviour
c) threads
d) security
e) state management
f) object life cycle
g) resource pooling
h) persistence

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When to Use EJB

1) scalability
2) transaction
3) multi-client

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Types of EJB

1) Session Beans
   a) Stateless – general services such as shopping catalogue
   b) Stateful – state for individual client needs to be preserve such as shopping cart
2) Entity Beans
   a) CMP (Container-Managed Persistence)
   b) BMP (Bean-Managed Persistence)
3) Message-Driven Beans (Introduced in `EJB 2.0`)
   a) This is a JMS bean. Designed for sending and receiving JMS messages.

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EJBs Characteristics

All `EJBs` implement a subtype of `EnterpriseBean`.

a) Either `SessionBean`, `EntityBean`, or `MessageDrivenBean`

Each of the subinterfaces declares callback methods for the container.

a) Each callback method provides a way for the container to notify the `EJB` about an event in the bean's lifecycle, e.g. removing a bean from memory.
b) The callback methods give the `EJB` a chance to do some internal housework before or after an event occurs.
c) These are the bean's event handlers.

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Components of EJBs

To create an `EJB`, a developer has to provide:

1) A home interface
   a) defines the life-cycle methods of the bean
2) A remote interface
   a) defines the business methods of the bean
3) A bean class
   a) business logic

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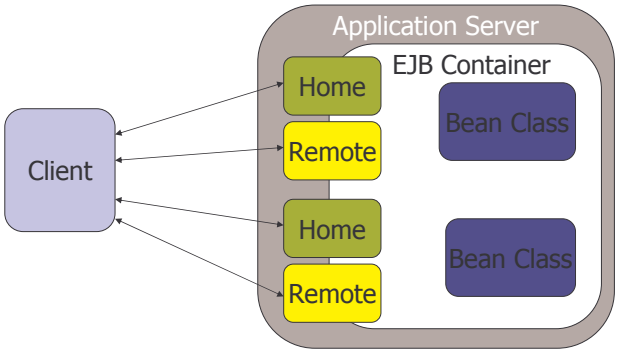
Conceptual Model



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Home Interface Characteristics

1) extends `javax.ejb.EJBHome`
2) acts as a factory pattern to create instances of the `EJB`
3) allows client to create, remove and find (for entity beans) an `EJB`
4) `EJB` container provides implementation

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Example: Home Interface

```
package com.interfaces;
// This is the home interface for HelloBean.
public interface HelloHome extends javax.ejb.EJBHome
{
   Hello create() throws java.rmi.RemoteException,
     javax.ejb.CreateException;
}
```

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Remote Interface Characteristics

1) extends `javax.ejb.EJBObject`
2) contains business methods called by the clients
3) implementation of the business methods is located in the bean class
4) acts as a proxy

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Example: Remote Interface

```
package com.interface;
// This is the HelloBean remote interface.
public interface Hello extends javax.ejb.EJBObject
{
   //The remote method
   public String hello() throws
          java.rmi.RemoteException;

}
```

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Bean Class Characteristics

1) implements either `SessionBean`, `EntityBean`, or `MessageDrivenBean`
2) contains implementations of the methods defined in the remote interface
3) defines `ejbCreate` methods corresponding to the create methods defined in the home interface

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Example: Bean Class 1

```
package com.ejb;
// Demonstration stateless session bean.
public class HelloBean implements javax.ejb.SessionBean
{
   private SessionContext ctx;
   // EJB-required methods
   public void ejbCreate() {
        System.out.println("ejbCreate()...");
   }
```

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Example: Bean Class 2

```
public void ejbRemove() {
       System.out.println("ejbRemove()...");
}
public void ejbActivate() {
  System.out.println("ejbActivate()...");
}
public void ejbPassivate() {
  System.out.println("ejbPassivate()...");
}
public void setSessionContext
    (javax.ejb.SessionContext ctx) {
    this.ctx = ctx;
}
```

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Example: Bean Class 3

```
        // Business methods
        public String hello() {
            System.out.println("hello()");
            return "Hello, World!";
        }
}
```

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Registering an EJB

1) After an EJB is deployed, the container generates the EJB Home object and skeleton from the home interface.
2) The EJB Home object is registered in the JNDI naming service.
3) Clients can then look up the advertised reference.
4) A stub object for the home interface is created automatically in client's container.

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Creating an EJB 1

1) After received the home interface reference, the client can call the create method to create an instance of the EJB component.
2) The client's stud object marshals the create parameters and send the message to the server.
3) The skeleton object in the server demarshals the message and delegate the invocation to the EJB Home object.
4) The EJB Home object then contacts the required services and create an EJB instance.
5) The skeleton and EJB object representing the EJB component are then instantiated.
6) The reference of the EJB object is passed back to the client and a stud for the EJB object is instantiated in the client.

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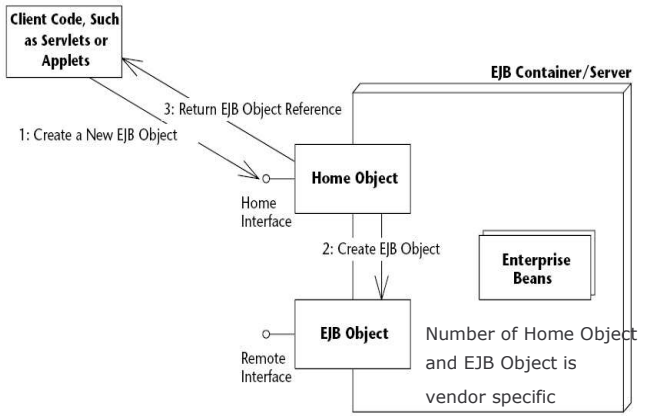
Creating an EJB 2



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Pooling EJB 1

EJB container is responsible for managing resources and life cycle of EJB.

It is ineffective for the EJB container to instantiate a new bean instance for every requests from clients.

Bean instance pooling is used to solve the problem.

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Pooling EJB 2

When a client requests an EJB, the container will instantiate a new instance if the bean instance does not exist in memory.

If a bean instance already exists and not actively serving a client, the bean instance may be assigned to another client to save system resources.

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Task 1: Basic Concepts

1) In order to create an EJB, what classes should a bean provider provide?
2) Which interface should a home interface extend? What methods are defined in the superinterface of the home interface? Who is responsible to implement these methods?
3) Which interface should a remote interface extend? What kind of methods should one define in the remote interface? Where should these methods be implemented?

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Deploying EJBs

For deploying an EJB, a deployment descriptor file, which is basically an XML file, is needed.

This descriptor allows attributes on the beans to be specified declaratively.

The file should be named ejb-jar.xml and stored in a directory named "META-INF".

A jar file including all the class files and the META-INF folder can then be deployed to an application server in a vendor specific manner.

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Example: ejb-jar.xml 1

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
  Inc.//DTD Enterprise JavaBeans 2.0//EN"
  "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar >
   <enterprise-beans>
      <session >
        <ejb-name>Hello</ejb-name>
          <home>
            iist.ejb.interface.HelloHome
          </home>
          <remote>
            iist.ejb.interface.Hello
          </remote>
```

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Example: ejb-jar.xml 2

```
          <ejb-class>
              iist.ejb.HelloBean
          </ejb-class>
          <session-type>Stateless</session-type>
           <transaction-type>
                 Container
            </transaction-type>
       </session>
   </enterprise-beans>
</ejb-jar>
```

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Vendor-specific file

Vendor specific functions such as clustering, instance pooling can be configured in a vendor-specific file.

For example, one may include the following file, `jboss.xml` in the `META-INF` folder, in order to publish the hello `EJB` with a different `JNDI` name in `JBoss`.

```
<!DOCTYPE jboss PUBLIC "-//JBoss//DTD JBOSS 3.2//En"
       "http://www.jboss.org/j2ee/dtd/jboss_3_2.dtd">
<jboss>
       <enterprise-beans>
            <session>
               <ejb-name>Hello</ejb-name>
               <jndi-name>myHelloHome</jndi-name>
            </session>
        </enterprise-beans>
</jboss>
```

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Task 2: Deploying an EJB

1) Try to deploy the `EJB` discussed in the example. You may use the Export function of Eclipse to generate the jar file to the following directory:
   `<JBoss_Home>\server\default\deploy`
2) Make sure that `JNDI` name of the bean is configured to `myHello`. Where can this configuration be made?
3) Create a client program to test the bean. The following is the skeleton code for the client application.

```
import javax.naming.Context;
import javax.naming.InitialContext;
import java.util.Properties;
public class HelloClient {
public static void main(String[] args) throws
       Exception {
```

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Task 3: Deploying an EJB

```
/* Setup properties for JNDI initialization.
* JNDI properties is stored in a file named
*jndi.properties include in the classpath*/
Properties props = System.getProperties();
Context ctx = new InitialContext(props);

Object obj = ctx.lookup("myHelloHome");
/*Home objects are RMI-IIOP objects, and so
* they must be cast into RMI-IIOP objects
*using a special RMI-IIOP cast.*/
HelloHome home = (HelloHome)
       javax.rmi.PortableRemoteObject.narrow
       (obj, HelloHome.class);
```

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Task 4: Deploying an EJB

```
// Use the factory to create the Hello EJB Object
       .......

// Call the hello() method on the EJB object. The
// EJB object will delegate the call to the bean,
// receive the result, and return it to us.
// Print the result to the screen.
       ......
// Done with EJB Object, so remove it.
// The container will destroy the EJB object.
         hello.remove();
       }
}
```

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Task 5: Deploying an EJB

4) The following file is needed for setting up the `JNDI` initial context for `JBoss`. Named this file as "`jndi.properties`" and put it in the classpath of the client's application.

```
java.naming.factory.initial=org.jnp.interfaces.Naming
ContextFactory
java.naming.provider.url=jnp://localhost:1099
java.naming.factory.url.pkgs=org.jboss.naming:org.jnp
.interfaces
```

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Task 6: Deploying an EJB

5) Download and install the `JBossIDE` plug-in for Eclipse from `www.jboss.org`.
   a) Unpack the archives into a directory on your computer.
   b) At `Eclipse:Help-->Find and Install-->Search for new features for install-->Add new Archive site-->` choose directory containing unpacked `JbossIDE` files.
   c) Follow the instruction to install `JbossIDE`.

6) Copy `<Jboss_Home>/client/jbossall-client.jar` to the build path of the client program.
7) Change the `JNDI` name of the bean to "`ejb/Hlelo`"; modify the client program and run the test again.

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Summary 1

EJB should be used when the followings are required:

1) Scalability
2) Transaction
3) Multi-client

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Summary 2

There are three types of EJB:

1) Session Beans
2) Entity Beans
3) Message-Driven Beans (Introduced in EJB 2.0)

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Summary 3

To create an EJB, the following files are needed:

1) A home interface
    a) defines the life-cycle methods of the bean
2) A remote interface
    a) defines the business methods of the bean
3) A bean class
    a) business logic

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Summary 4

1) After an EJB is deployed, the container generates the EJB Home object and skeleton from the home interface.
2) The EJB Home object is registered in the JNDI naming service.
3) Clients can then look up the advertised reference.
4) A stub object for the home interface is then created automatically in client's container.

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Summary 5

1) After received the home interface reference, the client can call the create method to create an instance of the EJB component.
2) The client's stud object marshals the create parameters and send the message to the server.
3) The skeleton object in the server demarshals the message and delegate the invocation to the EJB Home object.
4) The EJB Home object then contacts the required services and create an EJB instance.
5) The skeleton and EJB object representing the EJB component are the instantiated.
6) The reference of the EJB object is passed back to the client and a stud for the EJB object is instantiated in the client.

A.2. Vertical Concepts

Vertical Concepts

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

A.2.1. Session Beans

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Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary
2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary
3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

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Session Beans

Session beans characteristics:

1) should be used for short requests
2) require low resource costs and promotes fast response back to the client
3) are not persistent and do not survive application server or machine crashes
4) usually act as agents to the client and control process flow

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Types of Session Beans

There are two types of session beans:

1) Stateless session beans
   a) model single request business process
   b) no conversational state to be maintained across methods
   c) consume less resources and efficiently managed by the container

2) Stateful session beans
   a) conversational state are maintained by the container
   b) less efficient than stateless session beans

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Stateless Session Bean

A stateless session bean is a bean that holds conversations that span a single method call.

After each method call, the container may choose to destroy, recreate or clearing the stateless session bean out of all information.

Data must be provided as parameters or retrieved from external sources, such as a database.

Example: shopping catalogue

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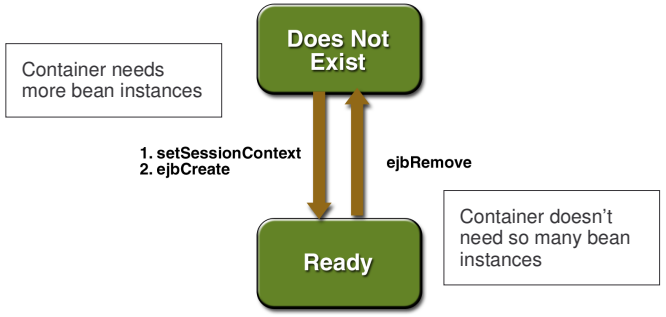
Life Cycle: Stateless Session Bean



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Task 7: Stateless Session Bean

1) Create and deploy a stateless session bean named `HolidayCalander`.
   a) Follow the example from task 2 to task 6 to create the necessary files for this session bean.
   b) Create a business method named "`isHoliday`" for this bean. This method checks if the input date is Saturday or Sunday and return a boolean value.

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Task 8: Stateless Session Bean

c) The implementation of this method may as follows:

```
public boolean isHoliday(Date date){
     Calendar cal = Calendar.getInstance();
     cal.setTime(date);
     int dayOfWeek = cal.get(Calendar.DAY_OF_WEEK);
     if (dayOfWeek==Calendar.SATURDAY ||
       dayOfWeek==Calendar.SUNDAY)
            return true;
     return false;
}
```

2) Deploy this bean as a stateless session bean.
3) Create a client to test the stateless session bean.

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Stateful Session Bean

A stateful session bean is a bean that is designed to service business processes that span multiple method requests or transactions.

Stateful session beans retain state on behalf of an individual client.

Example: online shopping cart

Each time the user adds a product to the shopping cart, another request will be performed. The components must track the user's state (such as a shopping cart state) from request to request.

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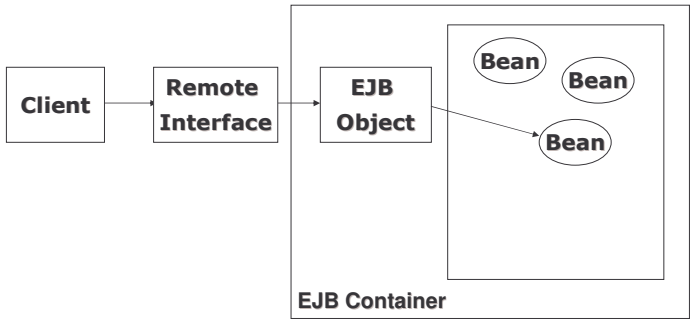
Pooling: Stateless Session Bean

Since a stateless session bean retains no state knowledge about its history, stateless session beans can be pooled, reused, and swapped from one client to another client on each method call.



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Pooling: Stateful Session Bean

As the state of each stateful session bean has to be retained, how could the pooling be achieved?

EJB container achieves this by passivation.

Passivation allows container to swap out the state of an EJB from the memory to another storage such as the hard disk.

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EJB Passivation

EJB is passivated according to container-specific algorithm and usually the least recently called bean will be passivated.

When the passivated bean is activated again, its states will be restored from the storage to memory again.

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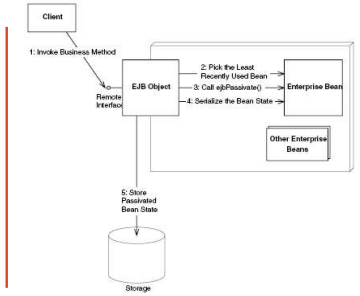
Passivation: Stateful Session Bean

Typical stateful session bean passivation:

a) The client has invoked a method on an EJB object that does not have a bean tied to it in memory.

b) The container's limit of beans is reached. Thus the container needs to passivate a bean before handling this client's request.



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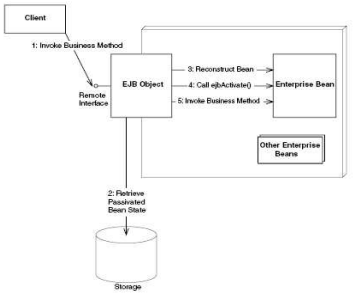
Activation: Stateful Session Bean

Typical stateful session bean activation :

a) The client has invoked a method on an EJB object whose stateful bean had been passivated.

b) The container retrieves the passivated data and reconstruct the bean state.



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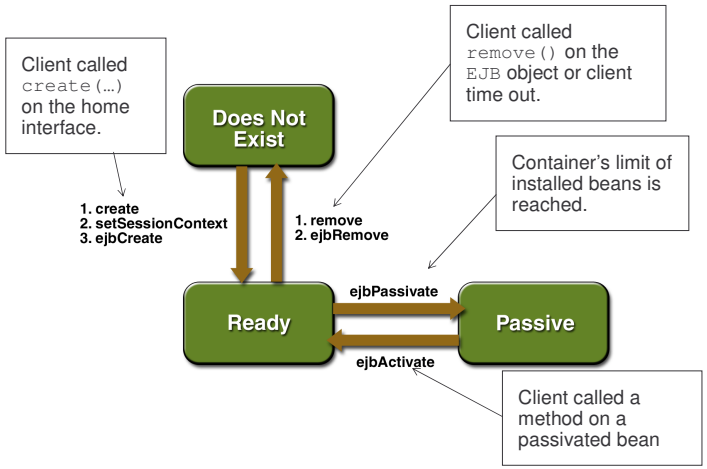
Life Cycle: Stateful Session Bean



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Task 9: Passivation

1) Investigate the passivation and activation process of stateful session bean.
   a) Create a stateful session bean call `CountBean`. It has an integer member variable "`val`".
   b) The bean should have a method named "`count`" as follows:

```
public int count() {
      System.out.println("count()");
       return ++val;
}
```

   c) Follow the `HelloBean` example to create the necessary interfaces for this session bean.
   d) The `ejbCreate` method in the `CountBean` class takes an integer as an argument and set its value to variable `val`. Create the corresponding `create` method in the home interface to accommodate this.

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Task 10: Passivation

   e) Modify the deployment descriptor file, `ejb-jar.xml`, to decorate the bean as a stateful session bean as follows:
   `<session-type>Stateful</session-type>`
   f) Choose your own ejb-name for this bean.
   g) In order to observe the passivation and activation process, configuration the server to minimize the total number of beans in memory. For `jboss`, modify the `jboss.xml` file as follows:

```
<!DOCTYPE ...>
<jboss>
  <enterprise-beans>
   <session>
     <ejb-name>...</ejb-name>
     <jndi-name>...</jndi-name>
```

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Task 11: Passivation

```
      <configuration-name>
         StatefulDemo
       </configuration-name>
     </session>
  </enterprise-beans>
<container-configurations>
   <container-configuration
      extends="Standard Stateful SessionBean">
      <container-name>StatefulDemo</container-name>
         <container-cache-conf>
            <cache-policy>
 org.jboss.ejb.plugins.LRUStatefulContextCachePolicy
            </cache-policy>
          <cache-policy-conf>
```

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Task 12: Passivation

```
            <min-capacity>1</min-capacity>
            <max-capacity>1</max-capacity>
          </cache-policy-conf>
        </container-cache-conf>
    </container-configuration>
  </container-configurations>
</jboss>
```

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Task 13: Passivation

h) Deploy the bean in `JBoss`.

i) Create a client called `CountClient` to test the `EJB` according to the following steps:

1. Get system properties for `JNDI`.
2. Get reference for the home object.
3. Create an array to hold 3 `Count EJB` objects.
4. Create and initialize them as follows:

```
for (int i=0; i < 3; i++) {
     count[i] = home.create(countVal);
     // Add 1 and print
     countVal = count[i].count();
     System.out.println(countVal);
     // Sleep for 1/2 second
     Thread.sleep(500);
  }
```

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Task 14: Passivation

5. Call the `count()` method on each `EJB` object and remove them when finished:

```
System.out.println("Calling count() on
beans . . . ");
     for (int i=0; i < 3; i++) {
       // Add 1 and print
        countVal = count[i].count();
      System.out.println(countVal);
       // Sleep for 1/2 second
      Thread.sleep(500);
     }
    // Done with EJB Objects, remove them
       for (int i=0; i < 3; i++) {
              count[i].remove();
         }
```

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Task 15: Passivation

j) Observe the output from both the client and server side. What conclusion can you make from the output about the passivation and activation process?

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Summary 1

Session beans has the following characteristics:

1) should be used for short requests
2) require low resource costs and promotes fast response back to the client
3) are not persistent and do not survive application server or machine crashes
4) usually act as agents to the client and control process flow

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Summary 2

There are two types of session beans:

1) Stateless session beans
   a) model single request business process
   b) no conversational state to be maintained across methods
   c) consume less resources and efficiently managed by the container

2) Stateful session beans
   a) conversational state are maintained by the container
   b) less efficient than stateless session beans

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Summary 3

Each EJB class instance is single threaded.

Stateless session beans can be pooled, reused, and swapped from one client to another client on each method call.

Stateful session beans achieve the pooling effect through a mechanism called passivation.

During passivation, the container swaps out the state of an `EJB` from the memory to another storage such as the hard disk.

The state of the `EJB` is recovered through activation.

A.2.2. Entity Beans

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Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary
2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary
3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

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Entity Bean

What is an `Entity Bean`?

a) An `Entity Bean` represents business data stored in a database.
b) Database data types are converted into Java data types and encapsulated into the `Entity Bean`.
c) Modifying the in-memory value of an `Entity Bean` can change the values of data, saved back into storage again and updating the database data.

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Entity Bean Characteristics

1) contains the standard set of files for `EJB` components
2) each `Entity` beans must have a **serializable** primary key
3) primary key can either be a Java class (primary key class) or primitive type pointing to a unique record in the database
4) container will take care the in-memory object synchronization with the underlying data storage
5) can live past the duration of a client's session

Example: shopping order

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Primary Key

Primary key is a unique identifier for an entity bean instance.

An entity bean instance has no identity unless it's primary key is stored in an `EJBObject`.

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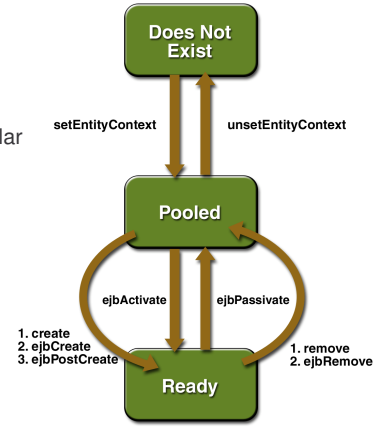
Life Cycle: Entity Bean

Instances in the pool are:

1) identical
2) not associated with any particular object identity
3) `EJB` container may assign an identity to an instance when moving it to the ready stage invoking the `ejbActivate` method



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Operations

J2EE defines specific methods for entity beans operations:

- ejbCreate
- ejbFind
- ejbHome
- ejbLoad
- ejbStore
- ejbRemove

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Creating Entity Bean 1

1) A client calls the home object's `create()` method, which delegates to the entity bean's `ejbCreate()`.
2) New record is created in the underlying data base.
3) A bean instance is also generated through the home object.
4) The bean returns a primary key to the container (that is, to the home object) so that the container can identify the bean.
5) Once the home object has this primary key, it can then generate an `EJB` object and return that to the client.

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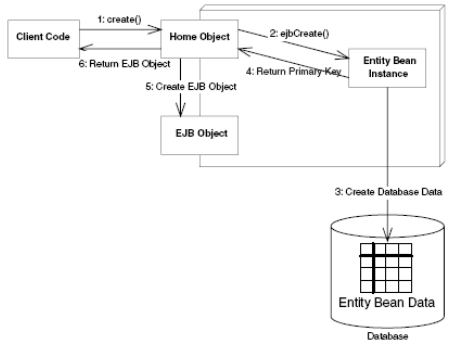
Creating Entity Bean 2



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Finding Existing Entity Beans

Finder method is a special type of method for finding existing bean in storage.

Rules for finder methods:

a) Finder methods must begin with `ejbFind`.
b) At least one finder method named, `ejbFindByPrimaryKey`, must be included.
c) Finder methods with different names and parameters can be defined.
d) The return types can either be a primary key or a collection of primary keys.
e) For each finder method defined in the bean, a corresponding finder method must be defined in the home interface.

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Home Method

A special business method called home method can be defined in the entity bean class to provide global operations such as counting the total number of records.

This method does not depend on any specific data.

Home method must be defined as `ejbHomeXXX` in the bean class and a corresponding method, named `XXX`, should be declared in the home interface.

For example,
in `EJB` class: `ejbHomeGetAllAccount()`
in home interface: `getAllAccount()`

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Loading and Storing Entity Bean

Multiple in-memory entity bean representing the same data can exist within a Java Virtual Machine.

Mechanism must be available to transfer data between the bean and database.

`ejbLoad` method and `ejbStore` methods are routinely called by the container to be synchronized with the database.

`ejbLoad()`: loads data from database into the entity bean.
`ejbStore()`: saves data from entity bean to database.

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Destroying Entity Bean 1

1) Client calls the `remove()` method on either the home object or the `EJB` object.
2) The container will issue an `ejbRemove()` method call on the entity bean instance.
3) Note that `ejbRemove()` destroys only database data but not the in-memory entity bean instance.

Remarks:

a) The bean instance can be recycled to handle a different database data instance.
b) The `ejbRemove()` method will not be called if the client times out.

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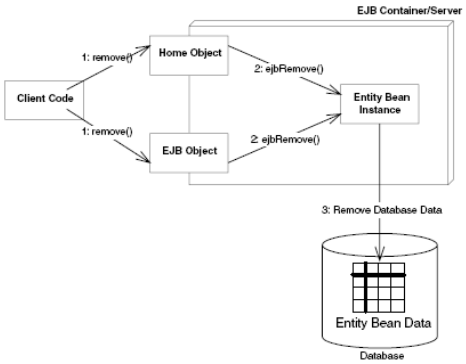
Destroying Entity Bean 2



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Types of Persistence 1

There are two ways to persist an Entity Bean:

1) Bean-Managed Persistence (`BMP`)
   a) Should be used for complex relationships such as data from different databases or resources from legacy systems.
   b) Developer needs to provide all of the code for managing persistence between the object and the database.
   c) Any changes in the database or in the structure of data require changes to the bean instance's definition.

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Types of Persistence 2

2) Container-Managed Persistent (CMP)
   a) The Container will handle reading data from storage to bean instance and writing data from bean to storage updating database records.
   b) Bean developer can then focus on the data and the business process.
   c) Should be used to handle simple relationships with the database.
   d) CMP entity bean is an in-memory Java representation of persistent data.

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Bean-Managed Persistence

When writing the Bean-Managed Persistence (BMP)entity bean, one must provide data access logic.

Database API such as JDBC can be used to map the entity bean instances to and from storage.

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BMP: ejbFind Method

The container will not implement the finder methods in BMP Entity Bean.

The ejbFindByPrimaryKey method must be implemented in the bean by the bean developer.

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BMP: getPrimaryKey Method 1

This method retrieve the primary key associated with the entity bean instance.

For example, used in the BMP ejbLoad method as follows:

```
protected EntityContext ctx;
. . .
public void setEntityContext(EntityContext ctx){
this.ctx = ctx;
}
. . .
```

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BMP: getPrimaryKey Method 2

```
. . .
public void ejbLoad(){
/* 1. acquire the primary key such as:
*  AccountPK accPk = (AccountPK) ctx.getPrimaryKey();
*  2. acquire database connection
*  3. execute sql statement to extract data
*     corresponding to the primary key
*  4. restore the variables with data obtained from
*     database.
*/
```

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Task 16: BMP Entity Bean

1) Build and deploy a `BMP` entity bean. This bean is called `AccountBean` which represents the account of a customer in a bank.
   a) Write a remote interface, `Account`, which extends `EJBObject` and defines the following business methods:
      `public void deposit(double amt) throws AccountException, RemoteException;`
      `public void withdraw(double amt) throws AccountException, RemoteException;`
   b) Define the getter/setter methods on `Entity Bean` fields: `double balance`, `String ownerName` and `accountID`.
   c) Define an Exception, `AccountException`, for the business methods.

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Task 17: BMP Entity Bean

d) Write the home interface, `AccountHome`, for the `AccountBean`. This interface should define the following methods:

```
package com.interfaces;

import javax.ejb.*;
import java.util.Collection;
import java.rmi.RemoteException;
public interface AccountHome extends EJBHome {
```

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Task 18: BMP Entity Bean

```
/*
* create method which creates a new account in
* database representing a bank account. It
* returns an EJB object to the client.
* Notice that application-level Exception
* CreateException must be thrown.
*/
Account create(String accountID, String
   ownerName) throws
CreateException, RemoteException;
```

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Task 19: BMP Entity Bean

```
/**
* Finds an Account by its primary Key
* (AccountID)
*/
public Account findByPrimaryKey(AccountPK key)
   throws
FinderException, RemoteException;
/**
* Finds all Accounts under an owner's name
*/
public Collection findByOwnerName(String name)
   throws
FinderException, RemoteException;
```

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Task 20: BMP Entity Bean

```
/**
* This home business method is independent of
*any particular account. It returns the total
*of all accounts in the bank.
*/
public double getTotalBankValue() throws
   AccountException, RemoteException;
}
```

Note : Because we're using bean-managed persistence, we need to implement the finder methods in our entity bean implementation.

If we were using container-managed persistence, the container would search the database for us.

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Task 21: BMP Entity Bean

e) Write the primary key class called `AccountPK` as follows:

```
package com.interfaces;
import java.io.Serializable;
/**
* Primary Key class for Account.
*/
public class AccountPK implements
   java.io.Serializable {
   public String accountID;
   public AccountPK(String id) {
   this.accountID = id;
   }
   public AccountPK() {}
```

e-Macao-16-7-106

Task 22: BMP Entity Bean

```
   public String toString() {
        return accountID;
   }
   public int hashCode() {
        return accountID.hashCode();
   }
   public boolean equals(Object account) {
        return
        ((AccountPK)account).accountID.equals
        (accountID);
   }
}
```

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Task 23: BMP Entity Bean

Note :

1. Entity beans may map to more than one table and can have primary key class having several fields, each representing the primary key of a table in the database.
2. A `toString()` method is required for the container to retrieve a `String` value of this primary key.
3. A `hashCode()` method is required as the primary key class allowing the container to store a list of all entity beans in a `Hashtable` or similar structure.
4. An `equal()` method allows the container to be sure that a single record is not represented by two entity bean.

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Task 24: BMP Entity Bean

f) Write the bean class called `AccountBean`, which has to implement `javax.ejb.EntityBean` interface. This interface defines the required methods that your entity bean class must implement and look like the follows:

```
public interface javax.ejb.EntityBean extends
javax.ejb.EnterpriseBean {
  public void
     setEntityContext(javax.ejb.EntityContext) ;
  public void unsetEntityContext();
  public void ejbRemove();
  public void ejbActivate();
  public void ejbPassivate();
  public void ejbLoad();
  public void ejbStore();
}
```

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Task 25: BMP Entity Bean

g) The actual bean class may look as follows:

```
package com.ejb;

import java.sql.*;
import javax.naming.*;
import javax.ejb.*;
import java.util.*;
public class AccountBean implements EntityBean
{
  // declare a variable for the Context object
   protected EntityContext ctx;
```

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Task 26: BMP Entity Bean

```
  // Bean-managed state fields

  private String accountID; // Primary Key
  private String ownerName;
  private double balance;
  public AccountBean() {
     System.out.println
          ("New Bank Account Entity Bean Java
             Object created by EJB Container.");
  }
```

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Task 27: BMP Entity Bean

```
// Business Logic Methods

/**
* Deposits amt into account.
* Transaction is not being taken care yet.
*/
public void deposit(double amt) throws
   AccountException {
      System.out.println("deposit(" + amt + ")
        called.");
           balance += amt;
}
```

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Task 28: BMP Entity Bean

```
// Withdraws from bank account.
// Transaction is not being taken care yet.

public void withdraw(double amt) throws
   AccountException {
   System.out.println("withdraw(" + amt + ")
   called.");
   if (amt > balance) {
        throw new AccountException("Your
        balance is " + balance + "! You cannot
        withdraw " + amt + "!");
   }
   balance -= amt;
}
```

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Task 29: BMP Entity Bean

```
// Getter/setter methods on Entity Bean fields
// For examples:
public double getBalance() {
       System.out.println("getBalance()
   called.");
    return balance;
}
public void setOwnerName(String name) {
  System.out.println("setOwnerName() called.");
   ownerName = name;
}
```

e-Macao-16-7-114

Task 30: BMP Entity Bean

```
public String getOwnerName() {
  System.out.println("getOwnerName() called.");
   return ownerName;
}

 //...please implement the rest of the methods
 //and make each method has a statement
 //printing out which method is running.
```

e-Macao-16-7-115

Task 31: BMP Entity Bean

```
// Gets JDBC connection from the connection pool.
public Connection getConnection() throws Exception {
 try {
    Context ctx = new InitialContext();
    javax.sql.DataSource ds = (javax.sql.DataSource)
    ctx.lookup("java:/DefaultDS");
        return ds.getConnection();
 }catch (Exception e) {
   System.err.println("Couldn't get datasource!");
  e.printStackTrace();
  throw e;
 }
}
```

e-Macao-16-7-116

Task 32: BMP Entity Bean

```
/*
* This home business method is independent of any
* particular account instance. It returns the total
* of all the bank accounts in the bank.
*/
public double ejbHomeGetTotalBankValue() throws
        AccountException
{
  PreparedStatement pstmt = null;
  Connection conn = null;
  try {
   System.out.println("ejbHomeGetTotalBankValue()");
// Acquire DB connection
        conn = getConnection();
```

e-Macao-16-7-117

Task 33: BMP Entity Bean

```
// Get the total of all accounts
pstmt = conn.prepareStatement(
"select sum(balance) as total from accounts");
ResultSet rs = pstmt.executeQuery();
   // Return the sum
    if (rs.next()) {
       return rs.getDouble("total");
    }
}
catch (Exception e) {
      e.printStackTrace();
   throw new AccountException(e);
}
```

e-Macao-16-7-118

Task 34: BMP Entity Bean

```
finally {
//  Release DB Connection for other beans
        try { if (pstmt != null) pstmt.close(); }
            catch (Exception e) {}
        try { if (conn != null) conn.close(); }
            catch (Exception e) {}
}
        throw new AccountException("Error!");
}
```

e-Macao-16-7-119

Task 35: BMP Entity Bean

```
public void ejbActivate() {
 System.out.println("ejbActivate() called.");
}

/* Another method that use the getPrimaryKey method
 * to retrieve the primary key
*/
public void ejbRemove() throws RemoveException {
 System.out.println("ejbRemove() called.");
 AccountPK pk = (AccountPK) ctx.getPrimaryKey();
 String id = pk.accountID;
 PreparedStatement pstmt = null;
 Connection conn = null;
```

e-Macao-16-7-120

Task 36: BMP Entity Bean

```
try {
 /*
 * 1) Acquire a new JDBC Connection
 */
 conn = getConnection();
/*
* 2) Remove account from the DB
*/
pstmt = conn.prepareStatement(
"delete from accounts where id = ?");
pstmt.setString(1, id);
```

e-Macao-16-7-121

Task 37: BMP Entity Bean

```
    /*
    * 3) Throw a system-level exception if something
    * bad happened.
    */
    if (pstmt.executeUpdate() == 0) {
      throw new RemoveException(
       "Account " + pk +
       " failed to be removed from the database");
    }
} catch (Exception ex) {
        throw new EJBException(ex.toString());
}
```

e-Macao-16-7-122

Task 38: BMP Entity Bean

```
    finally {
      /*
      * 4) Release the DB Connection
      */
      try { if (pstmt != null) pstmt.close(); }
       catch (Exception e) {}
      try { if (conn != null) conn.close(); }
       catch (Exception e) {}
      }
    }
```

e-Macao-16-7-123

Task 39: BMP Entity Bean

```
public void ejbPassivate() {
  System.out.println("ejbPassivate () called.");
}

/**
* Called by the container. Updates the in-memory
* entity
* bean object to reflect the current value stored in
* the database.
*/
public void ejbLoad() {
 System.out.println("ejbLoad() called.");
 AccountPK pk = (AccountPK) ctx.getPrimaryKey();
 String id = pk.accountID;
```

e-Macao-16-7-124

Task 40: BMP Entity Bean

```
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  conn = getConnection();
  pstmt = conn.prepareStatement(
    "select ownerName, balance from accounts "
     + "where id = ?");
   pstmt.setString(1, id);
 ResultSet rs = pstmt.executeQuery();
 rs.next();
 ownerName = rs.getString("ownerName");
 balance = rs.getDouble("balance");
}
```

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Task 41: BMP Entity Bean

```
 catch (Exception ex) {
  throw new EJBException( "Account " + pk
   + " failed to load from database", ex);
 }
 finally {
 /*
 * 3) Release the DB Connection
 */
    try { if (pstmt != null) pstmt.close(); }
    catch (Exception e) {}
    try { if (conn != null) conn.close(); }
    catch (Exception e) {}
 }
}
```

e-Macao-16-7-126

Task 42: BMP Entity Bean

```
/**
* Called from the Container. Updates the database
* to reflect the current values of this in-memory
* entity bean instance.
*/
public void ejbStore() {
 System.out.println("ejbStore() called.");
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  conn = getConnection();
  pstmt = conn.prepareStatement(
    "update accounts set ownerName = ?, balance = ?"
    + " where id = ?");
```

e-Macao-16-7-127

Task 43: BMP Entity Bean

```
    pstmt.setString(1, ownerName);
    pstmt.setDouble(2, balance);
    pstmt.setString(3, accountID);
    pstmt.executeUpdate();
  }
   catch (Exception ex) {
    throw new EJBException( "Account " + accountID
    + " failed to save to database", ex);
  }
```

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Task 44: BMP Entity Bean

```
    finally {
          //Release the DB Connection
          try { if (pstmt != null) pstmt.close(); }
          catch (Exception e) {}
          try { if (conn != null) conn.close(); }
         catch (Exception e) {}
      }
    }
```

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Task 45: BMP Entity Bean

```
public void setEntityContext(EntityContext ctx) {
 System.out.println("setEntityContext called");
 this.ctx = ctx;
}
public void unsetEntityContext() {
 System.out.println("unsetEntityContext called");
 this.ctx = null;
}
```

e-Macao-16-7-130

Task 46: BMP Entity Bean

```
/**
* Called after ejbCreate(). Now, the Bean can
* retrieve
* its EJBObject from its context, and pass it as
* a 'this' argument.
*/
public void ejbPostCreate(String accountID, String
  ownerName) {
}
```

e-Macao-16-7-131

Task 47: BMP Entity Bean

```
public AccountPK ejbCreate(String accountID, String
   ownerName) throws CreateException {
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  System.out.println("ejbCreate() called.");
  this.accountID = accountID;
  this.ownerName = ownerName;
  this.balance = 0;
  conn = getConnection();
```

e-Macao-16-7-132

Task 48: BMP Entity Bean

```
    pstmt = conn.prepareStatement(
    "insert into accounts (id, ownerName, balance)"
    + " values (?, ?, ?)");
    pstmt.setString(1, accountID);
    pstmt.setString(2, ownerName);
    pstmt.setDouble(3, balance);
    pstmt.executeUpdate();

    return null;
}
```

e-Macao-16-7-132

Task 48: BMP Entity Bean


```
    pstmt = conn.prepareStatement(
    "insert into accounts (id, ownerName, balance)"
    + " values (?, ?, ?)");
    pstmt.setString(1, accountID);
    pstmt.setString(2, ownerName);
    pstmt.setDouble(3, balance);
    pstmt.executeUpdate();

    return null;
}
```


e-Macao-16-7-133

Task 49: BMP Entity Bean

```
    catch (Exception e) {
      throw new CreateException(e.toString());
    }
    finally {
    /*
    * Release DB Connection for other beans
    */
     try { if (pstmt != null) pstmt.close(); }
     catch (Exception e) {}
     try { if (conn != null) conn.close(); }
     catch (Exception e) {}
    }
}
```

e-Macao-16-7-134

Task 50: BMP Entity Bean

```
/**
* Finds a Account by its primary Key
*/
public AccountPK ejbFindByPrimaryKey(AccountPK
 key) throws FinderException {
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
   System.out.println("ejbFindByPrimaryKey("
   + key + ") called");
   conn = getConnection();
   pstmt = conn.prepareStatement(
```

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Task 51: BMP Entity Bean

```
   "select id from accounts where id = ?");
   pstmt.setString(1, key.toString());
   ResultSet rs = pstmt.executeQuery();
   rs.next();
   return key;
   }
   catch (Exception e) {
   throw new FinderException(e.toString());
   }
   finally {
    // Release DB Connection for other beans
    . . .
   }
}
```

e-Macao-16-7-136

Task 52: BMP Entity Bean

```
public Collection ejbFindByOwnerName(String name)
 throws FinderException {
  PreparedStatement pstmt = null;
  Connection conn = null;
  Vector v = new Vector();
  try {
    System.out.println(
     "ejbFindByOwnerName(" + name + ") called");
      conn = getConnection();
      pstmt = conn.prepareStatement(
     "select id from accounts where ownerName = ?");
     pstmt.setString(1, name);
     ResultSet rs = pstmt.executeQuery();
```

e-Macao-16-7-137

Task 53: BMP Entity Bean

```
     // Insert every primary key found into a vector
     while (rs.next()) {
       String id = rs.getString("id");
       v.addElement(new AccountPK(id));
     }
    return v;
   } catch (Exception e) {
    throw new FinderException(e.toString());
   } finally {
    // Release DB Connection for other beans
    . . .
   }
  }
}
```

e-Macao-16-7-138

Task 54: BMP Entity Bean

g) Before you can test your ejb, you need to set up the data source in JBoss. JBoss comes with the hsqldb database server .To enable it, edit c:\jboss\server\default\deploy\hsqldb-ds.xml. Uncomment the <connection-url> element that connects to the localhost using TCP:

```
<datasources>
   <local-tx-datasource>
        ...
```

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Task 55: BMP Entity Bean

```
        <connection-url>
              jdbc:hsqldb:hsql://localhost:1701
        </connection-url>
           ...
    </local-tx-datasource>
     ...
</datasources>
```

e-Macao-16-7-140

Task 56: BMP Entity Bean

h) In the file hsqldb-ds.xml, the <mbean> element for the hsqldb TCP connection should not be commented out for TCP based connection:

```
<datasources> . . .
<mbean
   code="org.jboss.jdbc.HypersonicDatabase"
name="jboss:service=Hypersonic">
<attribute name="Port">1701</attribute>
<attribute name="Silent">true</attribute>
<attribute name="Database">default</attribute>
<attribute name="Trace">false</attribute>
<attribute
   name="No_system_exit">true</attribute>
</mbean>
</datasources>
```

e-Macao-16-7-141

Task 57: BMP Entity Bean

i) Restart JBoss if it is running.

j) The hsqldb-ds.xml also defines the JNDI name for the data source as "DefaultDS" (this name should be used along with a "java:/" prefix in your EJB to get the connection). In the getConnection () method of the AccountBean class, we use "java:/DefaultDS".

k) In order to create the database, open the JBoss JMX console by typing this url, http://localhost:8080/jmx-console/, in your browser. Click on the link "service=Hypersonic" and then invoke the "startDatabaseManager" operation. This will launch the hsqldb manager. Input the SQL statement to create accounts table and then click the "Execute SQL statement" button.

l) Deploy your EJB with proper deployment descriptor files.

e-Macao-16-7-142

Task 58: BMP Entity Bean

m) The `ejb-jar.xml` may look as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
 <enterprise-beans>
  <entity>
   <ejb-name>Account</ejb-name>
   <home>examples.AccountHome</home>
   <remote>examples.Account</remote>
   <ejb-class>examples.AccountBean</ejb-class>
   <persistence-type>Bean</persistence-type>
   <prim-key-class>examples.AccountPK
   </prim-key-class>
```

e-Macao-16-7-143

Task 59: BMP Entity Bean

```
    <reentrant>False</reentrant>
  </entity>
 </enterprise-beans>
 <assembly-descriptor>
  <container-transaction>
   <method>
    <ejb-name>Account</ejb-name>
    <method-intf>Local</method-intf>
    <method-name>*</method-name>
   </method>
```

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Task 60: BMP Entity Bean

```
   <method>
    <ejb-name>Account</ejb-name>
    <method-intf>Remote</method-intf>
    <method-name>*</method-name>
   </method>
   <trans-attribute>Required</trans-attribute>
  </container-transaction>
 </assembly-descriptor>
</ejb-jar>
```

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Task 61: BMP Entity Bean

n) The vendor specific deployment descriptor, `jboss.xml` may look as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<jboss>
  <enterprise-beans>
     <entity>
        <ejb-name>Account</ejb-name>
        <jndi-name>AccountHome</jndi-name>
     </entity>
  </enterprise-beans>
</jboss>
```

o) Develop a client program to test the entity bean.

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Task 62: Life Cycle of Entity Bean

1) There are two call back methods, `ejbLoad`() and `ejbStore`() declared within the `EntityBean` interface. What are their functions?
2) How many threads are allowed to run within a bean instance?
3) If entity bean is single-thread, a bean can only serve one client at a time. Will this create a performance bottleneck if many clients need to access the same account at the same time?
4) How does `J2EE` tackle the above performance problem?

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Container Managed Persistence 1

No code is needed in the bean for accessing the database.

There is no fields declared in the bean class as `BMP` entity bean does.

The get/set methods of the bean class needs to be declared as abstract methods. This makes the bean class that we created has to be an abstract class.

The container will subclass the bean, implements the declared getter and setter methods to handle the persistence of the data.

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Container Managed Persistence 2

The actual entity bean is a combination of the superclass and the subclass.

Links between beans are created using a structure called abstract schema.

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Container Managed Persistence 2

The actual entity bean is a combination of the superclass and the subclass.

Links between beans are created using a structure called abstract schema.

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Abstract Schema 1

Abstract schema is part of an entity bean's deployment descriptor.

Defines the bean's persistent fields and relationships.

The abstract schema in the deployment descriptor file (`ejb-jar.xml`) may defined as follows:

```
<cmp-version>2.x</cmp-version>
<abstract-schema-name>
          ProductBean
</abstract-schema-name>
<cmp-field>
    <field-name>productID</field-name>
</cmp-field>
```

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Abstract Schema 2

```
<cmp-field>
   <field-name>productName</field-name>
</cmp-field>
<primary-field>productID</primary-field>
. . .
```

Note:

1) The cmp-field elements are the persistent field that the container will generate in the subclass.
2) The names of these fields must match the names of your abstract get/set methods, except the first letter is not capitalized.

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EJB Query Language

EJB Query Language (`EJB-QL`) is an object-oriented SQL-like syntax for querying entity beans.

It contains a `SELECT` clause, a `FROM` clause, and an optional `WHERE` clause.

`EJB-QL` code is written in the deployment descriptor, and the container should be able to generate the corresponding database logic (such as `SQL`).

Please refer to the following link for the detail syntax of `EJB-QL`:
`http://java.sun.com/j2ee/tutorial/1_3-fcs/doc/EJBQL.html`

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Example: EJB Query Language 1

EJB Query Language (`EJB-QL`) for a method `findBigAccount()` may look like the following:

```
SELECT OBJECT(a) FROM Account AS a WHERE a.balance
> ?1
```

In the deployment descriptor file, it may look as follows:

```
<query>
   <query-method>
       <method-name>findBigAccount</method-name>
          <method-params>
                <method-param>double</method-
param>
          </method-params>
    </query-method>
```

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Example: EJB Query Language 2

```
    <ejb-ql>
          <![CDATA[SELECT OBJECT(a) FROM AccountBean
        AS a WHERE a.balance > ?1]]>
     </ejb-ql>
  </query>
```

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Example: EJB-QL 1

```
SELECT OBJECT(p) FROM Player p
```

Data retrieved: All players.

Finder method: `findall()`

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.position
 = ?1
```

Data retrieved: The players with the position specified by the finder method's parameter.

Finder method: `findByPosition(String position)`

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Example: EJB-QL 2

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.position
 = ?1 AND p.name = ?2
```

Data retrieved: The players with the specified position and name.

Finder method: `findByPositionAndName(String position, String name)`

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.city = ?1
```

Data retrieved: The players whose teams belong to the specified city.

Finder method: `findByCity(String city)`

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Example: EJB-QL 3

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.league = ?1
```

Data retrieved: The players that belong to the specified league.

Finder method: `findByLeague(LocalLeague league)`

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.league.sport = ?1
```

Data retrieved: The players who participate in the specified sport.

Finder method: `findBySport(String sport)`

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Example: EJB-QL 4

```
SELECT OBJECT(p) FROM Player p WHERE p.teams IS EMPTY
```

Data retrieved: All players who do not belong to a team.

Finder method: `findNotOnTeam()`

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.salary
BETWEEN ?1 AND ?2
```

Data retrieved: The players whose salaries fall within the range of the specified salaries.

Finder method: `findBySalaryRange(double low, double high)`

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Example: EJB-QL 5

```
SELECT DISTINCT OBJECT(p1) FROM Player p1, Player p2
WHERE p1.salary > p2.salary AND p2.name = ?1
```

Data retrieved: All players whose salaries are higher than the salary of the player with the specified name.

Finder method: `findByHigherSalary(String name)`

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EJB-QL Versus SQL

With `EJB-QL`, one can traverse relationships between entity beans using a dot-notation.

For example:

```
SELECT o.customer FROM Order o
```

Advantages:

1) The bean providers only need know the relationships between beans but not the tables or columns;
2) The container handles the traversal of relationships declared in the deployment descriptors.

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Aggregate Functions 1

Aggregate functions were not supported in `EJB 2.0 EJB-QL`.

In `EJB 2.1 EJB-QL`, the following aggregate functions are supported:

1) `AVG`: average value
```
SELECT AVG(o.quantity) FROM Order o
```

2) `COUNT`: total number of results
```
SELECT COUNT(c) FROM Customers WHERE c.payment
='VISA'
```

3) `MAX`: the largest value
```
SELECT MAX(e.salary) FROM Employees e WHERE
e.salarygrade = 'Z12'
```

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Aggregate Functions 2

4) `MIN`: smallest value

```
SELECT MIN(e.salary) FROM Employees e WHERE
e.salarygrade = 'Z12'
```

5) `SUM`: sum of the valules

```
SELECT SUM(e.salary) FROM Employees e
```

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EJB-QL: ORDER BY

The `ORDER BY` clause is supported by `EJB 2.1 EJB-QL`.

For example:

```
SELECT OBJECT(c) FROM Customers c ORDER BY c.name
SELECT OBJECT(c) FROM Customers c ORDER BY c.name ASC
SELECT OBJECT(c) FROM Customers c ORDER BY c.name DESC
SELECT OBJECT(o) FROM Order o ORDER BY o.quantity,
 o.totalcost
```

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Select Method

Besides finder methods, `CMP` entity beans can have special select methods.

Select methods are declared as abstract methods using the naming convention `ejbSelect<`*`METHOD-NAME`*`>`.

`ejbSelect()` methods work like private query methods and are not exposed to end clients.

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Example: Select Method 1

For example, one might define the following methods in the entity bean:

```
public abstract collection ejbSelectALLAccountBalance
() throws FinderException;


public double ejbHomeGetTotalBankValue(Long
accountNumber) throws Exception{
       Collection c =
this.ejbSelectAllAccountBalance();
      // Loop through the collection c and return the
sum
}
```

The selection is then defined by an `EJB-QL` query string in the deployment descriptor:

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Example: Select Method 2

The selection is then defined by an EJB-QL query string in the deployment descriptor:

```
<query>
  <description>
    Method to find all account balance
  </description>
  <query-method>
    <method-name>
          ejbSelectALLAccountBalance
    </method-name>
  </query-method>
. . .
  <ejb-ql>![CDATA[SELECT a.balance FROM Account as
                a]]</ejb-ql>
</query>
```

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Characteristics of Select Method

Select methods can perform fine-grained database operations without exposing to end clients.

Select methods can return entity beans, container-managed fields or a collection of container-managed fields.

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EJB-QL for Select Method

Unlike finder methods, a select method may return persistent fields or other entity beans.

The EJB-QL for these kinds of return types may look as follows:

```
SELECT DISTINCT t.league FROM Player p, IN (p.teams) AS
 t WHERE p = ?1
```

Data retrieved: The leagues to which the specified player belongs.

Select Method: `ejbSelectLeagues(LocalPlayer player)`

```
SELECT DISTINCT t.league.sport FROM Player p, IN
 (p.teams) AS t WHERE p = ?1
```

Data retrieved: The sports that the specified player participates in.

Select Method: `ejbSelectSports(LocalPlayer player)`

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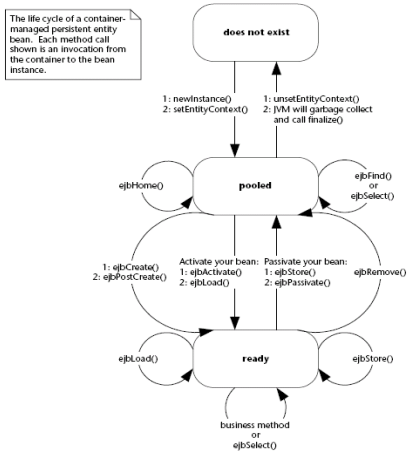
Life Cycle of CMP Entity Bean



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Task 63: CMP Entity Bean

1) Build and deploy a `CMP` entity bean. This bean is called `ProductBean`.
   a) Write a remote interface, `Product`, for the `ProductBean`. This interface need not to define any business methods.
   b) Define the getter/setter methods available to the client :

```
public String getName() throws RemoteException;
public void setName(String name) throws
   RemoteException;
public String getDescription() throws
   RemoteException;
```

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Task 64: CMP Entity Bean

```
public void setDescription(String description)
     throws RemoteException;
public double getBasePrice() throws
     RemoteException;
public void setBasePrice(double price) throws
     RemoteException;
public String getProductID() throws
     RemoteException;
```

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Task 65: CMP Entity Bean

   c) Write the home interface, `ProductHome`, for the ProductBean. This interface should define the following methods:

```
import javax.ejb.*;
import java.util.Collection;
import java.rmi.RemoteException;
public interface ProductHome extends EJBHome {
//Create method for createing a product
Product create(String productID, String name,
   String description, double basePrice) throws
   CreateException, RemoteException;
```

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Task 66: CMP Entity Bean

```
// Finder methods. These are implemented by the
// container. The functionality can be customized
// in the deployment descriptor through
// EJB-QL and container tools.

public Product findByPrimaryKey(ProductPK key)
  throws FinderException, RemoteException;

public Collection findByName(String name) throws
  FinderException, RemoteException;

public Collection findByDescription(String
  description) throws FinderException,
  RemoteException;
```

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Task 67: CMP Entity Bean

```
public Collection findExpensiveProducts(double
  minPrice) throws FinderException,
  RemoteException;

public Collection findCheapProducts(double
  maxPrice) throws FinderException,
  RemoteException;

public Collection findAllProducts() throws
  FinderException, RemoteException;
}
```

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Task 68: CMP Entity Bean

d) Write the primary key class, `ProductPK`.
Please note that primary key class must be serializable. And the fields in the primary key class must be a subset of the container-managed fields defined in the deployment descriptor.

```
import java.io.Serializable;
public class ProductPK implements
  java.io.Serializable {public String
  productID;
   public ProductPK(String productID) {
     this.productID = productID;
   }
```

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Task 69: CMP Entity Bean

```
  public ProductPK() {}
  public String toString() {
    return productID.toString();
  }
  public int hashCode() {
    return productID.hashCode();
  }
  public boolean equals(Object prod) {
    return
     ((ProductPK)prod).productID.equals(productID
     );
   }
 }
```

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Task 70: CMP Entity Bean

e) Write the entity bean class, `ProductBean`.

```
import javax.ejb;
//Note that the class is declared as abstract
public abstract class ProductBean implements
  EntityBean {
protected EntityContext ctx;
public ProductBean() {
}
//declare the abstract methods for the get/set
  methods
. . .
```

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Task 71: CMP Entity Bean

```
//EJB required methods called by the container

  public void ejbActivate() {
       System.out.println("ejbActivate()
       called.");
  }
  public void ejbRemove() {
       System.out.println("ejbRemove()
       called.");
  }
  public void ejbPassivate() {
       System.out.println("ejbPassivate ()
       called.");
  }
```

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Task 72: CMP Entity Bean

```
  public void ejbLoad() {
       System.out.println("ejbLoad()
       called.");
  }
  public void ejbStore() {
       System.out.println("ejbStore()
       called.");
  }
// Associates this Bean instance with a
  particular context
  public void setEntityContext(EntityContext
  ctx) {
       System.out.println("setEntityContext
       called");
       this.ctx = ctx;       }
```

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Task 73: CMP Entity Bean

```
//Disassociates this Bean instance
//with a particular context environment
  public void unsetEntityContext() {
    System.out.println("unsetEntityContext
       called");
       this.ctx = null;
  }
  public void ejbPostCreate(String productID,
  String name, String description, double
  basePrice)   {
     System.out.println("ejbPostCreate()
       called");
  }
```

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Task 74: CMP Entity Bean

```
public ProductPK ejbCreate(ProductPK productID,
  String name, String description, double
  basePrice) throws CreateException {
  System.out.println("ejbCreate() called");
  setProductID(productID);
  setName(name);
  setDescription(description);
  setBasePrice(basePrice);
  return null;
}
// Please be noted that CMP required that the
// ejbCreate method return a null value
```

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Task 75: CMP Entity Bean

f) Refer to the task for `BMP` entity bean, create the `ejb-jar.xml` file for the `ProductBean`. Part of the file is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
<enterprise-beans>
<entity>
<ejb-name>Product</ejb-name>
<home>examples.ProductHome</home>
<remote>examples.Product</remote>
<ejb-class>examples.ProductBean</ejb-class>
```

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Task 76: CMP Entity Bean

```
<persistence-type>Container</persistence-type>
<prim-key-class>examples.ProductPK</prim-key-
   class>
<reentrant>False</reentrant>
<cmp-version>2.x</cmp-version>
<abstract-schema-name>ProductBean</abstract-
   schema-name>
<cmp-field>
   <field-name>productID</field-name>
</cmp-field>
<cmp-field>
   <field-name>name</field-name>
</cmp-field>
```

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Task 77: CMP Entity Bean

```
<cmp-field>
   <field-name>description</field-name>
</cmp-field>
<cmp-field>
   <field-name>basePrice</field-name>
</cmp-field>
```

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Task 78: CMP Entity Bean

```
<query>
 <query-method>
   <method-name>findByName</method-name>
   <method-params>
        <method-param>java.lang.String
        </method-param>
   </method-params>
 </query-method>
 <ejb-ql>
 <![CDATA[SELECT OBJECT(a) FROM ProductBean AS
   a WHERE a.name = ?1]]>
 </ejb-ql>
</query>
```

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Task 79: CMP Entity Bean

```
<query>
  <query-method>
   <method-name>findByDescription
    </method-name>
   <method-params>
   <method-param>java.lang.String
    </method-param>
  </method-params>
 </query-method>
 <ejb-ql>
  <![CDATA[SELECT OBJECT(a) FROM ProductBean
   AS a WHERE a.description = ?1]]>
 </ejb-ql>
</query>
```

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Task 80: CMP Entity Bean

```
<query>
   <query-method>
     <method-name>findByBasePrice</method-name>
    <method-params>
     <method-param>double</method-param>
    </method-params>
   </query-method>
   <ejb-ql>
    <![CDATA[SELECT OBJECT(a) FROM
    ProductBean AS a WHERE a.basePrice = ?1]]>
   </ejb-ql>
</query>
```

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Task 81: CMP Entity Bean

```
<query>
   <query-method>
     <method-name>findExpensiveProducts
     </method-name>
     <method-params>
       <method-param>double</method-param>
     </method-params>
    </query-method>
   <ejb-ql>
     <![CDATA[SELECT OBJECT(a) FROM ProductBean
        AS a WHERE a.basePrice > ?1]]>
   </ejb-ql>
</query>
```

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Task 82: CMP Entity Bean

```
<query>
<query-method>
<method-name>findCheapProducts</method-name>
<method-params>
<method-param>double</method-param>
</method-params>
</query-method>
<ejb-ql>
<![CDATA[SELECT OBJECT(a) FROM ProductBean AS
   a WHERE a.basePrice < ?1]]>
</ejb-ql>
</query>
```

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Task 83: CMP Entity Bean

```
<query>
<query-method>
<method-name>findAllProducts</method-name>
<method-params>
</method-params>
</query-method>
<ejb-ql>
<![CDATA[SELECT OBJECT(a) FROM ProductBean AS
  a WHERE a.productID IS NOT NULL]]>
</ejb-ql>
</query>
</entity>
</enterprise-beans>
```

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Task 84: CMP Entity Bean

```
<assembly-descriptor>
<container-transaction>
<method>
<ejb-name>Product</ejb-name>
<method-intf>Remote</method-intf>
<method-name>*</method-name>
</method>
<trans-attribute>Required</trans-attribute>
</container-transaction>
</assembly-descriptor>
</ejb-jar>
```

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Task 85: CMP Entity Bean

g) Prepare the vendor-specific deployment descriptor (`jboss.xml`):

```
<?xml version="1.0" encoding="UTF-8"?>
<jboss>
  <enterprise-beans>
    <entity>
      <ejb-name>Product</ejb-name>
      <jndi-name>ProductHome</jndi-name>
    </entity>
  </enterprise-beans>
</jboss>
```

h) Deploy the `EJB`.

i) Develop a client program to test the `EJB`.

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Exercise: CMP Entity Bean

1) Create a `CMP` entity Bean named `CustomerBean`.
   a) The bean containing the following data:
      1. customerID – customer ID (String)
      2. customerName – customer's name (String)
      3. password – customer's password (String)
      4. address – customer's address (String)
   b) The bean has a protected variable `ctx` which is an `EntityContext` object. Declare and initialize this variable appropriately.
   c) Create the remote interface as `Customer` for the `CustomerBean`.
   d) Create the home interface as `CustomerHome` for the `CustomerBean`.
   e) Create the deployment descriptor file for the `CustomerBean`.

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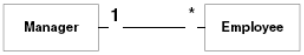
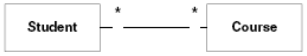
Entity Bean: Relationships

One-to-one (1:1) relationships, e.g. order and shipment

One-to-many (1:N) relationships, e.g. manager and employee



Many-to-many (M:N) relationships, e.g. student and course



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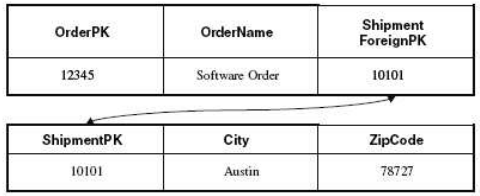
BMP 1:1 Relationships 1

The following code snippet illustrate how to implement 1:1 relationships using `BMP`:



OrderPK	OrderName	Shipment ForeignPK
12345	Software Order	10101

ShipmentPK	City	ZipCode
10101	Austin	78727

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BMP 1:1 Relationships 2

```
public class OrderBean implements EntityBean {
private String orderPK;
private String orderName;
private Shipment shipment; // EJB local object stub
public Shipment getShipment() { return shipment; }
public void setShipment(Shipment s) { this.shipment =
s;}
...
```

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BMP 1:1 Relationships 3

```
public void ejbLoad() {
 // 1: SQL SELECT Order. This also retrieves the
 // shipment foreign key.
 // 2: JNDI lookup of ShipmentHome
 // 3: Call ShipmentHome.findByPrimaryKey(), passing
 // in the shipment foreign key
}
public void ejbStore() {
 // 1: Call shipment.getPrimaryKey() to retrieve
 // the Shipment foreign key
 // 2: SQL UPDATE Order. This also stores the
 // Shipment foreign key.
}
}
```

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CMP 1:1 Relationships 1

For CMP entity bean, you don't implement the ejbLoad and ejbStore methods. The container will implement them in the subclass.

The bean may look as follows:

```
public abstract class OrderBean implements EntityBean
{
   // no fields
   public abstract Shipment getShipment();
   public abstract void setShipment(Shipment s);
   ...
   public void ejbLoad() {} // Empty
   public void ejbStore() {} // Empty
}
```

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CMP 1:1 Relationships 2

Specify the relationships in the deployment descriptor as follows:

```
<ejb-jar>
 <enterprise-beans>
 ...
 </enterprise-beans>
 <relationships>
 <!-- This declares a relationship -->
 <ejb-relation>
   <ejb-relation-name>Order-Shipment</ejb-relation-name>
   <ejb-relationship-role>
     <ejb-relationship-role-name>
         order-spawns-shipment
     </ejb-relationship-role-name>
```

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CMP 1:1 Relationships 3

```
   <!--The Cardinality of this half of the
        relationship-->
     <multiplicity>One</multiplicity>
     <relationship-role-source>
       <ejb-name>Order</ejb-name>
     </relationship-role-source>

     <cmr-field>
        <cmr-field-name>shipment</cmr-field-name>
     </cmr-field>
   </ejb-relationship-role>
```

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CMP 1:1 Relationships 4

```
  <!-- This declares the 2nd half of the relationship
       (the Shipment side)-->
     <ejb-relationship-role>
        <ejb-relationship-role-name>
              shipment-fulfills-order
        </ejb-relationship-role-name>
        <multiplicity>One</multiplicity>
        <relationship-role-source>
              <ejb-name>Shipment</ejb-name>
        </relationship-role-source>
     </ejb-relationship-role>
    </ejb-relation>
   </relationships>
  </ejb-jar>
```

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BMP 1:N Relationships 1

The following code illustrates how to implement 1:N relationships using BMP:

CompanyPK	Name
12345	The Middleware Company

EmployeePK	Name	Sex	Company
20202	Ed	M	12345
20203	Floyd	M	12345

e-Macao-16-7-202

BMP 1:N Relationships 2

```
public class CompanyBean implements EntityBean {
      private String companyPK;
      private String companyName;
      private Vector employees; // EJB object stubs
      public Collection getEmployees()
      { return employees; }
      public void setEmployees(Collection e) {
      this.employees = (Vector) e;
      }
      ...
```

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BMP 1:N Relationships 3

```
public void ejbLoad() {
// 1: SQL SELECT Company
// 2: JNDI lookup of EmployeeHome
// 3: Call EmployeeHome.findByCompany(companyPK)
}
public void ejbStore() {
// 2: SQL UPDATE Company
}
```

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CMP 1:N Relationships 1

The following code shows how to implement a 1:N relationship using CMP:

```
public abstract class CompanyBean implements EntityBean
{
      // no fields
      public abstract Collection getEmployees();
      public abstract void setEmployees(Collection
        employees);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

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CMP 1:N Relationships 2

The relationships in the deployment descriptor is defined as follows:

```
<ejb-jar>
 <enterprise-beans>
 ...
 </enterprise-beans>
  <relationships>
  <ejb-relation>
       <ejb-relation-name>
            Company-Employees
       </ejb-relation-name>
       <ejb-relationship-role>
           <ejb-relationship-role-name>
               Company-Employs-Employees
           </ejb-relationship-role-name>
```

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CMP 1:N Relationships 3

```
           <multiplicity>One</multiplicity>
       <relationship-role-source>
           <ejb-name>Company</ejb-name>
       </relationship-role-source>
    <cmr-field>
       <cmr-field-name>employees</cmr-field-name>
       <cmr-field-type>
           java.util.Collection
       </cmr-field-type>
    </cmr-field>
 </ejb-relationship-role>
```

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CMP 1:N Relationships 4

```
       <ejb-relationship-role>
           <ejb-relationship-role-name>
              Employees-WorkAt-Company
           </ejb-relationship-role-name>
           <multiplicity>Many</multiplicity>
          <relationship-role-source>
            <ejb-name>Employee</ejb-name>
          </relationship-role-source>
       </ejb-relationship-role>
      </ejb-relation>
  </relationships>
</ejb-jar>
```

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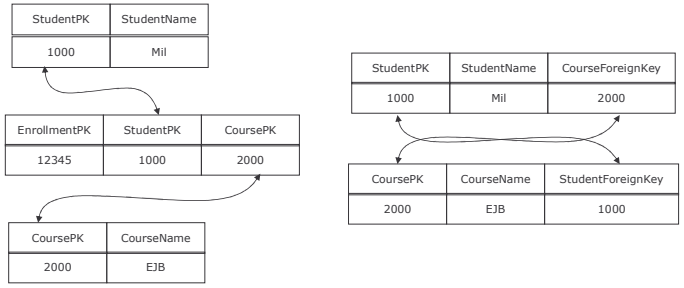
Implementing M:N Relationships 1

M:N relationships can be implemented in two ways:

1) Fake M:N relationship
2) True M:N relationship



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Implementing M:N Relationships 2

The following code illustrates one way to implement M:N relationships using CMP:

```
public abstract class StudentBean implements
EntityBean {
      // no fields
      public abstract Collection getCourses();
      public abstract void setCourses(Collection
      courses);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

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Implementing M:N Relationships 3

```
public abstract class CourseBean implements EntityBean
{
      // no fields
      public abstract Collection getStudents();
      public abstract void setStudents(Collection
      students);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

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Implementing M:N Relationships 4

The relationships in the deployment descriptor are defined as follows:

```
<ejb-jar>
<enterprise-beans>
...
</enterprise-beans>
<relationships>
 <ejb-relation>
  <ejb-relation-name>
        Student-Course
  </ejb-relation-name>
  <ejb-relationship-role>
```

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Implementing M:N Relationships 5

```
      <ejb-relationship-role-name>
        Students-EnrollIn-Courses
       </ejb-relationship-role-name>
       <multiplicity>Many</multiplicity>
      <relationship-role-source>
        <ejb-name>Student</ejb-name>
      </relationship-role-source>
     <cmr-field>
        <cmr-field-name>courses</cmr-field-name>
        <cmr-field-type>
           java.util.Collection
        </cmr-field-type>
```

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Implementing M:N Relationships 6

```
</cmr-field>
</ejb-relationship-role>
<ejb-relationship-role>
  <ejb-relationship-role-name>
    Courses-HaveEnrolled-Students
  </ejb-relationship-role-name>
  <multiplicity>Many</multiplicity>
  <relationship-role-source>
   <ejb-name>Course</ejb-name>
  </relationship-role-source>
```

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Implementing M:N Relationships 7

```
      <cmr-field>
        <cmr-field-name>students</cmr-field-name>
            <cmr-field-type>
           java.util.Collection
          </cmr-field-type>
      </cmr-field>
  </ejb-relationship-role>
 </ejb-relation>
</relationships>
</ejb-jar>
```

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Directionality

Directionality specifies the direction in which you can navigate a relationship.

There are two types of directionality:

1) Bidirectional -one can get from entity A to entity B and vice versa.
2) Unidirectional - one can get from entity A to entity B, but cannot get from entity B to entity A.

Directionality applies to all cardinalities.

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Directionality with BMP

With BMP entity bean, directionality is controlled by the get/set methods and a field pointing to the destination.

For example:


```
public class OrderBean implements EntityBean {
      private String orderPK;
      private String orderName;

      private Shipment shipment;
      public Shipment getShipment() {
            return shipment; }
      public void setShipment(Shipment s)
      { this.shipment = s; }
. . .
}
```

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Directionality with CMP 1

With CMP relationship, the direction is indicated by combining a pair get/set abstract method pointing to the other bean and the container-managed relationship (CMR) fields.

For example:

```
public abstract class OrderBean implements EntityBean
{     public abstract Shipment getShipment();
      public abstract void setShipment(Shipment s);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

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Directionality with CMP 2

```
<ejb-jar>
<enterprise-beans>... </enterprise-beans>
<relationships>
 <ejb-relation>
 <ejb-relation-name>Order-Shipment</ejb-relation-name>
 <ejb-relationship-role>
  <ejb-relationship-role-name>
   order-spawns-shipment
  </ejb-relationship-role-name>
  <multiplicity>One</multiplicity>
```

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Directionality with CMP 3

```
   <relationship-role-source>
            <ejb-name>Order</ejb-name>
   </relationship-role-source>
  <cmr-field>
     <cmr-field-name>
        shipment
     </cmr-field-name>
  </cmr-field>
 </ejb-relationship-role>
```

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Directionality with CMP 4

```
   <ejb-relationship-role>
    <ejb-relationship-role-name>
      shipment-fulfills-order
    </ejb-relationship-role-name>
    <multiplicity>One</multiplicity>
    <relationship-role-source>
     <ejb-name>Shipment</ejb-name>
    </relationship-role-source>
   <!- No cmr for shipment to access order -->
   </ejb-relationship-role>
  </ejb-relation>
 </relationships>
</ejb-jar>
```

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Cascading Delete

Two relationship concepts:

1) Aggregation
   a uses relationship, e.g. Student / Course
2) Composition
   an is-assembled-of relationship, e.g. Order / Line Items

Composition relationship will cause cascading delete.

e-Macao-16-7-222

Cascading Delete with BMP

With BMP, cascading delete is implement in ejbRemove() method.

For example:

```
public class OrderBean implements EntityBean {
    private String orderPK;
    private String orderName;
    private Shipment shipment; // EJB local object stub
    public Shipment getShipment() { return shipment; }
    public void setShipment(Shipment s) { this.shipment
       = s;}
    ...
    public void ejbRemove() {
    // 1: SQL DELETE Order
    // 2: shipment.remove();
    }
}
```

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Cascading Delete with CMP 1

With CMP, cascade-delete is setup through the deployment descriptor, as follows:

```
<ejb-jar>
 <enterprise-beans>...</enterprise-beans>
 <relationships>
  <ejb-relation>
   <ejb-relation-name>
        Order-Shipment
   </ejb-relation-name>
   <ejb-relationship-role>
    <ejb-relationship-role-name>
     order-spawns-shipment
    </ejb-relationship-role-name>
```

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Cascading Delete with CMP 2

```
    <multiplicity>One</multiplicity>
    <relationship-role-source>
      <ejb-name>Order</ejb-name>
    </relationship-role-source>
    <cmr-field>
      <cmr-field-name>shipment</cmr-field-name>
    </cmr-field>
   </ejb-relationship-role>
   <ejb-relationship-role>
     <ejb-relationship-role-name>
        shipment-fulfills-order
     </ejb-relationship-role-name>
     <multiplicity>One</multiplicity>
```

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Cascading Delete with CMP 3

```
      <cascade-delete/>
      <relationship-role-source>
        <ejb-name>Shipment</ejb-name>
      </relationship-role-source>
      <cmr-field>
           <cmr-field-name>order</cmr-field-name>
        </cmr-field>
    </ejb-relationship-role>
   </ejb-relation>
 </relationships>
</ejb-jar>
```

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Task 86: Setup JBossIDE

1) Instead of writing all the codes, tools can be used to generate the interfaces and deployment descriptor. There are some free tools available. The usage of the Eclipse plug-in named `JBossIDE` will be explained as follows:
   a) Download `Eclipse JbossIDE` plugin from `www.jboss.org`.
   b) Unpack the archives into a local directory.
   c) At Eclipse, choose `Help`→`Find` and `Install`→`Search for new features for install` → `Add new Archive site` → choose directory containing unpacked `JbossIDE` files.
   d) Follow the instruction to install `JbossIDE`.

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Task 87: Setup JBossIDE

   e) In Eclipse, Select `File` → `New` → `Project...`. Find an entry `Jboss-IDE`. Choose J2EE 1.4 Project to create a J2EE project with proper libraries.
   f) Copy `<Jboss_Home>/client/jbossall-client.jar` to the build path of the client program. The jar file contains everything an `EJB` client could ever need.
   g) After `JBossIDE` is installed, setup the `XDoclet` for development and deployment of `J2EE` project.
   h) For more information about `XDoclet`, check out this site:
      `http://xdoclet.sourceforge.net/xdoclet/index.html`

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Task 88: Using JBossIDE

1) After setting up Eclipse, create an `EJB` as follows:
   a) Right clicking on the J2EE project created, choose New → Other…
   b) Choose a type of `EJB` from `JBoss-IDE` → `EJB` Components.
   c) Follow the instruction to create an `EJB`.
   d) At the Package Explorer of Eclipse, expand the `EJB` file node.
   e) Right click on the bean class.
   f) Choose `J2EE` → Choose an option such as "`Add Business Method`" to allow `JBoss-IDE` to generate the codes.

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Task 89: Configuring XDoclet

1) In order to use `XDoclet` to generate the interfaces and classes for `J2EE` project, create an `XDoclet` configuration in Eclipse as follows:
   a) Right clicking on the project icon and select "`Properties`".
   b) In the property page, select "`XDoclet configurations`".
   c) Right-click in the upper area to pop-up the menu and choose "`Add`".
   d) Type "`EJB`" in the dialog and click "`Ok`".
   e) Keep the "`EJB`" configuration selected and In the lower-left area, right-click to popup the menu and choose "`Add Doclet`".

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Task 90: Configuring XDoclet

   f) Choose "`ejbdoclet`" in the popup list and click "`Ok`".
   g) On the lower-right area, you see the properties of the "`ejbdoclet`". Set them to:
      "destDir" with "src" and ckeck it
      "ejbSpec" with "2.0" and ckeck it

result: the configuration contains an "`ejbdoclet`" that will produce files in "`src`" folder and for the `EJB 2.0` specifications.

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Task 91: Configuring XDoclet

2) Configure the fileset subtask:

   a) Right-click on "`ejbdoclet`" to choose "`Add `" at the popup menu.
   b) A list of available subtasks will appear. Choose "`fileset`" and click "`Ok`".
   c) On the lower-right area, check the properties of the " `fileset` ". Set up as the following setting:
      "`dir`" with "`src`" and ckeck it
      uncheck "`excludes`"
      "`includes`" with "`**/*Bean.java`" and ckeck it.

result: "`ejbdoclet`" will produce files based on fileset "`src`" folder and have a filter only pick up files ended with "`Bean.java`".

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Task 92: Configuring XDoclet

3) Configure the deployment descriptor subtask:

   a) Repeat the previous operation to add a new subtask "`deploymentdescriptor`".
   b) Set the property "`destDir`" with "`src/META-INF`". Don't forget to check it.

result: "`ejbdoclet`" will generate the deployment descriptor in the "`src/META-INF`" folder.

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Task 93: Configuring XDoclet

4) Configure the `jboss` subtask

   a) Repeat the previous operation to add a new subtask "`jboss`".
   b) Set "`destDir`" with "`src/META-INF`". Don't forget to check it.
   c) Set "`Version`" with "`4.0`".

result: jboss deployment descriptor will be generated in the "`src/META-INF`" folder.

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Task 94: Configuring XDoclet

5) Configure the `packageSubstitution` subtask

   a) Repeat the previous operation to add a new subtask "`packageSubstitution`".
   b) Set "`packages`" with "`ejb`". Don't forget to check it. Note that the packages need to have more than two levels, such as `task.ejb`, to make the substitution work.
   c) Set "`substituteWith`" with "`interfaces`".

result: `EJB` related classes will be generated in different package, i.e. interfaces will be generated in package `xxx.interfaces` for `EJB` lies in packages `xxx.ejb`.

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Task 95: Configuring XDoclet

6) Configure the `remoteinterface` and `homeinterface` subtask

   a) Repeat the previous operation to add new subtasks "`remoteinterface`" and "`homeinterface`".
   b) No option is required to be set. Don't forget to check it.

result: Both "`remoteinterface`" and "`homeinterface`" will be generated.

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Task 96: Configuring XDoclet

7) Configure the `localinterface` and `localhomeinterface` subtask

   1) Repeat the previous operation to add a new subtask "`localinterface`" and "`localhomeinterface`".
   2) No option is required to be set. Don't forget to check it.

result: Both "`localinterface`" and "`localhomeinterface`" will be generated.

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Task 97: Configuring XDoclet

8) Configure the `entitypk` subtask:

   a) Repeat the previous operation to add a new subtask "entitypk".
   b) Set "`destDir`" with "`src`". Don't forget to check it.

result: The primary key classes for the entity beans will be generated.

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Task 98: Using XDoclet

1) After created an `EJB`, run `XDoclet` to generate the corresponding classes, interfaces and files as follows:

   a) Right click on the `J2EE` project, choose run `XDoclet`.

   b) Files will be generated according to the configuration.

   c) At some instance, `XDoclet` tags inside the `EJB` has to be modified to create proper output.

Note: The following link is official web site of `XDoclet`:
`http://xdoclet.sourceforge.net/xdoclet/index.html`

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Task 99: Configuring Packaging

1) Configure the packaging configuration for the `EJB` Jar containing the `EJB` classes, interfaces and the deployment descriptors:

   a) Right clicking on the `J2EE` project and select "`Properties`" → "`Packaging configurations`".

   b) Right-click in the area to pop-up the menu → "`Add Archive`".

   c) Type the name of the jar file such as "`myEJB.jar`" in the dialog and click "`Ok`".

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Task 100: Configuring Packaging

   d) Select the "`myEJB.jar`" item and right-click in the area to pop-up the menu and choose "`Add Folder`".

   e) A "`Folder Selection`" dialog appears. Click on "`Project Folder`". A "`Folder Chooser`" dialog appears for selecting which folder to include.

   f) Select the folder containing the classes file, e.g. bin folder, and click "Ok".

   g) In the include filter area, type in the classes filter you need to include separated by comma. For example,
   `com/ejb/*.class, com/interfaces/*.class`

   h) Click "`OK`".

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Task 101: Configuring Packaging

h) Select the "myEJB.jar" item and right-click in the area to pop-up the menu and choose "Add File".

i) A "File Selection" dialog appears. Click on "Project File ...". A "File Chooser" dialog appears for selecting which file to include.

j) Select the deployment descriptor file such as "prj/src/META-INF/ejb-jar.xml" and click "Ok".

k) Since deployment descriptor must located in the "META-INF" folder, type "META-INF" in prefix and click "OK".

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Task 102: Configuring Packaging

l) Repeat steps e to h and for adding the vendor specific deployment descriptor "jboss.xml".

m) Click "OK" and the configuration for myEJB.jar is completed.

n) For deploying the package, just copy file myEJB.jar to Jboss at <JBoss_Home>/server/default/deploy.

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Task 103: CMP Relationship

1) Use the JBossIDE for generating and deploying J2EE project. Create two entity beans with the following conditions:
   a) a CMP entity bean named CompanyBean
   b) field: companyId (String), name (String)
   c) primary key class : CompanyPK
   d) a CMP entity bean named EmployeeBean
   e) field: employeeId (Integer), name (String) and sex (String)
   f) primary key class: employeePK
   g) CompanyBean and EmployeeBean has an unidirectional many-to-one relationship pointing from employee to company.
   h) When the company is deleted, the employees' records will be deleted automatically.

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Task 104: CMP Relationship

Note:
1) Use XDoclet to create the relationship.
2) Only use remote interface for this task.
3) The setter of the CMR field has to be put inside the ejbPostCreate method.
4) Try to explore the set up for different relationships and directions.

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Summary 1

1) An `Entity Bean` represents business data stored in a database.
2) Database data types are converted into Java data types and encapsulated into the `Entity Bean`.
3) Modifying the in-memory value of an `Entity Bean` can change the values of data, saved back into storage again and updating the database data.
4) Each `Entity Bean` must have a `Primary Key`
5) There are two ways to persist an Entity Bean:
   a) Bean-Managed Persistence (`BMP`)
   b) Container-Managed Persistence (`CMP`)

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Summary 2

Finder method is a special type of method for finding existing bean in storage.

Besides finder methods, `CMP` entity beans can have special select methods.

Select methods are declared as abstract methods using the naming convention `ejbSelect<`*`METHOD-NAME`*`>`.

`ejbSelect()` methods work like private query methods and are not exposed to end clients.

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Summary 3

A special business method called home method can be defined in the entity bean class to provide global operations such as counting the total number of records.

`ejbLoad` method and `ejbStore` methods are routinely called by the container to be synchronized with the database.

When the `ejbRemove()` is called, database data will be destroyed but not the in-memory entity bean instance.

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Summary 4

EJB Query Language (`EJB-QL`) is an object-oriented SQL-like syntax for querying entity beans.

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Summary 5

Different types of relationships and directions can be defined for entity beans.

For example:

a) one-to-one (1:1) unidirectional
b) one-to-one (1:1) bidirectional
c) one-to-many (1:N) unidirectional
d) one-to-many (1:N) bidirectional
e) many-to-many (M:N) unidirectional
f) many-to-many (M:N) unidirectional

A.2.3. Message-Driven Beans

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Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary
2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary
3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

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Java Messaging Service (JMS)

JMS is a vendor-neutral API for a Java program to access Message Oriented Middlewares(MOM) products.

JMS has two models:

1) Publish and Subscribe
2) Point-to-Point

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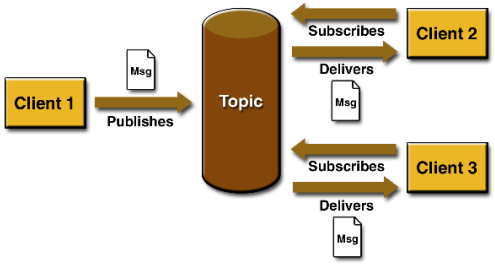
Publish/Subscribe Messaging

1) Clients publish messages to a topic.
2) The system distributes the messages to the subscribed clients.
3) Only current subscribers can receive messages.



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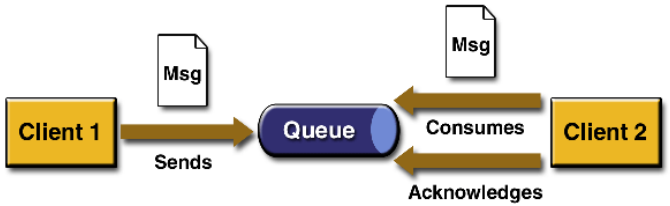
Point-to-Point Messaging

1) Each message is sent to a specific queue.
2) Receiving clients extract messages from the queue(s)
3) Queues retain all messages sent to them until:
   a) the messages are consumed
   b) the messages expire



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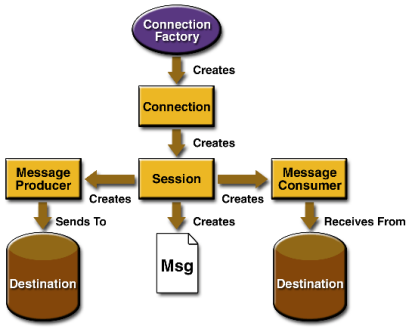
JMS API Programming Model

The basic building blocks of a JMS application:

1) Administered objects
2) Sessions
3) Message producers
4) Message consumers
5) Messages



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JMS Client Setup Procedure

A typical pub/sub JMS client executes the following setup procedure:

1) Use `JNDI` to find a `ConnectionFactory` object.
2) Use `JNDI` to find one or more Destination objects.
3) Use the `ConnectionFactory` to create a JMS Connection.
4) Use the Connection to create one or more JMS Sessions.
5) Use a Session and the Destinations to create the `MessagePublisher` and `MessageSubscriber` needed.
6) Enable the Connection to start delivering messages to the destination.

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Message Driven Bean 1

The Message-Driven Bean was introduced in EJB 2.0 to support the processing of asynchronous messages from a Java Message Service (JMS) provider.

EJB 2.1 expanded the definition of the message-driven bean so that it can support any messaging system, not just JMS.

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Message Driven Bean 2

Message-driven bean (MDB) is like a session bean in that it implements the business methods.

What is the difference?

A session bean provides **synchronous communication**, e.g. it calls an entity bean and waits for a reply.

Message-driven beans provides **asynchronous communication**.

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.

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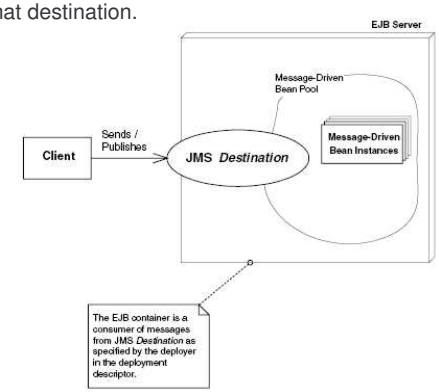
Message Driven Bean 3

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.



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Example: Message Driven Bean

1) Using Message Driven Bean for online ordering:
   a) When shopping cart Checkout method completes, it sends an asynchronous message to the shipping department to ship the purchased goods.
   b) The shipping department maintains a message queue, ShippingMessageQ, and a message driven bean, ShippingMessageQBean, associated with that queue.
   c) When a message is placed on the queue, the system selects an instance of the bean to process it and calls that bean's onMessage method.

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MDB Characteristics

1) does not have a home interface, local home interface, remote interface, or a local interface
2) has only one business method, called `onMessage()`
3) do not have any return values
4) cannot send exceptions back to clients
5) are stateless
6) can be durable or nondurable subscribers

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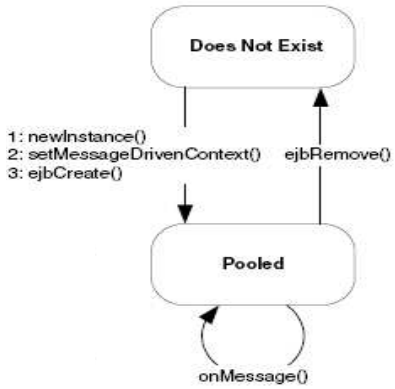
MDB Life Cycle



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MDB Implementation 1

Must implement two interfaces:

a) javax.jms.MessageListener

```
public interface javax.jms.MessageListener {
      public void onMessage(Message message);
}
```

b) javax.ejb.MessageDrivenBean

```
public interface javax.ejb.MessageDrivenBean
   extends javax.ejb.EnterpriseBean {

  public void ejbRemove() throws EJBException;

  public void setMessageDrivenContext
 (MessageDrivenContext ctx) throws EJBException;
}
```

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MDB Implementation 2

```
import javax.ejb.*;
import javax.jms.*;
public class LogBean implements MessageDrivenBean,
  MessageListener {
  protected MessageDrivenContext ctx;

  public void setMessageDrivenContext
  (MessageDrivenContext ctx) {
    this.ctx = ctx;
  }
  public void ejbCreate() {
   System.err.println("ejbCreate()");
  }
```

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MDB Implementation 3

```
public void onMessage(Message msg) {
    if (msg instanceOf TextMessage) {
       TextMessage tm = (TextMessage) msg;
       try {
             String text = tm.getText();
              System.err.println("Received new
              message : " + text);
       } catch(JMSException e) {
           e.printStackTrace();
       }
    }
  }
```

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MDB Implementation 4

```
     public void ejbRemove() {
           System.err.println("ejbRemove()");
     }
}
```

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MDB Implementation 5

Deployment descriptor file:

```
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
<enterprise-beans>
 <message-driven>
 <!-- The nickname for the bean -->
  <ejb-name>Log</ejb-name>
  <ejb-class>examples.LogBean</ejb-class>
  <transaction-type>Container</transaction-type>
```

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MDB Implementation 6

```
    <message-driven-destination>
     <destination-type>
           javax.jms.Topic
     </destination-type>
    </message-driven-destination>
   </message-driven>
  </enterprise-beans>
 </ejb-jar>
```

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Task 105: MDB

1) Use the ejb client in pervious example to test the function of a Message Driven Bean.
   a) In JBoss, create a topic named "emacaoMDB" by editing the file: <JBoss_Home>\server\default\deploy\jms\jbossmq-destinations-service.xml

```
<server>
        ...
 <mbean code="org.jboss.mq.server.jmx.Topic"
    name="jboss.mq.destination:service=Topic,
    name=log">
  <depends
        optional-
attributename="DestinationManager">
            jboss.mq:service=DestinationManager
  </depends>
 </mbean>
```

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Task 106: MDB

```
      ...
  </server>
```

   b) Specify the JNDI name for the topic in the deployment descriptor as follows:

```
...
  <enterprise-beans>
       <message-driven>
            <ejb-name>Log</ejb-name>
            <destination-jndi-name>
                topic/log
       </destination-jndi-name>
        </message-driven>
  </enterprise-beans>
...
```

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Task 107: MDB

   c) Develop a client to produce message to the topic "log". Please be noted that in JBoss, the JNDI name of the driver for both topic and queue messaging is "ConnectionFactory". The code snippet for creating connection in JBoss may look as follows:

```
InitialContext iniCtx = new InitialContext();
Object tmp = iniCtx.lookup("ConnectionFactory");
ConnectionFactory tcf = (ConnectionFactory) tmp;
conn = tcf.createConnection();
topic = (Topic) iniCtx.lookup("topic/log");
session = conn.createSession

      (false,Session.AUTO_ACKNOWLEDGE);
conn.start();
```

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Summary 1

Message-driven bean (MDB) works like a session bean providing asynchronous communication.

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.

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Summary 2

Message-Driven Bean has the following characteristics:

1) has to implement interfaces `MessageDrivenBean and MessageListener`
2) does not have a home interface, local home interface, remote interface, or a local interface
3) has only one business method, called `onMessage()`
4) do not have any return values
5) cannot send exceptions back to clients
6) are stateless
7) can be durable or nondurable subscribers

A.3. Horizontal Concepts

Horizontal Concepts

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Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

A.3.1. Local Interface

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Horizontal Concepts Outline

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Calling Remote Object

The followings are the work needed to be completed for calling a remote object:

1) The client calls a local stub.
2) The stub marshals parameters into a form suitable for the network.
3) The stub goes over a network connection to the skeleton.
4) The skeleton demarshals parameters into a form suitable for Java.
5) The skeleton calls the EJB object.
6) The EJB object performs needed services, such as connection pooling, transactions, security, and lifecycle services.
7) The EJB object calls the enterprise bean instance, and the bean does its work.
8) Step 1 to 6 must be repeated for the return trip home.

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Local Object

EJB 2.0 allows local client to call enterprise beans in a fast, efficient way by calling EJBs through their local objects rather than remote objects.

The following steps may occur:

1) The client calls a local object.
2) The local object performs needed services, such as connection pooling, transactions, security, and lifecycle services.
3) Once the enterprise bean instance does its work, it returns control to the local object, which then returns control to the client.

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Local Home Interfaces

For creating the local objects, you need to call the special local home interface which will be implemented by the container as the local home object.

The local home interface may look as follows:

```
import javax.ejb.*;
public interface CustomerLocalHome extends
  javax.ejb.EJBLocalHome
{
      public CustomerLocal create(Integer id) throws
            javax.ejb.CreateException, EJBException;
  public CustomerLocal findByPrimaryKey(Integer pk)
      throws FinderException,EJBException;
}
```

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EJBLocalHome Interfaces

The EJBLocalHome interface is as follows:

```
public interface javax.ejb.EJBLocalHome {
      public void remove(java.lang.Object)
            throws javax.ejb.RemoveException,
                  javax.ejb.EJBException;
}
```

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Local Interfaces

The local interface, like the remote interface, defines business methods for local clients.

These business methods must match the signatures of business methods defined in the bean class.

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EJBLocalObject Interface

Local interfaces has to extend `javax.ejb.EJBLocalObject`.

```
public interface javax.ejb.EJBLocalObject {
   public javax.ejb.EJBLocalHome getEJBLocalHome()
         throws javax.ejb.EJBException;
   public Object getPrimaryKey()
         throws javax.ejb.EJBException;
   public boolean    isIdentical

     (javax.ejb.EJBLocalObject)
      throws javax.ejb.EJBException;
   public void remove()
         throws javax.ejb.RemoveException,
                javax.ejb.EJBException;
}
```

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Deployment Descriptor 1

Deployment descriptor needed to be modify for an `EJB` to use local interfaces.

For example:

```
<ejb-jar>
 <enterprise-beans>
<entity>
       <ejb-name>CustomerEJB</ejb-name>
       <local-home>com.interfaces.CustomerHomeLocal
              </local-home>
       <local>com.interfaces.CustomerLocal</local>
        <ejb-class>com.ejb.CustomerBean</ejb-class>
       . . .
```

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Deployment Descriptor 2

For any bean that needs to call the local interface, local reference has to added under the `<ejb-local-ref>` tag in the deployment descriptor.

```
<ejb-local-ref>
    <ejb-ref-name>ejb/CustomerHomeLocal</ejb-ref-name>
     <ejb-ref-type>Entity</ejb-ref-type>
    <local-home>com.interfaces.CustomerHomeLocal
      </local-home>
      <local>com.interfaces.CustomerLocal</local>
 </ejb-local-ref>
```

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When to Use Local Interfaces

Considerations for choosing either a local interface or remote interface:

1) Local interface may speed up the application.
2) While using local interface, one must change the code for switching between a local or remote call.
3) Local client passes object arguments by reference from one bean to another. This means that changes of the passed object is seen by both beans.

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Local Client

Skeleton code for a local client to use the local interface:

```
javax.naming.Context jndiContext = new
InitialContext( );
HelloHomeLocal home = (CustomerHomeLocal)
jndiContext.lookup
      ("java:comp/env/ejb/CustoemrHomeLocal");
. . .
CustomerLocal customer = home.findByPrimaryKey(pk);
. . .
```

Note: remember to catch the `FinderException` and `NamingException`.

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Task 108: Local Interface

1) Modify the `CMP` entity Bean, `CustomerBean` created in previous task as follows:
   a) Delete the remote and home interface of the `CustomerBean`.
   b) Use `XDoclet` to generate the local and local home interfaces for the `CustomerBean`. The bean should have a `ejb-local-ref` name "`ejb/customer`".
   c) Create a stateless session bean named `TellerBean` which needs to access the customer bean through its local interface.
   d) Since the client can't access the customer bean directly, a class like `CustomerData`, which contains the ID and the name of a customer, is needed for storing the customer information.

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Task 109: Local Interface

   e) Return a list of `CustomerData` object to the client. In order to pass `CustomerData` by value, it must implement `Serializable`.
   f) Develop a client to create some customers through `TellerBean`.

A.3.2. JNDI

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Horizontal Concepts Outline

1) Local Interface
   a) local home
   b) local object
2) JNDI
   a) initial Context
   b) operations
3) Security
   a) declarative
   b) programmatic
4) Transactions
   a) declarative
   b) programmatic
5) J2EE Design Patterns
   a) service locator
   b) session façade
   c) Data Transfer Object
6) Summary

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Naming Service

1) It associates names with objects. This procedure is called binding names to objects.
   This is similar to a phone book that associating a person's name with a specific telephone number.

2) It provides a facility to find an object based on a name and is called looking up or searching for an object.
   This is similar to finding a person's telephone number based on that person's name.

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Directory

A directory can be think of as a tree-like structure connecting directory objects. A company can use a directory to store the information such as the locations of computers, printers and personnel.

A directory works like a database to store data and provide query operations to lookup stored information. In fact, most directories are implemented by a database.

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JNDI

Why `JNDI`?

There are many vendors providing naming and directory service using different protocols for accessing the directories. You have to modify your code to accommodate different naming and directory services.

`JNDI` provides a common interface for Java-based clients to interact with different naming and directory.

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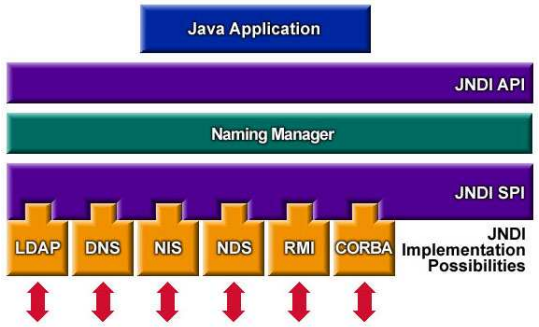
JNDI Architecture



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Initial Context Factory

An initial context is a starting point for performing all naming and directory operations.

We use an initial context factory to acquire an initial context. For `JNDI`, an initial context factory basically is the `JNDI` driver.

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Using JNDI 1

One can use the following code fragment to obtain the initial context:

```
// Obtain an Initial Context
javax.naming.Context ctx =
            new javax.naming.InitialContext

          (System.getProperties());
```

While using JBoss, the following option can be used to run a program named example:

```
java example
-Djava.naming.factory.initial
=org.jnp.interfaces.NamingContextFactory
-Djava.naming.provider.url=jnp://localhost:1099
-Djava.naming.factory.url.pkgs
=org.jboss.naming:org.jnp.interfaces
```

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Using JNDI 2

The java.naming.factory.initial parameter identifies the class of the JNDI driver. This is vendor specific. if a JNDI service from SUN Microsystems is using, this and would be:
com.sun.jndi.fscontext.RefFSContextFactory

The second line is a URL string to identify the starting point to begin the navigation and is called the provider URL in JNDI.

JNDI implementation and driver is typically bundled with the J2EE server.

JNDI usually runs in process at start up and the clients can call the driver to connect to that JNDI tree implementation .

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JNDI Operations

After acquiring the initial context, one can begin to execute JNDI operations and some available operations are as follows:

- lookup(): finds objects bound to the JNDI tree. The return type of lookup() is JNDI driver specific and depends on the type of objects you are looking for. For example, if you're looking up RMI-IIOP objects, you would receive a java.rmi.Remote object; if you're looking up a file in a file system, you would receive a java.io.File.
- bind(): publishes something to the JNDI tree at the current context.
- rebind(): same as bind(), except it forces a bind even if there is already something in the JNDI tree with the same name.

A.3.3. Security

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Horizontal Concepts Outline

1) Local Interface
   a) local home
   b) local object
2) JNDI
   a) initial Context
   b) operations
3) Security
   a) declarative
   b) programmatic
4) Transactions
   a) declarative
   b) programmatic
5) J2EE Design Patterns
   a) service locator
   b) session façade
   c) Data Transfer Object
6) Summary

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Security

Authentication – verify the identity of a client. Once the client is authenticated, he is associated with a security identity.

Authorization – permissions are granted to clients to perform specific operations.

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Authentication

The EJB specification does not directly address the process of authentication. Authentication is assumed to have been performed by some other component when the call to the EJB is made.

Authentication can be performed through the Java Authentication and Authorization Service (JAAS) API.

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EJB Security

EJB security can be managed:

1) declaratively by making entries in the Deployment Descriptor File, or
2) programmatically using method calls in the application.

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Declarative Security

Declarative security is the preferred method of implementing a security policy using EJBs.

Using EJBs a security role can be defined. This security roles control permission to execute specific methods.

For EJB, security roles are declared within the deployment descriptor file (ejb-jar.xml).

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EJB Security Roles

In the deployment descriptor, under the <assembly-descriptor> tag, <security-role> subelements can be defined as follows:

```
<assembly-descriptor>
   ...
   <security-role>
      <description>RoleDescription1</description>
      <role-name>Manager</role-name>
   </security-role>
   <security-role>
      <description>RoleDescription2</description>
      <role-name>Agent</role-name>
   </security-role>
    ...
<assembly-descriptor>
```

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EJB Method Authorizations 1

After the security roles are defined, it is possible to specify the authorization requirements for each of the methods of the enterprise beans in the JAR file.

```
<assembly-descriptor>
. . .
 <method-permission>
   <role-name>Agent</role-name>
   <method>
      <ejb-name>TravelerCreditCard</ejb-name>
      <method-name>debit</method-name>
   </method>
 </method-permission>
. . .
```

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EJB Method Authorizations 2

```
<method-permission>
  <role-name>Manager</role-name>
  <method>
     <ejb-name>TravelerCreditCard</ejb-name>
     <method-name>*</method-name>
  </method>
</method-permission>
<assembly-descriptor>
```

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EJB Method Authorizations 3

If the `<role-name>` were to be replaced by a tag `</unchecked>`, the method(s) are authorized for every security role.

If an `<exclude-list>` element is used, no one would be authorized to call the method, even if there were other declarations containing roles for the same method.

```
<assembly-descriptor>
     <method-permission>
          <unchecked/>
           <method>
               <ejb-name>EmployeeService</ejb-name>
               <method-name>*</method-name>
           </method>
      </method-permission>
```

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EJB Method Authorizations 4

```
      <exclude-list>
           <method>
               <ejb-name>ManagerService</ejb-name>
               <method-name>fireTheCTO</method-name>
           </method>
       </exclude-list>
</assembly-descriptor>
```

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Declaring Security Roles

Bean developers are responsible for declaring abstract security roles as follows:

```
<ejb-jar>
  <enterprise-beans>
    <entity>
      <ejb-name>SecureService</ejb-name>
      ...
      <security-role-ref>
        <role-name>TrustedUser</role-name>
      </security-role-ref>
    </entity>
  </enterprise-beans>
</ejb-jar>
```

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Mapping Abstract Role

Application deployer uses tag `<role-link>` for mapping the `security-role` elements to the `security-role-ref` elements as the follows:

```
 <ejb-jar>
  <enterprise-beans>
    <entity>
      <ejb-name>SecureEJB</ejb-name>
      ...
      <security-role-ref>
         <role-name>TrustedUser</role-name>
            <role-link>Manager</role-link>
      </security-role-ref>
    </entity>
  </enterprise-beans>
</ejb-jar>
```

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Programmatic Security Procedure

1) Deployer maps actual user identities to actual roles using vendor specific tools.
2) Bean provider writes programmatic authorization logic inside the bean code.
3) Bean provider declares abstract security roles in the bean's deployment descriptor.
4) Deployer maps abstract security roles to actual roles in deployment descriptor.

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Programmatic Security

A developer can use programmatic security and references a security role in the application code as follows:

```
public class SecureServiceBean extends EntityBean
{   EntityContext ejbContext;
   . . .
   public void debit(double amount)
      throws UnTrusedException
   {
      if (! ejbContext.isCallerInRole("TrustedUser"))
         throw new UnTrusedException();
      // Other code goes here...
   }
   // Other code goes here...
}
```

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RUN-AS Element

Using the <run-as> element in the deployment descriptor file, the security role of the caller can be replaced by the security role declared within the <run-as> tag and propagated to all other beans called.

```
<enterprise-beans>
     ...
      <session>
       ...
        <ejb-name>AccountLookupService</ejb-name>
         ....
          <security-identity>
           <run-as>
                        <role-name>accounting-
manager</role-name>
                       </run-as>
          </security-identity>
       </session>
...
```

A.3.4. Transactions

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Horizontal Concepts Outline

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Transactions

J2EE server offers transaction monitor that takes care of transactions.

There are three ways to demarcate transactions:
1) Client-initiated
2) Declaratively
3) Programmatically

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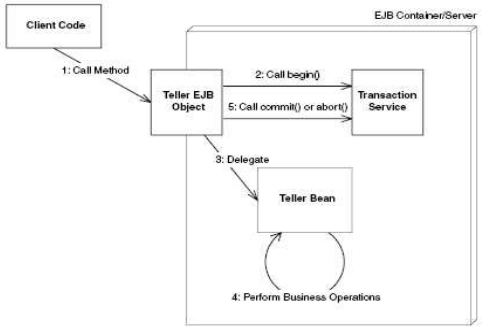
Client-initiated Transaction 1

Client can write code to begin and end the transaction. But the beans being called by the client still need to be written to use either programmatic or declarative transactions.



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Client-Initiated Transaction 2

A client must lookup the `JTA UserTransaction` interface with the Java `JNDI` as follows:

```
. . .
try{
Context ctx = new InitialContext();
/*
* Look up the JTA UserTransaction interface
* via JNDI. The container is required to
* make the JTA available at the location
* java:comp/UserTranasction.
*/
userTran = (javax.transaction.UserTransaction)
ctx.lookup("java:comp/UserTransaction");
```

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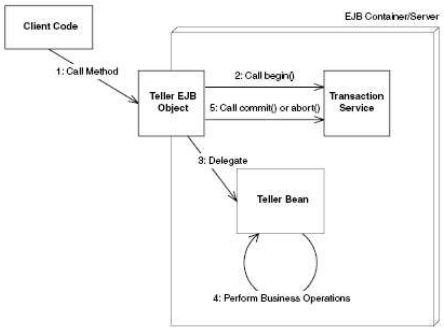
Declarative Transaction

Enterprise beans never explicitly issue a begin, commit ,or abort statement. Transaction is declared in the deployment descriptor and the `EJB` container performs it for you.



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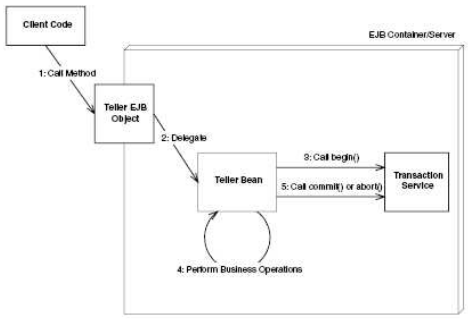
Programmatic Transaction

A begin statement and either a commit or an abort statement are hard-coded in the `EJB`.



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Declare Transaction Type

```
. . .
<ejb-jar>
   <enterprise-beans>
        <session>
          <ejb-name>Hello</ejb-name>
          <home>HelloHome</home>
          <remote>Hello</remote>
          <ejb-class>HelloBean</ejb-class>
          <session-type>Stateless</session-type>
       <transaction-type>Container</transaction-type>
     </session>
   </enterprise-beans>
</ejb-jar>
```

Container: Declarative
Bean: Programmatic

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Control of Declarative Transaction

For declarative transaction (container-managed transaction), transaction attributes are required in the deployment descriptor to instruct the container how to handle the transaction.

Transaction attributes must specify for all business methods of the beans.

With entity beans, transaction attributes must cover home interface methods, because the home interface creation methods insert database data and thus need to be transactional.

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Example : Setup 1

```
<assembly-descriptor>
  <container-transaction>
   <method>
    <ejb-name>Account</ejb-name>
    <method-name>*</method-name>
   </method>
   <!--
   Transaction attribute. Can be "NotSupported",
   "Supports", "Required", "RequiresNew",
   "Mandatory", or "Never".
    -->
   <trans-attribute>Required</trans-attribute>
</container-transaction>
```

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Example : Setup 2

```
<!--
 You can also set transaction attributes on
 individual methods.
 -->
<container-transaction>
 <method>
  <ejb-name>Account</ejb-name>
  <method-name>deposit</method-name>
 </method>
 <trans-attribute>Required</trans-attribute>
</container-transaction>
```

e-Macao-16-7-322

Example : Setup 3

```
  <!--
   You can even set different transaction attributes
   on overload methods.
   -->
  <container-transaction>
   <method>
    <ejb-name>Account</ejb-name>
    <method-name>deposit</method-name>
    <method-param>double</method-param>
   </method>
   <trans-attribute>Required</trans-attribute>
  </container-transaction>
</assembly-descriptor>
```

e-Macao-16-7-323

Transaction Attributes 1

1) Required
   a) If client has started transaction, bean is associated to the same transaction.
   b) If client has not started a transaction, a new transaction is created.

2) Supports
   a) If client has started a transaction, bean is associated to the same transaction.
   b) Otherwise method is executed without transaction.

3) RequiresNew
   a) When method is invoked, a new transaction is created and last only that method call.

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Transaction Attributes 2

4) Mandatory
   a) If transaction has not started before calling the method, exception is thrown.

5) NotSupported
   a) If transaction has started before calling the method, transaction will be suspended until the method is completed.

6) Never
   a) If method is called within a transaction, exception is thrown.

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Transaction Roll Back

There are two ways to roll back a container-managed transaction:

1) If a **system exception** is thrown, the container will automatically roll back the transaction.
2) The bean method invokes a roll back by calling the `setRollbackOnly` method of the `EJBContext` interface.

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Programmatic Transactions

Only session and message-driven bean can use programmatic (bean-managed) transaction to marks the boundaries of a transaction.

Bean-managed transaction provides a fine-grained control over the transaction.

Either JDBC or JTA (Java Transaction API) can be used for coding a bean-managed transaction.

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JDBC Transactions 1

1) JDBC Transaction is controlled by the transaction manager of the DBMS.
2) It is used when legacy code is wrapped inside a session bean.
3) Generally, a transaction begins with the first SQL statement that follows the most recent commit, rollback, or connect statement.

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JDBC Transactions 2

The **commit** and **rollback** methods of the **java.sql.Connection** interface can be invoked as follows:

```
public void ship (String productId, String orderId, int
 quantity) {
try {
 makeConnection();
 con.setAutoCommit(false);
 updateOrderItem(productId, orderId);
 updateInventory(productId, quantity);
 con.commit();
} catch (Exception ex) {
```

e-Macao-16-7-330

JDBC Transactions 3

```
    try {
       con.rollback();
       throw new EJBException("Transaction failed: " +
       ex.getMessage());
    } catch (SQLException sqx) {
       throw new EJBException("Rollback failed: " +
       sqx.getMessage());
    }
 } finally {
      releaseConnection();
 }
}
```

e-Macao-16-7-331

JTA Transaction 1

JTA (Java Transaction API) provides a unify high-level abstraction for the JTS (Java Transaction Service).

A JTA transaction is controlled by the J2EE transaction manager.

It cannot start a transaction for an instance until the preceding transaction has ended.

The following methods of the **javax.transaction.UserTransaction** interface are used to demarcate a JTA transaction:

begin
commit
rollback

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JTA Transaction 2

Both the client and bean code can use the Java Transaction API (JTA) to control the transaction programmatically through the interface:
javax.transaction.UserTransaction

```
public interface javax.transaction.UserTransaction {
    public void begin();
    public void commit();
    public int getStatus();
    public void rollback();
    //Calls this to force the current transaction to
       roll back
    public void setRollbackOnly();
    public void setTransactionTimeout(int);
}
```

e-Macao-16-7-333

Example: UserTansaction 1

```
. . .
public void deposit(double amt) throws AccountException
{
      javax.transaction.UserTransaction userTran = null;
      try {
            System.out.println("deposit(" + amt );
            //ctx is the InitialContext
            userTran = ctx.getUserTransaction();
            userTran.begin();
            balance += amt;
            userTran.commit();
      }catch (Exception e) {
     try{userTran.rollback();
        }catch (SystemException se){
```

e-Macao-16-7-334

Example: UserTansaction 2

```
            throw new EJBExcepiton("RollBasck " +
                        se.getMessage());
      }
     throw new EJBExcepiton
         ("Transaction Fail " + e.getMessage());

   }
}
```

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Task 110: Transaction

1) Use the `EmployeeBean` developed in Task 103 to test the operations of transaction.
    a) Develop a stateless session bean using `Jboss-IDE` plug-in.
    b) This bean should have a method "`createEmployee`" which receives an array of id and names as arguments. `createEmployee` method will uses the arguments received for creating employees.
    c) Add a `xdoclet` tag to declare the `createEmployee` method with a "`Required`" transaction: `@ejb.transaction type = "Required"`
    d) Create a client which adds the same employees twice. This will initiate an exception and cause a roll-back. Use the client program to test the roll-back operation.

A.3.5. J2EE Design Patterns

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Horizontal Concepts Outline

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EJB Design Patterns

For designing, building and working with EJB, there are many proven approaches being known as J2EE design patterns.

By being aware of these J2EE design patterns, you can avoid the common pitfalls others have experienced.

The followings will be discussed:
1) Service Locator
2) Session Façade
3) Data Transfer Object (DTO)

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Service Locator

Problems need to be addressed:

1) A client need to implements the lookup mechanism in order to use JNDI to obtain services or EJB components.
2) This operation is complex and vendor dependent.
3) Repeatedly creating JNDI initial context and looking up EJB home object are heavy operations.

Solution: use Service Locator

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Service Locator Implementation

A Service Locator is typically implemented as a Singleton which encapsulates the JNDI lookup services and business object creation to provide a simple interface to clients.

e-Macao-16-7-340

Example: Service Locator

```
import java.io.*;

import java.rmi.RemoteException;
import java.util.Collections;
import java.util.HashMap;
import java.util.Map;

import javax.ejb.EJBHome;
import javax.ejb.EJBLocalHome;
import javax.ejb.EJBObject;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import javax.rmi.PortableRemoteObject;
```

e-Macao-16-7-341

Example: Service Locator

```
public class ServiceLocator {
      private InitialContext initialContext;
      private Map serviceCache;
      private static ServiceLocator _instance;
      static {
          try {
              _instance = new ServiceLocator();
         } catch (NamingException se) {
              System.err.println(se);
             se.printStackTrace(System.err);
          }
      }
```

e-Macao-16-7-342

Example: Service Locator

```
private ServiceLocator() throws NamingException {
      initialContext = new InitialContext();
       serviceCache =
         Collections.synchronizedMap(new HashMap());
      }

      static public ServiceLocator getInstance() {
          return _instance;
      }
```

e-Macao-16-7-343

Example: Service Locator

```
// look up the local home object
      public EJBLocalHome getLocalHome(String
       jndiHomeName) throws NamingException {
        EJBLocalHome localHome = null;
        if (serviceCache.containsKey(jndiHomeName)) {
           localHome = (EJBLocalHome)
              serviceCache.get(jndiHomeName);
     } else {
          localHome = (EJBLocalHome)

      initialContext.lookup(jndiHomeName);
       serviceCache.put(jndiHomeName, localHome);
         }
        return localHome;
      }
```

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Example: Service Locator

```
// lookup the remote home object
      public EJBHome getRemoteHome(String
      jndiHomeName,     Class homeClassName)throws
NamingException {
       EJBHome remoteHome = null;
       if (serviceCache.containsKey(jndiHomeName)) {
         remoteHome = (EJBHome)
            serviceCache.get(jndiHomeName);
       } else {
         Object objref =
         initialContext.lookup(jndiHomeName);
         Object obj =
         PortableRemoteObject.narrow(objref,
            homeClassName);
```

e-Macao-16-7-345

Example: Service Locator

```
            remoteHome = (EJBHome) obj;
            serviceCache.put(jndiHomeName,
             remoteHome);
           }
            return remoteHome;
      }
}
```

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Session Façades

Problems need to be addressed:

1) High coupling
   - Allowing client directly access the server-side components leads to direct dependency.
2) Poor reusability and manageability
   - Direct access may also require the client to include complex logic to cooperate and interact with various business components.
3) High network overhead
   - Allowing client to access fine-grained components repeatedly will increase the network traffic due to many remote network calls.

Solution: use Session Façade

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Session Façade Implementation

A Session Façade is typically implemented as a session bean which encapsulates the components and provides a remote service layer for the client.

A session façade can either be implemented as a stateful or a stateless session bean.

1) Sateful:
   a) The use case is conversational.
   b) The state must be saved between each client method invocation.
2) Stateless:
   a) The use case is non-conversational.
   b) The client only need to initiate a single method in the Session Façade

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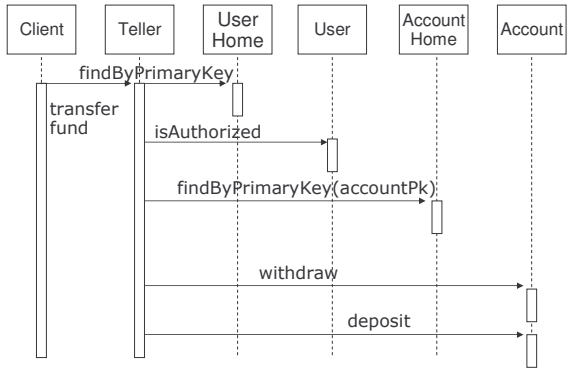
Example: Session Façade



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Data Transfer Object

Problems need to be addressed:

1) If a client want to transfer multiple data elements over a tier, several getter methods of an `EJB` may be invoked to get all the attribute values.
2) Network overhead is increased.

Solution: use Data Transfer Object (`DTO`)

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DTO Implementation

A Data Transfer Object:

1) is usually implemented as a serializable Java object
2) created by EJB component, populated with data and transmitted
3) can be used for both reading and update operations

A.3.6. Summary

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Horizontal Concepts Outline

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Summary 1

EJB 2.0 allows local client to call enterprise beans in a fast, efficient way by calling EJBs through their local objects rather than remote objects.

Considerations for choosing either a local interface or remote interface:

a) Local interface may speed up the application by marshalling parameters by reference rather than by value.

b) While using local interface, one must change the code for switching between a local or remote call.

c) Local client passes object arguments by reference from one bean to another. This means that changes of the passed object is seen by both beans.

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Summary 2

There are many vendors providing naming and directory service using different protocols for accessing the directories.

`JNDI` provides a common interface for Java-based clients to interact with different naming and directory.

Using `JNDI`, one should first acquire the initial context, then begin to execute `JNDI` operations such as:

1) `lookup()`
2) `bind()`
3) `rebind()`

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Summary 3

`EJB` security can be managed:

1) declaratively by making entries in the Deployment Descriptor File, or
2) programmatically using method calls in the application.

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Summary 4

There are three ways to demarcate transactions:

1) Client-initiated
2) Declaratively
3) Programmatically

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Summary 5

A client must lookup the `JTA UserTransaction` interface with the `Java JNDI` as follows:

```
. . .
try{
Context ctx = new InitialContext();
userTran = (javax.transaction.UserTransaction)
ctx.lookup("java:comp/UserTransaction");
```

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Summary 6

Only session and message-driven bean can use programmatic (bean-managed) transaction to marks the boundaries of a transaction.

Either JDBC or JTA (Java Transaction API) can be used for coding a bean-managed transaction.

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Summary 7

For designing, building and working with EJB, there are many proven approaches being known as J2EE design patterns.

By being aware of these J2EE design patterns, one can avoid the common pitfalls others have experienced.

Some of them are:

1) Service Locator
2) Session Façade
3) Data Transfer Object

A.4. Case Study

Case Study

e-Macao-16-7-361

Objective

In this section, an hands-on practice is required to be completed in order to review the technologies discussed in the course.

e-Macao-16-7-362

Task 111: Hands-On Practice

1) Each customer of a bank has an ID (an integer) and a name. Use `XDoclet` to write a `CMP` entity bean to represent the customers.
2) Develop a session façade named TellerBean so that the client can create a customer and list all the customers through this teller session bean.
3) The customer bean is not allowed to be exposed to the remote client. How to achieve this requirement. (Hint: use `XDoclet` tasks localinterface and localhomeinterface to generate the corresponding interfaces)
4) As the teller bean needs to access the customer bean, it needs an `ejb-ref` tag. In particular, as the access to the customer bean will be through its local interface, you must set the view-type parameter of the ejb-ref tag to local, otherwise the teller bean will be unable to find the customer bean.

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Task 112: Hands-On Practice

5) Create a Data Transfer Object named `CustomerData` to hold the ID and the name of a customer. The teller bean should return a list of `CustomerData` object instead of a list of Customer `EJB` objects. In order to pass `CustomerData` by value, it must implement `Serializable`.
6) Modify the create method so that it takes a `CustomerData` as an argument.
7) The methods of the teller bean must run in a transaction.
8) Create a client to test it.

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Task 113: Hands-On Practice

9) Enhance the program to allow the client to open an account, to find all accounts and to find the accounts of a certain customer given his ID. Each account has an ID (an integer) and a balance (an integer) and an owner (a customer). A customer can open more than one accounts. The client can access the accounts through the teller bean only.
10) Create a `CMP` entity bean for the accounts. It supports local interface only and a transfer object is needed to return an account to the client. It is required that an account bean has an unidirectional relationship with to its owner pointing from account to owner.
11) In order to find the accounts of a customer, a finder method in the account bean is required.

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Task 114: Hands-On Practice

12) Enhance the teller session bean developed so that the client can delete a customer. Make sure the his accounts are also deleted automatically (using cascade delete).
13) Enhance the client to test it.
14) Enhance the program again to allow the client to deposit into or withdraw from an account. Each such operation must be recorded. Such an operation has an ID (an integer) and an amount. The amount is positive for a deposit, and is negative for a withdrawal. The program should allow the client to find all the operations of an account given its account ID. A client is restricted to receive this information through the teller bean only.

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Task 115: Hands-On Practice

15) Create a `CMP` entity bean for the account operation. Again it supports local interface only. Use a data transfer object to return the information of the accounts' operation to the client. Again, an account is required to have an unidirectional relationship with it's operation pointing from account to operation.
16) Each operation of an account should have an ID number supplied by the system. The system is required to find the maximum existing ID and then add one to it to get the next ID. To find the maximum ID, use an `EJB-QL` statement such as `"select max(...)"` in an `ejbSelect` method. This `ejbSelect` should return an `Integer` object. Note that if there is no bank transaction yet, the `EJB-QL` will return null.
17) Make sure that if an account is deleted, all the operation records of that account must also be deleted automatically (using cascade delete).
18) Enhance the client to test it.

B. Assessment

B.1. Set 1

1.	Which of the following kinds of beans would survive a server crash?	
	A.	Entity bean
	B.	State-less session bean
	C.	State-full session bean
	D.	Message-driven bean
Answer	A	
2.	Suppose you make a JNDI lookup on a JDBC connection by the following code: InitialContext ctx = new InitialContext(); DataSource dsrc = (DataSource)ctx.lookup("java:comp/env/jdbc/discountDB"); Connection con = dsrc.getConnection(); Which of the following are correct entries in the <resource-ref-name> element of the deployment descriptor?	
	A.	java:comp/env/jdbc/discountDB
	B.	env/jdbc/discountDB
	C.	jdbc/discountDB
	D.	discountDB
Answer	C	
3.	Suppose Hello is a reference to the component interface of a stateless session bean named HelloBean. Which of the following is a valid home interface of HelloBean?	
	A.	create()
	B.	create(String name)
	C.	create(String name, String date)
	D.	All of the above
Answer	A	
4.	Which of the following statements are true about locating or using the home interface of a session bean?	
	A.	Once acquired, the home interface can be used only once.
	B.	Each instance of a session bean has its own EJBHome object.
	C.	Only remote clients need to get the home interface; local clients can get the component interface directly.
	D.	None of the above
Answer	D	
5.	Which of the following statements are true about the remote component interface of a session bean?	
	A.	All methods in the remote home interface and the remote component

		interface are declared to throw javax.ejb.RemoteException.
	B.	All methods in the remote home interface and the remote component interface are declared to throw java.rmi.RemoteException.
	C.	A client locates the remote component interface from JNDI and then narrows it before invoking a methods on it.
	D.	A remote client can use the method remove(Object key) from the home interface to remove a state-full session bean instance.
Answer	B	
6.	Consider an entity bean with Customer as its remote component interface and CustomerHome as its remote home interface. Which of the following are legal method declarations in the home interface?	
	A.	public CustomerHome findCustomerByEmail(String email);
	B.	public Customer findCustomerByEmail(String email);
	C.	public Customer findCustomerByEmail(String email) throws FinderException, RemoteException;
	D.	public Customer findCustomerByEmail(String email) throws FinderException;
Answer	C	
7.	Which of the following are true statements about what happens when remove() method is called using the component interface of an entity bean representing a specific entity in the database?	
	A.	The entity bean instance is deleted.
	B.	The entity in the database is deleted.
	C.	Both the entity and the entity bean instance survive, but that entity bean instance does not represent that entity anymore.
	D.	Nothing happens; the container simply ignores the call.
Answer	B	
8.	Which of the following statements are true about a CMP entity bean?	
	A.	You cannot write JDBC code in the bean class to make a connection and send queries to any database.
	B.	You cannot write JDBC code in the bean class to change the values of virtual persistent fields of your bean.
	C.	You can write JDBC code and get connected to any database you want.
	D.	You can write JDBC code to read the virtual persistent fields, but you cannot change their values.
Answer	B	
9.	Which of the following are legal method declarations for an entity bean class?	
	A.	public static Collection ejbHomeListCustomers()
	B.	public Collection ejbHomeListCustomers() throws RemoteException
	C.	public Collection ejbHomeListCustomers()
	D.	public Collection EJBHomeListCustomers()
Answer	C	

10.	Which of the following statements are true for an entity bean that uses a container to manage its persistence and relationships?	
	A.	The type of a CMP field is determined by the corresponding get and set methods.
	B.	The type of a CMP field is determined from the corresponding get and set methods.
	C.	The type of a CMP field is declared in the deployment descriptor.
	D.	The type of a CMP or CMR field is declared inside the bean class in the form of a variable declaration.
Answer	A	
11.	Which of the following are valid statements about a message-driven bean?	
	A.	A message-driven bean can have only a local home interface.
	B.	The identity of a message-driven bean is hidden from the client.
	C.	You can invoke the getEJBLocalHome() method on the bean's context from inside the onMessage() method.
	D.	The container invokes the ejbActivate() method on the bean instance before invoking the onMessage() method.
Answer	B	
12.	Consider that method A() in an application sends a message. In response, the method onMessage() of an MDB is called. The onMessage() method invokes another method, B(). Method B() throws an application (checked) exception. Which of the following are the correct ways to deal with this exception in the onMessage() method?	
	A.	Throw the exception back to method A().
	B.	Handle the exception inside the method onMessage().
	C.	Throw the exception back to the container.
	D.	Throw RemoteException.
Answer	B	

B.2. Set 2

1.	Consider the following lines in the deployment descriptor: 1. <ejb-relationship-role> 2. <ejb-relationship-role-name> 3. OrderBean 4. </ejb-relationship-role-name> 5. <multiplicity>Many</multiplicity> 6. <cascade-delete/> 7. <relationship-role-source> 8. <ejb-name>OrderBean</ejb-name> 9. </relationship-role-source> 10. <cmr-field> 11. <cmr-field-name> 12. customer 13. </cmr-field-name> 14. </cmr-field> 15. </ejb-relationship-role> What does the line 6 in the above listing mean?	
	A.	If a customer is deleted, all orders related to that customer are deleted.
	B.	If a customer is deleted, all orders related to all customers are deleted.
	C.	If an order is deleted, the customer related to that order is deleted.
	D.	If all orders related to a customer are deleted, the customer is deleted.
Answer	A	
2.	Which of the following are true statements about what happens when a remove() method is called using the component interface of an entity bean representing a specific entity in the database?	
	A.	The entity bean instance is deleted.
	B.	The entity in the database is deleted.
	C.	Both the entity and the entity bean instance survive, but that entity bean instance does not represent the entity anymore.
	D.	Nothing happens; the container simply ignores the call.
Answer	B	
3.	The following bean code does a JNDI lookup on a JDBC connection: InitialContext ctx = new InitialContext(); DataSource dsrc = (DataSource)ctx.lookup("java:comp/env/jdbc/discountDB"); Connection con = dsrc.getConnection(); Which of the following are correct entries in the <resource-ref-name> element in the deployment descriptor?	
	A.	java:comp/env/jdbc/discountDB
	B.	env/jdbc/discountDB
	C.	jdbc/discountDB

	D.	discountDB
Answer	C	
4.	Which of the following statements are true about locating or using the home interface of a session bean?	
	A.	Once acquired, the home interface can be used only once.
	B.	Each instance of a session bean has its own EJBHome object.
	C.	Only remote clients need to get the home interface; local clients can get to the component interface directly.
	D.	None of the above
Answer	D	
5.	Consider an entity bean with Customer as its remote component interface and CustomerHome as its remote home interface. Which of the following are legal method declarations in the home interface?	
	A.	public CustomerHome findCustomerByEmail(String email);
	B.	public Customer findCustomerByEmail(String email);
	C.	public Customer findCustomerByEmail(String email) throws FinderException, RemoteException;
	D.	public Customer findCustomerByEmail(String email) throws FinderException;
Answer	C	
6.	Which of the following are legal method declarations for an entity bean class?	
	A.	public static Collection ejbHomeListCustomers()
	B.	public Collection ejbHomeListCustomers() throws RemoteException
	C.	public Collection ejbHomeListCustomers()
	D.	public Collection EJBHomeListCustomers()
Answer	C	
7.	Suppose Hello is a reference to the component interface of a state-less session bean named HelloBean. Which of the following is a valid home interface of HelloBean?	
	A.	create()
	B.	create(String name)
	C.	create(String name, String date)
	D.	All of the above
Answer	A	
8.	Which of the following statements are true for an entity bean that uses a container to manage its persistence and relationships?	
	A.	The type of a CMP field is determined by the corresponding get and set methods.
	B.	The type of a CMR field is determined from the corresponding get and set methods.

	C.	The type of a CMP field is declared in the deployment descriptor.
	D.	The type of a CMP or CMR field is declared inside the bean class in the form of a variable declaration.
Answer	A	
9.	Which of the following kinds of beans would survive a server crash?	
	A.	Entity beans
	B.	State-less session beans
	C.	State-full session beans
	D.	Message-driven beans
Answer	A	
10.	Which of the following statements are true about the remote component interface of a session bean?	
	A.	All methods in the remote home interface and the remote component interface are declared to throw javax.ejb.RemoteException.
	B.	All methods in the remote home interface and the remote component interface are declared to throw java.rmi.RemoteException.
	C.	A client locates the remote component interface from JNDI and then narrows it before invoking methods on it.
	D.	A remote client can use the method remove(Object key) from the home interface to remove a state-full session bean instance.
Answer	B	
11.	Which of the following are valid statements about a message-driven bean?	
	A.	A message-driven bean can have only a local home interface.
	B.	The identity of a message-driven bean is hidden from the client.
	C.	You can invoke the getEJBLocalHome() method on the bean's context from inside the onMessage() method.
	D.	The container invokes the ejbActivate() method on the bean instance before invoking the onMessage() method.
Answer	B	
12.	Consider that method A() in an application sends a message. In response, the method onMessage() of an MDB is called. The onMessage() method invokes another method, B(). Method B() throws an application (checked) exception. Which of the following are the correct ways to deal with this exception in the onMessage() method?	
	A.	Throw the exception back to method A().
	B.	Handle the exception inside the method onMessage().
	C.	Throw the exception back to the container.
	D.	Throw RemoteException.
Answer	B	

J2EE Business Component Development

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The Course

1) objectives - what do we intend to achieve?
2) outline - what content will be taught?
3) resources - what teaching resources will be available?
4) organization - duration, major activities, daily schedule

Course Objectives

1) Introduce the Enterprise JavaBeans development environment.

2) present the core J2EE Business Components technologies:
   a) Session Bean
   b) Entity Bean
   c) Message-Driven Bean

3) present the techniques to develop an n-tier, distributed J2EE application.

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

Outline: Basic Concepts

An overview of the Enterprise Java Bean Architecture:

1) basic concepts of Enterprise JavaBeans (EJB)
2) deployment environment of EJB
3) benefits of using EJB

Outline: Vertical Concepts

The main concepts about different types of business components:

1) introduction to Session Bean, Entity Bean and Message-Driven Bean
2) life cycle of different business components
3) development of different types of business components
4) deployment of J2EE applications

Outline: Horizontal Concepts

Supporting technologies to develop J2EE applications:

1) usage of local interface
2) usage of JNDI
3) setup for role-based security
4) transaction declaration
5) application of J2EE design patterns

Outline: Case Study

Review the J2EE technologies with a hands-on practice:

1) development of session façades using session beans
2) development of data transfer objects using session beans
3) development of container managed persistence entity beans
4) defining relationship between entity beans
5) setting up transaction control for operations

Course Resources

1) Books

   a) The J2EE Tutorial, Sun Microsystems, http://java.sun.com/j2ee/1.4/docs/tutorial/doc/J2EETutorial.pdf, 2004

2) Articles

   Links available from the website http://www.emacao.gov.mo.

3) Tools

   a) JDK 1.5

   b) Eclipse IDE

   c) Jboss 4.0.1

   d) Jboss-IDE 1.4.0

Course Logistics

1) duration - 29 hours
2) activities – lectures
3) timing
    a) Monday 09:00–13:00 14:30–17:45
    b) Tuesday 09:00–13:00 14:30–17:45
    c) Wednesday 09:00–13:00 14:30–17:45
    d) Thursday 09:00–13:00 14:30–17:45
4) sessions - 4 mornings, 4 afternoons
5) style - interactive and tutorial

Course Prerequisites

1) basic Java
2) basic understanding of TCP/IP networking concepts
3) basic understanding of XML

Basic Concepts

Course Outline

1) basic concepts

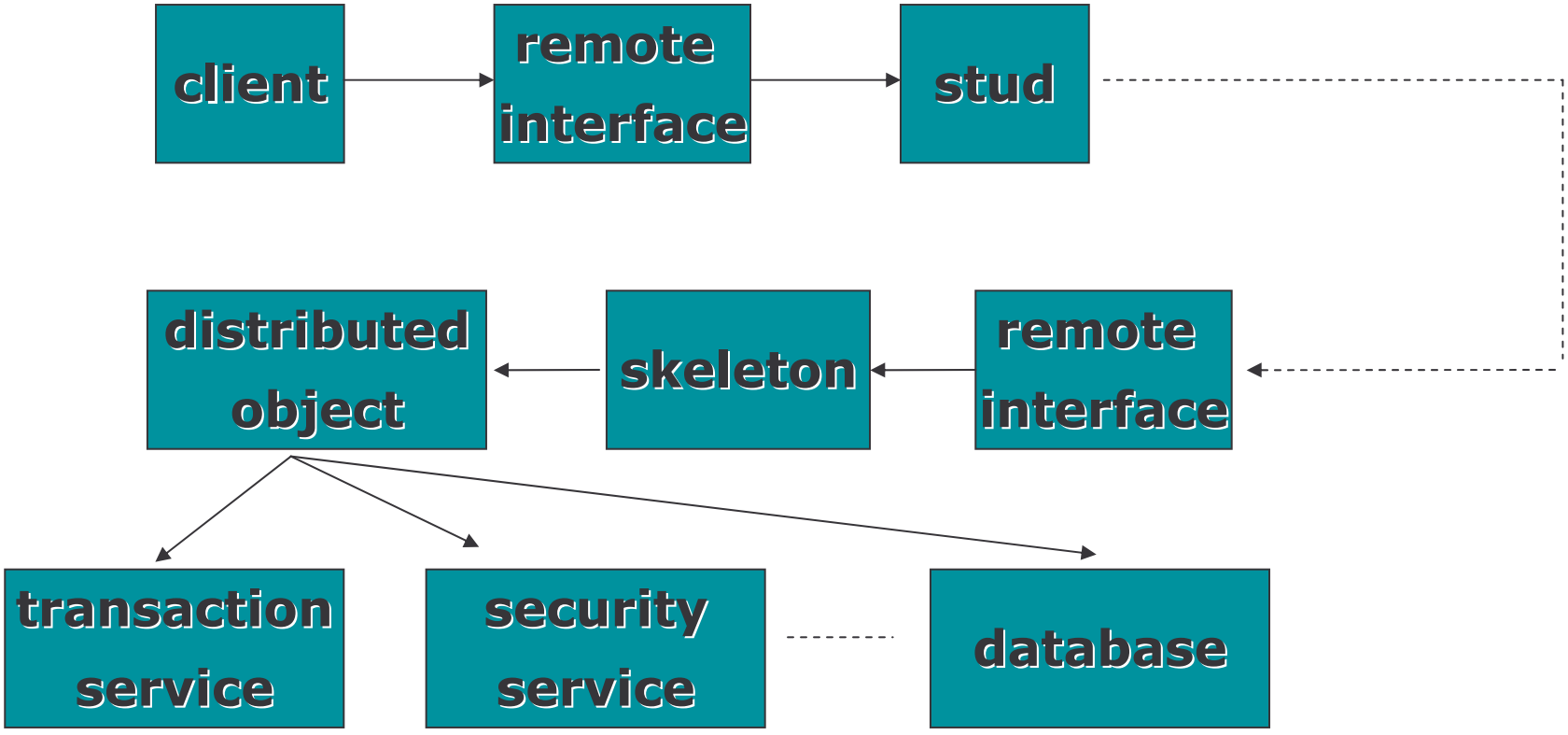
2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

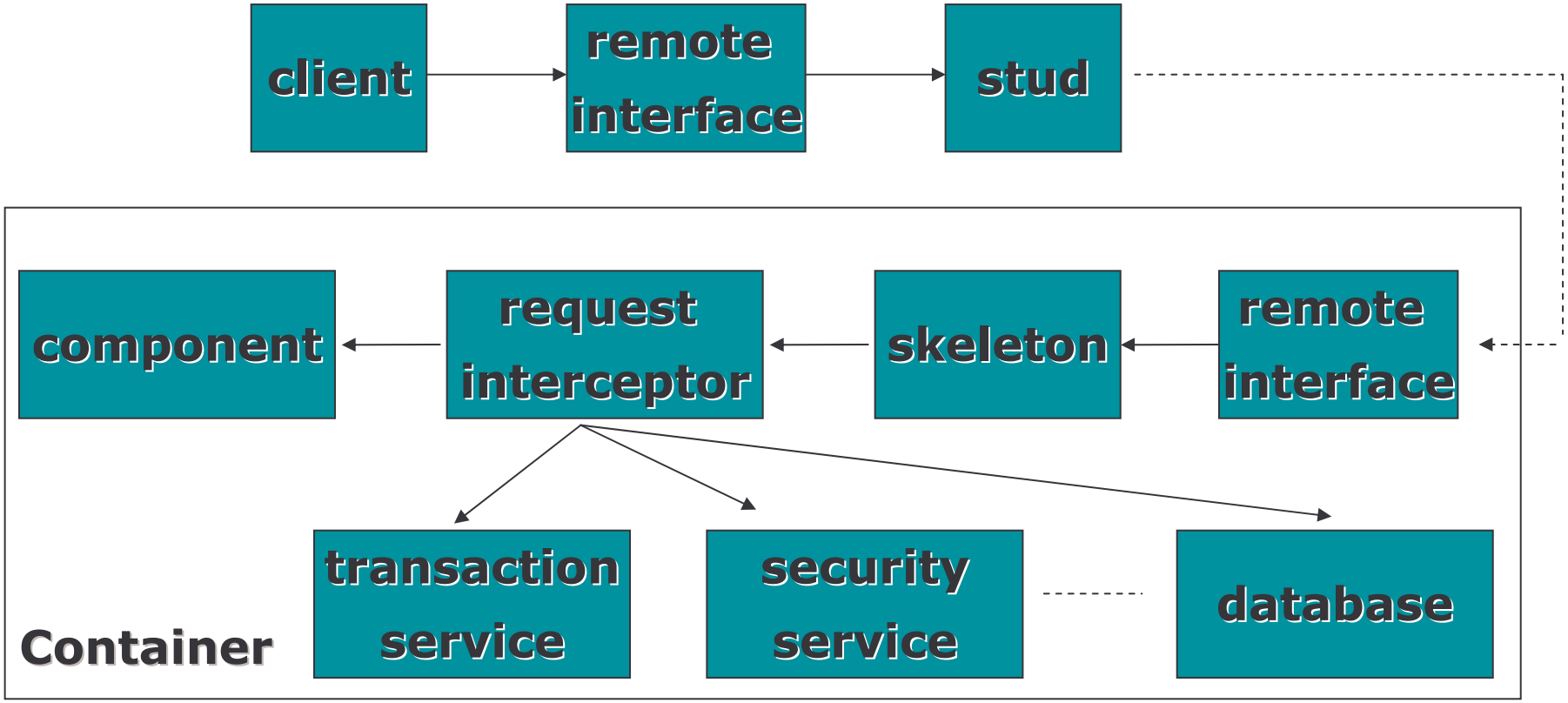
Distributed Objects

1) are objects called from remote system
2) use stubs and skeleton to hide the complexity of network communication
3) external services are invoked explicitly by user applications

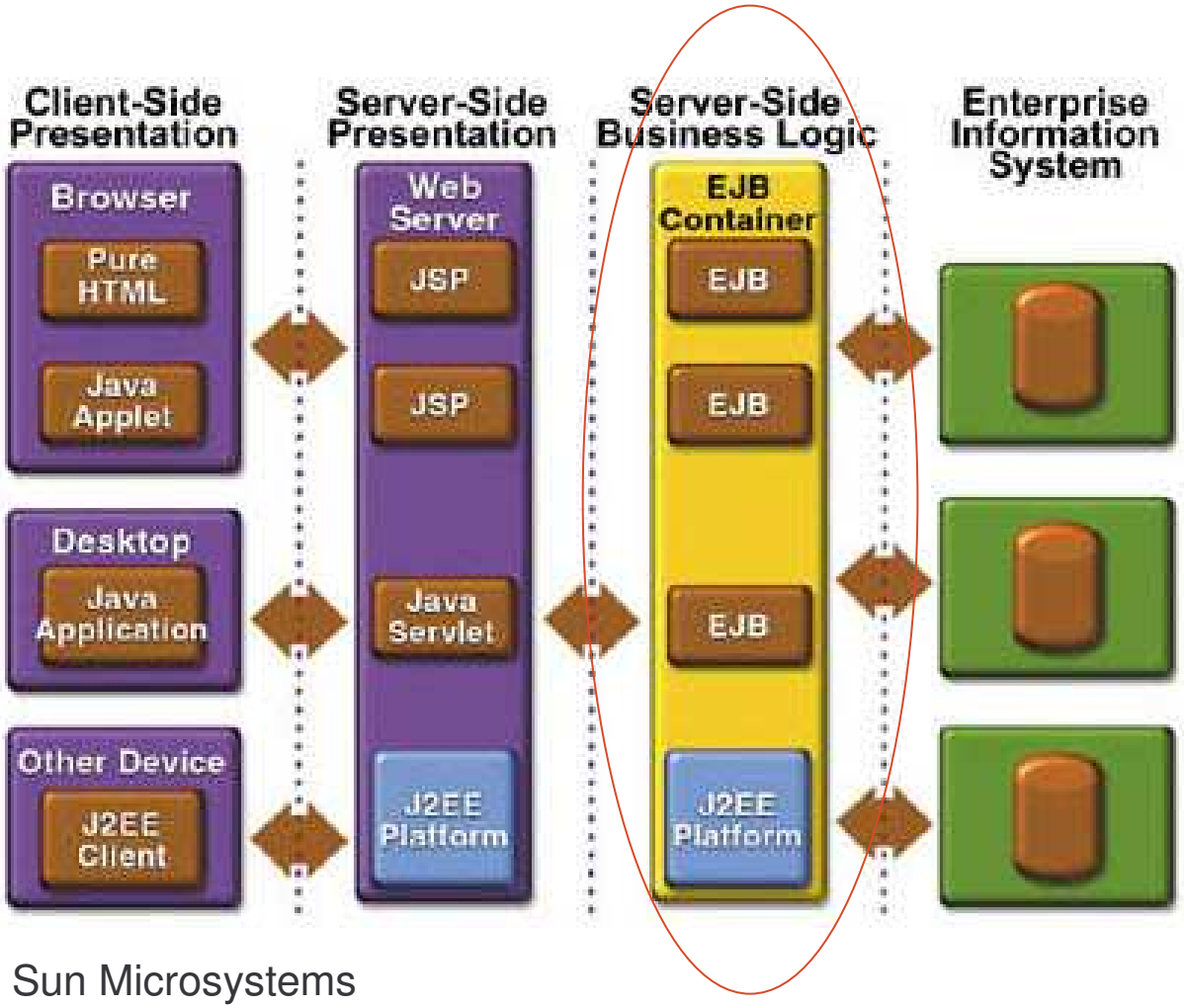


Component Objects

1) request interceptors intercepts all communications
2) components focus on business logic
3) system level services are controlled and maintained by the container and request interceptors



J2EE Platform



courtesy of Sun Microsystems

Business Components

Enterprise JavaBeans (`EJB`)

a) is a server side component written in Java Language

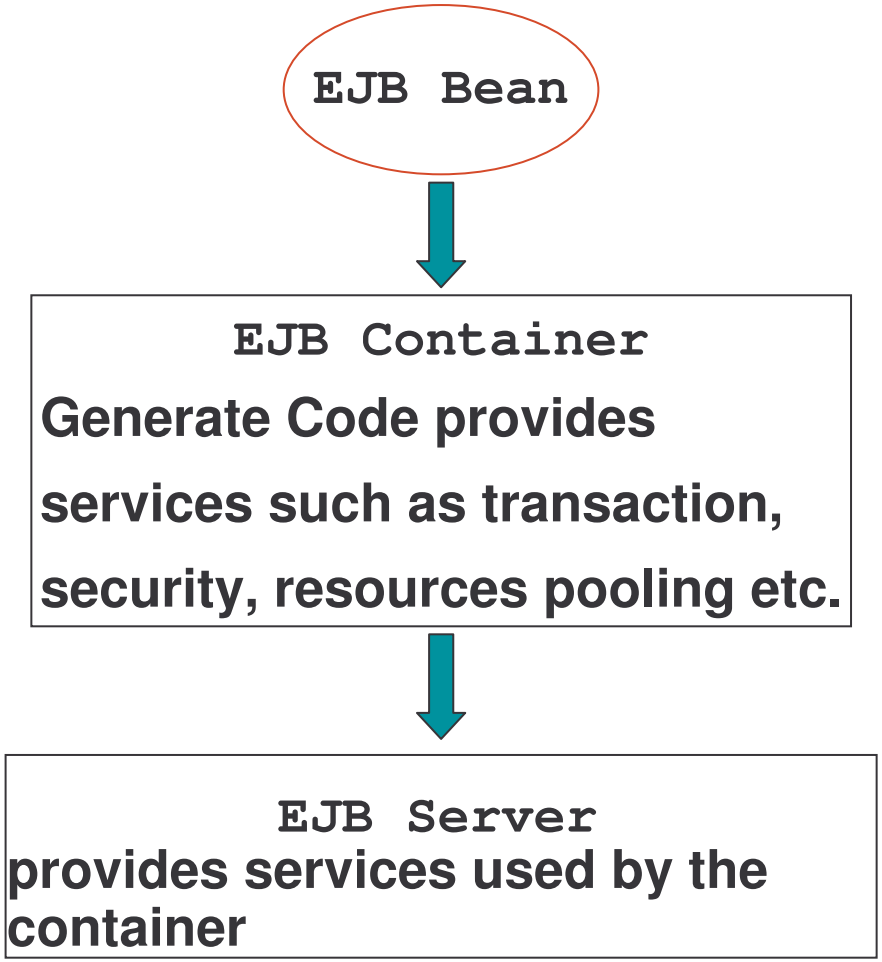
b) is a standard distribuited component model

c) requires a container to function

d) allows developer concentrates on business logic

e) allows `JSPs`, `Servlets`, other `EJBs` and external applications act as clients

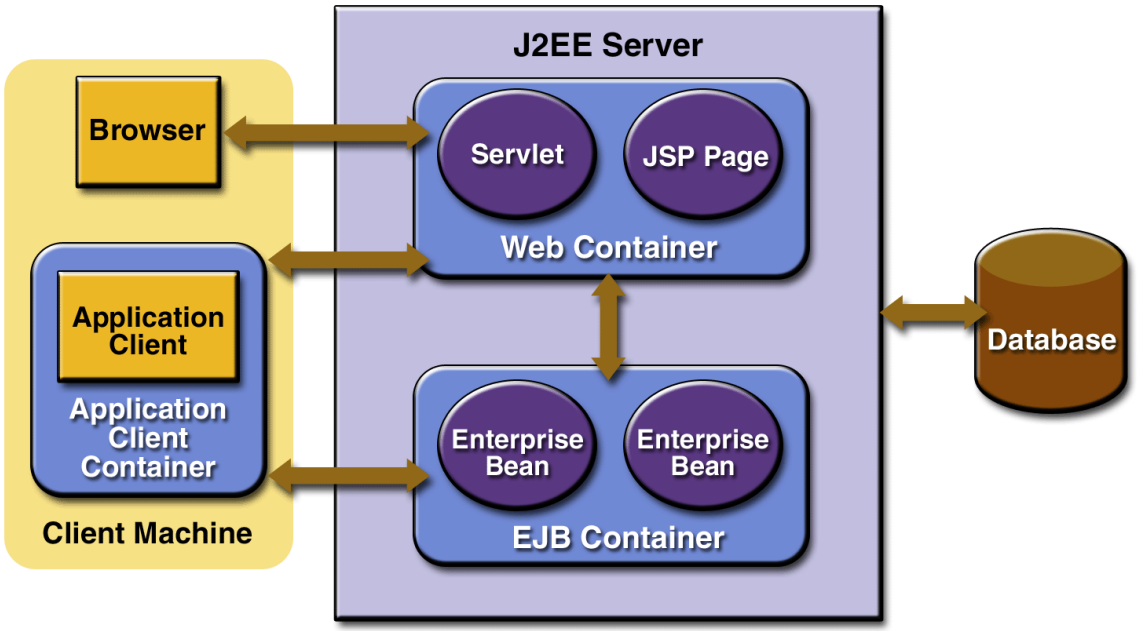
Deploying Enterprise JavaBeans



What is Application Server

Application servers enable the development of multi-tiered distributed applications. They are also called “middleware”.

An application server acts as the interface between the database(s), the web container, the EJB container and the client machines.



Commercial Platforms

1) J2EE SDK 1.4 (Sun)
2) WebLogic (BEA Systems)
3) WebSphere (IBM)
4) iPlanet (Sun & Netscape)
5) JBoss (Open source)

Benefits

Bean writers need not write codes for:

a) remote access protocols
b) transactional behaviour
c) threads
d) security
e) state management
f) object life cycle
g) resource pooling
h) persistence

When to Use EJB

1) scalability
2) transaction
3) multi-client

Types of EJB

1) Session Beans
   a) Stateless – general services such as shopping catalogue
   b) Stateful – state for individual client needs to be preserve such as shopping cart
2) Entity Beans
   a) CMP (Container-Managed Persistence)
   b) BMP (Bean-Managed Persistence)
3) Message-Driven Beans (Introduced in `EJB 2.0`)
   a) This is a JMS bean. Designed for sending and receiving JMS messages.

EJBs Characteristics

All `EJBs` implement a subtype of `EnterpriseBean`.

a) Either `SessionBean`, `EntityBean`, or `MessageDrivenBean`

Each of the subinterfaces declares callback methods for the container.

a) Each callback method provides a way for the container to notify the `EJB` about an event in the bean's lifecycle, e.g. removing a bean from memory.

b) The callback methods give the `EJB` a chance to do some internal housework before or after an event occurs.

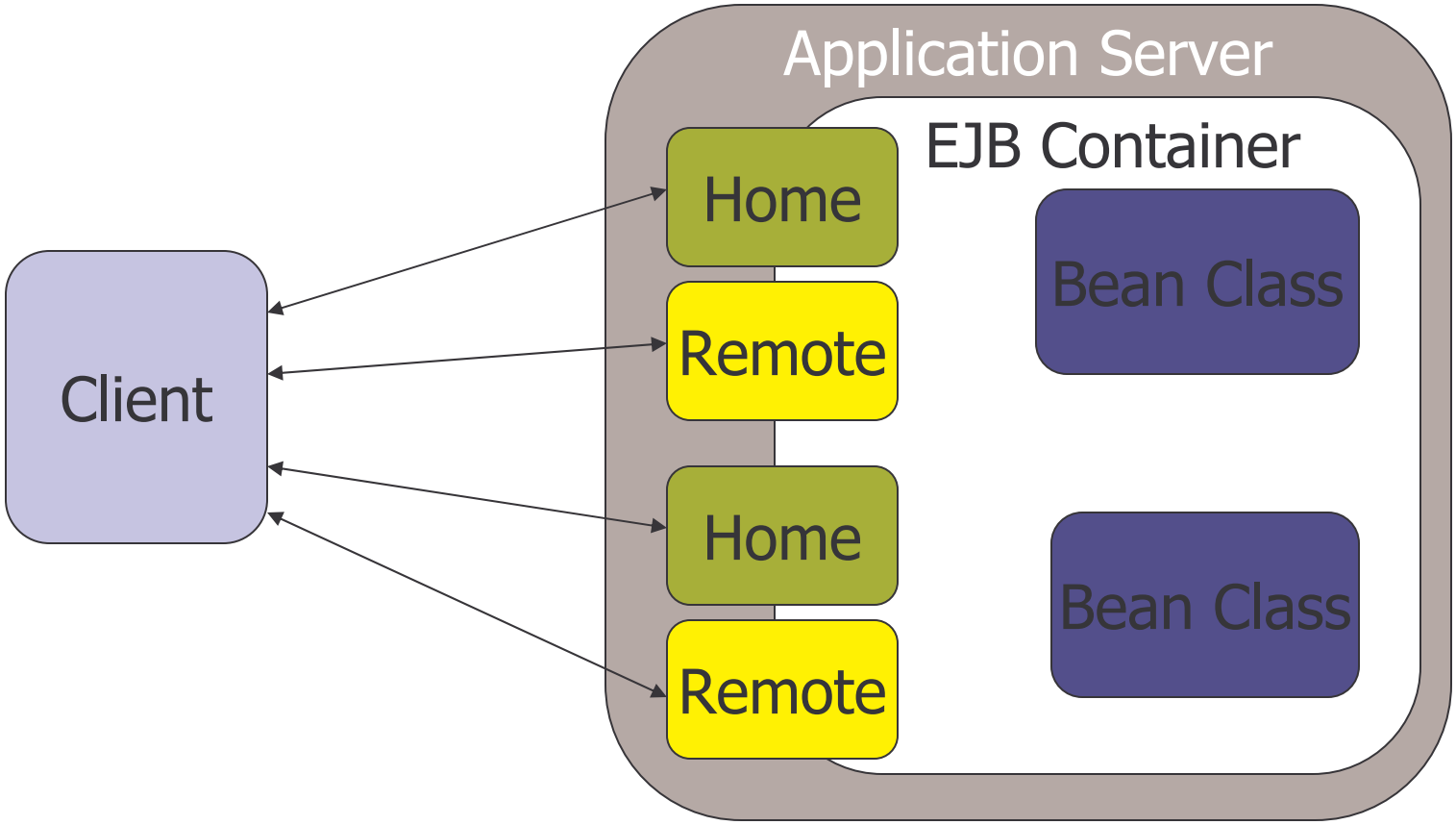
c) These are the bean's event handlers.

Components of EJBs

To create an `EJB`, a developer has to provide:

1) A home interface
    a) defines the life-cycle methods of the bean
2) A remote interface
    a) defines the business methods of the bean
3) A bean class
    a) business logic

Conceptual Model



Home Interface Characteristics

1) extends `javax.ejb.EJBHome`
2) acts as a factory pattern to create instances of the `EJB`
3) allows client to create, remove and find (for entity beans) an `EJB`
4) `EJB` container provides implementation

Example: Home Interface

```
package com.interfaces;
// This is the home interface for HelloBean.
public interface HelloHome extends javax.ejb.EJBHome
{
   Hello create() throws java.rmi.RemoteException,
     javax.ejb.CreateException;
}
```

Remote Interface Characteristics

1) extends `javax.ejb.EJBObject`
2) contains business methods called by the clients
3) implementation of the business methods is located in the bean class
4) acts as a proxy

Example: Remote Interface

```
package com.interface;
// This is the HelloBean remote interface.
public interface Hello extends javax.ejb.EJBObject
{
   //The remote method
   public String hello() throws
          java.rmi.RemoteException;

}
```

Bean Class Characteristics

1) implements either `SessionBean`, `EntityBean`, or `MessageDrivenBean`
2) contains implementations of the methods defined in the remote interface
3) defines `ejbCreate` methods corresponding to the create methods defined in the home interface

Example: Bean Class 1

```
package com.ejb;
// Demonstration stateless session bean.
public class HelloBean implements javax.ejb.SessionBean
{
    private SessionContext ctx;
    // EJB-required methods
    public void ejbCreate() {
        System.out.println("ejbCreate()...");
    }
```

Example: Bean Class 2

```
public void ejbRemove() {
        System.out.println("ejbRemove()...");
}
public void ejbActivate() {
   System.out.println("ejbActivate()...");
}
public void ejbPassivate() {
   System.out.println("ejbPassivate()...");
}
public void setSessionContext
     (javax.ejb.SessionContext ctx) {
     this.ctx = ctx;
}
```

Example: Bean Class 3

```
    // Business methods
    public String hello() {
        System.out.println("hello()");
        return "Hello, World!";
    }
}
```

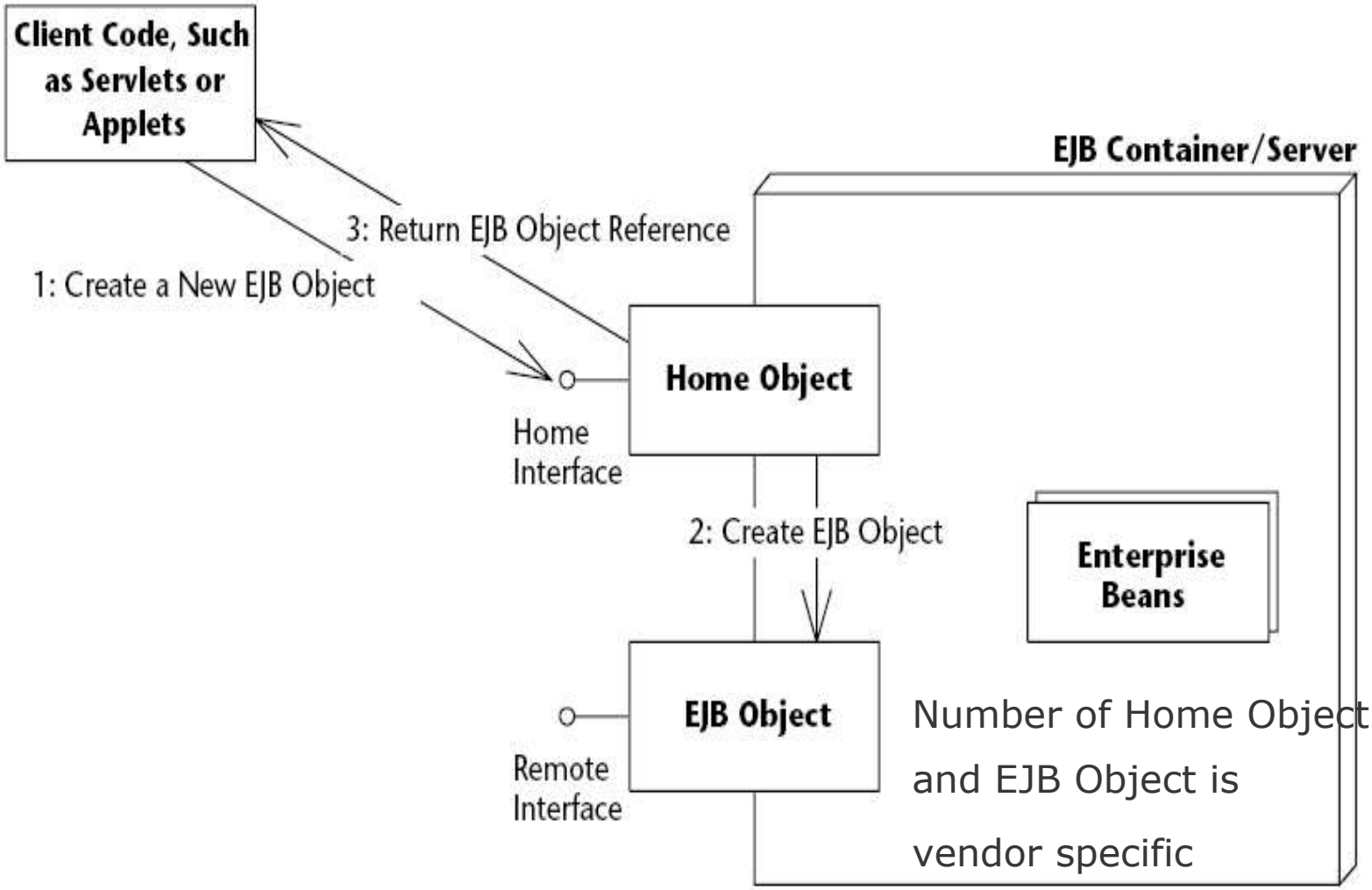
Registering an EJB

1) After an EJB is deployed, the container generates the EJB Home object and skeleton from the home interface.
2) The EJB Home object is registered in the JNDI naming service.
3) Clients can then look up the advertised reference.
4) A stub object for the home interface is created automatically in client's container.

Creating an EJB 1

1) After received the home interface reference, the client can call the create method to create an instance of the EJB component.
2) The client's stud object marshals the create parameters and send the message to the server.
3) The skeleton object in the server demarshals the message and delegate the invocation to the EJB Home object.
4) The EJB Home object then contacts the required services and create an EJB instance.
5) The skeleton and EJB object representing the EJB component are then instantiated.
6) The reference of the EJB object is passed back to the client and a stud for the EJB object is instantiated in the client.

Creating an EJB 2



Pooling EJB 1

EJB container is responsible for managing resources and life cycle of EJB.

It is ineffective for the EJB container to instantiate a new bean instance for every requests from clients.

Bean instance pooling is used to solve the problem.

Pooling EJB 2

When a client requests an `EJB`, the container will instantiate a new instance if the bean instance does not exist in memory.

If a bean instance already exists and not actively serving a client, the bean instance may be assigned to another client to save system resources.

Task 1: Basic Concepts

1) In order to create an `EJB`, what classes should a bean provider provide?
2) Which interface should a home interface extend? What methods are defined in the superinterface of the home interface? Who is responsible to implement these methods?
3) Which interface should a remote interface extend? What kind of methods should one define in the remote interface? Where should these methods be implemented?

Deploying EJBs

For deploying an EJB, a deployment descriptor file, which is basically an XML file, is needed.

This descriptor allows attributes on the beans to be specified declaratively.

The file should be named ejb-jar.xml and stored in a directory named "META-INF".

A jar file including all the class files and the META-INF folder can then be deployed to an application server in a vendor specific manner.

Example: ejb-jar.xml 1

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
  Inc.//DTD Enterprise JavaBeans 2.0//EN"
  "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar >
   <enterprise-beans>
      <session >
        <ejb-name>Hello</ejb-name>
          <home>
             iist.ejb.interface.HelloHome
          </home>
          <remote>
             iist.ejb.interface.Hello
          </remote>
```

Example: ejb-jar.xml 2

```
            <ejb-class>
                iist.ejb.HelloBean
            </ejb-class>
            <session-type>Stateless</session-type>
             <transaction-type>
                   Container
              </transaction-type>
        </session>
    </enterprise-beans>
</ejb-jar>
```

Vendor-specific file

Vendor specific functions such as clustering, instance pooling can be configured in a vendor-specific file.

For example, one may include the following file, `jboss.xml` in the `META-INF` folder, in order to publish the hello `EJB` with a different `JNDI` name in `JBoss`.

```
<!DOCTYPE jboss PUBLIC "-//JBoss//DTD JBOSS 3.2//En"
       "http://www.jboss.org/j2ee/dtd/jboss_3_2.dtd">

<jboss>
       <enterprise-beans>
            <session>
               <ejb-name>Hello</ejb-name>

               <jndi-name>myHelloHome</jndi-name>
            </session>
         </enterprise-beans>

</jboss>
```

Task 2: Deploying an EJB

1) Try to deploy the EJB discussed in the example. You may use the Export function of Eclipse to generate the jar file to the following directory:
   <JBoss_Home>\server\default\deploy
2) Make sure that JNDI name of the bean is configured to myHello. Where can this configuration be made?
3) Create a client program to test the bean. The following is the skeleton code for the client application.

```
import javax.naming.Context;
import javax.naming.InitialContext;
import java.util.Properties;
public class HelloClient {
public static void main(String[] args) throws
       Exception {
```

Task 3: Deploying an EJB

```
/* Setup properties for JNDI initialization.
* JNDI properties is stored in a file named
*jndi.properties include in the classpath*/
Properties props = System.getProperties();
Context ctx = new InitialContext(props);

Object obj = ctx.lookup("myHelloHome");
/*Home objects are RMI-IIOP objects, and so
* they must be cast into RMI-IIOP objects
*using a special RMI-IIOP cast.*/
HelloHome home = (HelloHome)
       javax.rmi.PortableRemoteObject.narrow
       (obj, HelloHome.class);
```

Task 4: Deploying an EJB

```
// Use the factory to create the Hello EJB Object
        .......

// Call the hello() method on the EJB object. The
// EJB object will delegate the call to the bean,
// receive the result, and return it to us.
// Print the result to the screen.
        ......
// Done with EJB Object, so remove it.
// The container will destroy the EJB object.
          hello.remove();
        }
}
```

Task 5: Deploying an EJB

4) The following file is needed for setting up the JNDI initial context for JBoss. Named this file as "jndi.properties" and put it in the classpath of the client's application.

```
java.naming.factory.initial=org.jnp.interfaces.NamingContextFactory
java.naming.provider.url=jnp://localhost:1099
java.naming.factory.url.pkgs=org.jboss.naming:org.jnp.interfaces
```

Task 6: Deploying an EJB

5) Download and install the `JBossIDE` plug-in for Eclipse from `www.jboss.org`.
   a) Unpack the archives into a directory on your computer.
   b) At `Eclipse:Help-->Find and Install-->Search for new features for install-->Add new Archive site-->` choose directory containing unpacked `JbossIDE` files.
   c) Follow the instruction to install `JbossIDE`.

6) Copy `<Jboss_Home>/client/jbossall-client.jar` to the build path of the client program.
7) Change the `JNDI` name of the bean to "`ejb/Hlelo`"; modify the client program and run the test again.

Summary 1

EJB should be used when the followings are required:

1) Scalability
2) Transaction
3) Multi-client

Summary 2

There are three types of EJB:

1) Session Beans
2) Entity Beans
3) Message-Driven Beans (Introduced in EJB 2.0)

Summary 3

To create an EJB, the following files are needed:

1) A home interface
    a) defines the life-cycle methods of the bean
2) A remote interface
    a) defines the business methods of the bean
3) A bean class
    a) business logic

Summary 4

1) After an EJB is deployed, the container generates the EJB Home object and skeleton from the home interface.
2) The EJB Home object is registered in the JNDI naming service.
3) Clients can then look up the advertised reference.
4) A stub object for the home interface is then created automatically in client's container.

Summary 5

1) After received the home interface reference, the client can call the create method to create an instance of the EJB component.
2) The client's stud object marshals the create parameters and send the message to the server.
3) The skeleton object in the server demarshals the message and delegate the invocation to the EJB Home object.
4) The EJB Home object then contacts the required services and create an EJB instance.
5) The skeleton and EJB object representing the EJB component are the instantiated.
6) The reference of the EJB object is passed back to the client and a stud for the EJB object is instantiated in the client.

Vertical Concepts

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary

2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary

3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

Session Beans

Session beans characteristics:

1) should be used for short requests
2) require low resource costs and promotes fast response back to the client
3) are not persistent and do not survive application server or machine crashes
4) usually act as agents to the client and control process flow

Types of Session Beans

There are two types of session beans:

1) Stateless session beans
   a) model single request business process
   b) no conversational state to be maintained across methods
   c) consume less resources and efficiently managed by the container

2) Stateful session beans
   a) conversational state are maintained by the container
   b) less efficient than stateless session beans

Stateless Session Bean

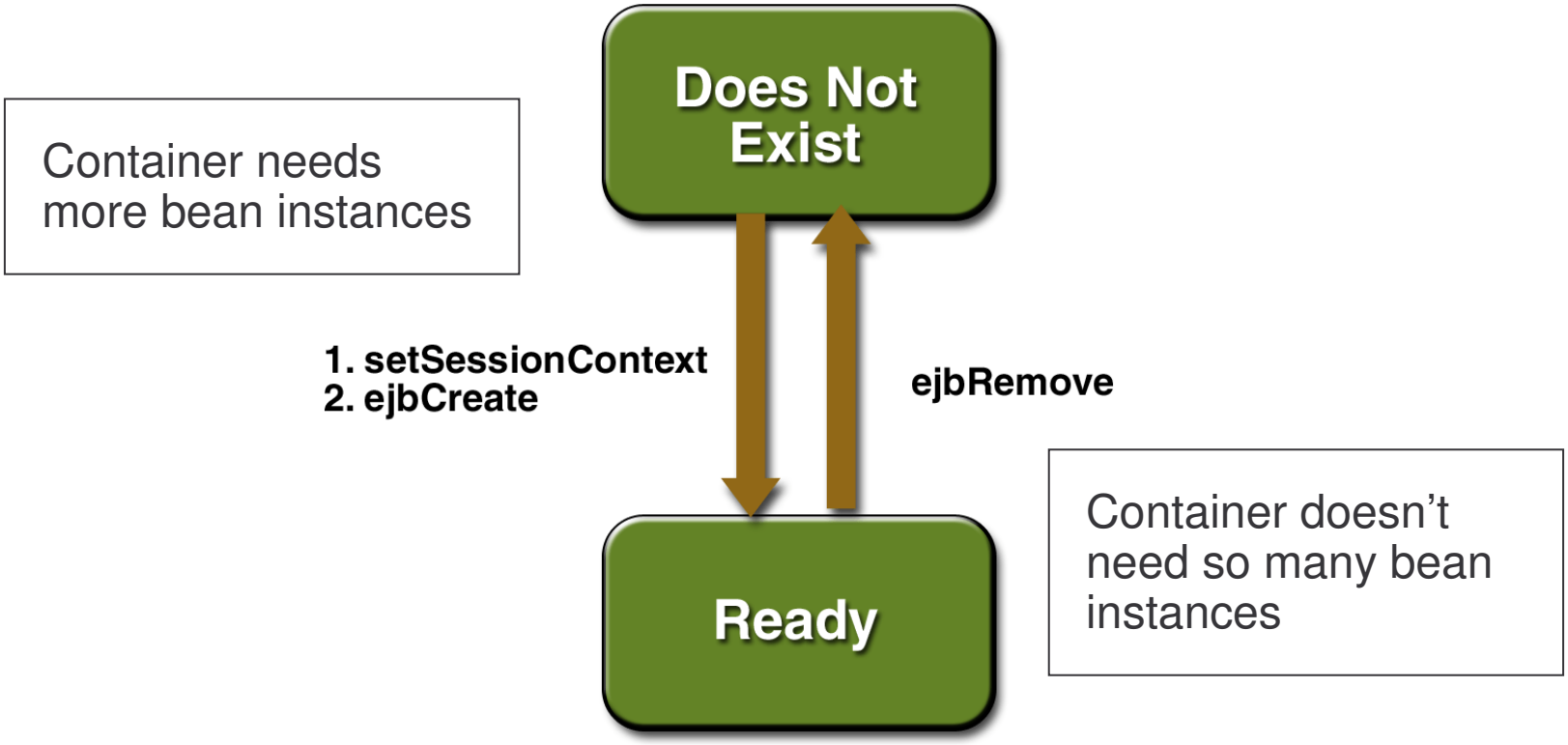
A stateless session bean is a bean that holds conversations that span a single method call.

After each method call, the container may choose to destroy, recreate or clearing the stateless session bean out of all information.

Data must be provided as parameters or retrieved from external sources, such as a database.

Example: shopping catalogue

Life Cycle: Stateless Session Bean



Task 7: Stateless Session Bean

1) Create and deploy a stateless session bean named `HolidayCalander`.
   a) Follow the example from task 2 to task 6 to create the necessary files for this session bean.
   b) Create a business method named "`isHoliday`" for this bean. This method checks if the input date is Saturday or Sunday and return a boolean value.

Task 8: Stateless Session Bean

c) The implementation of this method may as follows:

```
public boolean isHoliday(Date date){
    Calendar cal = Calendar.getInstance();
    cal.setTime(date);
    int dayOfWeek = cal.get(Calendar.DAY_OF_WEEK);
    if (dayOfWeek==Calendar.SATURDAY ||
      dayOfWeek==Calendar.SUNDAY)
          return true;
    return false;
}
```

2) Deploy this bean as a stateless session bean.

3) Create a client to test the stateless session bean.

Stateful Session Bean

A stateful session bean is a bean that is designed to service business processes that span multiple method requests or transactions.

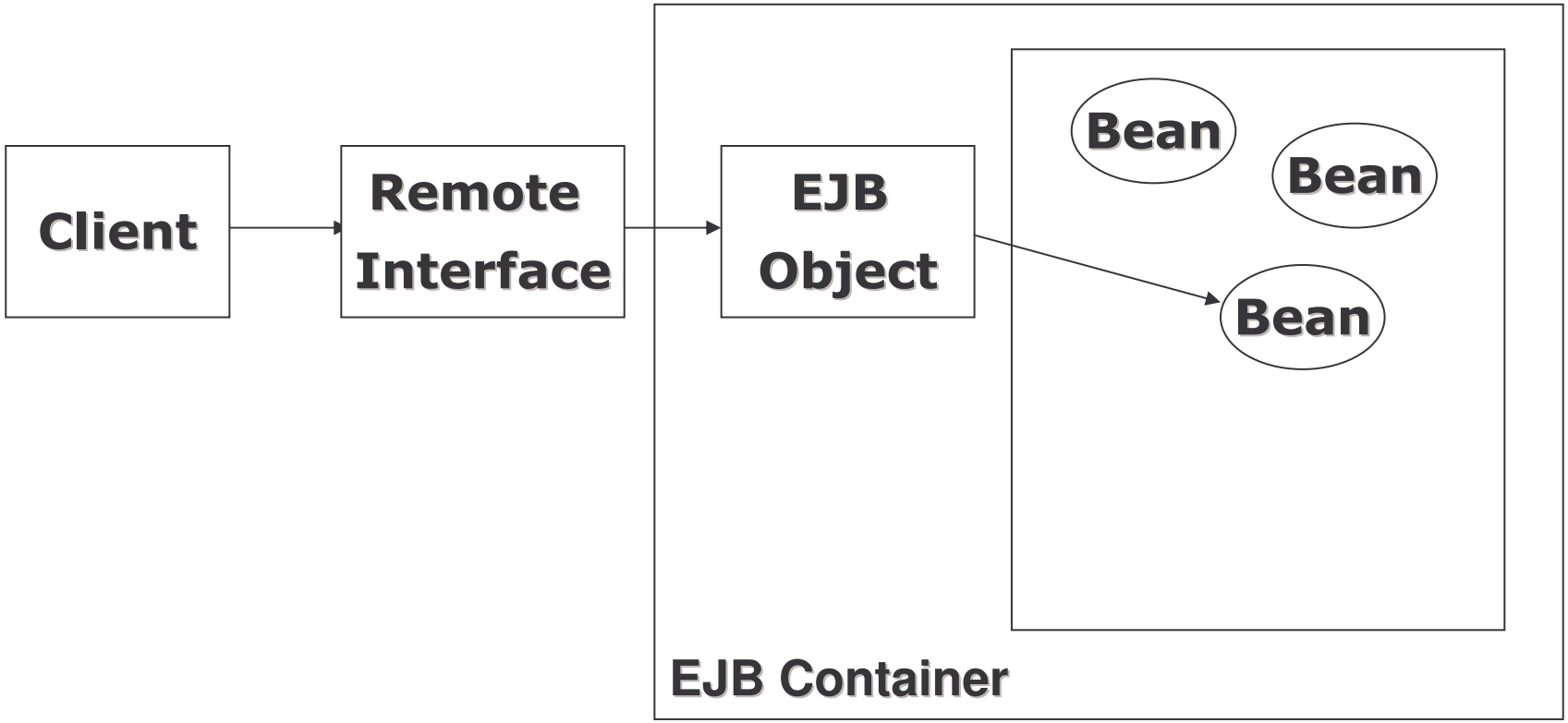
Stateful session beans retain state on behalf of an individual client.

Example: online shopping cart

Each time the user adds a product to the shopping cart, another request will be performed. The components must track the user's state (such as a shopping cart state) from request to request.

Pooling: Stateless Session Bean

Since a stateless session bean retains no state knowledge about its history, stateless session beans can be pooled, reused, and swapped from one client to another client on each method call.



Pooling: Stateful Session Bean

As the state of each stateful session bean has to be retained, how could the pooling be achieved?

`EJB` container achieves this by passivation.

Passivation allows container to swap out the state of an `EJB` from the memory to another storage such as the hard disk.

EJB Passivation

`EJB` is passivated according to container-specific algorithm and usually the least recently called bean will be passivated.

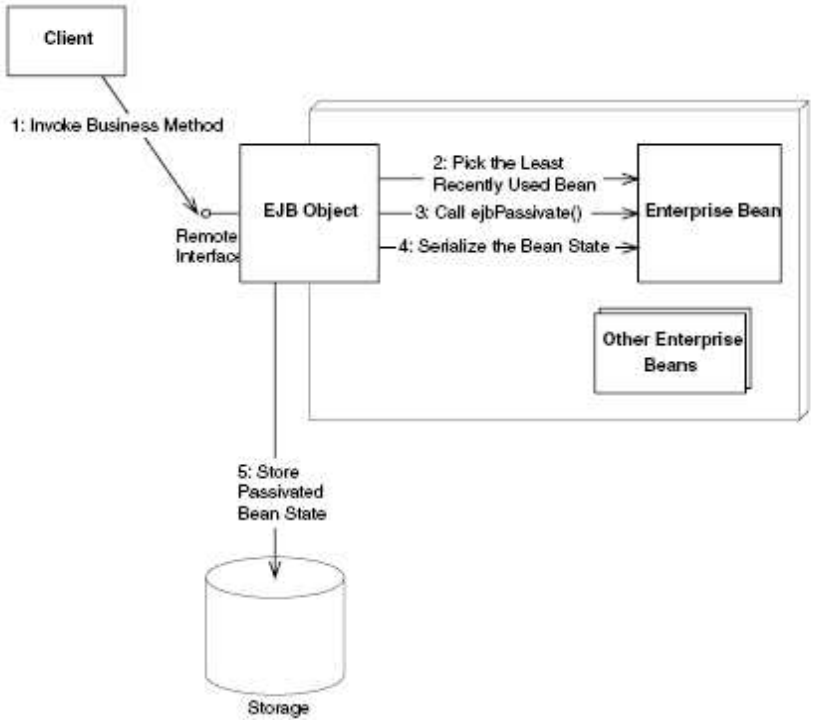
When the passivated bean is activated again, its states will be restored from the storage to memory again.

Passivation: Stateful Session Bean

Typical stateful session bean passivation:

a) The client has invoked a method on an `EJB` object that does not have a bean tied to it in memory.

b) The container's limit of beans is reached. Thus the container needs to passivate a bean before handling this client's request.

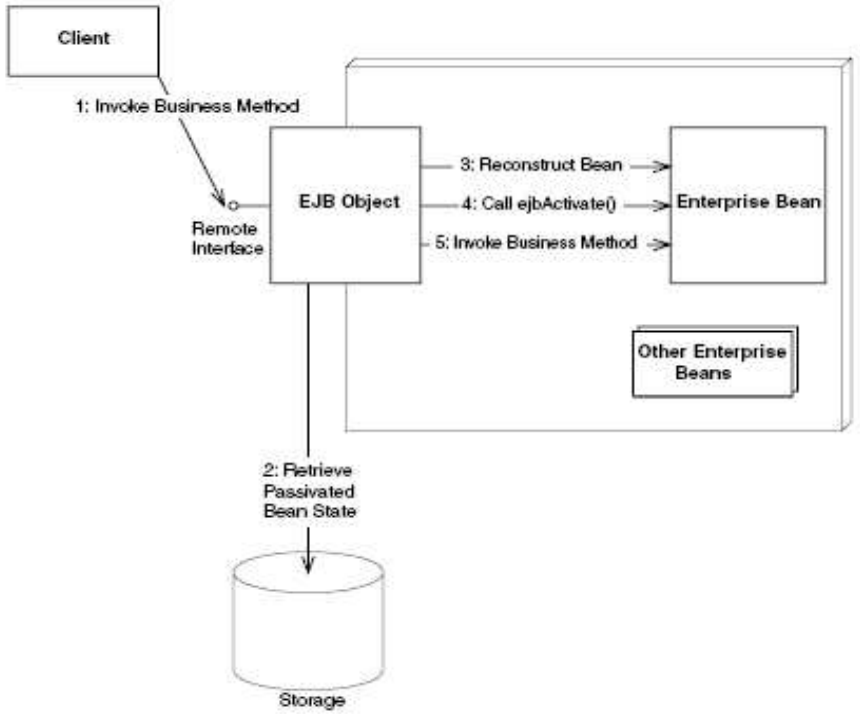


Activation: Stateful Session Bean

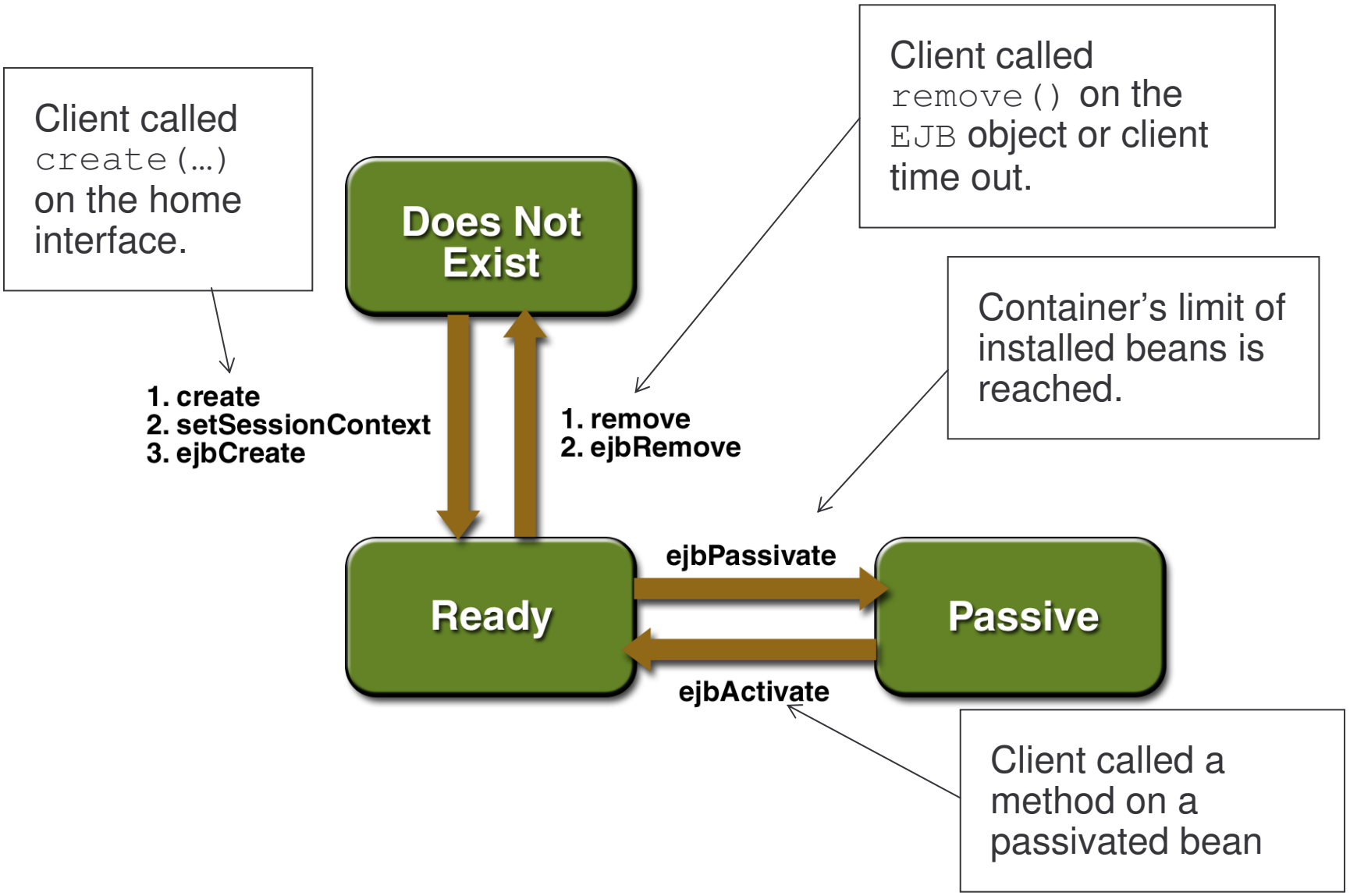
Typical stateful session bean activation :

a) The client has invoked a method on an `EJB` object whose stateful bean had been passivated.

b) The container retrieves the passivated data and reconstruct the bean state.



Life Cycle: Stateful Session Bean



Task 9: Passivation

1) Investigate the passivation and activation process of stateful session bean.
   a) Create a stateful session bean call `CountBean`. It has an integer member variable `"val"`.
   b) The bean should have a method named "`count`" as follows:

```
public int count() {
      System.out.println("count()");
       return ++val;
}
```

   c) Follow the `HelloBean` example to create the necessary interfaces for this session bean.
   d) The `ejbCreate` method in the `CountBean` class takes an integer as an argument and set its value to variable `val`. Create the corresponding `create` method in the home interface to accommodate this.

Task 10: Passivation

e) Modify the deployment descriptor file, `ejb-jar.xml`, to decorate the bean as a stateful session bean as follows:
`<session-type>Stateful</session-type>`

f) Choose your own ejb-name for this bean.

g) In order to observe the passivation and activation process, configuration the server to minimize the total number of beans in memory. For `jboss`, modify the `jboss.xml` file as follows:

```
<!DOCTYPE ...>
<jboss>
  <enterprise-beans>
    <session>
      <ejb-name>...</ejb-name>
      <jndi-name>...</jndi-name>
```

Task 11: Passivation

```
        <configuration-name>
            StatefulDemo
        </configuration-name>
      </session>
    </enterprise-beans>
  <container-configurations>
      <container-configuration
        extends="Standard Stateful SessionBean">
        <container-name>StatefulDemo</container-name>
          <container-cache-conf>
            <cache-policy>
    org.jboss.ejb.plugins.LRUStatefulContextCachePolicy
            </cache-policy>
          <cache-policy-conf>
```

Task 12: Passivation

```
            <min-capacity>1</min-capacity>
            <max-capacity>1</max-capacity>
         </cache-policy-conf>
      </container-cache-conf>
   </container-configuration>
  </container-configurations>
</jboss>
```

Task 13: Passivation

h) Deploy the bean in `JBoss`.

i) Create a client called `CountClient` to test the `EJB` according to the following steps:

1. Get system properties for `JNDI`.
2. Get reference for the home object.
3. Create an array to hold 3 `Count EJB` objects.
4. Create and initialize them as follows:

```
for (int i=0; i < 3; i++) {
        count[i] = home.create(countVal);
        // Add 1 and print
        countVal = count[i].count();
        System.out.println(countVal);
        // Sleep for 1/2 second
        Thread.sleep(500);
    }
```

Task 14: Passivation

5. Call the `count()` method on each `EJB` object and remove them when finished:

```
System.out.println("Calling count() on
beans . . . ");
      for (int i=0; i < 3; i++) {
        // Add 1 and print
         countVal = count[i].count();
       System.out.println(countVal);
        // Sleep for 1/2 second
        Thread.sleep(500);
      }
      // Done with EJB Objects, remove them
        for (int i=0; i < 3; i++) {
              count[i].remove();
          }
```

Task 15: Passivation

j) Observe the output from both the client and server side. What conclusion can you make from the output about the passivation and activation process?

Summary 1

Session beans has the following characteristics:

1) should be used for short requests
2) require low resource costs and promotes fast response back to the client
3) are not persistent and do not survive application server or machine crashes
4) usually act as agents to the client and control process flow

Summary 2

There are two types of session beans:

1) Stateless session beans
    a) model single request business process
    b) no conversational state to be maintained across methods
    c) consume less resources and efficiently managed by the container

2) Stateful session beans
    a) conversational state are maintained by the container
    b) less efficient than stateless session beans

Summary 3

Each EJB class instance is single threaded.

Stateless session beans can be pooled, reused, and swapped from one client to another client on each method call.

Stateful session beans achieve the pooling effect through a mechanism called passivation.

During passivation, the container swaps out the state of an `EJB` from the memory to another storage such as the hard disk.

The state of the `EJB` is recovered through activation.

Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary

2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary

3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

Entity Bean

What is an `Entity Bean`?

a) An `Entity Bean` represents business data stored in a database.

b) Database data types are converted into Java data types and encapsulated into the `Entity Bean`.

c) Modifying the in-memory value of an `Entity Bean` can change the values of data, saved back into storage again and updating the database data.

Entity Bean Characteristics

1) contains the standard set of files for `EJB` components
2) each `Entity` beans must have a **serializable** primary key
3) primary key can either be a Java class (primary key class) or primitive type pointing to a unique record in the database
4) container will take care the in-memory object synchronization with the underlying data storage
5) can live past the duration of a client's session

Example: shopping order

Primary Key

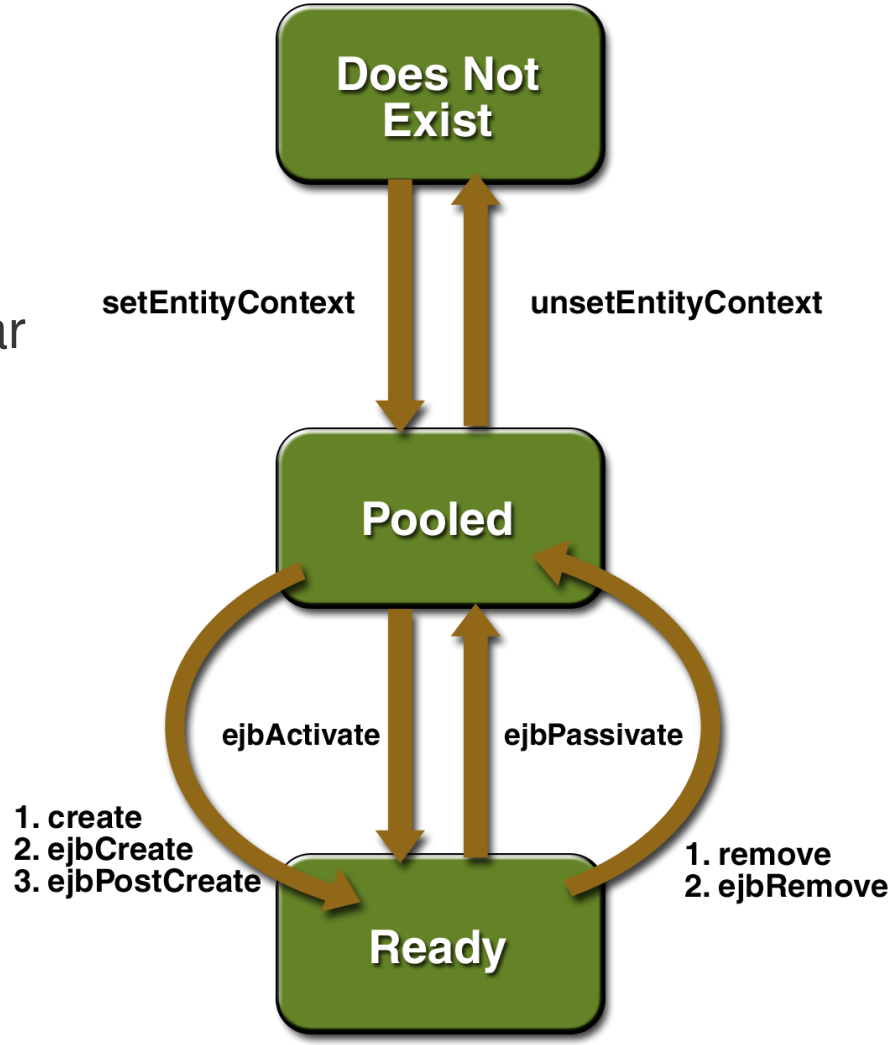
Primary key is a unique identifier for an entity bean instance.

An entity bean instance has no identity unless it's primary key is stored in an `EJBObject`.

Life Cycle: Entity Bean

Instances in the pool are:

1) identical
2) not associated with any particular object identity
3) `EJB` container may assign an identity to an instance when moving it to the ready stage invoking the `ejbActivate` method



Operations

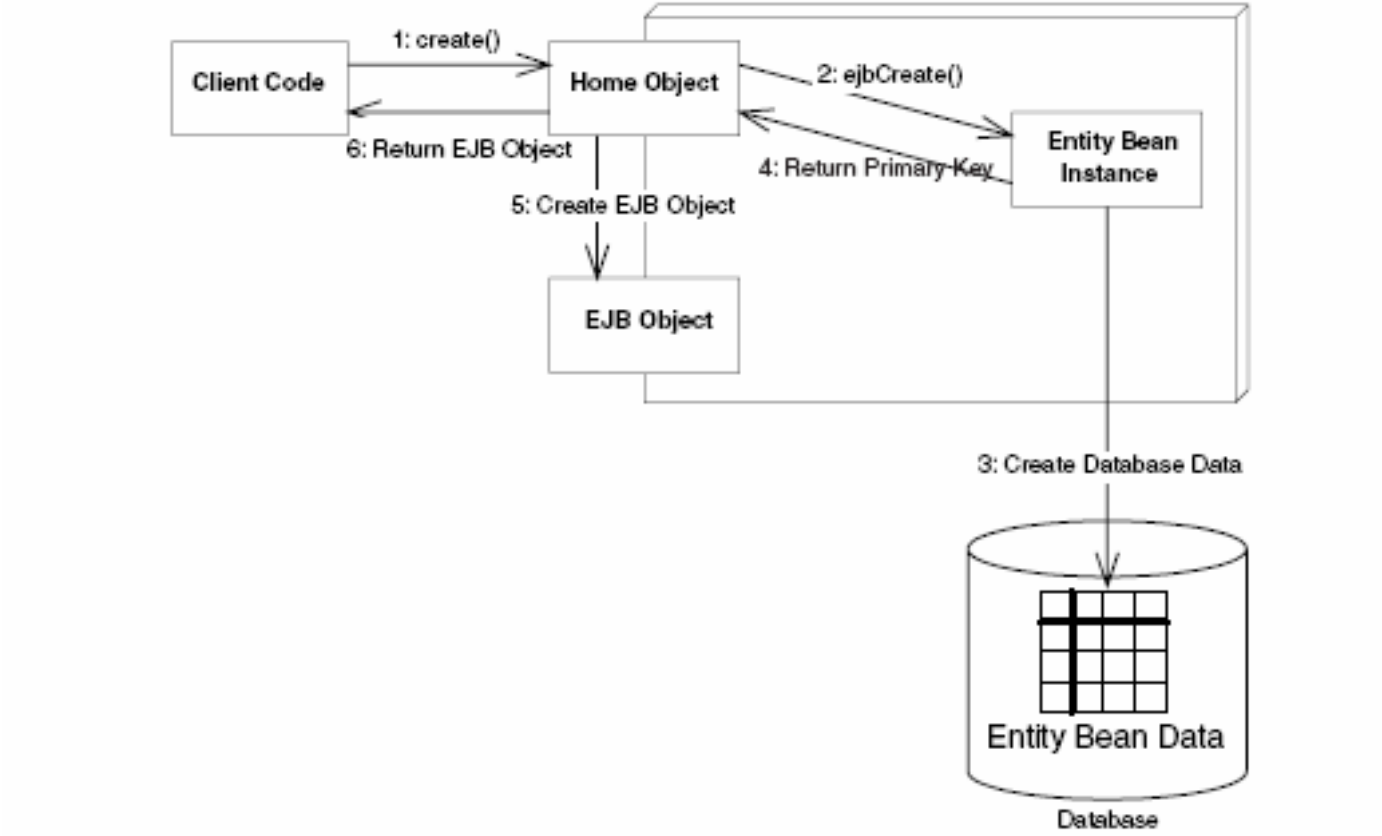
J2EE defines specific methods for entity beans operations:

- ejbCreate
- ejbFind
- ejbHome
- ejbLoad
- ejbStore
- ejbRemove

Creating Entity Bean 1

1) A client calls the home object's `create`() method, which delegates to the entity bean's `ejbCreate`().
2) New record is created in the underlying data base.
3) A bean instance is also generated through the home object.
4) The bean returns a primary key to the container (that is, to the home object) so that the container can identify the bean.
5) Once the home object has this primary key, it can then generate an `EJB` object and return that to the client.

Creating Entity Bean 2



Finding Existing Entity Beans

Finder method is a special type of method for finding existing bean in storage.

Rules for finder methods:

a) Finder methods must begin with `ejbFind`.

b) At least one finder method named, `ejbFindByPrimaryKey`, must be included.

c) Finder methods with different names and parameters can be defined.

d) The return types can either be a primary key or a collection of primary keys.

e) For each finder method defined in the bean, a corresponding finder method must be defined in the home interface.

Home Method

A special business method called home method can be defined in the entity bean class to provide global operations such as counting the total number of records.

This method does not depend on any specific data.

Home method must be defined as `ejbHomeXXX` in the bean class and a corresponding method, named `XXX`, should be declared in the home interface.

For example,
in `EJB` class: `ejbHomeGetAllAccount()`
in home interface: `getAllAccount()`

Loading and Storing Entity Bean

Multiple in-memory entity bean representing the same data can exist within a Java Virtual Machine.

Mechanism must be available to transfer data between the bean and database.

`ejbLoad` method and `ejbStore` methods are routinely called by the container to be synchronized with the database.

`ejbLoad()`: loads data from database into the entity bean.

`ejbStore()`: saves data from entity bean to database.

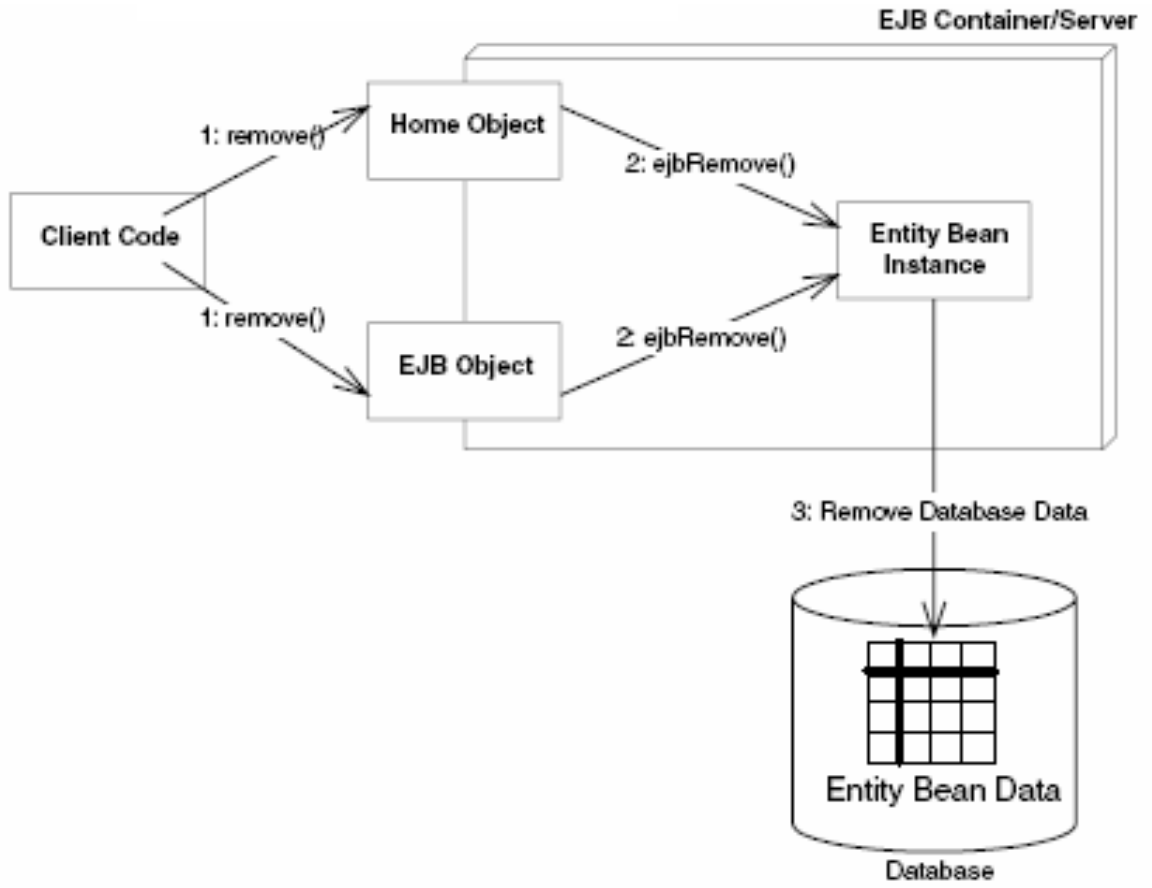
Destroying Entity Bean 1

1) Client calls the `remove()` method on either the home object or the `EJB` object.
2) The container will issue an `ejbRemove()` method call on the entity bean instance.
3) Note that `ejbRemove()` destroys only database data but not the in-memory entity bean instance.

Remarks:

a) The bean instance can be recycled to handle a different database data instance.
b) The `ejbRemove()` method will not be called if the client times out.

Destroying Entity Bean 2



Types of Persistence 1

There are two ways to persist an Entity Bean:

1) Bean-Managed Persistence (`BMP`)
   a) Should be used for complex relationships such as data from different databases or resources from legacy systems.
   b) Developer needs to provide all of the code for managing persistence between the object and the database.
   c) Any changes in the database or in the structure of data require changes to the bean instance's definition.

Types of Persistence 2

2) Container-Managed Persistent (CMP)
   a) The Container will handle reading data from storage to bean instance and writing data from bean to storage updating database records.
   b) Bean developer can then focus on the data and the business process.
   c) Should be used to handle simple relationships with the database.
   d) CMP entity bean is an in-memory Java representation of persistent data.

Bean-Managed Persistence

When writing the Bean-Managed Persistence (BMP)entity bean, one must provide data access logic.

Database API such as JDBC can be used to map the entity bean instances to and from storage.

BMP: ejbFind Method

The container will not implement the finder methods in `BMP` Entity Bean.

The `ejbFindByPrimaryKey` method must be implemented in the bean by the bean developer.

BMP: getPrimaryKey Method 1

This method retrieve the primary key associated with the entity bean instance.

For example, used in the `BMP ejbLoad` method as follows:

```
protected EntityContext ctx;
. . .
public void setEntityContext(EntityContext ctx){
this.ctx = ctx;
}
. . .
```

BMP: getPrimaryKey Method 2

```
. . .
public void ejbLoad(){
/* 1. acquire the primary key such as:
*  AccountPK accPk = (AccountPK) ctx.getPrimaryKey();
*  2. acquire database connection
*  3. execute sql statement to extract data
*     corresponding to the primary key
*  4. restore the variables with data obtained from
*     database.
*/
```

Task 16: BMP Entity Bean

1) Build and deploy a `BMP` entity bean. This bean is called `AccountBean` which represents the account of a customer in a bank.
   a) Write a remote interface, `Account`, which extends `EJBObject` and defines the following business methods:

```
public void deposit(double amt) throws
AccountException, RemoteException;
public void withdraw(double amt) throws
AccountException, RemoteException;
```

   b) Define the getter/setter methods on `Entity Bean` fields: `double balance`, `String ownerName` and `accountID`.
   c) Define an Exception, `AccountException`, for the business methods.

Task 17: BMP Entity Bean

d) Write the home interface, `AccountHome`, for the `AccountBean`. This interface should define the following methods:

```
package com.interfaces;

import javax.ejb.*;
import java.util.Collection;
import java.rmi.RemoteException;
public interface AccountHome extends EJBHome {
```

Task 18: BMP Entity Bean

```
/*
* create method which creates a new account in
* database representing a bank account. It
* returns an EJB object to the client.
* Notice that application-level Exception
* CreateException must be thrown.
*/
Account create(String accountID, String
   ownerName) throws
CreateException, RemoteException;
```

Task 19: BMP Entity Bean

```
/**
* Finds an Account by its primary Key
* (AccountID)
*/
public Account findByPrimaryKey(AccountPK key)
   throws
FinderException, RemoteException;
/**
* Finds all Accounts under an owner's name
*/
public Collection findByOwnerName(String name)
   throws
FinderException, RemoteException;
```

Task 20: BMP Entity Bean

```
/**
* This home business method is independent of
*any particular account. It returns the total
*of all accounts in the bank.
*/
public double getTotalBankValue() throws
   AccountException, RemoteException;
}
```

Note : Because we're using bean-managed persistence, we need to implement the finder methods in our entity bean implementation.

If we were using container-managed persistence, the container would search the database for us.

Task 21: BMP Entity Bean

e) Write the primary key class called `AccountPK` as follows:

```
package com.interfaces;
import java.io.Serializable;
/**
* Primary Key class for Account.
*/
public class AccountPK implements
   java.io.Serializable {
   public String accountID;
   public AccountPK(String id) {
   this.accountID = id;
   }
   public AccountPK() {}
```

Task 22: BMP Entity Bean

```
        public String toString() {
            return accountID;
        }
        public int hashCode() {
            return accountID.hashCode();
        }
        public boolean equals(Object account) {
            return
            ((AccountPK)account).accountID.equals
            (accountID);
        }
    }
```

Task 23: BMP Entity Bean

Note :

1. Entity beans may map to more than one table and can have primary key class having several fields, each representing the primary key of a table in the database.
2. A `toString()` method is required for the container to retrieve a `String` value of this primary key.
3. A `hashCode()` method is required as the primary key class allowing the container to store a list of all entity beans in a `Hashtable` or similar structure.
4. An `equal()` method allows the container to be sure that a single record is not represented by two entity bean.

Task 24: BMP Entity Bean

f) Write the bean class called `AccountBean`, which has to implement `javax.ejb.EntityBean` interface. This interface defines the required methods that your entity bean class must implement and look like the follows:

```
public interface javax.ejb.EntityBean extends
javax.ejb.EnterpriseBean {
  public void
     setEntityContext(javax.ejb.EntityContext) ;
  public void unsetEntityContext();
  public void ejbRemove();
  public void ejbActivate();
  public void ejbPassivate();
  public void ejbLoad();
  public void ejbStore();
}
```

Task 25: BMP Entity Bean

g) The actual bean class may look as follows:

```
package com.ejb;

import java.sql.*;
import javax.naming.*;
import javax.ejb.*;
import java.util.*;
public class AccountBean implements EntityBean
{
  // declare a variable for the Context object
   protected EntityContext ctx;
```

Task 26: BMP Entity Bean

```
// Bean-managed state fields

private String accountID; // Primary Key
private String ownerName;
private double balance;
public AccountBean() {
   System.out.println
        ("New Bank Account Entity Bean Java
           Object created by EJB Container.");
}
```

Task 27: BMP Entity Bean

```
// Business Logic Methods

/**
* Deposits amt into account.
* Transaction is not being taken care yet.
*/
public void deposit(double amt) throws
   AccountException {
      System.out.println("deposit(" + amt + ")
        called.");
           balance += amt;
}
```

Task 28: BMP Entity Bean

```
// Withdraws from bank account.
// Transaction is not being taken care yet.

public void withdraw(double amt) throws
   AccountException {
   System.out.println("withdraw(" + amt + ")
   called.");
   if (amt > balance) {
        throw new AccountException("Your
        balance is " + balance + "! You cannot
        withdraw " + amt + "!");
   }
   balance -= amt;
}
```

Task 29: BMP Entity Bean

```
// Getter/setter methods on Entity Bean fields
// For examples:
public double getBalance() {
        System.out.println("getBalance()
   called.");
    return balance;
}
public void setOwnerName(String name) {
   System.out.println("setOwnerName()
   called.");
   ownerName = name;
}
```

Task 30: BMP Entity Bean

```
public String getOwnerName() {
   System.out.println("getOwnerName()
   called.");
   return ownerName;
}

 //...please implement the rest of the methods
 //and make each method has a statement
 //printing out which method is running.
```

Task 31: BMP Entity Bean

```
// Gets JDBC connection from the connection pool.
public Connection getConnection() throws Exception {
 try {
    Context ctx = new InitialContext();
    javax.sql.DataSource ds = (javax.sql.DataSource)
    ctx.lookup("java:/DefaultDS");
         return ds.getConnection();
 }catch (Exception e) {
   System.err.println("Couldn't get datasource!");
  e.printStackTrace();
  throw e;
 }
}
```

Task 32: BMP Entity Bean

```
/*
* This home business method is independent of any
* particular account instance. It returns the total
* of all the bank accounts in the bank.
*/
public double ejbHomeGetTotalBankValue() throws
        AccountException
{
  PreparedStatement pstmt = null;
  Connection conn = null;
  try {
   System.out.println("ejbHomeGetTotalBankValue()");
// Acquire DB connection
        conn = getConnection();
```

Task 33: BMP Entity Bean

```
// Get the total of all accounts
pstmt = conn.prepareStatement(
"select sum(balance) as total from accounts");
ResultSet rs = pstmt.executeQuery();
   // Return the sum
    if (rs.next()) {
       return rs.getDouble("total");
    }
}
catch (Exception e) {
      e.printStackTrace();
   throw new AccountException(e);
}
```

Task 34: BMP Entity Bean

```
finally {
//  Release DB Connection for other beans
        try { if (pstmt != null) pstmt.close(); }
            catch (Exception e) {}
        try { if (conn != null) conn.close(); }
            catch (Exception e) {}
}
        throw new AccountException("Error!");
}
```

Task 35: BMP Entity Bean

```
public void ejbActivate() {
 System.out.println("ejbActivate() called.");
}

/* Another method that use the getPrimaryKey method
 * to retrieve the primary key
*/
public void ejbRemove() throws RemoveException {
 System.out.println("ejbRemove() called.");
 AccountPK pk = (AccountPK) ctx.getPrimaryKey();
 String id = pk.accountID;
 PreparedStatement pstmt = null;
 Connection conn = null;
```

Task 36: BMP Entity Bean

```
try {
 /*
 * 1) Acquire a new JDBC Connection
 */
 conn = getConnection();
/*
* 2) Remove account from the DB
*/
pstmt = conn.prepareStatement(
"delete from accounts where id = ?");
pstmt.setString(1, id);
```

Task 37: BMP Entity Bean

```
      /*
      * 3) Throw a system-level exception if something
      * bad happened.
      */
      if (pstmt.executeUpdate() == 0) {
        throw new RemoveException(
         "Account " + pk +
         " failed to be removed from the database");
      }
  } catch (Exception ex) {
          throw new EJBException(ex.toString());
  }
```

Task 38: BMP Entity Bean

```
    finally {
       /*
       * 4) Release the DB Connection
       */
       try { if (pstmt != null) pstmt.close(); }
        catch (Exception e) {}
       try { if (conn != null) conn.close(); }
        catch (Exception e) {}
       }
    }
```

Task 39: BMP Entity Bean

```
public void ejbPassivate() {
  System.out.println("ejbPassivate () called.");
}

/**
* Called by the container. Updates the in-memory
* entity
* bean object to reflect the current value stored in
* the database.
*/
public void ejbLoad() {
 System.out.println("ejbLoad() called.");
 AccountPK pk = (AccountPK) ctx.getPrimaryKey();
 String id = pk.accountID;
```

Task 40: BMP Entity Bean

```
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  conn = getConnection();
  pstmt = conn.prepareStatement(
    "select ownerName, balance from accounts "
     + "where id = ?");
   pstmt.setString(1, id);
 ResultSet rs = pstmt.executeQuery();
 rs.next();
 ownerName = rs.getString("ownerName");
 balance = rs.getDouble("balance");
}
```

Task 41: BMP Entity Bean

```
  catch (Exception ex) {
   throw new EJBException( "Account " + pk
     + " failed to load from database", ex);
  }
  finally {
  /*
  * 3) Release the DB Connection
  */
      try { if (pstmt != null) pstmt.close(); }
      catch (Exception e) {}
      try { if (conn != null) conn.close(); }
      catch (Exception e) {}
  }
}
```

Task 42: BMP Entity Bean

```
/**
* Called from the Container. Updates the database
* to reflect the current values of this in-memory
* entity bean instance.
*/
public void ejbStore() {
 System.out.println("ejbStore() called.");
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  conn = getConnection();
  pstmt = conn.prepareStatement(
    "update accounts set ownerName = ?, balance = ?"
    + " where id = ?");
```

Task 43: BMP Entity Bean

```
      pstmt.setString(1, ownerName);
      pstmt.setDouble(2, balance);
      pstmt.setString(3, accountID);
      pstmt.executeUpdate();
    }
     catch (Exception ex) {
      throw new EJBException( "Account " + accountID
      + " failed to save to database", ex);
    }
```

Task 44: BMP Entity Bean

```
    finally {
          //Release the DB Connection
          try { if (pstmt != null) pstmt.close(); }
          catch (Exception e) {}
          try { if (conn != null) conn.close(); }
         catch (Exception e) {}
      }
    }
```

Task 45: BMP Entity Bean

```
public void setEntityContext(EntityContext ctx) {
 System.out.println("setEntityContext called");
 this.ctx = ctx;
}
public void unsetEntityContext() {
 System.out.println("unsetEntityContext called");
 this.ctx = null;
}
```

Task 46: BMP Entity Bean

```
/**
* Called after ejbCreate(). Now, the Bean can
* retrieve
* its EJBObject from its context, and pass it as
* a 'this' argument.
*/
public void ejbPostCreate(String accountID, String
   ownerName) {
}
```

Task 47: BMP Entity Bean

```
public AccountPK ejbCreate(String accountID, String
   ownerName) throws CreateException {
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
  System.out.println("ejbCreate() called.");
  this.accountID = accountID;
  this.ownerName = ownerName;
  this.balance = 0;
  conn = getConnection();
```

Task 48: BMP Entity Bean

```
        pstmt = conn.prepareStatement(
        "insert into accounts (id, ownerName, balance)"
        + " values (?, ?, ?)");
        pstmt.setString(1, accountID);
        pstmt.setString(2, ownerName);
        pstmt.setDouble(3, balance);
        pstmt.executeUpdate();

        return null;
    }
```

Task 49: BMP Entity Bean

```
    catch (Exception e) {
      throw new CreateException(e.toString());
    }
    finally {
    /*
    * Release DB Connection for other beans
    */
     try { if (pstmt != null) pstmt.close(); }
     catch (Exception e) {}
     try { if (conn != null) conn.close(); }
     catch (Exception e) {}
    }
}
```

Task 50: BMP Entity Bean

```
/**
* Finds a Account by its primary Key
*/
public AccountPK ejbFindByPrimaryKey(AccountPK
 key) throws FinderException {
 PreparedStatement pstmt = null;
 Connection conn = null;
 try {
   System.out.println("ejbFindByPrimaryKey("
   + key + ") called");
   conn = getConnection();
   pstmt = conn.prepareStatement(
```

Task 51: BMP Entity Bean

```
        "select id from accounts where id = ?");
        pstmt.setString(1, key.toString());
        ResultSet rs = pstmt.executeQuery();
        rs.next();
        return key;
        }
        catch (Exception e) {
        throw new FinderException(e.toString());
        }
        finally {
         // Release DB Connection for other beans
         . . .
        }
    }
```

Task 52: BMP Entity Bean

```
public Collection ejbFindByOwnerName(String name)
 throws FinderException {
  PreparedStatement pstmt = null;
  Connection conn = null;
  Vector v = new Vector();
  try {
    System.out.println(
     "ejbFindByOwnerName(" + name + ") called");
      conn = getConnection();
      pstmt = conn.prepareStatement(
     "select id from accounts where ownerName = ?");
     pstmt.setString(1, name);
     ResultSet rs = pstmt.executeQuery();
```

Task 53: BMP Entity Bean

```
      // Insert every primary key found into a vector
      while (rs.next()) {
        String id = rs.getString("id");
        v.addElement(new AccountPK(id));
      }
     return v;
    } catch (Exception e) {
     throw new FinderException(e.toString());
    } finally {
     // Release DB Connection for other beans
     . . .
    }
  }
}
```

Task 54: BMP Entity Bean

g) Before you can test your ejb, you need to set up the data source in `JBoss`. `JBoss` comes with the `hsqldb` database server .To enable it, edit `c:\jboss\server\default\deploy\hsqldb-ds.xml`.

Uncomment the `<connection-url>` element that connects to the localhost using `TCP`:

```
<datasources>
   <local-tx-datasource>
        ...
```

Task 55: BMP Entity Bean

```
        <connection-url>
              jdbc:hsqldb:hsql://localhost:1701
        </connection-url>
           ...
    </local-tx-datasource>
     ...
</datasources>
```

Task 56: BMP Entity Bean

h) In the file `hsqldb-ds.xml`, the `<mbean>` element for the `hsqldb TCP` connection should not be commented out for TCP based connection:

```
<datasources> . . .
<mbean
   code="org.jboss.jdbc.HypersonicDatabase"
name="jboss:service=Hypersonic">
<attribute name="Port">1701</attribute>
<attribute name="Silent">true</attribute>
<attribute name="Database">default</attribute>
<attribute name="Trace">false</attribute>
<attribute
   name="No_system_exit">true</attribute>
</mbean>
</datasources>
```

Task 57: BMP Entity Bean

i) Restart `JBoss` if it is running.

j) The `hsqldb-ds.xml` also defines the `JNDI` name for the data source as "`DefaultDS`" (this name should be used along with a "`java:/`" prefix in your `EJB` to get the connection). In the `getConnection ()` method of the `AccountBean` class, we use "`java:/DefaultDS`".

k) In order to create the database, open the `JBoss JMX` console by typing this url, `http://localhost:8080/jmx-console/`, in your browser. Click on the link "service=Hypersonic" and then invoke the "`startDatabaseManager`" operation. This will launch the `hsqldb` manager. Input the `SQL` statement to create accounts table and then click the "Execute SQL statement" button.

l) Deploy your EJB with proper deployment descriptor files.

Task 58: BMP Entity Bean

m) The `ejb-jar.xml` may look as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
 <enterprise-beans>
  <entity>
   <ejb-name>Account</ejb-name>
   <home>examples.AccountHome</home>
   <remote>examples.Account</remote>
   <ejb-class>examples.AccountBean</ejb-class>
   <persistence-type>Bean</persistence-type>
   <prim-key-class>examples.AccountPK
   </prim-key-class>
```

Task 59: BMP Entity Bean

```
      <reentrant>False</reentrant>
    </entity>
  </enterprise-beans>
  <assembly-descriptor>
    <container-transaction>
      <method>
        <ejb-name>Account</ejb-name>
        <method-intf>Local</method-intf>
        <method-name>*</method-name>
      </method>
```

Task 60: BMP Entity Bean

```
      <method>
       <ejb-name>Account</ejb-name>
       <method-intf>Remote</method-intf>
       <method-name>*</method-name>
      </method>
      <trans-attribute>Required</trans-attribute>
    </container-transaction>
  </assembly-descriptor>
</ejb-jar>
```

Task 61: BMP Entity Bean

n) The vendor specific deployment descriptor, `jboss.xml` may look as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<jboss>
   <enterprise-beans>
        <entity>
            <ejb-name>Account</ejb-name>
            <jndi-name>AccountHome</jndi-name>
        </entity>
   </enterprise-beans>
</jboss>
```

o) Develop a client program to test the entity bean.

Task 62: Life Cycle of Entity Bean

1) There are two call back methods, `ejbLoad()` and `ejbStore()` declared within the `EntityBean` interface. What are their functions?
2) How many threads are allowed to run within a bean instance?
3) If entity bean is single-thread, a bean can only serve one client at a time. Will this create a performance bottleneck if many clients need to access the same account at the same time?
4) How does `J2EE` tackle the above performance problem?

Container Managed Persistence 1

No code is needed in the bean for accessing the database.

There is no fields declared in the bean class as `BMP` entity bean does.

The get/set methods of the bean class needs to be declared as abstract methods. This makes the bean class that we created has to be an abstract class.

The container will subclass the bean, implements the declared getter and setter methods to handle the persistence of the data.

Container Managed Persistence 2

The actual entity bean is a combination of the superclass and the subclass.

Links between beans are created using a structure called abstract schema.

Abstract Schema 1

Abstract schema is part of an entity bean's deployment descriptor.

Defines the bean's persistent fields and relationships.

The abstract schema in the deployment descriptor file (`ejb-jar.xml`) may defined as follows:

```
<cmp-version>2.x</cmp-version>
<abstract-schema-name>
          ProductBean
</abstract-schema-name>
<cmp-field>
    <field-name>productID</field-name>
</cmp-field>
```

Abstract Schema 2

```
<cmp-field>
   <field-name>productName</field-name>
</cmp-field>
<primary-field>productID</primary-field>
. . .
```

Note:

1) The cmp-field elements are the persistent field that the container will generate in the subclass.
2) The names of these fields must match the names of your abstract get/set methods, except the first letter is not capitalized.

EJB Query Language

EJB Query Language (EJB-QL) is an object-oriented SQL-like syntax for querying entity beans.

It contains a SELECT clause, a FROM clause, and an optional WHERE clause.

EJB-QL code is written in the deployment descriptor, and the container should be able to generate the corresponding database logic (such as SQL).

Please refer to the following link for the detail syntax of EJB-QL:

http://java.sun.com/j2ee/tutorial/1_3-fcs/doc/EJBQL.html

Example: EJB Query Language 1

EJB Query Language (`EJB-QL`) for a method `findBigAccount()` may look like the following:

```
SELECT OBJECT(a) FROM Account AS a WHERE a.balance
> ?1
```

In the deployment descriptor file, it may look as follows:

```
<query>
   <query-method>
      <method-name>findBigAccount</method-name>
         <method-params>
               <method-param>double</method-
param>
         </method-params>
    </query-method>
```

Example: EJB Query Language 2

```
  <ejb-ql>
        <![CDATA[SELECT OBJECT(a) FROM AccountBean
     AS a WHERE a.balance > ?1]]>
   </ejb-ql>
</query>
```

Example: EJB-QL 1

```
SELECT OBJECT(p) FROM Player p
```

Data retrieved: All players.

Finder method: `findall()`

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.position
 = ?1
```

Data retrieved: The players with the position specified by the finder method's parameter.

Finder method: `findByPosition(String position)`

Example: EJB-QL 2

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.position
 = ?1 AND p.name = ?2
```

Data retrieved: The players with the specified position and name.

Finder method: `findByPositionAndName(String position, String name)`

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.city = ?1
```

Data retrieved: The players whose teams belong to the specified city.

Finder method: `findByCity(String city)`

Example: EJB-QL 3

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.league = ?1
```

Data retrieved: The players that belong to the specified league.

Finder method: `findByLeague(LocalLeague league)`

```
SELECT DISTINCT OBJECT(p) FROM Player p, IN (p.teams) AS
 t WHERE t.league.sport = ?1
```

Data retrieved: The players who participate in the specified sport.

Finder method: `findBySport(String sport)`

Example: EJB-QL 4

```
SELECT OBJECT(p) FROM Player p WHERE p.teams IS EMPTY
```

Data retrieved: All players who do not belong to a team.

Finder method: `findNotOnTeam()`

```
SELECT DISTINCT OBJECT(p) FROM Player p WHERE p.salary
 BETWEEN ?1 AND ?2
```

Data retrieved: The players whose salaries fall within the range of the specified salaries.

Finder method: `findBySalaryRange(double low, double high)`

Example: EJB-QL 5

```
SELECT DISTINCT OBJECT(p1) FROM Player p1, Player p2
 WHERE p1.salary > p2.salary AND p2.name = ?1
```

Data retrieved: All players whose salaries are higher than the salary of the player with the specified name.

Finder method: `findByHigherSalary(String name)`

EJB-QL Versus SQL

With `EJB-QL`, one can traverse relationships between entity beans using a dot-notation.

For example:

```
SELECT o.customer FROM Order o
```

Advantages:

1) The bean providers only need know the relationships between beans but not the tables or columns;
2) The container handles the traversal of relationships declared in the deployment descriptors.

Aggregate Functions 1

Aggregate functions were not supported in EJB 2.0 EJB-QL.

In EJB 2.1 EJB-QL, the following aggregate functions are supported:

1) AVG: average value

```
SELECT AVG(o.quantity) FROM Order o
```

2) COUNT: total number of results

```
SELECT COUNT(c) FROM Customers WHERE c.payment
='VISA'
```

3) MAX: the largest value

```
SELECT MAX(e.salary) FROM Employees e WHERE
e.salarygrade = 'Z12'
```

Aggregate Functions 2

4) `MIN`: smallest value

```
SELECT MIN(e.salary) FROM Employees e WHERE
e.salarygrade = 'Z12'
```

5) `SUM`: sum of the valules

```
SELECT SUM(e.salary) FROM Employees e
```

EJB-QL: ORDER BY

The `ORDER BY` clause is supported by `EJB 2.1 EJB-QL`.

For example:

```
SELECT OBJECT(c) FROM Customers c ORDER BY c.name

SELECT OBJECT(c) FROM Customers c ORDER BY c.name ASC

SELECT OBJECT(c) FROM Customers c ORDER BY c.name DESC

SELECT OBJECT(o) FROM Order o ORDER BY o.quantity,
 o.totalcost
```

Select Method

Besides finder methods, `CMP` entity beans can have special select methods.

Select methods are declared as abstract methods using the naming convention `ejbSelect<`*`METHOD-NAME`*`>`.

`ejbSelect()` methods work like private query methods and are not exposed to end clients.

Example: Select Method 1

For example, one might define the following methods in the entity bean:

```
public abstract collection ejbSelectALLAccountBalance
() throws FinderException;


public double ejbHomeGetTotalBankValue(Long
accountNumber) throws Exception{
       Collection c =
this.ejbSelectAllAccountBalance();
      // Loop through the collection c and return the
sum
}
```

The selection is then defined by an `EJB-QL` query string in the deployment descriptor:

Example: Select Method 2

The selection is then defined by an EJB-QL query string in the deployment descriptor:

```
<query>
  <description>
    Method to find all account balance
  </description>
  <query-method>
    <method-name>
          ejbSelectALLAccountBalance
    </method-name>
  </query-method>
. . .
  <ejb-ql>![CDATA[SELECT a.balance FROM Account as
                a]]</ejb-ql>
</query>
```

Characteristics of Select Method

Select methods can perform fine-grained database operations without exposing to end clients.

Select methods can return entity beans, container-managed fields or a collection of container-managed fields.

EJB-QL for Select Method

Unlike finder methods, a select method may return persistent fields or other entity beans.

The `EJB-QL` for these kinds of return types may look as follows:

```
SELECT DISTINCT t.league FROM Player p, IN (p.teams) AS
 t WHERE p = ?1
```

Data retrieved: The leagues to which the specified player belongs.

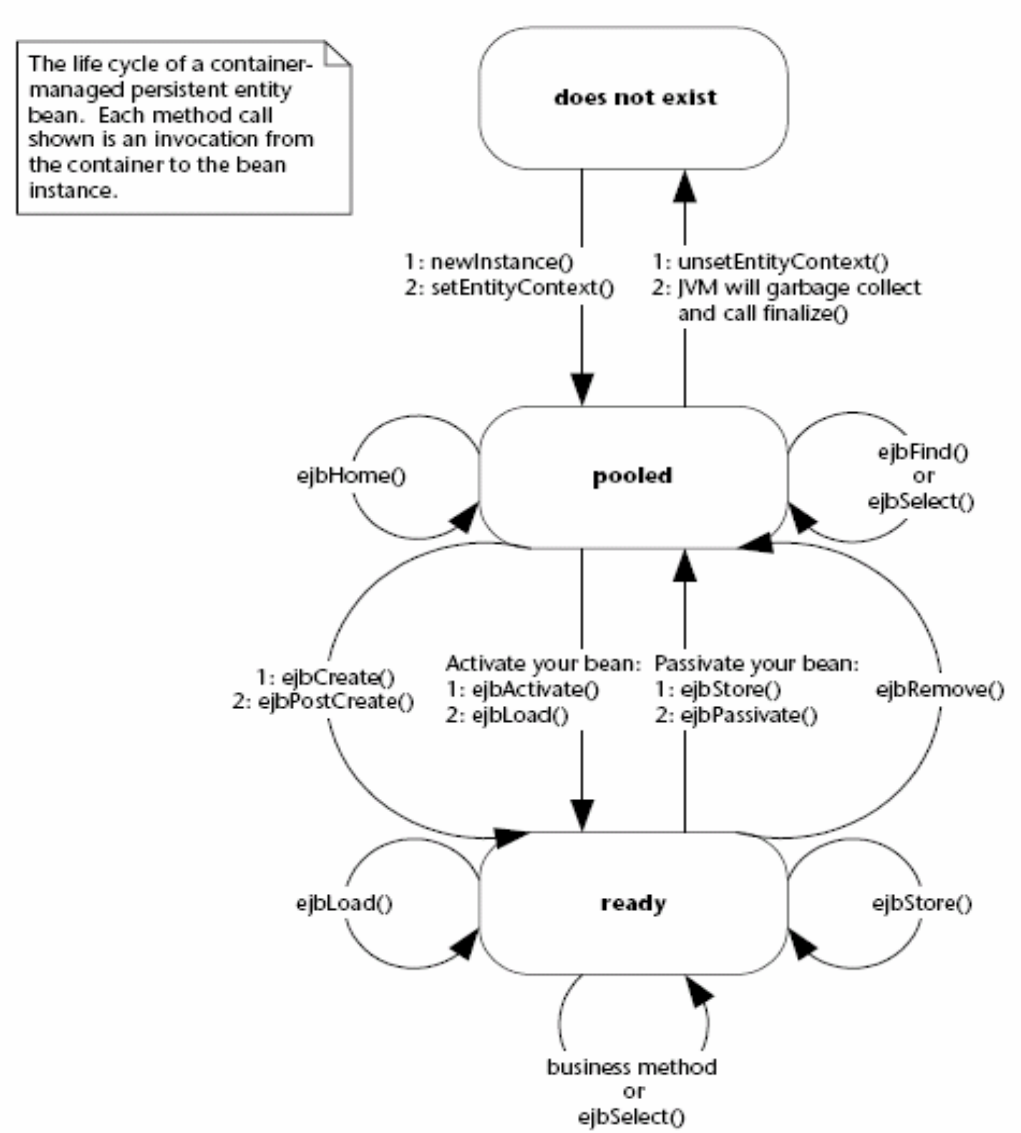
Select Method: `ejbSelectLeagues(LocalPlayer player)`

```
SELECT DISTINCT t.league.sport FROM Player p, IN
 (p.teams) AS t WHERE p = ?1
```

Data retrieved: The sports that the specified player participates in.

Select Method: `ejbSelectSports(LocalPlayer player)`

Life Cycle of CMP Entity Bean



Task 63: CMP Entity Bean

1) Build and deploy a `CMP` entity bean. This bean is called `ProductBean`.
   a) Write a remote interface, `Product`, for the `ProductBean`. This interface need not to define any business methods.

   b) Define the getter/setter methods available to the client :

```
public String getName() throws
   RemoteException;
public void setName(String name) throws
   RemoteException;
public String getDescription() throws
   RemoteException;
```

Task 64: CMP Entity Bean

```
public void setDescription(String description)
    throws RemoteException;
public double getBasePrice() throws
    RemoteException;
public void setBasePrice(double price) throws
    RemoteException;
public String getProductID() throws
    RemoteException;
```

Task 65: CMP Entity Bean

c) Write the home interface, `ProductHome`, for the ProductBean. This interface should define the following methods:

```
import javax.ejb.*;
import java.util.Collection;
import java.rmi.RemoteException;
public interface ProductHome extends EJBHome {
//Create method for createing a product
Product create(String productID, String name,
   String description, double basePrice) throws
   CreateException, RemoteException;
```

Task 66: CMP Entity Bean

```
// Finder methods. These are implemented by the
// container. The functionality can be customized
// in the deployment descriptor through
// EJB-QL and container tools.

public Product findByPrimaryKey(ProductPK key)
  throws FinderException, RemoteException;

public Collection findByName(String name) throws
  FinderException, RemoteException;

public Collection findByDescription(String
  description) throws FinderException,
  RemoteException;
```

Task 67: CMP Entity Bean

```
public Collection findExpensiveProducts(double
   minPrice) throws FinderException,
   RemoteException;

public Collection findCheapProducts(double
   maxPrice) throws FinderException,
   RemoteException;

public Collection findAllProducts() throws
   FinderException, RemoteException;
}
```

Task 68: CMP Entity Bean

d) Write the primary key class, `ProductPK`.
Please note that primary key class must be serializable. And the fields in the primary key class must be a subset of the container-managed fields defined in the deployment descriptor.

```
import java.io.Serializable;
public class ProductPK implements
   java.io.Serializable {public String
   productID;
    public ProductPK(String productID) {
       this.productID = productID;
    }
```

Task 69: CMP Entity Bean

```
    public ProductPK() {}
    public String toString() {
      return productID.toString();
    }
    public int hashCode() {
      return productID.hashCode();
    }
    public boolean equals(Object prod) {
      return
       ((ProductPK)prod).productID.equals(productID
       );
     }
  }
```

Task 70: CMP Entity Bean

e) Write the entity bean class, `ProductBean`.

```
import javax.ejb;
//Note that the class is declared as abstract
public abstract class ProductBean implements
   EntityBean {
protected EntityContext ctx;
public ProductBean() {
}
//declare the abstract methods for the get/set
   methods
. . .
```

Task 71: CMP Entity Bean

```
//EJB required methods called by the container

  public void ejbActivate() {
       System.out.println("ejbActivate()
       called.");
  }
  public void ejbRemove() {
       System.out.println("ejbRemove()
       called.");
  }
  public void ejbPassivate() {
       System.out.println("ejbPassivate ()
       called.");
  }
```

Task 72: CMP Entity Bean

```
    public void ejbLoad() {
        System.out.println("ejbLoad()
        called.");
    }
    public void ejbStore() {
        System.out.println("ejbStore()
        called.");
    }
  // Associates this Bean instance with a
    particular context
    public void setEntityContext(EntityContext
    ctx) {
        System.out.println("setEntityContext
        called");
        this.ctx = ctx;       }
```

Task 73: CMP Entity Bean

```
//Disassociates this Bean instance
//with a particular context environment
  public void unsetEntityContext() {
    System.out.println("unsetEntityContext
        called");
        this.ctx = null;
  }
  public void ejbPostCreate(String productID,
  String name, String description, double
  basePrice)   {
     System.out.println("ejbPostCreate()
      called");
  }
```

Task 74: CMP Entity Bean

```
public ProductPK ejbCreate(ProductPK
   productID, String name, String description,
   double basePrice) throws CreateException {
   System.out.println("ejbCreate() called");
   setProductID(productID);
   setName(name);
   setDescription(description);
   setBasePrice(basePrice);
   return null;
}
// Please be noted that CMP required that the
// ejbCreate method return a null value
```

Task 75: CMP Entity Bean

f) Refer to the task for `BMP` entity bean, create the `ejb-jar.xml` file for the `ProductBean`. Part of the file is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
<enterprise-beans>
<entity>
<ejb-name>Product</ejb-name>
<home>examples.ProductHome</home>
<remote>examples.Product</remote>
<ejb-class>examples.ProductBean</ejb-class>
```

Task 76: CMP Entity Bean

```
<persistence-type>Container</persistence-type>
<prim-key-class>examples.ProductPK</prim-key-
  class>
<reentrant>False</reentrant>
<cmp-version>2.x</cmp-version>
<abstract-schema-name>ProductBean</abstract-
  schema-name>
<cmp-field>
  <field-name>productID</field-name>
</cmp-field>
<cmp-field>
  <field-name>name</field-name>
</cmp-field>
```

Task 77: CMP Entity Bean

```
<cmp-field>
   <field-name>description</field-name>
</cmp-field>
<cmp-field>
   <field-name>basePrice</field-name>
</cmp-field>
```

Task 78: CMP Entity Bean

```
<query>
 <query-method>
   <method-name>findByName</method-name>
   <method-params>
        <method-param>java.lang.String
        </method-param>
   </method-params>
 </query-method>
 <ejb-ql>
 <![CDATA[SELECT OBJECT(a) FROM ProductBean AS
   a WHERE a.name = ?1]]>
 </ejb-ql>
</query>
```

Task 79: CMP Entity Bean

```
<query>
  <query-method>
   <method-name>findByDescription
    </method-name>
   <method-params>
   <method-param>java.lang.String
    </method-param>
  </method-params>
 </query-method>
 <ejb-ql>
  <![CDATA[SELECT OBJECT(a) FROM ProductBean
   AS a WHERE a.description = ?1]]>
 </ejb-ql>
</query>
```

Task 80: CMP Entity Bean

```
<query>
  <query-method>
    <method-name>findByBasePrice</method-name>
    <method-params>
     <method-param>double</method-param>
    </method-params>
  </query-method>
  <ejb-ql>
    <![CDATA[SELECT OBJECT(a) FROM
    ProductBean AS a WHERE a.basePrice = ?1]]>
  </ejb-ql>
</query>
```

Task 81: CMP Entity Bean

```
<query>
  <query-method>
    <method-name>findExpensiveProducts
    </method-name>
    <method-params>
      <method-param>double</method-param>
    </method-params>
  </query-method>
  <ejb-ql>
    <![CDATA[SELECT OBJECT(a) FROM ProductBean
       AS a WHERE a.basePrice > ?1]]>
  </ejb-ql>
</query>
```

Task 82: CMP Entity Bean

```
<query>
<query-method>
<method-name>findCheapProducts</method-name>
<method-params>
<method-param>double</method-param>
</method-params>
</query-method>
<ejb-ql>
<![CDATA[SELECT OBJECT(a) FROM ProductBean AS
   a WHERE a.basePrice < ?1]]>
</ejb-ql>
</query>
```

Task 83: CMP Entity Bean

```
<query>
<query-method>
<method-name>findAllProducts</method-name>
<method-params>
</method-params>
</query-method>
<ejb-ql>
<![CDATA[SELECT OBJECT(a) FROM ProductBean AS
   a WHERE a.productID IS NOT NULL]]>
</ejb-ql>
</query>
</entity>
</enterprise-beans>
```

Task 84: CMP Entity Bean

```
<assembly-descriptor>
<container-transaction>
<method>
<ejb-name>Product</ejb-name>
<method-intf>Remote</method-intf>
<method-name>*</method-name>
</method>
<trans-attribute>Required</trans-attribute>
</container-transaction>
</assembly-descriptor>
</ejb-jar>
```

Task 85: CMP Entity Bean

g) Prepare the vendor-specific deployment descriptor (`jboss.xml`):

```
<?xml version="1.0" encoding="UTF-8"?>
<jboss>
   <enterprise-beans>
        <entity>
            <ejb-name>Product</ejb-name>
            <jndi-name>ProductHome</jndi-name>
        </entity>
   </enterprise-beans>
</jboss>
```

h) Deploy the `EJB`.

i) Develop a client program to test the `EJB`.

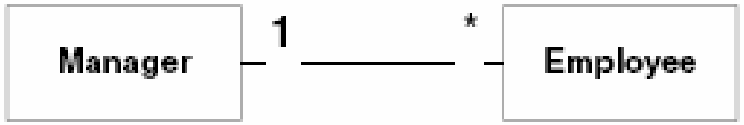
Exercise: CMP Entity Bean

1) Create a `CMP` entity Bean named `CustomerBean`.
   a) The bean containing the following data:
      1. customerID – customer ID (String)
      2. customerName – customer's name (String)
      3. password – customer's password (String)
      4. address – customer's address (String)
   b) The bean has a protected variable `ctx` which is an `EntityContext` object. Declare and initialize this variable appropriately.
   c) Create the remote interface as `Customer` for the `CustomerBean`.
   d) Create the home interface as `CustomerHome` for the `CustomerBean`.
   e) Create the deployment descriptor file for the `CustomerBean`.

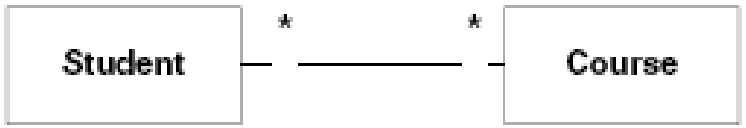
Entity Bean: Relationships

One-to-one (1:1) relationships, e.g. order and shipment

One-to-many (1:N) relationships, e.g. manager and employee



Many-to-many (M:N) relationships, e.g. student and course



BMP 1:1 Relationships 1

The following code snippet illustrate how to implement 1:1 relationships using `BMP`:

OrderPK	OrderName	Shipment ForeignPK
12345	Software Order	10101

ShipmentPK	City	ZipCode
10101	Austin	78727

BMP 1:1 Relationships 2

```
public class OrderBean implements EntityBean {
private String orderPK;
private String orderName;
private Shipment shipment; // EJB local object stub
public Shipment getShipment() { return shipment; }
public void setShipment(Shipment s) { this.shipment =
s;}
...
```

BMP 1:1 Relationships 3

```
  public void ejbLoad() {
    // 1: SQL SELECT Order. This also retrieves the
    // shipment foreign key.
    // 2: JNDI lookup of ShipmentHome
    // 3: Call ShipmentHome.findByPrimaryKey(), passing
    // in the shipment foreign key
  }
  public void ejbStore() {
    // 1: Call shipment.getPrimaryKey() to retrieve
    // the Shipment foreign key
    // 2: SQL UPDATE Order. This also stores the
    // Shipment foreign key.
  }
}
```

CMP 1:1 Relationships 1

For `CMP` entity bean, you don't implement the `ejbLoad` and `ejbStore` methods. The container will implement them in the subclass.

The bean may look as follows:

```
public abstract class OrderBean implements EntityBean
{
   // no fields
   public abstract Shipment getShipment();
   public abstract void setShipment(Shipment s);
   ...
   public void ejbLoad() {} // Empty
   public void ejbStore() {} // Empty
}
```

CMP 1:1 Relationships 2

Specify the relationships in the deployment descriptor as follows:

```
<ejb-jar>
 <enterprise-beans>
 ...
 </enterprise-beans>
 <relationships>
 <!-- This declares a relationship -->
 <ejb-relation>
   <ejb-relation-name>Order-Shipment</ejb-relation-name>
   <ejb-relationship-role>
     <ejb-relationship-role-name>
         order-spawns-shipment
     </ejb-relationship-role-name>
```

CMP 1:1 Relationships 3

```
<!--The Cardinality of this half of the
     relationship-->
  <multiplicity>One</multiplicity>
  <relationship-role-source>
    <ejb-name>Order</ejb-name>
  </relationship-role-source>

  <cmr-field>
     <cmr-field-name>shipment</cmr-field-name>
  </cmr-field>
</ejb-relationship-role>
```

CMP 1:1 Relationships 4

```
<!-- This declares the 2nd half of the relationship
     (the Shipment side)-->
   <ejb-relationship-role>
      <ejb-relationship-role-name>
            shipment-fulfills-order
      </ejb-relationship-role-name>
      <multiplicity>One</multiplicity>
      <relationship-role-source>
            <ejb-name>Shipment</ejb-name>
      </relationship-role-source>
   </ejb-relationship-role>
  </ejb-relation>
 </relationships>
</ejb-jar>
```

BMP 1:N Relationships 1

The following code illustrates how to implement 1:N relationships using BMP:

CompanyPK	Name
12345	The Middleware Company

EmployeePK	Name	Sex	Company
20202	Ed	M	12345
20203	Floyd	M	12345

BMP 1:N Relationships 2

```
public class CompanyBean implements EntityBean {
      private String companyPK;
      private String companyName;
      private Vector employees; // EJB object stubs
      public Collection getEmployees()
      { return employees; }
      public void setEmployees(Collection e) {
      this.employees = (Vector) e;
      }
      ...
```

BMP 1:N Relationships 3

```
public void ejbLoad() {
// 1: SQL SELECT Company
// 2: JNDI lookup of EmployeeHome
// 3: Call EmployeeHome.findByCompany(companyPK)
}
public void ejbStore() {
// 2: SQL UPDATE Company
}
```

CMP 1:N Relationships 1

The following code shows how to implement a 1:N relationship using CMP:

```
public abstract class CompanyBean implements EntityBean
{
      // no fields
      public abstract Collection getEmployees();
      public abstract void setEmployees(Collection
         employees);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

CMP 1:N Relationships 2

The relationships in the deployment descriptor is defined as follows:

```
<ejb-jar>
 <enterprise-beans>
 ...
 </enterprise-beans>
  <relationships>
  <ejb-relation>
       <ejb-relation-name>
            Company-Employees
       </ejb-relation-name>
       <ejb-relationship-role>
          <ejb-relationship-role-name>
             Company-Employs-Employees
          </ejb-relationship-role-name>
```

CMP 1:N Relationships 3

```
            <multiplicity>One</multiplicity>
        <relationship-role-source>
            <ejb-name>Company</ejb-name>
        </relationship-role-source>
    <cmr-field>
        <cmr-field-name>employees</cmr-field-name>
        <cmr-field-type>
            java.util.Collection
        </cmr-field-type>
    </cmr-field>
</ejb-relationship-role>
```

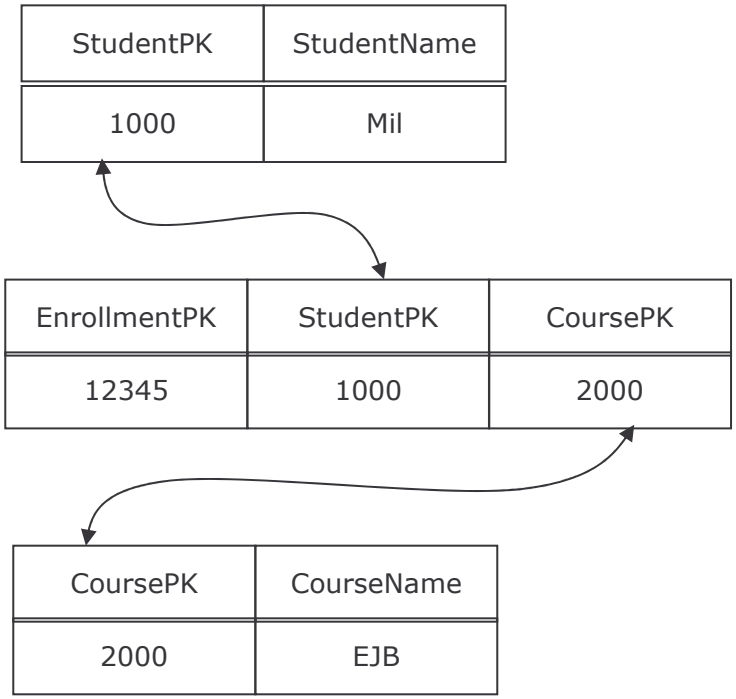
CMP 1:N Relationships 4

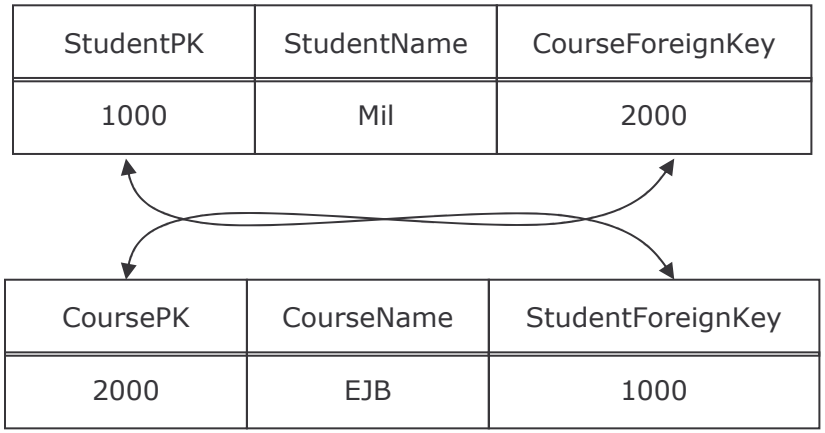
```
        <ejb-relationship-role>
            <ejb-relationship-role-name>
               Employees-WorkAt-Company
            </ejb-relationship-role-name>
            <multiplicity>Many</multiplicity>
          <relationship-role-source>
            <ejb-name>Employee</ejb-name>
          </relationship-role-source>
        </ejb-relationship-role>
      </ejb-relation>
  </relationships>
</ejb-jar>
```

Implementing M:N Relationships 1

M:N relationships can be implemented in two ways:

1) Fake M:N relationship
2) True M:N relationship





Implementing M:N Relationships 2

The following code illustrates one way to implement M:N relationships using CMP:

```
public abstract class StudentBean implements
EntityBean {
      // no fields
      public abstract Collection getCourses();
      public abstract void setCourses(Collection
      courses);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

Implementing M:N Relationships 3

```
public abstract class CourseBean implements EntityBean
{
      // no fields
      public abstract Collection getStudents();
      public abstract void setStudents(Collection
      students);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

Implementing M:N Relationships 4

The relationships in the deployment descriptor are defined as follows:

```
<ejb-jar>
<enterprise-beans>
...
</enterprise-beans>
<relationships>
 <ejb-relation>
  <ejb-relation-name>
        Student-Course
  </ejb-relation-name>
  <ejb-relationship-role>
```

Implementing M:N Relationships 5

```
<ejb-relationship-role-name>
  Students-EnrollIn-Courses
</ejb-relationship-role-name>
<multiplicity>Many</multiplicity>
<relationship-role-source>
  <ejb-name>Student</ejb-name>
</relationship-role-source>
<cmr-field>
    <cmr-field-name>courses</cmr-field-name>
    <cmr-field-type>
       java.util.Collection
    </cmr-field-type>
```

Implementing M:N Relationships 6

```
</cmr-field>
</ejb-relationship-role>
<ejb-relationship-role>
  <ejb-relationship-role-name>
    Courses-HaveEnrolled-Students
  </ejb-relationship-role-name>
  <multiplicity>Many</multiplicity>
  <relationship-role-source>
   <ejb-name>Course</ejb-name>
  </relationship-role-source>
```

Implementing M:N Relationships 7

```
        <cmr-field>
           <cmr-field-name>students</cmr-field-name>
               <cmr-field-type>
              java.util.Collection
            </cmr-field-type>
        </cmr-field>
    </ejb-relationship-role>
  </ejb-relation>
 </relationships>
</ejb-jar>
```

Directionality

Directionality specifies the direction in which you can navigate a relationship.

There are two types of directionality:

1) Bidirectional -one can get from entity A to entity B and vice versa.
2) Unidirectional - one can get from entity A to entity B, but cannot get from entity B to entity A.

Directionality applies to all cardinalities.

Directionality with BMP

With BMP entity bean, directionality is controlled by the get/set methods and a field pointing to the destination.

For example:


```
public class OrderBean implements EntityBean {
      private String orderPK;
      private String orderName;

      private Shipment shipment;
      public Shipment getShipment() {
            return shipment; }
      public void setShipment(Shipment s)
      { this.shipment = s; }
. . .
}
```

Directionality with CMP 1

With CMP relationship, the direction is indicated by combining a pair get/set abstract method pointing to the other bean and the container-managed relationship (CMR) fields.

For example:

```
public abstract class OrderBean implements EntityBean
{     public abstract Shipment getShipment();
      public abstract void setShipment(Shipment s);
      ...
      public void ejbLoad() {} // Empty
      public void ejbStore() {} // Empty
}
```

Directionality with CMP 2

```
<ejb-jar>
<enterprise-beans>... </enterprise-beans>
<relationships>
 <ejb-relation>
 <ejb-relation-name>Order-Shipment</ejb-relation-name>
 <ejb-relationship-role>
  <ejb-relationship-role-name>
   order-spawns-shipment
  </ejb-relationship-role-name>
  <multiplicity>One</multiplicity>
```

Directionality with CMP 3

```
  <relationship-role-source>
            <ejb-name>Order</ejb-name>
  </relationship-role-source>
 <cmr-field>
    <cmr-field-name>
       shipment
    </cmr-field-name>
 </cmr-field>
</ejb-relationship-role>
```

Directionality with CMP 4

```
    <ejb-relationship-role>
     <ejb-relationship-role-name>
       shipment-fulfills-order
     </ejb-relationship-role-name>
     <multiplicity>One</multiplicity>
     <relationship-role-source>
      <ejb-name>Shipment</ejb-name>
     </relationship-role-source>
    <!- No cmr for shipment to access order -->
    </ejb-relationship-role>
  </ejb-relation>
 </relationships>
</ejb-jar>
```

Cascading Delete

Two relationship concepts:

1) Aggregation
   a uses relationship, e.g. Student / Course
2) Composition
   an is-assembled-of relationship, e.g. Order / Line Items

Composition relationship will cause cascading delete.

Cascading Delete with BMP

With BMP, cascading delete is implement in ejbRemove() method.

For example:

```
public class OrderBean implements EntityBean {
    private String orderPK;
    private String orderName;
    private Shipment shipment; // EJB local object stub
    public Shipment getShipment() { return shipment; }
    public void setShipment(Shipment s) { this.shipment
       = s;}
    ...
    public void ejbRemove() {
    // 1: SQL DELETE Order
    // 2: shipment.remove();
    }
}
```

Cascading Delete with CMP 1

With CMP, cascade-delete is setup through the deployment descriptor, as follows:

```
<ejb-jar>
 <enterprise-beans>...</enterprise-beans>
 <relationships>
  <ejb-relation>
   <ejb-relation-name>
        Order-Shipment
   </ejb-relation-name>
   <ejb-relationship-role>
    <ejb-relationship-role-name>
     order-spawns-shipment
    </ejb-relationship-role-name>
```

Cascading Delete with CMP 2

```
    <multiplicity>One</multiplicity>
    <relationship-role-source>
      <ejb-name>Order</ejb-name>
    </relationship-role-source>
    <cmr-field>
      <cmr-field-name>shipment</cmr-field-name>
    </cmr-field>
  </ejb-relationship-role>
  <ejb-relationship-role>
    <ejb-relationship-role-name>
       shipment-fulfills-order
    </ejb-relationship-role-name>
    <multiplicity>One</multiplicity>
```

Cascading Delete with CMP 3

```
      <cascade-delete/>
      <relationship-role-source>
        <ejb-name>Shipment</ejb-name>
      </relationship-role-source>
      <cmr-field>
           <cmr-field-name>order</cmr-field-name>
        </cmr-field>
    </ejb-relationship-role>
   </ejb-relation>
 </relationships>
</ejb-jar>
```

Task 86: Setup JBossIDE

1) Instead of writing all the codes, tools can be used to generate the interfaces and deployment descriptor. There are some free tools available. The usage of the Eclipse plug-in named `JBossIDE` will be explained as follows:

   a) Download `Eclipse JbossIDE` plugin from `www.jboss.org`.

   b) Unpack the archives into a local directory.

   c) At Eclipse, choose `Help`→`Find` and `Install`→`Search for new features for install` → `Add new Archive site` → choose directory containing unpacked `JbossIDE` files.

   d) Follow the instruction to install `JbossIDE`.

Task 87: Setup JBossIDE

e) In Eclipse, Select `File` → `New` → `Project...`. Find an entry `Jboss-IDE`. Choose J2EE 1.4 Project to create a J2EE project with proper libraries.

f) Copy `<Jboss_Home>/client/jbossall-client.jar` to the build path of the client program. The jar file contains everything an `EJB` client could ever need.

g) After `JBossIDE` is installed, setup the `XDoclet` for development and deployment of `J2EE` project.

h) For more information about `XDoclet`, check out this site:

`http://xdoclet.sourceforge.net/xdoclet/index.html`

Task 88: Using JBossIDE

1) After setting up Eclipse, create an `EJB` as follows:
   a) Right clicking on the J2EE project created, choose New → Other…
   b) Choose a type of `EJB` from `JBoss-IDE` → `EJB` Components.
   c) Follow the instruction to create an `EJB`.
   d) At the Package Explorer of Eclipse, expand the `EJB` file node.
   e) Right click on the bean class.
   f) Choose `J2EE` → Choose an option such as "`Add Business Method`" to allow `JBoss-IDE` to generate the codes.

Task 89: Configuring XDoclet

1) In order to use `XDoclet` to generate the interfaces and classes for `J2EE` project, create an `XDoclet` configuration in Eclipse as follows:
   a) Right clicking on the project icon and select “`Properties`”.
   b) In the property page, select “`XDoclet configurations`”.
   c) Right-click in the upper area to pop-up the menu and choose "`Add`".
   d) Type "`EJB`" in the dialog and click "`Ok`".
   e) Keep the “`EJB`” configuration selected and In the lower-left area, right-click to popup the menu and choose "`Add Doclet`".

Task 90: Configuring XDoclet

f) Choose "`ejbdoclet`" in the popup list and click "`Ok`".

g) On the lower-right area, you see the properties of the "`ejbdoclet`". Set them to:

"destDir" with "src" and ckeck it

"ejbSpec" with "2.0" and ckeck it

result: the configuration contains an "`ejbdoclet`" that will produce files in "`src`" folder and for the `EJB 2.0` specifications.

Task 91: Configuring XDoclet

2) Configure the fileset subtask:

a) Right-click on "`ejbdoclet`" to choose "`Add `" at the popup menu.

b) A list of available subtasks will appear. Choose "`fileset`" and click "`Ok`".

c) On the lower-right area, check the properties of the " `fileset` ". Set up as the following setting:

"`dir`" with "`src`" and ckeck it

uncheck "`excludes`"

"`includes`" with "`**/*Bean.java`" and ckeck it.

result: "`ejbdoclet`" will produce files based on fileset "`src`" folder and have a filter only pick up files ended with "`Bean.java`".

Task 92: Configuring XDoclet

3) Configure the deployment descriptor subtask:

a) Repeat the previous operation to add a new subtask "`deploymentdescriptor`".

b) Set the property "`destDir`" with "`src/META-INF`". Don't forget to check it.

result: "`ejbdoclet`" will generate the deployment descriptor in the "`src/META-INF`" folder.

Task 93: Configuring XDoclet

4) Configure the `jboss` subtask

   a) Repeat the previous operation to add a new subtask "`jboss`".
   b) Set "`destDir`" with "`src/META-INF`". Don't forget to check it.
   c) Set “`Version`” with “`4.0`”.

result: jboss deployment descriptor will be generated in the "`src/META-INF`" folder.

Task 94: Configuring XDoclet

5) Configure the `packageSubstitution` subtask

a) Repeat the previous operation to add a new subtask "`packageSubstitution`".

b) Set "`packages`" with "`ejb`". Don't forget to check it. Note that the packages need to have more than two levels, such as `task.ejb`, to make the substitution work.

c) Set "`substituteWith`" with "`interfaces`".

result: `EJB` related classes will be generated in different package, i.e. interfaces will be generated in package `xxx.interfaces` for `EJB` lies in packages `xxx.ejb`.

Task 95: Configuring XDoclet

6) Configure the `remoteinterface` and `homeinterface` subtask

   a) Repeat the previous operation to add new subtasks "`remoteinterface`" and "`homeinterface`".

   b) No option is required to be set. Don't forget to check it.

result: Both "`remoteinterface`" and "`homeinterface`" will be generated.

Task 96: Configuring XDoclet

7) Configure the `localinterface` and `localhomeinterface` subtask

    1) Repeat the previous operation to add a new subtask "`localinterface`" and "`localhomeinterface`".
    2) No option is required to be set. Don't forget to check it.

result: Both "`localinterface`" and "`localhomeinterface`" will be generated.

Task 97: Configuring XDoclet

8) Configure the `entitypk` subtask:

   a) Repeat the previous operation to add a new subtask "entitypk".
   b) Set "`destDir`" with "`src`". Don't forget to check it.

result: The primary key classes for the entity beans will be generated.

Task 98: Using XDoclet

1) After created an EJB, run XDoclet to generate the corresponding classes, interfaces and files as follows:

   a) Right click on the J2EE project, choose run XDoclet.

   b) Files will be generated according to the configuration.

   c) At some instance, XDoclet tags inside the EJB has to be modified to create proper output.

Note: The following link is official web site of XDoclet:
http://xdoclet.sourceforge.net/xdoclet/index.html

Task 99: Configuring Packaging

1) Configure the packaging configuration for the `EJB` Jar containing the `EJB` classes, interfaces and the deployment descriptors:

   a) Right clicking on the `J2EE` project and select "`Properties`" → "`Packaging configurations`".

   b) Right-click in the area to pop-up the menu → "`Add Archive`".

   c) Type the name of the jar file such as "`myEJB.jar`" in the dialog and click "`Ok`".

Task 100: Configuring Packaging

d) Select the "`myEJB.jar`" item and right-click in the area to pop-up the menu and choose "`Add Folder`".

e) A "`Folder Selection`" dialog appears. Click on "`Project Folder`". A "`Folder Chooser`" dialog appears for selecting which folder to include.

f) Select the folder containing the classes file, e.g. bin folder, and click "Ok".

g) In the include filter area, type in the classes filter you need to include separated by comma. For example,
`com/ejb/*.class, com/interfaces/*.class`

h) Click "`OK`".

Task 101: Configuring Packaging

h) Select the “myEJB.jar” item and right-click in the area to pop-up the menu and choose "Add File".

i) A “File Selection” dialog appears. Click on “Project File ...”. A “File Chooser” dialog appears for selecting which file to include.

j) Select the deployment descriptor file such as “prj/src/META-INF/ejb-jar.xml” and click “Ok”.

k) Since deployment descriptor must located in the “META-INF” folder, type “META-INF” in prefix and click “OK”.

Task 102: Configuring Packaging

l) Repeat steps e to h and for adding the vendor specific deployment descriptor "`jboss.xml`".

m) Click "`OK`" and the configuration for `myEJB.jar` is completed.

n) For deploying the package, just copy file `myEJB.jar` to `Jboss` at `<JBoss_Home>/server/default/deploy.`

Task 103: CMP Relationship

1) Use the `JBossIDE` for generating and deploying `J2EE` project. Create two entity beans with the following conditions:
   a) a `CMP` entity bean named `CompanyBean`
   b) field: `companyId` (`String`), `name` (`String`)
   c) primary key class : `CompanyPK`
   d) a `CMP` entity bean named `EmployeeBean`
   e) field: `employeeId` (`Integer`), `name` (`String`) and `sex(String)`
   f) primary key class: `employeePK`
   g) `CompanyBean` and `EmployeeBean` has an unidirectional many-to-one relationship pointing from employee to company.
   h) When the company is deleted, the employees' records will be deleted automatically.

Task 104: CMP Relationship

Note:

1) Use `XDoclet` to create the relationship.
2) Only use remote interface for this task.
3) The setter of the `CMR` field has to be put inside the `ejbPostCreate` method.
4) Try to explore the set up for different relationships and directions.

Summary 1

1) An `Entity Bean` represents business data stored in a database.
2) Database data types are converted into Java data types and encapsulated into the `Entity Bean`.
3) Modifying the in-memory value of an `Entity Bean` can change the values of data, saved back into storage again and updating the database data.
4) Each `Entity Bean` must have a `Primary Key`
5) There are two ways to persist an Entity Bean:
   a) Bean-Managed Persistence (`BMP`)
   b) Container-Managed Persistence (`CMP`)

Summary 2

Finder method is a special type of method for finding existing bean in storage.

Besides finder methods, `CMP` entity beans can have special select methods.

Select methods are declared as abstract methods using the naming convention `ejbSelect<`*`METHOD-NAME`*`>`.

`ejbSelect()` methods work like private query methods and are not exposed to end clients.

Summary 3

A special business method called home method can be defined in the entity bean class to provide global operations such as counting the total number of records.

`ejbLoad` method and `ejbStore` methods are routinely called by the container to be synchronized with the database.

When the `ejbRemove()` is called, database data will be destroyed but not the in-memory entity bean instance.

Summary 4

EJB Query Language (`EJB-QL`) is an object-oriented SQL-like syntax for querying entity beans.

Summary 5

Different types of relationships and directions can be defined for entity beans.

For example:

a) one-to-one (1:1) unidirectional

b) one-to-one (1:1) bidirectional

c) one-to-many (1:N) unidirectional

d) one-to-many (1:N) bidirectional

e) many-to-many (M:N) unidirectional

f) many-to-many (M:N) unidirectional

Vertical Concepts Outline

1) Session Beans
   a) basic concepts
   b) stateless
   c) stateful
   d) summary

2) Entity Beans
   a) basic concepts
   b) persistence
   c) relationships
   d) summary

3) Message-Driven Beans
   a) basic concepts
   b) life cycle
   c) implementation
   d) summary

Java Messaging Service (JMS)

JMS is a vendor-neutral API for a Java program to access Message Oriented Middlewares(MOM) products.

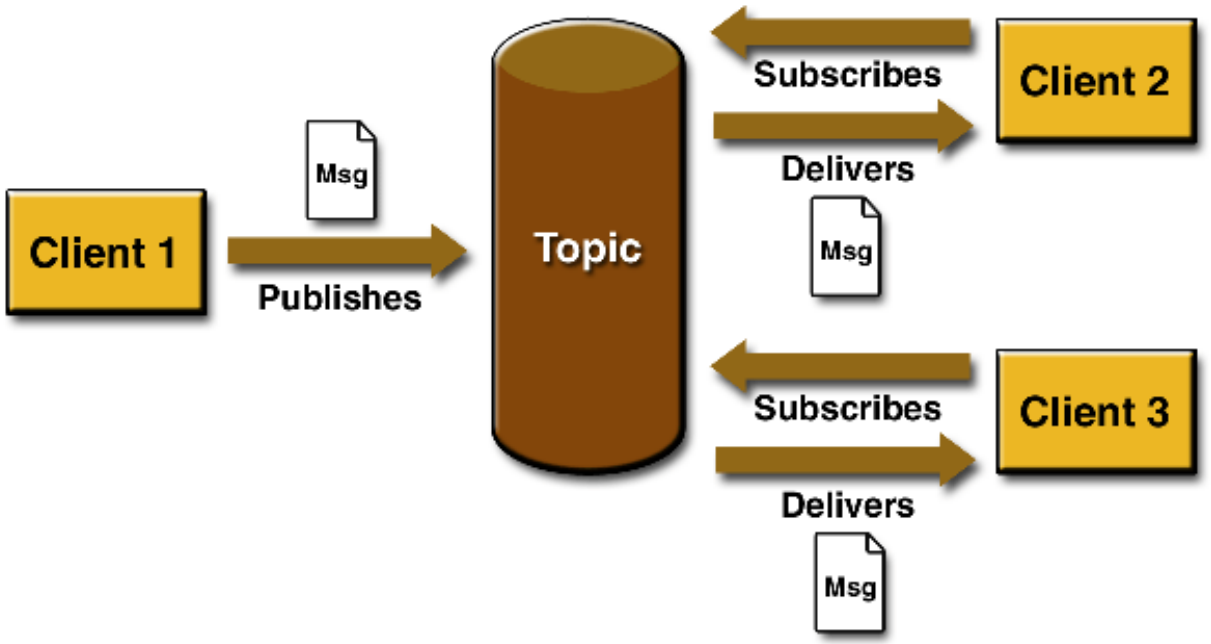
JMS has two models:

1) Publish and Subscribe

2) Point-to-Point

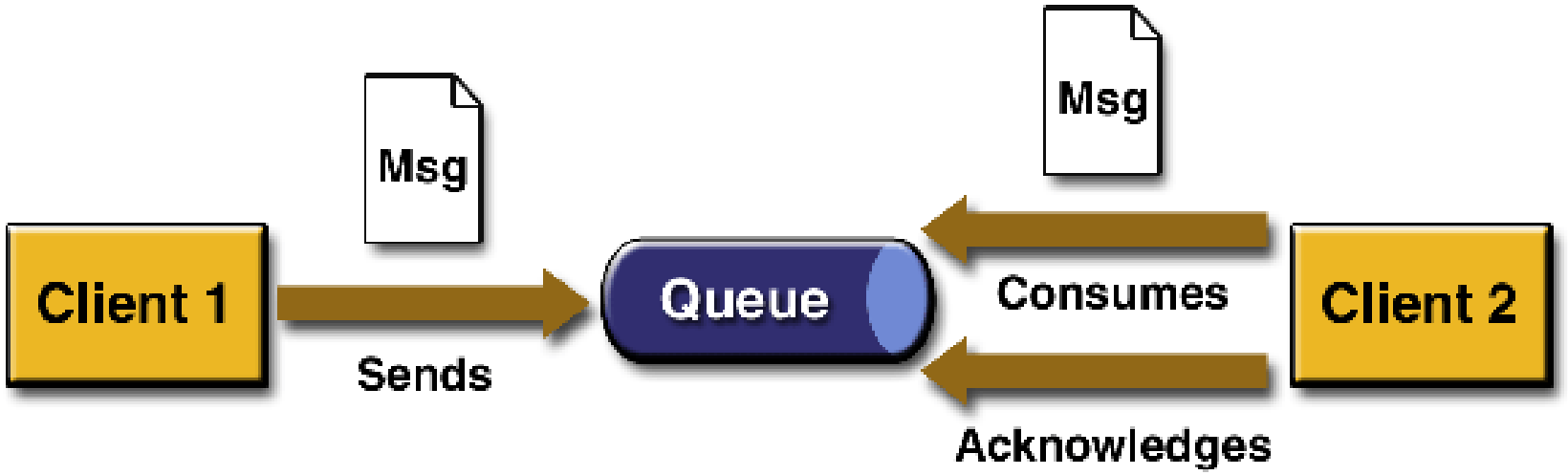
Publish/Subscribe Messaging

1) Clients publish messages to a topic.
2) The system distributes the messages to the subscribed clients.
3) Only current subscribers can receive messages.



Point-to-Point Messaging

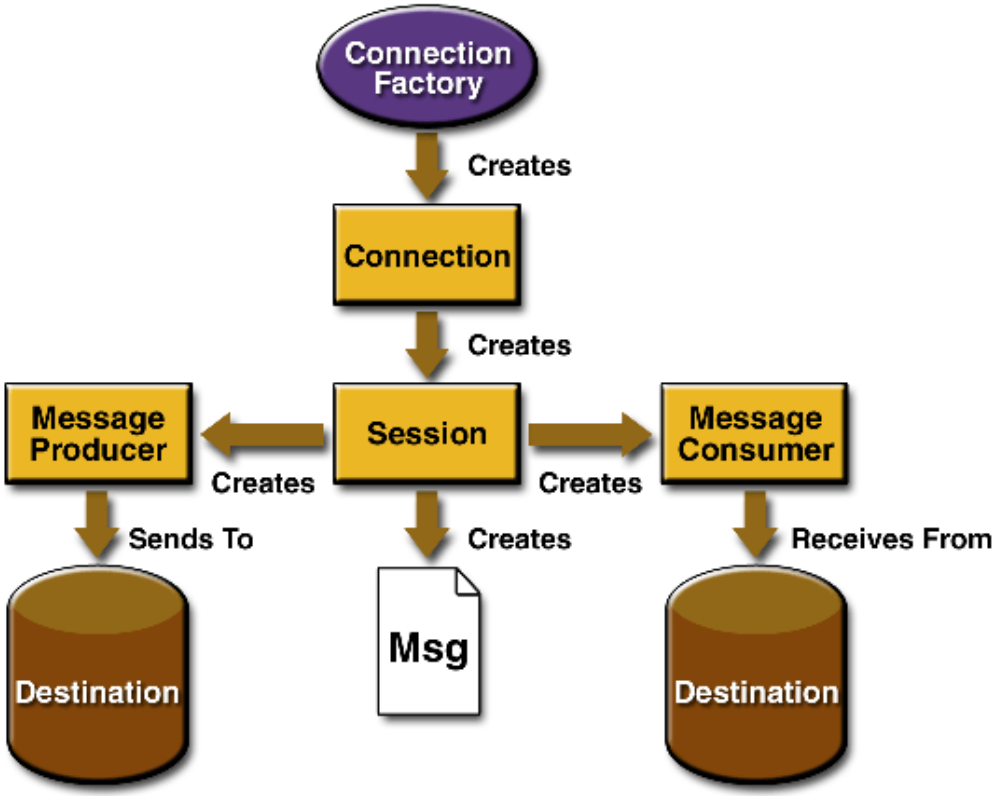
1) Each message is sent to a specific queue.
2) Receiving clients extract messages from the queue(s)
3) Queues retain all messages sent to them until:
   a) the messages are consumed
   b) the messages expire



JMS API Programming Model

The basic building blocks of a JMS application:

1) Administered objects
2) Sessions
3) Message producers
4) Message consumers
5) Messages



JMS Client Setup Procedure

A typical pub/sub JMS client executes the following setup procedure:

1) Use `JNDI` to find a `ConnectionFactory` object.
2) Use `JNDI` to find one or more Destination objects.
3) Use the `ConnectionFactory` to create a JMS Connection.
4) Use the Connection to create one or more JMS Sessions.
5) Use a Session and the Destinations to create the `MessagePublisher` and `MessageSubscriber` needed.
6) Enable the Connection to start delivering messages to the destination.

Message Driven Bean 1

The Message-Driven Bean was introduced in EJB 2.0 to support the processing of asynchronous messages from a Java Message Service (JMS) provider.

EJB 2.1 expanded the definition of the message-driven bean so that it can support any messaging system, not just JMS.

Message Driven Bean 2

Message-driven bean (MDB) is like a session bean in that it implements the business methods.

What is the difference?

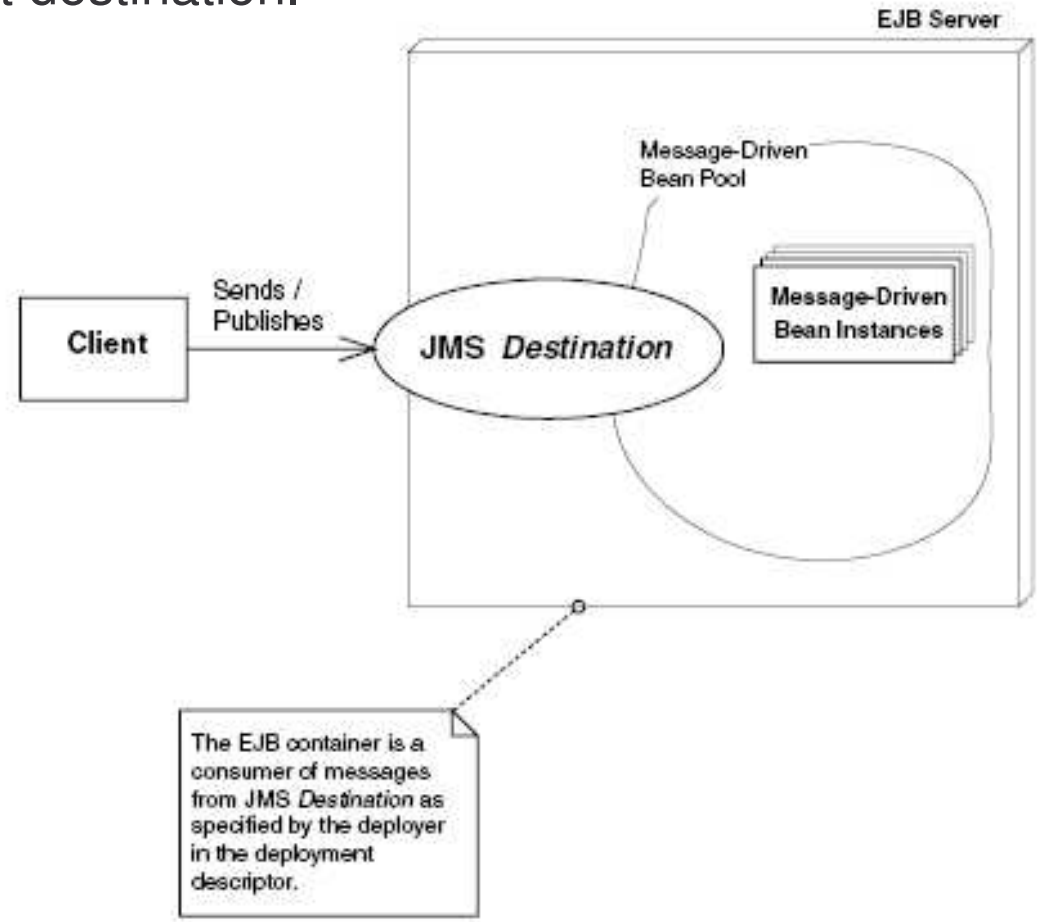
A session bean provides **synchronous communication**, e.g. it calls an entity bean and waits for a reply.

Message-driven beans provides **asynchronous communication**.

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.

Message Driven Bean 3

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.



Example: Message Driven Bean

1) Using Message Driven Bean for online ordering:
   a) When shopping cart `Checkout` method completes, it sends an asynchronous message to the shipping department to ship the purchased goods.

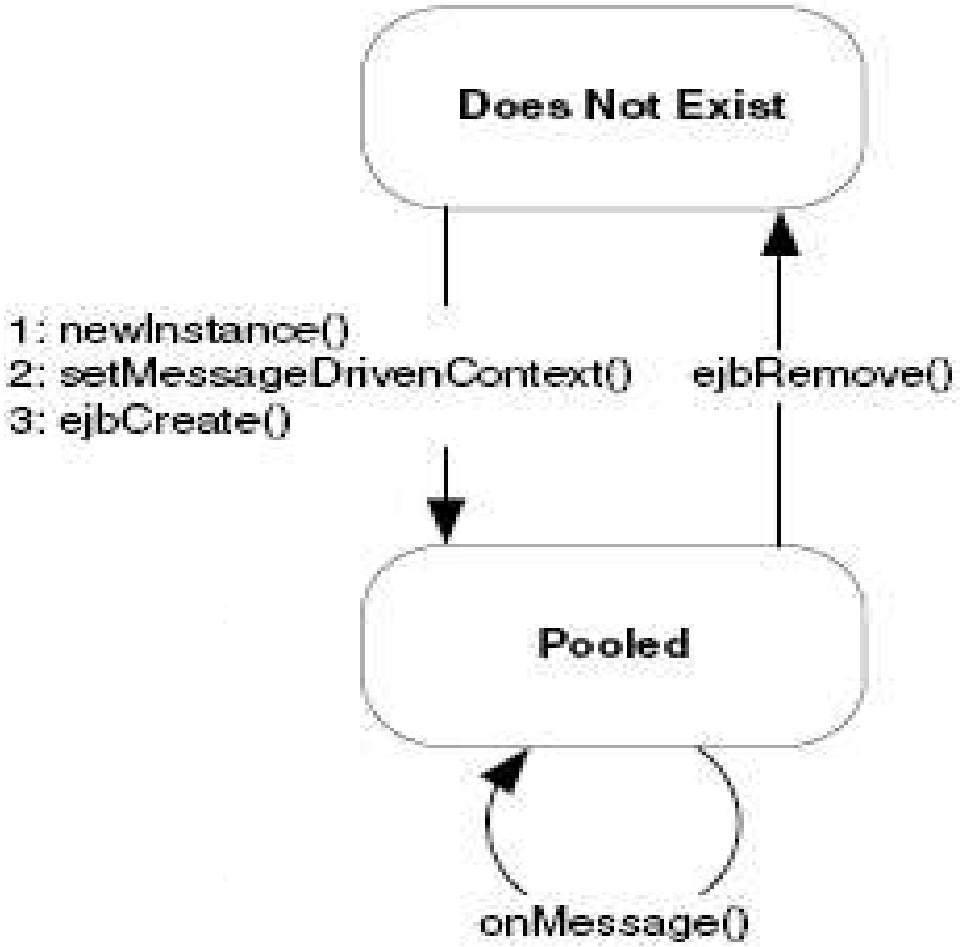
   b) The shipping department maintains a message queue, `ShippingMessageQ`, and a message driven bean, `ShippingMessageQBean`, associated with that queue.

   c) When a message is placed on the queue, the system selects an instance of the bean to process it and calls that bean's `onMessage` method.

MDB Characteristics

1) does not have a home interface, local home interface, remote interface, or a local interface
2) has only one business method, called `onMessage()`
3) do not have any return values
4) cannot send exceptions back to clients
5) are stateless
6) can be durable or nondurable subscribers

MDB Life Cycle



MDB Implementation 1

Must implement two interfaces:

a) javax.jms.MessageListener

```
public interface javax.jms.MessageListener {
        public void onMessage(Message message);
}
```

b) javax.ejb.MessageDrivenBean

```
public interface javax.ejb.MessageDrivenBean
   extends javax.ejb.EnterpriseBean {

  public void ejbRemove() throws EJBException;

  public void setMessageDrivenContext
 (MessageDrivenContext ctx) throws EJBException;
}
```

MDB Implementation 2

```
import javax.ejb.*;
import javax.jms.*;
public class LogBean implements MessageDrivenBean,
   MessageListener {
   protected MessageDrivenContext ctx;

    public void setMessageDrivenContext
    (MessageDrivenContext ctx) {
      this.ctx = ctx;
    }
    public void ejbCreate() {
     System.err.println("ejbCreate()");
    }
```

MDB Implementation 3

```
public void onMessage(Message msg) {
    if (msg instanceOf TextMessage) {
        TextMessage tm = (TextMessage) msg;
        try {
              String text = tm.getText();
               System.err.println("Received new
               message : " + text);
        } catch(JMSException e) {
            e.printStackTrace();
        }
    }
}
```

MDB Implementation 4

```
        public void ejbRemove() {
                System.err.println("ejbRemove()");
        }
}
```

MDB Implementation 5

Deployment descriptor file:

```
<!DOCTYPE ejb-jar PUBLIC "-//Sun Microsystems,
   Inc.//DTD Enterprise JavaBeans 2.0//EN"
   "http://java.sun.com/dtd/ejb-jar_2_0.dtd">
<ejb-jar>
<enterprise-beans>
 <message-driven>
 <!-- The nickname for the bean -->
  <ejb-name>Log</ejb-name>
  <ejb-class>examples.LogBean</ejb-class>
  <transaction-type>Container</transaction-type>
```

MDB Implementation 6

```
    <message-driven-destination>
      <destination-type>
            javax.jms.Topic
      </destination-type>
    </message-driven-destination>
  </message-driven>
 </enterprise-beans>
</ejb-jar>
```

Task 105: MDB

1) Use the `ejb` client in pervious example to test the function of a Message Driven Bean.
   a) In `JBoss`, create a topic named "`emacaoMDB`" by editing the file: `<JBoss_Home>\server\default\deploy\jms\jbossmq-destinations-service.xml`

```
<server>
        ...
 <mbean code="org.jboss.mq.server.jmx.Topic"
   name="jboss.mq.destination:service=Topic,
   name=log">
  <depends
       optional-
attributename="DestinationManager">
            jboss.mq:service=DestinationManager
  </depends>
 </mbean>
```

Task 106: MDB

```
        ...
    </server>
```

b) Specify the JNDI name for the topic in the deployment descriptor as follows:

```
...
   <enterprise-beans>
         <message-driven>
               <ejb-name>Log</ejb-name>
               <destination-jndi-name>
                  topic/log
          </destination-jndi-name>
          </message-driven>
   </enterprise-beans>
...
```

Task 107: MDB

c) Develop a client to produce message to the topic “log”. Please be noted that in JBoss, the JNDI name of the driver for both topic and queue messaging is "ConnectionFactory". The code snippet for creating connection in JBoss may look as follows:

```
InitialContext iniCtx = new InitialContext();
Object tmp = iniCtx.lookup("ConnectionFactory");
ConnectionFactory tcf = (ConnectionFactory) tmp;
conn = tcf.createConnection();
topic = (Topic) iniCtx.lookup("topic/log");
session = conn.createSession

      (false,Session.AUTO_ACKNOWLEDGE);
conn.start();
```

Summary 1

Message-driven bean (MDB) works like a session bean providing asynchronous communication.

Clients deliver messages to a JMS destination (a queue or a topic) and the container passes it to a message-driven bean object that has registered as a listener for that destination.

Summary 2

Message-Driven Bean has the following characteristics:

1) has to implement interfaces `MessageDrivenBean and MessageListener`
2) does not have a home interface, local home interface, remote interface, or a local interface
3) has only one business method, called `onMessage()`
4) do not have any return values
5) cannot send exceptions back to clients
6) are stateless
7) can be durable or nondurable subscribers

Horizontal Concepts

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

Horizontal Concepts Outline

1) Local Interface
   a) local home
   b) local object
2) JNDI
   a) initial Context
   b) operations
3) Security
   a) declarative
   b) programmatic
4) Transactions
   a) declarative
   b) programmatic
5) J2EE Design Patterns
   a) service locator
   b) session façade
   c) Data Transfer Object
6) Summary

Calling Remote Object

The followings are the work needed to be completed for calling a remote object:

1) The client calls a local stub.
2) The stub marshals parameters into a form suitable for the network.
3) The stub goes over a network connection to the skeleton.
4) The skeleton demarshals parameters into a form suitable for Java.
5) The skeleton calls the `EJB` object.
6) The `EJB` object performs needed services, such as connection pooling, transactions, security, and lifecycle services.
7) The `EJB` object calls the enterprise bean instance, and the bean does its work.
8) Step 1 to 6 must be repeated for the return trip home.

Local Object

EJB 2.0 allows local client to call enterprise beans in a fast, efficient way by calling EJBs through their local objects rather than remote objects.

The following steps may occur:

1) The client calls a local object.
2) The local object performs needed services, such as connection pooling, transactions, security, and lifecycle services.
3) Once the enterprise bean instance does its work, it returns control to the local object, which then returns control to the client.

Local Home Interfaces

For creating the local objects, you need to call the special local home interface which will be implemented by the container as the local home object.

The local home interface may look as follows:

```
import javax.ejb.*;
public interface CustomerLocalHome extends
  javax.ejb.EJBLocalHome
{
      public CustomerLocal create(Integer id) throws
            javax.ejb.CreateException, EJBException;
  public CustomerLocal findByPrimaryKey(Integer pk)
      throws FinderException,EJBException;
}
```

EJBLocalHome Interfaces

The `EJBLocalHome` interface is as follows:

```
public interface javax.ejb.EJBLocalHome {
      public void remove(java.lang.Object)
            throws javax.ejb.RemoveException,
                   javax.ejb.EJBException;
}
```

Local Interfaces

The local interface, like the remote interface, defines business methods for local clients.

These business methods must match the signatures of business methods defined in the bean class.

EJBLocalObject Interface

Local interfaces has to extend `javax.ejb.EJBLocalObject`.

```
public interface javax.ejb.EJBLocalObject {
   public javax.ejb.EJBLocalHome getEJBLocalHome()
         throws javax.ejb.EJBException;
   public Object getPrimaryKey()
         throws javax.ejb.EJBException;
   public boolean    isIdentical

     (javax.ejb.EJBLocalObject)
      throws javax.ejb.EJBException;
   public void remove()
         throws javax.ejb.RemoveException,
                javax.ejb.EJBException;
}
```

Deployment Descriptor 1

Deployment descriptor needed to be modify for an EJB to use local interfaces.

For example:

```
<ejb-jar>
 <enterprise-beans>
 <entity>
        <ejb-name>CustomerEJB</ejb-name>
        <local-home>com.interfaces.CustomerHomeLocal
                </local-home>
        <local>com.interfaces.CustomerLocal</local>
         <ejb-class>com.ejb.CustomerBean</ejb-class>
        . . .
```

Deployment Descriptor 2

For any bean that needs to call the local interface, local reference has to added under the `<ejb-local-ref>` tag in the deployment descriptor.

```
<ejb-local-ref>
    <ejb-ref-name>ejb/CustomerHomeLocal</ejb-ref-name>
     <ejb-ref-type>Entity</ejb-ref-type>
    <local-home>com.interfaces.CustomerHomeLocal
      </local-home>
      <local>com.interfaces.CustomerLocal</local>
 </ejb-local-ref>
```

When to Use Local Interfaces

Considerations for choosing either a local interface or remote interface:

1) Local interface may speed up the application.
2) While using local interface, one must change the code for switching between a local or remote call.
3) Local client passes object arguments by reference from one bean to another. This means that changes of the passed object is seen by both beans.

Local Client

Skeleton code for a local client to use the local interface:

```
javax.naming.Context jndiContext = new
InitialContext( );
HelloHomeLocal home = (CustomerHomeLocal)
jndiContext.lookup
      ("java:comp/env/ejb/CustoemrHomeLocal");
. . .
CustomerLocal customer = home.findByPrimaryKey(pk);
. . .
```

Note: remember to catch the `FinderException` and `NamingException`.

Task 108: Local Interface

1) Modify the `CMP` entity Bean, `CustomerBean` created in previous task as follows:
   a) Delete the remote and home interface of the `CustomerBean`.
   b) Use `XDoclet` to generate the local and local home interfaces for the `CustomerBean`. The bean should have a `ejb-local-ref` name "`ejb/customer`".
   c) Create a stateless session bean named `TellerBean` which needs to access the customer bean through its local interface.
   d) Since the client can't access the customer bean directly, a class like `CustomerData`, which contains the ID and the name of a customer, is needed for storing the customer information.

Task 109: Local Interface

e) Return a list of `CustomerData` object to the client. In order to pass `CustomerData` by value, it must implement `Serializable`.

f) Develop a client to create some customers through `TellerBean`.

Horizontal Concepts Outline

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   b) programmatic
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6) Summary

Naming Service

1) It associates names with objects. This procedure is called binding names to objects.

   This is similar to a phone book that associating a person's name with a specific telephone number.

2) It provides a facility to find an object based on a name and is called looking up or searching for an object.

   This is similar to finding a person's telephone number based on that person's name.

Directory

A directory can be think of as a tree-like structure connecting directory objects. A company can use a directory to store the information such as the locations of computers, printers and personnel.

A directory works like a database to store data and provide query operations to lookup stored information. In fact, most directories are implemented by a database.

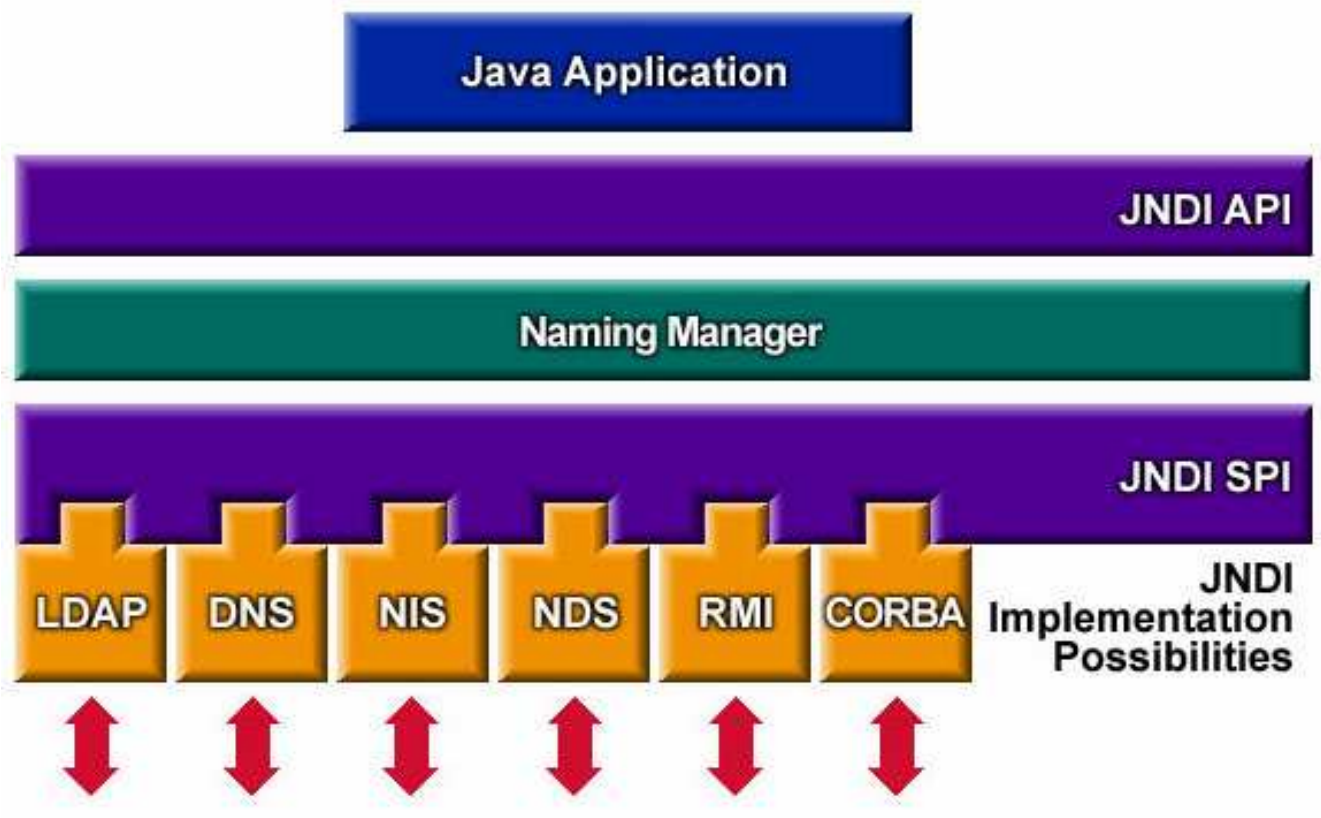
JNDI

Why JNDI?

There are many vendors providing naming and directory service using different protocols for accessing the directories. You have to modify your code to accommodate different naming and directory services.

JNDI provides a common interface for Java-based clients to interact with different naming and directory.

JNDI Architecture



Initial Context Factory

An initial context is a starting point for performing all naming and directory operations.

We use an initial context factory to acquire an initial context. For `JNDI`, an initial context factory basically is the `JNDI` driver.

Using JNDI 1

One can use the following code fragment to obtain the initial context:

```
// Obtain an Initial Context
javax.naming.Context ctx =
            new javax.naming.InitialContext

          (System.getProperties());
```

While using JBoss, the following option can be used to run a program named example:

```
java example
-Djava.naming.factory.initial
=org.jnp.interfaces.NamingContextFactory
-Djava.naming.provider.url=jnp://localhost:1099
-Djava.naming.factory.url.pkgs
=org.jboss.naming:org.jnp.interfaces
```

Using JNDI 2

The `java.naming.factory.initial` parameter identifies the class of the `JNDI` driver. This is vendor specific. if a `JNDI` service from SUN Microsystems is using, this and would be:
`com.sun.jndi.fscontext.RefFSContextFactory`

The second line is a `URL` string to identify the starting point to begin the navigation and is called the provider `URL` in `JNDI`.

`JNDI` implementation and driver is typically bundled with the `J2EE` server.

`JNDI` usually runs in process at start up and the clients can call the driver to connect to that `JNDI` tree implementation .

JNDI Operations

After acquiring the initial context, one can begin to execute `JNDI` operations and some available operations are as follows:

`lookup()`: finds objects bound to the `JNDI` tree. The return type of `lookup()` is `JNDI` driver specific and depends on the type of objects you are looking for. For example, if you're looking up `RMI-IIOP` objects, you would receive a `java.rmi.Remote` object; if you're looking up a file in a file system, you would receive a `java.io.File`.

`bind()`: publishes something to the `JNDI` tree at the current context.

`rebind()`: same as `bind()`, except it forces a bind even if there is already something in the `JNDI` tree with the same name.

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Security

Authentication – verify the identity of a client. Once the client is authenticated, he is associated with a security identity.

Authorization – permissions are granted to clients to perform specific operations.

Authentication

The EJB specification does not directly address the process of authentication. Authentication is assumed to have been performed by some other component when the call to the EJB is made.

Authentication can be performed through the Java Authentication and Authorization Service (JAAS) API.

EJB Security

EJB security can be managed:

1) declaratively by making entries in the Deployment Descriptor File, or
2) programmatically using method calls in the application.

Declarative Security

Declarative security is the preferred method of implementing a security policy using `EJBs`.

Using `EJBs` a security role can be defined. This security roles control permission to execute specific methods.

For `EJB`, security roles are declared within the deployment descriptor file (`ejb-jar.xml`).

EJB Security Roles

In the deployment descriptor, under the `<assembly-descriptor>` tag, `<security-role>` subelements can be defined as follows:

```
<assembly-descriptor>
    ...
    <security-role>
       <description>RoleDescription1</description>
       <role-name>Manager</role-name>
    </security-role>
    <security-role>
       <description>RoleDescription2</description>
       <role-name>Agent</role-name>
    </security-role>
     ...
<assembly-descriptor>
```

EJB Method Authorizations 1

After the security roles are defined, it is possible to specify the authorization requirements for each of the methods of the enterprise beans in the JAR file.

```
<assembly-descriptor>
. . .
 <method-permission>
   <role-name>Agent</role-name>
   <method>
      <ejb-name>TravelerCreditCard</ejb-name>
      <method-name>debit</method-name>
   </method>
 </method-permission>
. . .
```

EJB Method Authorizations 2

```
 <method-permission>
   <role-name>Manager</role-name>
   <method>
      <ejb-name>TravelerCreditCard</ejb-name>
      <method-name>*</method-name>
   </method>
 </method-permission>
<assembly-descriptor>
```

EJB Method Authorizations 3

If the `<role-name>` were to be replaced by a tag `</unchecked>`, the method(s) are authorized for every security role.

If an `<exclude-list>` element is used, no one would be authorized to call the method, even if there were other declarations containing roles for the same method.

```
<assembly-descriptor>
      <method-permission>
            <unchecked/>
             <method>
                  <ejb-name>EmployeeService</ejb-name>
                  <method-name>*</method-name>
             </method>
       </method-permission>
```

EJB Method Authorizations 4

```
        <exclude-list>
              <method>
                  <ejb-name>ManagerService</ejb-name>
                  <method-name>fireTheCTO</method-name>
              </method>
         </exclude-list>
</assembly-descriptor>
```

Declaring Security Roles

Bean developers are responsible for declaring abstract security roles as follows:

```
<ejb-jar>
  <enterprise-beans>
    <entity>
      <ejb-name>SecureService</ejb-name>
      ...
      <security-role-ref>
        <role-name>TrustedUser</role-name>
      </security-role-ref>
    </entity>
  </enterprise-beans>
</ejb-jar>
```

Mapping Abstract Role

Application deployer uses tag `<role-link>` for mapping the `security-role` elements to the `security-role-ref` elements as the follows:

```
<ejb-jar>
 <enterprise-beans>
   <entity>
     <ejb-name>SecureEJB</ejb-name>
     ...
     <security-role-ref>
        <role-name>TrustedUser</role-name>
           <role-link>Manager</role-link>
     </security-role-ref>
   </entity>
 </enterprise-beans>
</ejb-jar>
```

Programmatic Security Procedure

1) Deployer maps actual user identities to actual roles using vendor specific tools.
2) Bean provider writes programmatic authorization logic inside the bean code.
3) Bean provider declares abstract security roles in the bean's deployment descriptor.
4) Deployer maps abstract security roles to actual roles in deployment descriptor.

Programmatic Security

A developer can use programmatic security and references a security role in the application code as follows:

```
public class SecureServiceBean extends EntityBean
{   EntityContext ejbContext;
   . . .
   public void debit(double amount)
      throws UnTrusedException
   {
      if (! ejbContext.isCallerInRole("TrustedUser"))
         throw new UnTrusedException();
      // Other code goes here...
   }
   // Other code goes here...
}
```

RUN-AS Element

Using the <run-as> element in the deployment descriptor file, the security role of the caller can be replaced by the security role declared within the <run-as> tag and propagated to all other beans called.

```
<enterprise-beans>
     ...
      <session>
       ...
        <ejb-name>AccountLookupService</ejb-name>
         ....
          <security-identity>
           <run-as>
                          <role-name>accounting-
manager</role-name>
                        </run-as>
          </security-identity>
       </session>
...
```

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Transactions

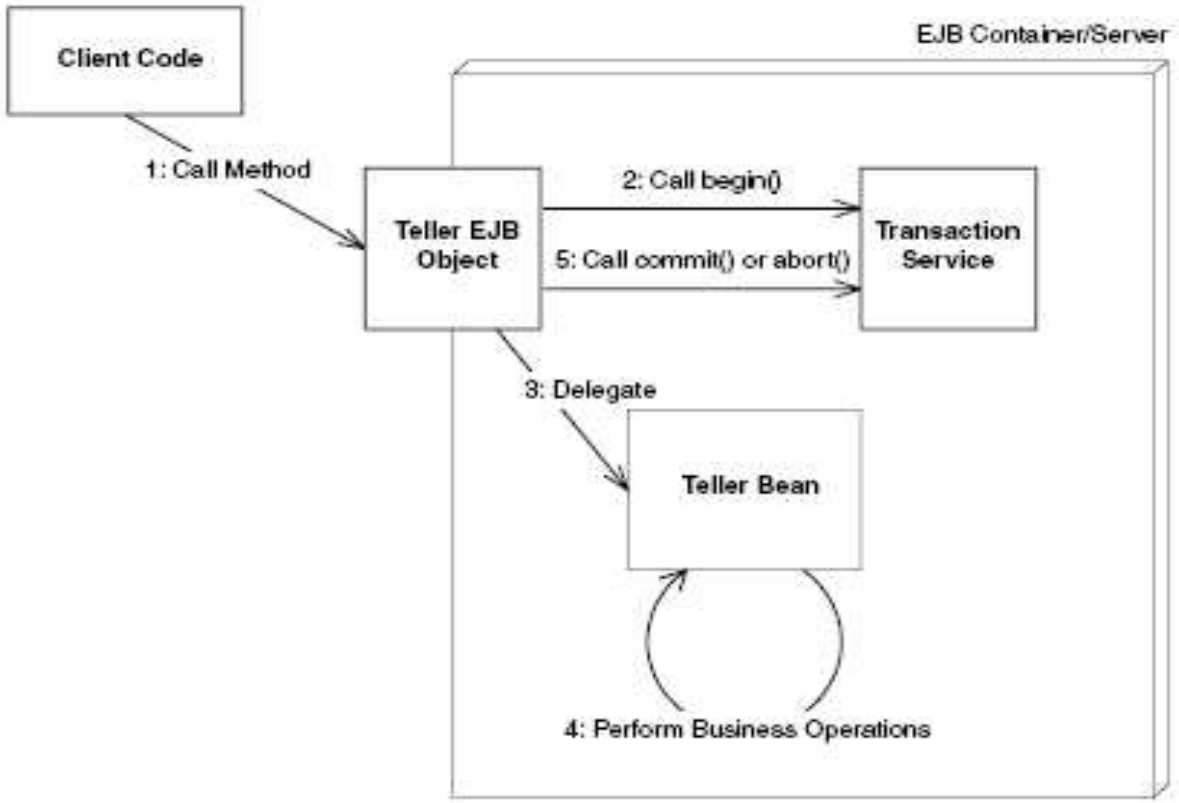
J2EE server offers transaction monitor that takes care of transactions.

There are three ways to demarcate transactions:

1) Client-initiated
2) Declaratively
3) Programmatically

Client-initiated Transaction 1

Client can write code to begin and end the transaction. But the beans being called by the client still need to be written to use either programmatic or declarative transactions.



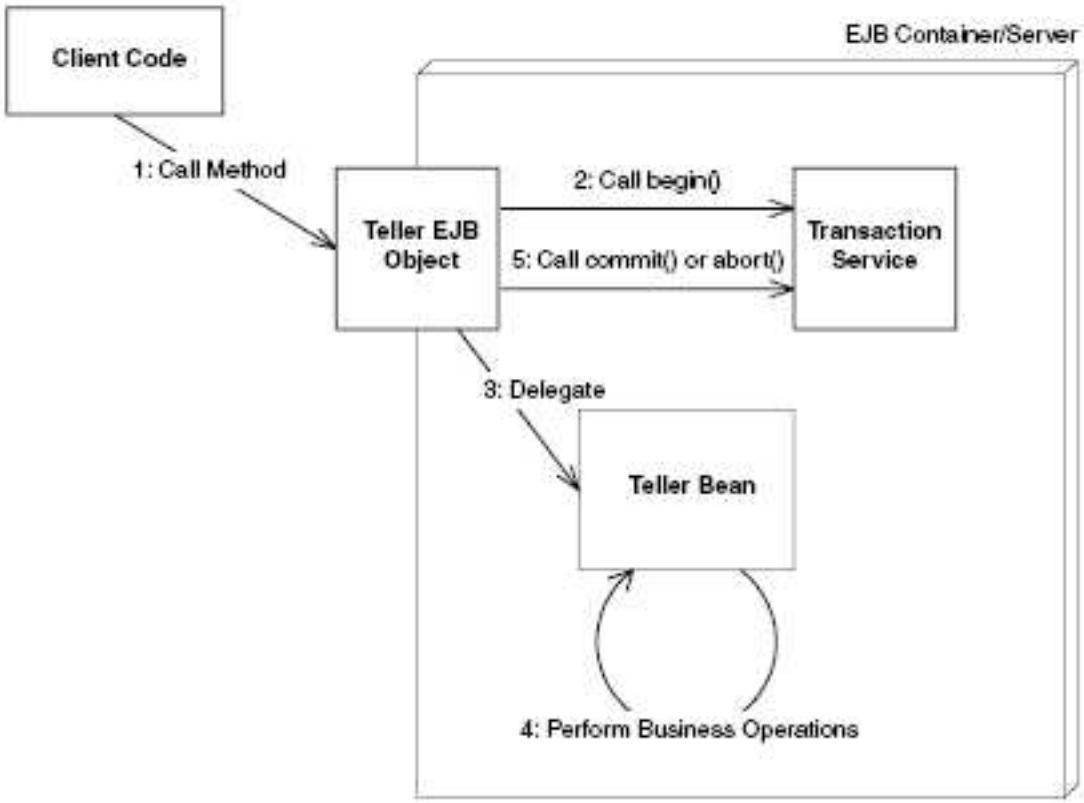
Client-Initiated Transaction 2

A client must lookup the `JTA UserTransaction` interface with the Java `JNDI` as follows:

```
. . .
try{
Context ctx = new InitialContext();
/*
* Look up the JTA UserTransaction interface
* via JNDI. The container is required to
* make the JTA available at the location
* java:comp/UserTranasction.
*/
userTran = (javax.transaction.UserTransaction)
ctx.lookup("java:comp/UserTransaction");
```

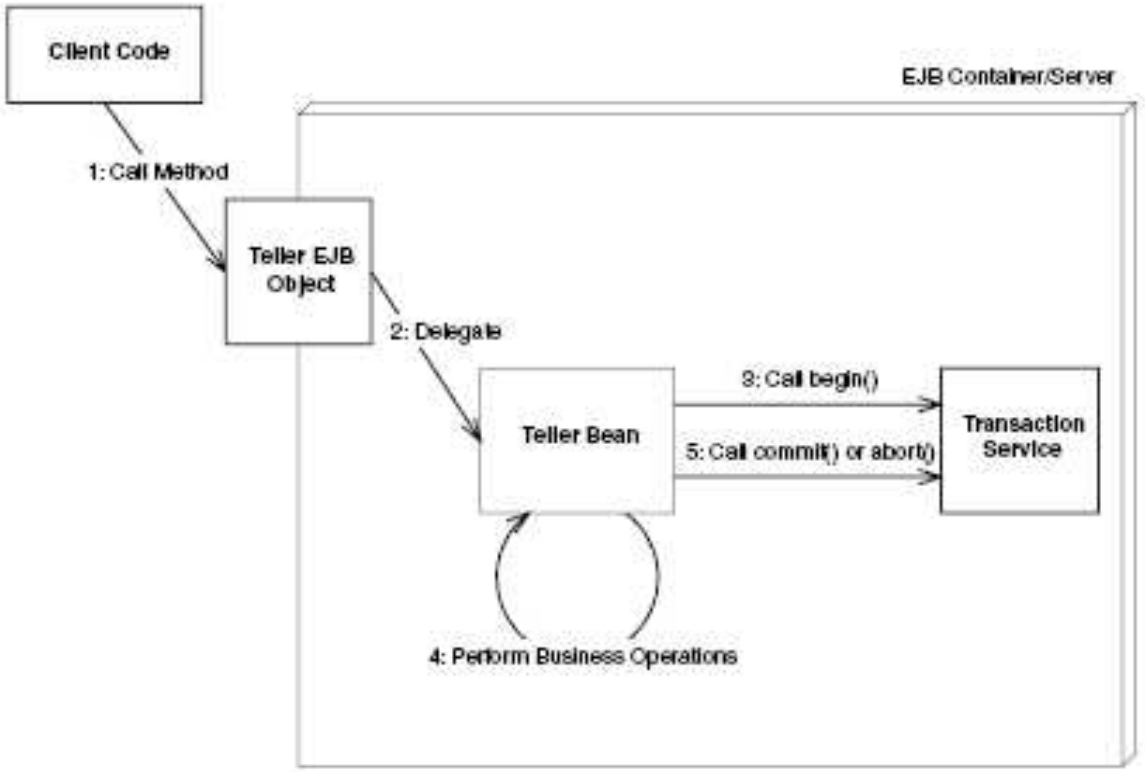
Declarative Transaction

Enterprise beans never explicitly issue a begin, commit ,or abort statement. Transaction is declared in the deployment descriptor and the EJB container performs it for you.



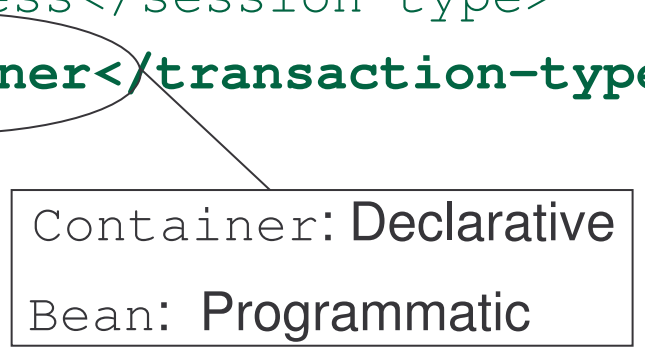
Programmatic Transaction

A begin statement and either a commit or an abort statement are hard-coded in the `EJB`.



Declare Transaction Type

```
. . .
<ejb-jar>
   <enterprise-beans>
         <session>
           <ejb-name>Hello</ejb-name>
           <home>HelloHome</home>
           <remote>Hello</remote>
           <ejb-class>HelloBean</ejb-class>
           <session-type>Stateless</session-type>
       <transaction-type>Container</transaction-type>
     </session>
   </enterprise-beans>
</ejb-jar>
```



Control of Declarative Transaction

For declarative transaction (container-managed transaction), transaction attributes are required in the deployment descriptor to instruct the container how to handle the transaction.

Transaction attributes must specify for all business methods of the beans.

With entity beans, transaction attributes must cover home interface methods, because the home interface creation methods insert database data and thus need to be transactional.

Example : Setup 1

```
<assembly-descriptor>
  <container-transaction>
   <method>
    <ejb-name>Account</ejb-name>
    <method-name>*</method-name>
   </method>
   <!--
   Transaction attribute. Can be "NotSupported",
   "Supports", "Required", "RequiresNew",
   "Mandatory", or "Never".
    -->
   <trans-attribute>Required</trans-attribute>
</container-transaction>
```

Example : Setup 2

```
<!--
 You can also set transaction attributes on
 individual methods.
 -->
<container-transaction>
 <method>
  <ejb-name>Account</ejb-name>
  <method-name>deposit</method-name>
 </method>
 <trans-attribute>Required</trans-attribute>
</container-transaction>
```

Example : Setup 3

```
  <!--
   You can even set different transaction attributes
   on overload methods.
   -->
  <container-transaction>
   <method>
    <ejb-name>Account</ejb-name>
    <method-name>deposit</method-name>
    <method-param>double</method-param>
   </method>
   <trans-attribute>Required</trans-attribute>
  </container-transaction>
</assembly-descriptor>
```

Transaction Attributes 1

1) `Required`
   a) If client has started transaction, bean is associated to the same transaction.
   b) If client has not started a transaction, a new transaction is created.

2) `Supports`
   a) If client has started a transaction, bean is associated to the same transaction.
   b) Otherwise method is executed without transaction.

3) `RequiresNew`
   a) When method is invoked, a new transaction is created and last only that method call.

Transaction Attributes 2

4) `Mandatory`

   a) If transaction has not started before calling the method, exception is thrown.

5) `NotSupported`

   a) If transaction has started before calling the method, transaction will be suspended until the method is completed.

6) `Never`

   a) If method is called within a transaction, exception is thrown.

Effects of Transaction Attributes

Transaction Attribute	Client's Transaction	Bean's Transaction
Required	None	T2
	T1	T1
RequiresNew	None	T2
	T1	T2
Supports	None	None
	T1	T1
NotSupported	None	None
	T1	None
Mandatory	None	Error
	T1	T1
Never	None	None
	T1	Error

Transaction Roll Back

There are two ways to roll back a container-managed transaction:

1) If a **system exception** is thrown, the container will automatically roll back the transaction.
2) The bean method invokes a roll back by calling the `setRollbackOnly` method of the `EJBContext` interface.

Programmatic Transactions

Only session and message-driven bean can use programmatic (bean-managed) transaction to marks the boundaries of a transaction.

Bean-managed transaction provides a fine-grained control over the transaction.

Either `JDBC` or `JTA` (Java Transaction API) can be used for coding a bean-managed transaction.

JDBC Transactions 1

1) JDBC Transaction is controlled by the transaction manager of the DBMS.
2) It is used when legacy code is wrapped inside a session bean.
3) Generally, a transaction begins with the first SQL statement that follows the most recent commit, rollback, or connect statement.

JDBC Transactions 2

The **`commit`** and **`rollback`** methods of the **`java.sql.Connection`** interface can be invoked as follows:

```
public void ship (String productId, String orderId, int
 quantity) {
try {
 makeConnection();
 con.setAutoCommit(false);
 updateOrderItem(productId, orderId);
 updateInventory(productId, quantity);
 con.commit();
} catch (Exception ex) {
```

JDBC Transactions 3

```
        try {
            con.rollback();
            throw new EJBException("Transaction failed: " +
            ex.getMessage());
        } catch (SQLException sqx) {
            throw new EJBException("Rollback failed: " +
            sqx.getMessage());
        }
    } finally {
         releaseConnection();
    }
}
```

JTA Transaction 1

JTA (Java Transaction API) provides a unify high-level abstraction for the JTS (Java Transaction Service).

A JTA transaction is controlled by the J2EE transaction manager.

It cannot start a transaction for an instance until the preceding transaction has ended.

The following methods of the **javax.transaction.UserTransaction** interface are used to demarcate a JTA transaction:

```
begin
commit
rollback
```

JTA Transaction 2

Both the client and bean code can use the Java Transaction API (JTA) to control the transaction programmatically through the interface:

javax.transaction.UserTransaction

```
public interface javax.transaction.UserTransaction {
    public void begin();
    public void commit();
    public int getStatus();
    public void rollback();
    //Calls this to force the current transaction to
       roll back
    public void setRollbackOnly();
    public void setTransactionTimeout(int);
}
```

Example: UserTansaction 1

```
. . .
public void deposit(double amt) throws AccountException
{
      javax.transaction.UserTransaction userTran = null;
      try {
            System.out.println("deposit(" + amt );
            //ctx is the InitialContext
            userTran = ctx.getUserTransaction();
            userTran.begin();
            balance += amt;
            userTran.commit();
      }catch (Exception e) {
     try{userTran.rollback();
        }catch (SystemException se){
```

Example: UserTansaction 2

```
                throw new EJBExcepiton("RollBasck " +
                                    se.getMessage());
            }
          throw new EJBExcepiton
              ("Transaction Fail " + e.getMessage());

      }
}
```

Task 110: Transaction

1) Use the `EmployeeBean` developed in Task 103 to test the operations of transaction.
    a) Develop a stateless session bean using `Jboss-IDE` plug-in.
    b) This bean should have a method "`createEmployee`" which receives an array of id and names as arguments. `createEmployee` method will uses the arguments received for creating employees.
    c) Add a `xdoclet` tag to declare the `createEmployee` method with a "`Required`" transaction:
    ```
    @ejb.transaction type = "Required"
    ```
    d) Create a client which adds the same employees twice. This will initiate an exception and cause a roll-back. Use the client program to test the roll-back operation.

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EJB Design Patterns

For designing, building and working with EJB, there are many proven approaches being known as J2EE design patterns.

By being aware of these J2EE design patterns, you can avoid the common pitfalls others have experienced.

The followings will be discussed:

1) Service Locator
2) Session Façade
3) Data Transfer Object (DTO)

Service Locator

Problems need to be addressed:

1) A client need to implements the lookup mechanism in order to use `JNDI` to obtain services or `EJB` components.
2) This operation is complex and vendor dependent.
3) Repeatedly creating `JNDI` initial context and looking up `EJB` home object are heavy operations.

Solution: use Service Locator

Service Locator Implementation

A Service Locator is typically implemented as a `Singleton` which encapsulates the `JNDI` lookup services and business object creation to provide a simple interface to clients.

Example: Service Locator

```
import java.io.*;

import java.rmi.RemoteException;
import java.util.Collections;
import java.util.HashMap;
import java.util.Map;

import javax.ejb.EJBHome;
import javax.ejb.EJBLocalHome;
import javax.ejb.EJBObject;
import javax.naming.InitialContext;
import javax.naming.NamingException;
import javax.rmi.PortableRemoteObject;
```

Example: Service Locator

```
public class ServiceLocator {
      private InitialContext initialContext;
      private Map serviceCache;
      private static ServiceLocator _instance;
      static {
          try {
              _instance = new ServiceLocator();
         } catch (NamingException se) {
              System.err.println(se);
             se.printStackTrace(System.err);
          }
      }
```

Example: Service Locator

```
private ServiceLocator() throws NamingException {
      initialContext = new InitialContext();
       serviceCache =
         Collections.synchronizedMap(new HashMap());
      }

      static public ServiceLocator getInstance() {
          return _instance;
      }
```

Example: Service Locator

```
// look up the local home object
      public EJBLocalHome getLocalHome(String
       jndiHomeName) throws NamingException {
        EJBLocalHome localHome = null;
        if (serviceCache.containsKey(jndiHomeName)) {
           localHome = (EJBLocalHome)
              serviceCache.get(jndiHomeName);
     } else {
         localHome = (EJBLocalHome)

       initialContext.lookup(jndiHomeName);
        serviceCache.put(jndiHomeName, localHome);
          }
        return localHome;
       }
```

Example: Service Locator

```
// lookup the remote home object
      public EJBHome getRemoteHome(String
      jndiHomeName,     Class homeClassName)throws
NamingException {
       EJBHome remoteHome = null;
       if (serviceCache.containsKey(jndiHomeName)) {
         remoteHome = (EJBHome)
            serviceCache.get(jndiHomeName);
       } else {
         Object objref =
         initialContext.lookup(jndiHomeName);
         Object obj =
         PortableRemoteObject.narrow(objref,
            homeClassName);
```

Example: Service Locator

```
                remoteHome = (EJBHome) obj;
                serviceCache.put(jndiHomeName,
                 remoteHome);
               }
                return remoteHome;
        }
}
```

Session Façades

Problems need to be addressed:

1) High coupling
   - Allowing client directly access the server-side components leads to direct dependency.
2) Poor reusability and manageability
   - Direct access may also require the client to include complex logic to cooperate and interact with various business components.
3) High network overhead
   - Allowing client to access fine-grained components repeatedly will increase the network traffic due to many remote network calls.

Solution: use Session Façade

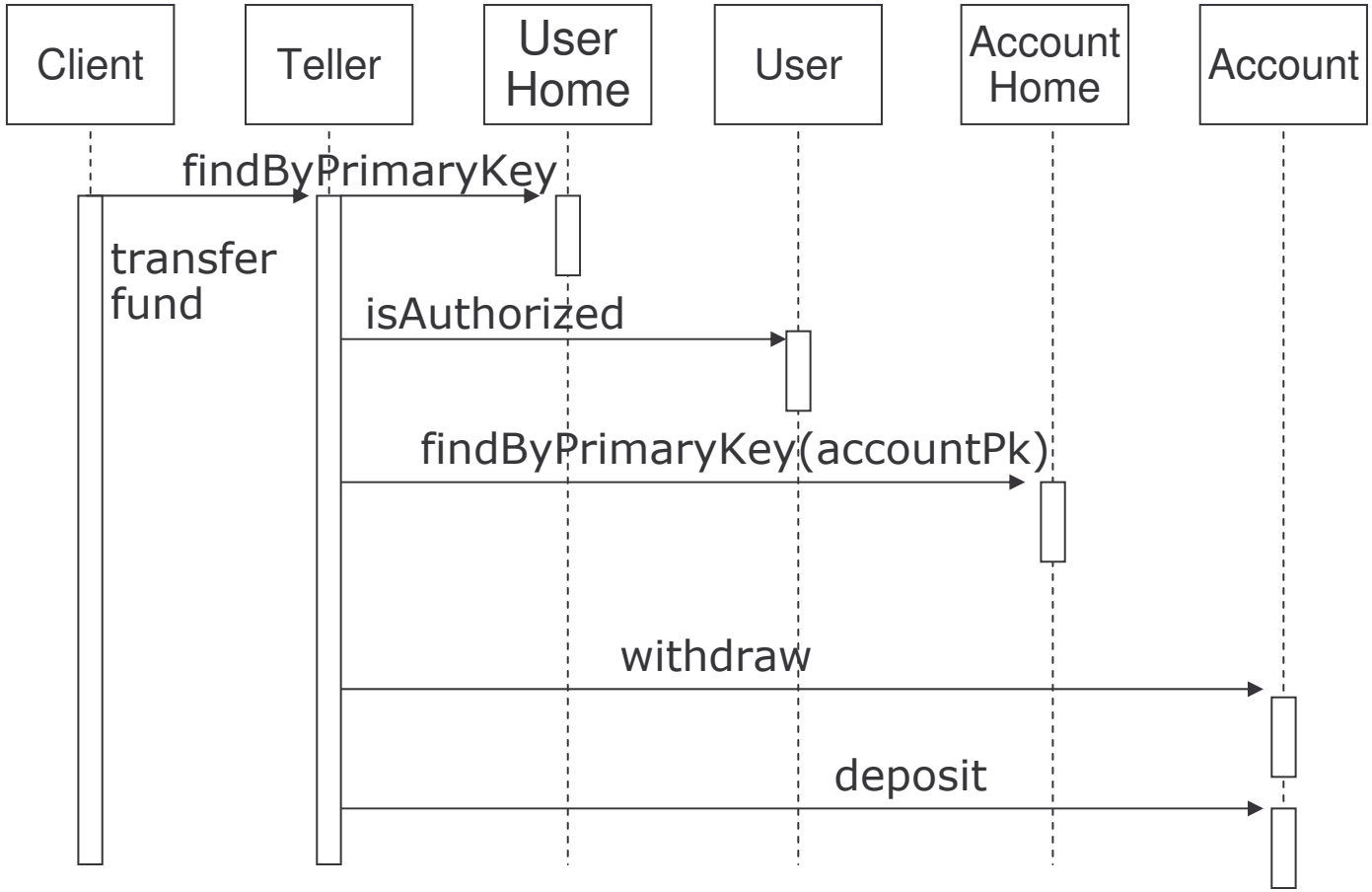
Session Façade Implementation

A Session Façade is typically implemented as a session bean which encapsulates the components and provides a remote service layer for the client.

A session façade can either be implemented as a stateful or a stateless session bean.

1) Sateful:
   a) The use case is conversational.
   b) The state must be saved between each client method invocation.
2) Stateless:
   a) The use case is non-conversational.
   b) The client only need to initiate a single method in the Session Façade

Example: Session Façade



Data Transfer Object

Problems need to be addressed:

1) If a client want to transfer multiple data elements over a tier, several getter methods of an EJB may be invoked to get all the attribute values.
2) Network overhead is increased.

Solution: use Data Transfer Object (DTO)

DTO Implementation

A Data Transfer Object:

1) is usually implemented as a serializable Java object
2) created by `EJB` component, populated with data and transmitted
3) can be used for both reading and update operations

Horizontal Concepts Outline

1) Local Interface
   a) local home
   b) local object
2) JNDI
   a) initial Context
   b) operations
3) Security
   a) declarative
   b) programmatic
4) Transactions
   a) declarative
   b) programmatic
5) J2EE Design Patterns
   a) service locator
   b) session façade
   c) Data Transfer Object
6) Summary

Summary 1

EJB 2.0 allows local client to call enterprise beans in a fast, efficient way by calling EJBs through their local objects rather than remote objects.

Considerations for choosing either a local interface or remote interface:

a) Local interface may speed up the application by marshalling parameters by reference rather than by value.

b) While using local interface, one must change the code for switching between a local or remote call.

c) Local client passes object arguments by reference from one bean to another. This means that changes of the passed object is seen by both beans.

Summary 2

There are many vendors providing naming and directory service using different protocols for accessing the directories.

`JNDI` provides a common interface for Java-based clients to interact with different naming and directory.

Using `JNDI`, one should first acquire the initial context, then begin to execute `JNDI` operations such as:

1) `lookup()`

2) `bind()`

3) `rebind()`

Summary 3

EJB security can be managed:

1) declaratively by making entries in the Deployment Descriptor File, or
2) programmatically using method calls in the application.

Summary 4

There are three ways to demarcate transactions:

1) Client-initiated
2) Declaratively
3) Programmatically

Summary 5

A client must lookup the `JTA UserTransaction` interface with the `Java JNDI` as follows:

```
. . .
try{
Context ctx = new InitialContext();
userTran = (javax.transaction.UserTransaction)
ctx.lookup("java:comp/UserTransaction");
```

Summary 6

Only session and message-driven bean can use programmatic (bean-managed) transaction to marks the boundaries of a transaction.

Either `JDBC` or `JTA` (Java Transaction API) can be used for coding a bean-managed transaction.

Summary 7

For designing, building and working with EJB, there are many proven approaches being known as J2EE design patterns.

By being aware of these J2EE design patterns, one can avoid the common pitfalls others have experienced.

Some of them are:

1) Service Locator
2) Session Façade
3) Data Transfer Object

Case Study

Course Outline

1) basic concepts

2) vertical concepts
   a) session beans
      a) stateful
      b) stateless
   b) entity beans
      a) bean managed
      b) container managed
      c) relationships
   c) message-driven beans

3) horizontal concepts
   a) local interface
   b) JNDI
   c) role-based security
   d) transactions
   e) J2EE design patterns

4) case study

Objective

In this section, an hands-on practice is required to be completed in order to review the technologies discussed in the course.

Task 111: Hands-On Practice

1) Each customer of a bank has an ID (an integer) and a name. Use `XDoclet` to write a `CMP` entity bean to represent the customers.
2) Develop a session façade named TellerBean so that the client can create a customer and list all the customers through this teller session bean.
3) The customer bean is not allowed to be exposed to the remote client. How to achieve this requirement. (Hint: use `XDoclet` tasks localinterface and localhomeinterface to generate the corresponding interfaces)
4) As the teller bean needs to access the customer bean, it needs an `ejb-ref` tag. In particular, as the access to the customer bean will be through its local interface, you must set the view-type parameter of the ejb-ref tag to local, otherwise the teller bean will be unable to find the customer bean.

Task 112: Hands-On Practice

5) Create a Data Transfer Object named `CustomerData` to hold the ID and the name of a customer. The teller bean should return a list of `CustomerData` object instead of a list of Customer `EJB` objects. In order to pass `CustomerData` by value, it must implement `Serializable`.
6) Modify the create method so that it takes a `CustomerData` as an argument.
7) The methods of the teller bean must run in a transaction.
8) Create a client to test it.

Task 113: Hands-On Practice

9) Enhance the program to allow the client to open an account, to find all accounts and to find the accounts of a certain customer given his ID. Each account has an ID (an integer) and a balance (an integer) and an owner (a customer). A customer can open more than one accounts. The client can access the accounts through the teller bean only.
10) Create a `CMP` entity bean for the accounts. It supports local interface only and a transfer object is needed to return an account to the client. It is required that an account bean has an unidirectional relationship with to its owner pointing from account to owner.
11) In order to find the accounts of a customer, a finder method in the account bean is required.

Task 114: Hands-On Practice

12) Enhance the teller session bean developed so that the client can delete a customer. Make sure the his accounts are also deleted automatically (using cascade delete).
13) Enhance the client to test it.
14) Enhance the program again to allow the client to deposit into or withdraw from an account. Each such operation must be recorded. Such an operation has an ID (an integer) and an amount. The amount is positive for a deposit, and is negative for a withdrawal. The program should allow the client to find all the operations of an account given its account ID. A client is restricted to receive this information through the teller bean only.

Task 115: Hands-On Practice

15) Create a `CMP` entity bean for the account operation. Again it supports local interface only. Use a data transfer object to return the information of the accounts' operation to the client. Again, an account is required to have an unidirectional relationship with it's operation pointing from account to operation.
16) Each operation of an account should have an ID number supplied by the system. The system is required to find the maximum existing ID and then add one to it to get the next ID. To find the maximum ID, use an `EJB-QL` statement such as `"select max(...)"` in an `ejbSelect` method. This `ejbSelect` should return an `Integer` object. Note that if there is no bank transaction yet, the `EJB-QL` will return null.
17) Make sure that if an account is deleted, all the operation records of that account must also be deleted automatically (using cascade delete).
18) Enhance the client to test it.