# CSC584 Enterprise Programming

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CHAPTER 2 – INTRODUCTION TO JAVA EE

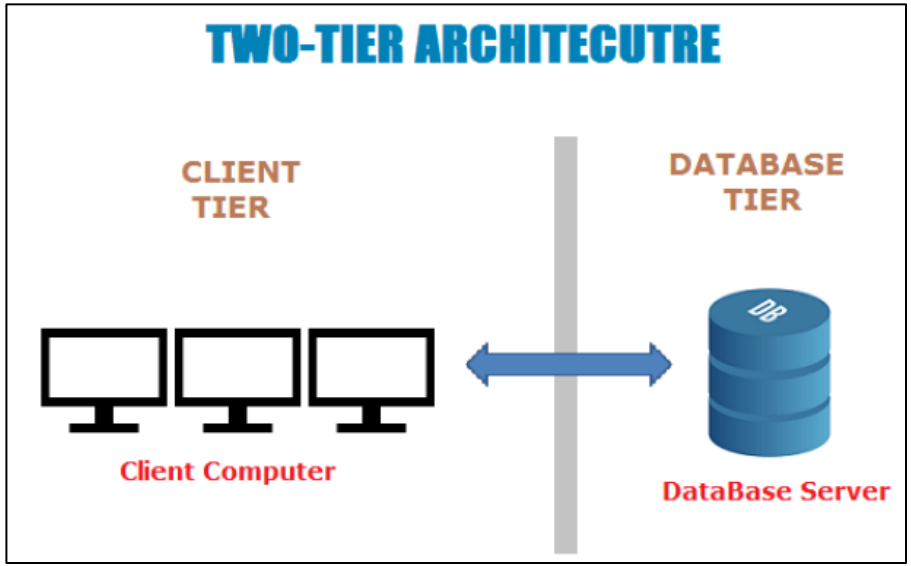
# Chapter 2 Outline

- Overview of Java EE Platform
- Role of Application Servers
- Java EE Architecture
- Java EE Patterns
- Java EE Components (Web components, EJB)

# Overview of Java EE Platform

# Past History

- Initially two tier architecture (client server applications)
- Client is responsible for data access applying business logic and presentation of data
- Only service provided by Server was that of  database server.

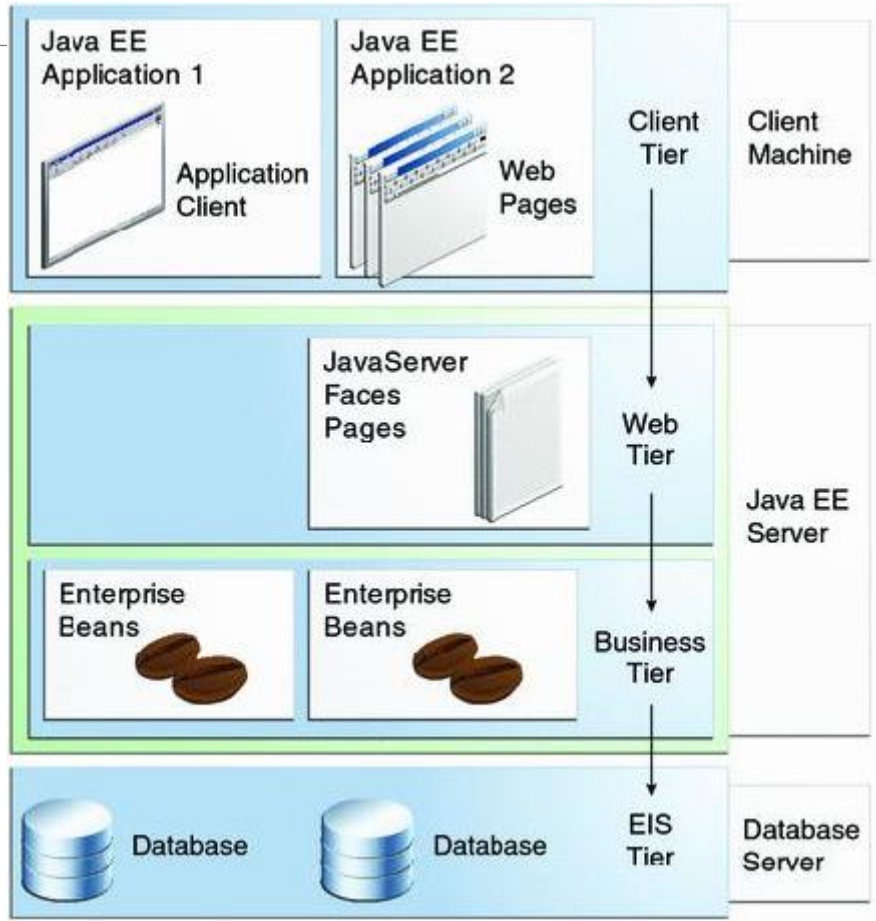



**Drawbacks**

- Easy to deploy but difficult to enhance or upgrade.
- It makes reuse of business and presentation logic difficult
- Not scalable and not suited for internet

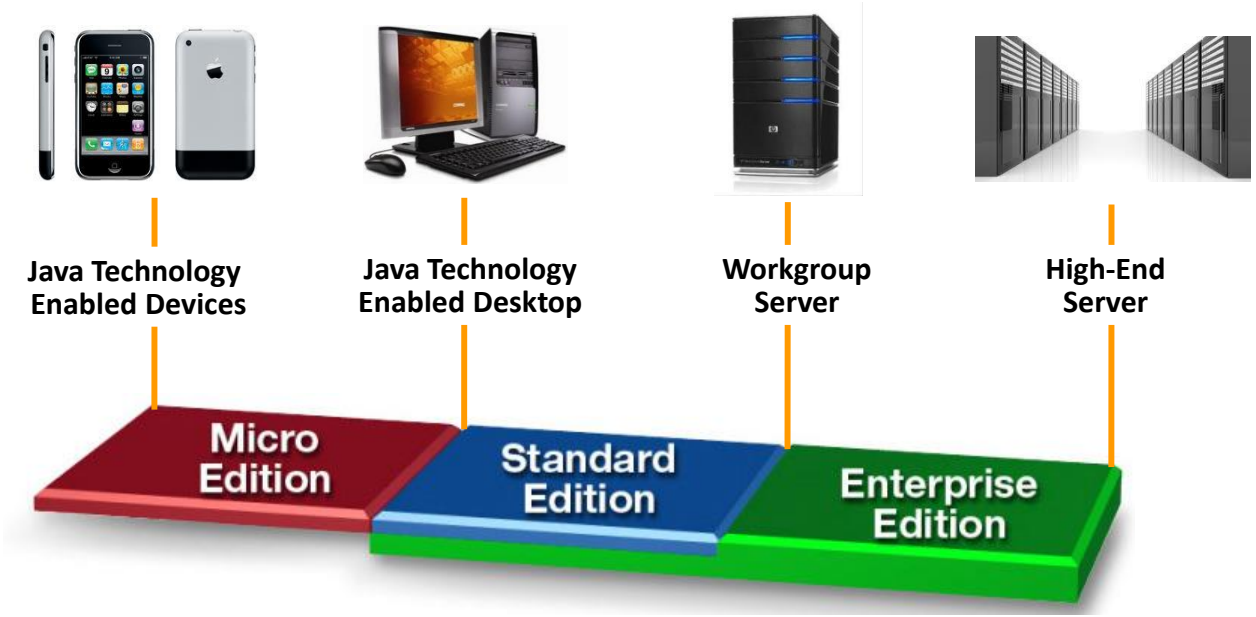
# Java Platform

- Java EE is an architecture for implementing enterprise class applications using Java and Internet Technology
  - Solves problems of two tier architecture



# Java Platform

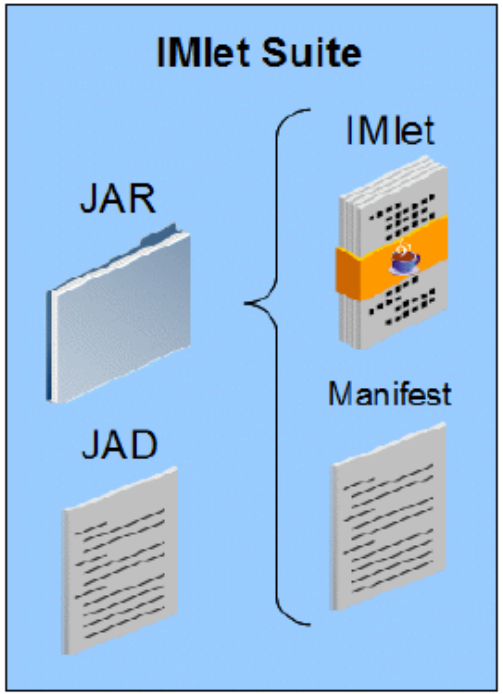
- A Java platform comprises the **JVM** together with **supporting class libraries**.



# Java Platform

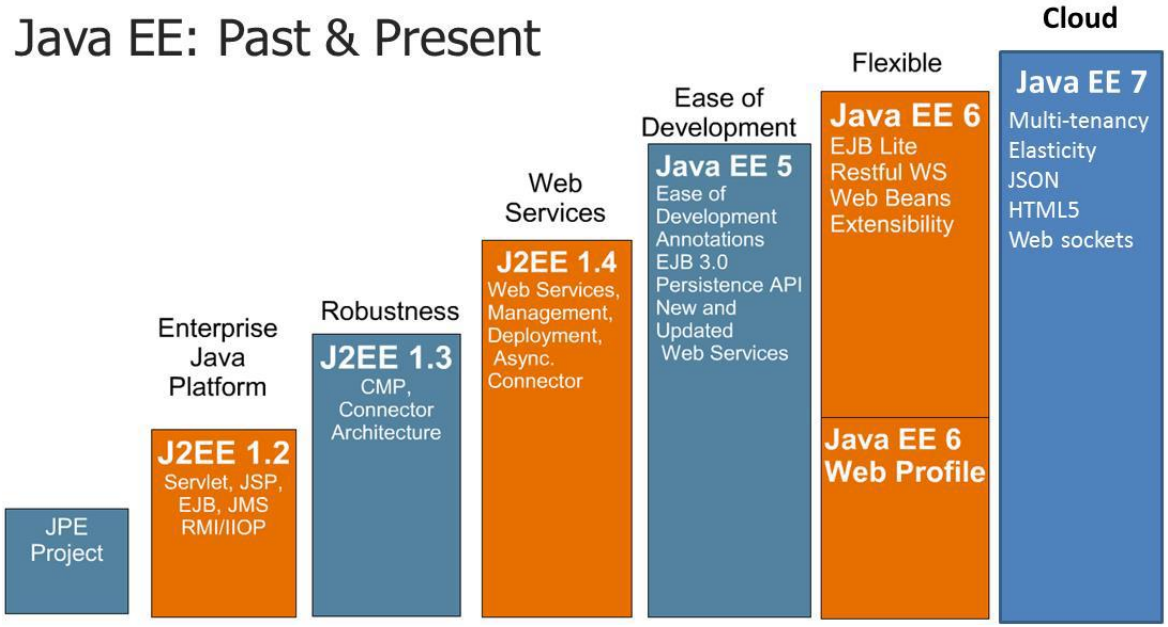
- **Java Micro Edition (Java ME)**
  - comprises the necessary core libraries and tools for writing Java for embedded systems and other small footprint platforms, along with some **specialised libraries** for specific types of device such as **mobile phones**.

Java ME Embedded Application



# Overview of Java EE Platform

- Java Platform, Enterprise Edition is a set of specifications, extending Java SE with specifications for enterprise features such as distributed computing and web services.



# Java Platform

- **Java 2 Standard Edition (J2SE)**
  - (1999) provides core libraries for data structures, xml parsing, security, internationalization, db connectivity, RMI
- **Java 2 Platform, Enterprise Edition (J2EE)**
  - provides more class libraries for servlets, JSPs, Enterprise Java Beans, advanced XML
- **Java Platform, Enterprise Edition (Java EE)**
  - When Java Platform 5.0 was released (2004) the '2' was dropped from these titles.

# Java Web Application

- A **Java web application** generates **interactive web pages** containing various types of markup language (**HTML**, **XML**) and **dynamic content**.
- It is typically comprised of web components such as:
  - **JavaServer Pages (JSP)**
  - **Servlets**
  - **JavaBeans**
- to **modify** and temporarily **store data**, **interact with databases** and **web services**, and **render content** in response to **client requests**.

# Java EE (Enterprise Edition)

- **Java EE** is a widely used **platform** containing a **set of coordinated technologies** that significantly reduce the cost and complexity of:
  - **developing**
  - **deploying and**
  - **Managing**

**Java EE 6 is supported only by the GlassFish server v3.x.**

- multitier, server-centric applications.
- Java EE builds upon the Java SE platform and **provides a set of APIs** (application programming interfaces) for developing and running portable, robust, scalable, reliable and secure server-side applications.

# Java EE Platform

- The Java EE platform uses a simplified programming model.
- **XML deployment descriptors** are **optional**. Instead, a developer can simply enter the information as an **annotation** directly into a Java source file, and the **Java EE server** will configure the component at deployment and runtime.
- With **annotations**, you put the specification information in your code next to the program element affected.

# Java EE Application Model

- an architecture for implementing **services as multitier applications** that deliver the scalability, accessibility, and manageability needed by enterprise-level applications.
- With this structure you can more easily change one of the tiers without compromising your entire application.
- **Business and presentation logic** - to be implemented by the **developer**
- **Standard system services** – to be provided by the **Java EE platform**

# Role of Application Servers

- A Java EE server is **a server application** that implements the Java EE platform APIs and provides the standard Java EE services.
- Java EE servers are sometimes called **application servers**, because they allow you to serve application data to clients, much as how web servers serve web pages to web browsers.
- The Java EE server provides services to these components in the form of a **container**.

# Java EE Containers

- are the **Interface** between a **Java component** and the **low-level platform-specific functionality** (*i.e.* **transaction and state management, multithreading, resource pooling, etc.**) that supports the component.
- provide for the separation of **business logic** from **resource** and **lifecycle management.**
- this allows developers to focus on writing business logic rather than writing **enterprise infrastructure**.

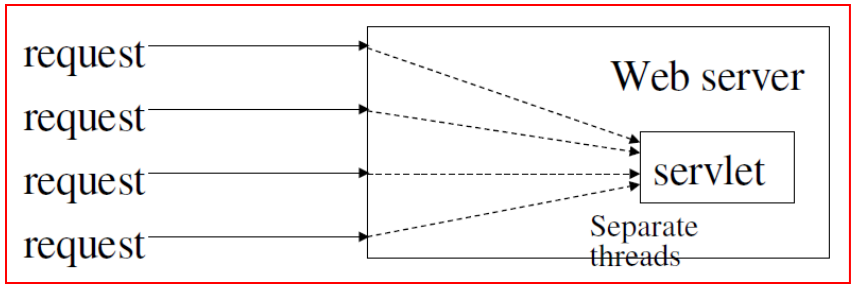
The **Java EE platform** uses "**containers**" to simplify development.

# Java EE Containers

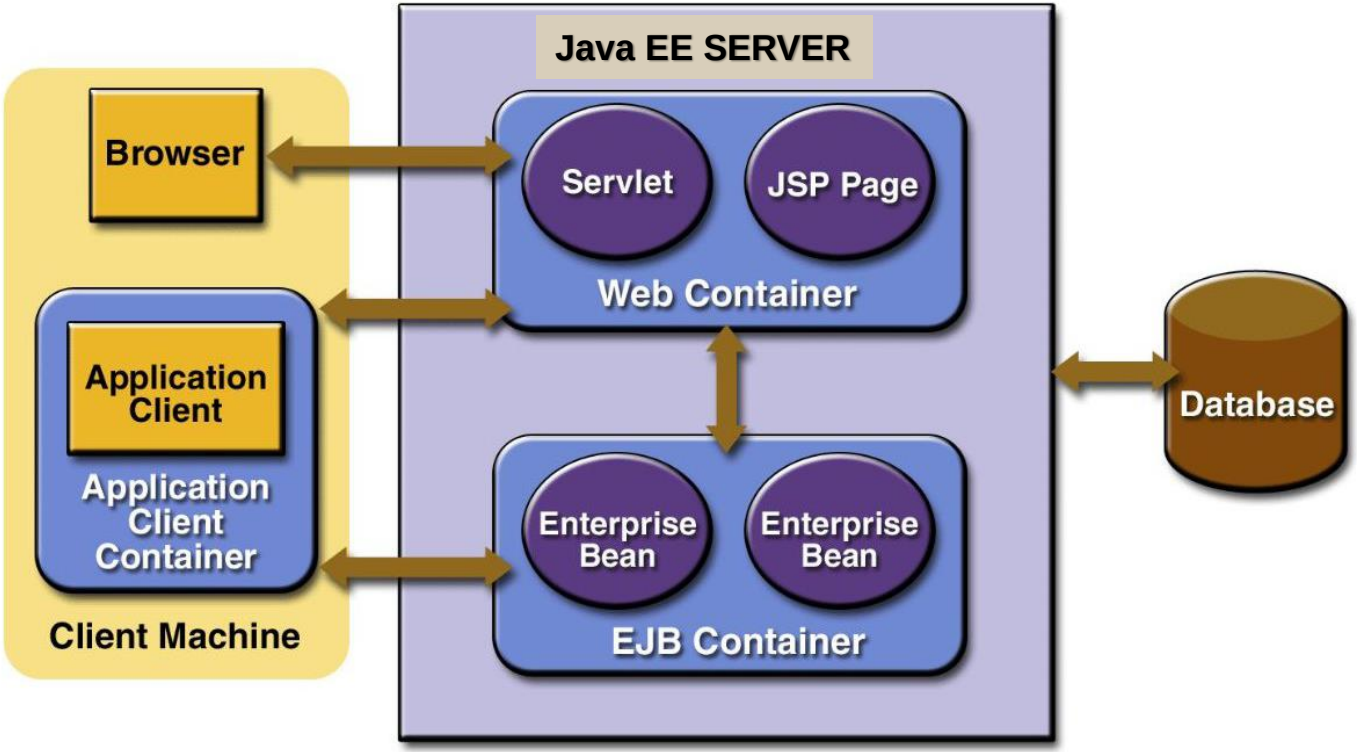
**When a request comes in:**

- a **Servlet** needs to be **instantiated** and create a **new thread** to handle the request.
- call the **Servlet's** `doPost()` or `doGet()` method and pass the **HTTP request** and **HTTP response** objects
- get the request and the response to the **Servlet**
- manage the life, death and resources of the **Servlet**

* All of the above are the tasks of the **web container**.

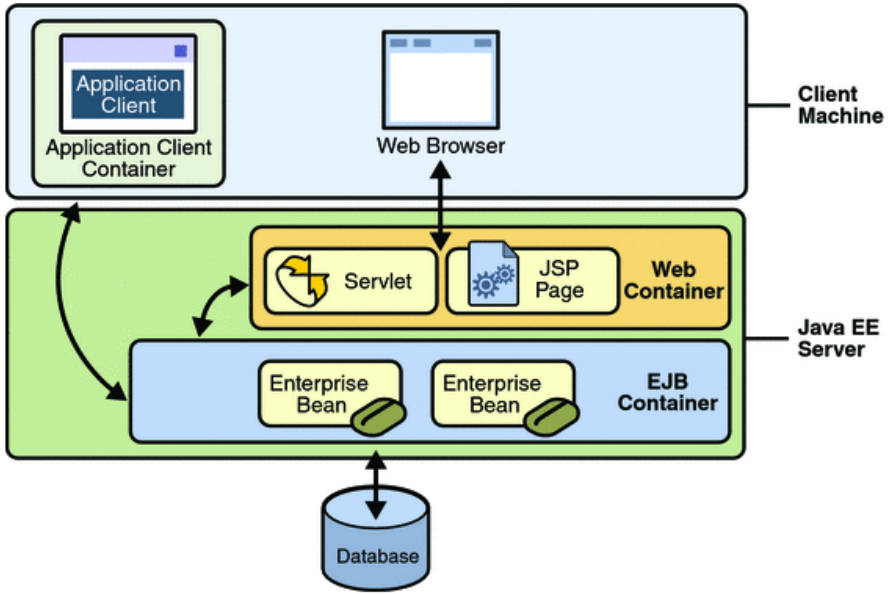


# Java EE Containers



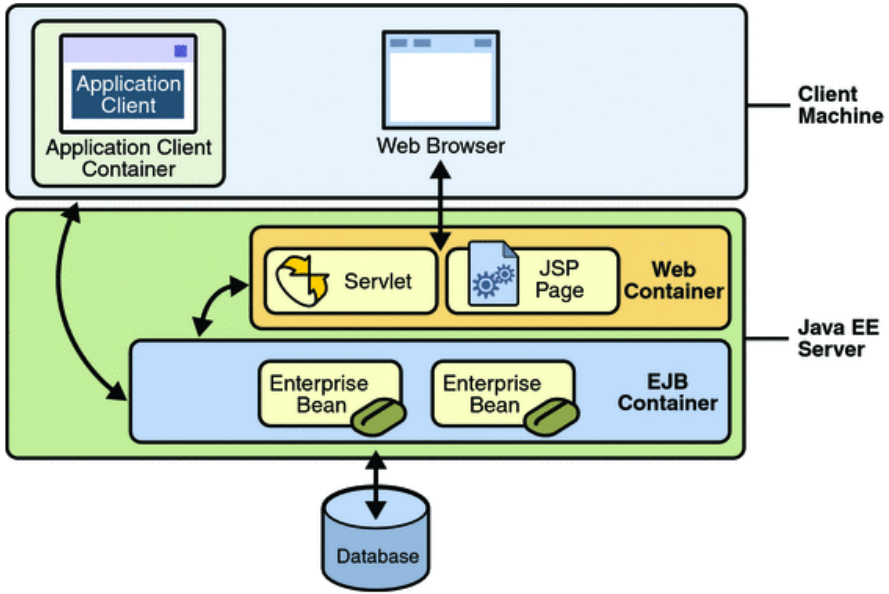
# Container Types

- **Java EE server**: The runtime portion of a Java EE product. A Java EE server provides EJB and web containers.
- **Enterprise JavaBeans (EJB) container**: Manages the execution of enterprise beans for Java EE applications. Enterprise beans and their container run on the Java EE server.
- **Web container**: Manages the execution of JSP page and servlet components for Java EE applications. Web components and their container run on the Java EE server.



# Container Types

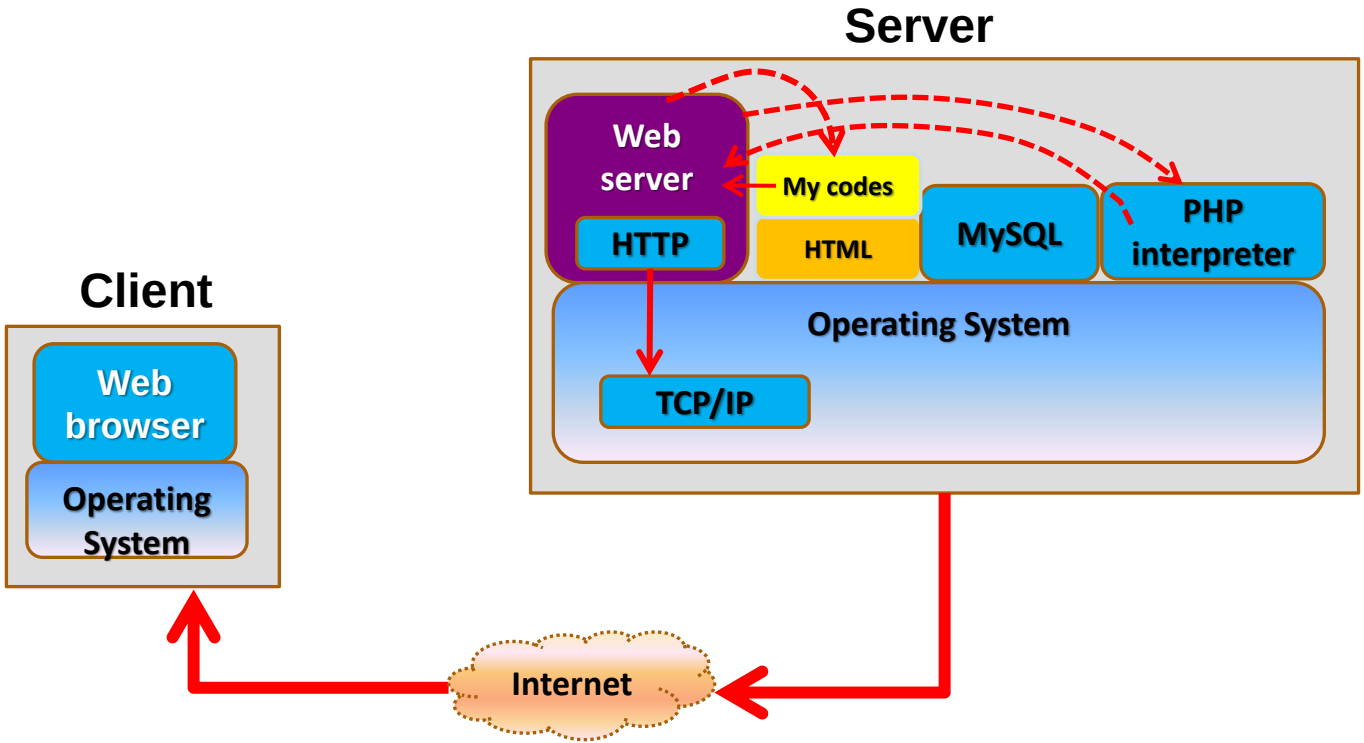
- **Application client container**: Manages the execution of application client components. Application clients and their container run on the client
- **Applet container:** Manages the execution of applets. Consists of a web browser and Java Plug-in running on the client together.



# The Available Java Application Servers

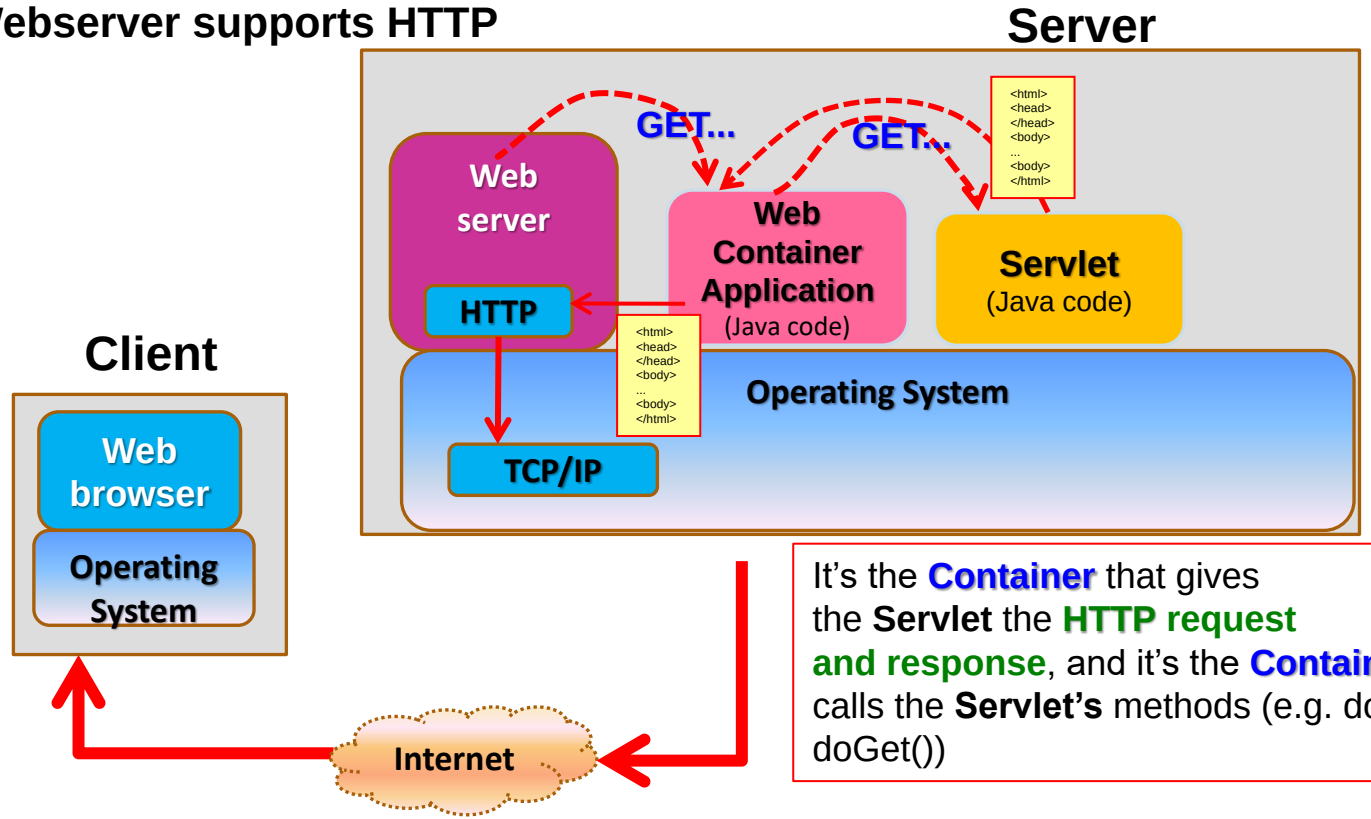
# Recall: (PHP-MySQL) Server: response

- **Webserver supports HTTP.**



# Historically (Java Web App) Server: response

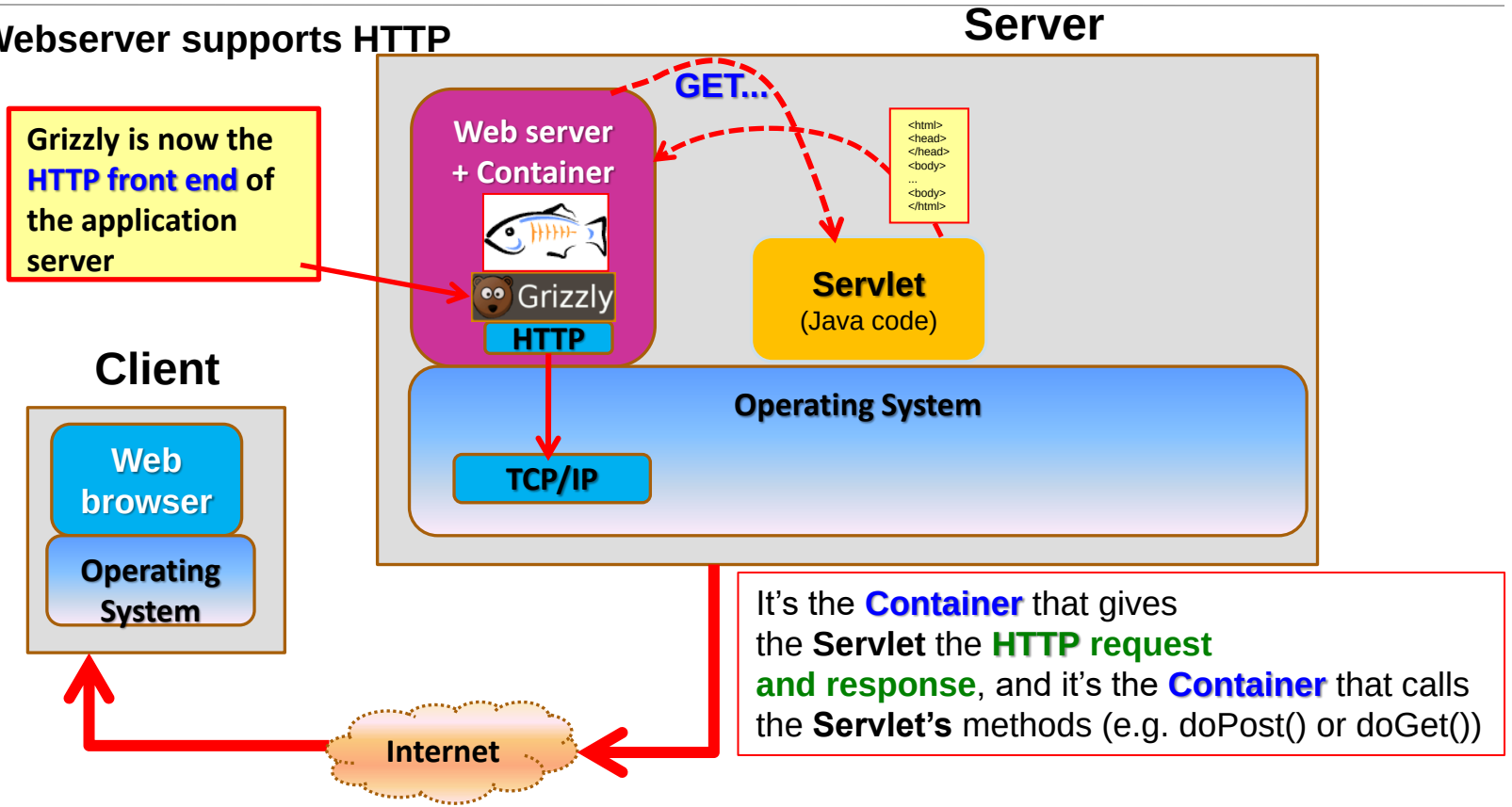
- **Webserver supports HTTP**




It's the **Container** that gives the **Servlet** the **HTTP request and response**, and it's the **Container** that calls the **Servlet's** methods (e.g. doPost() or doGet())

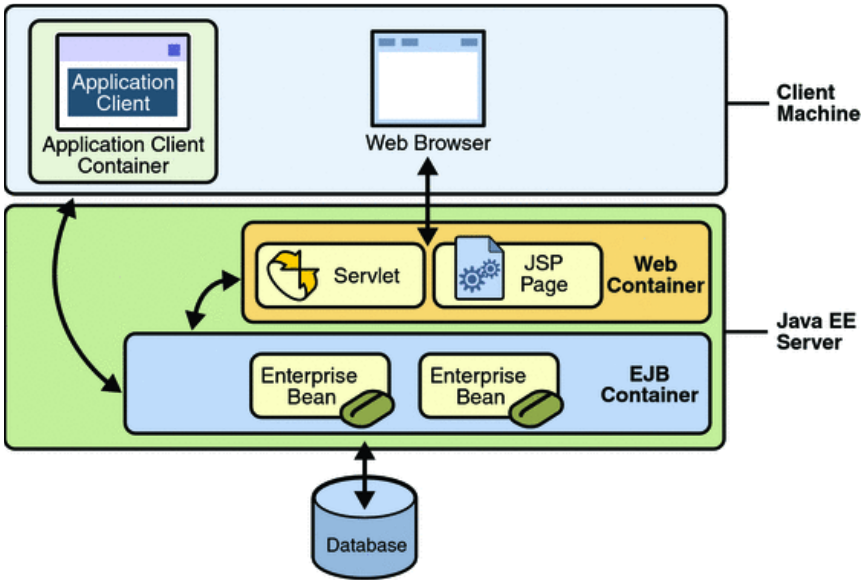
# (Java Web App) Server: response

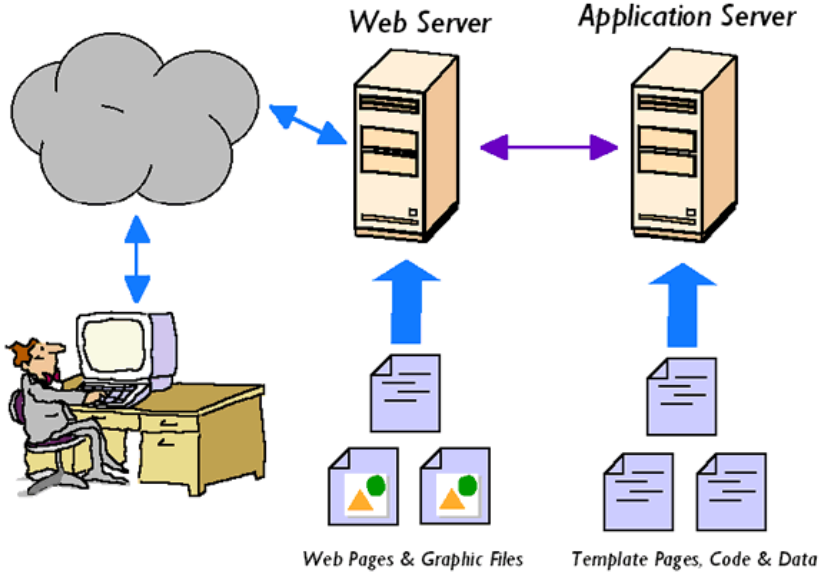
- **Webserver supports HTTP**



# Discussions…

- What is the difference between Web Server, Web Container and Application Server?



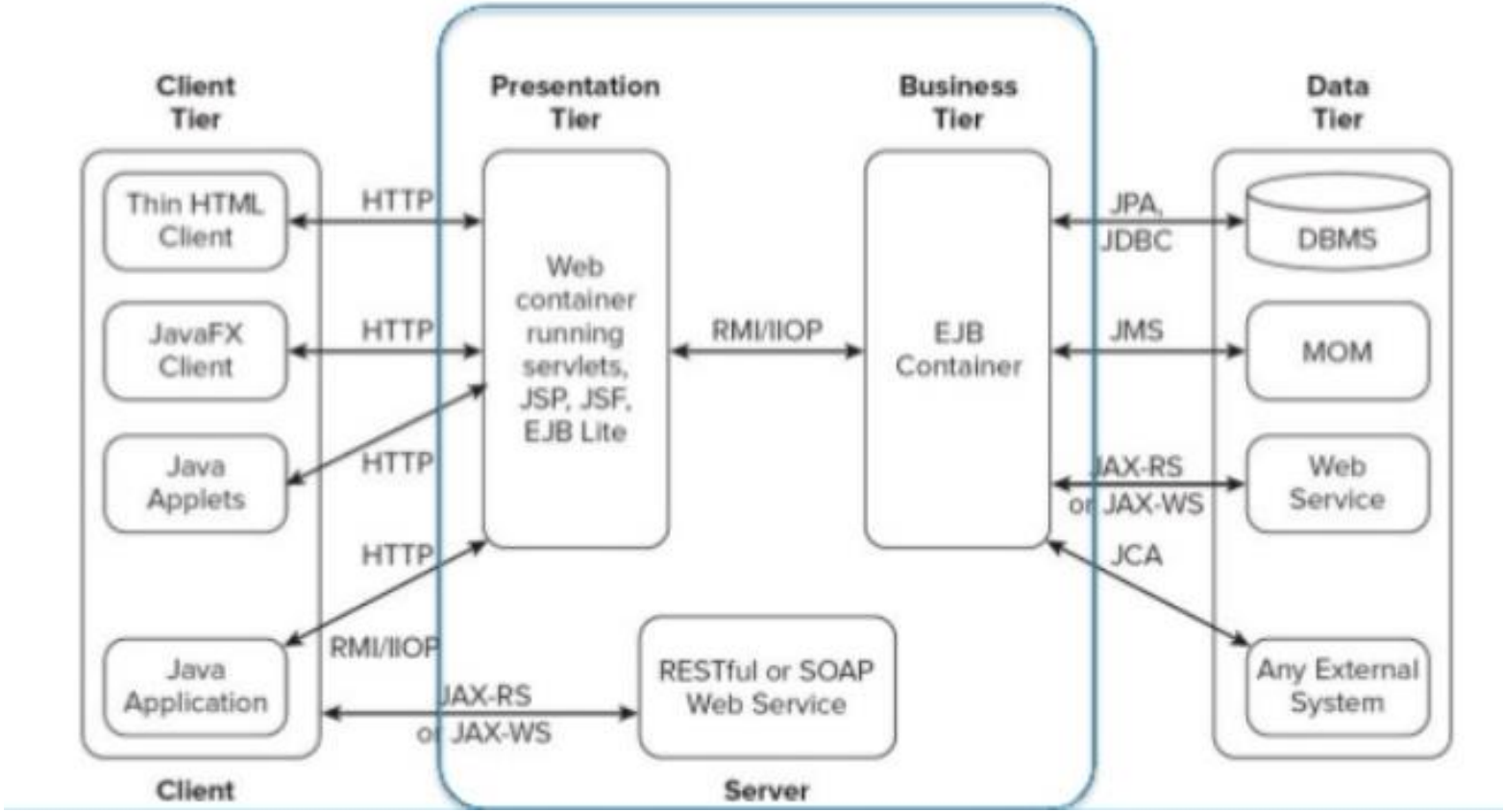



# Answer…

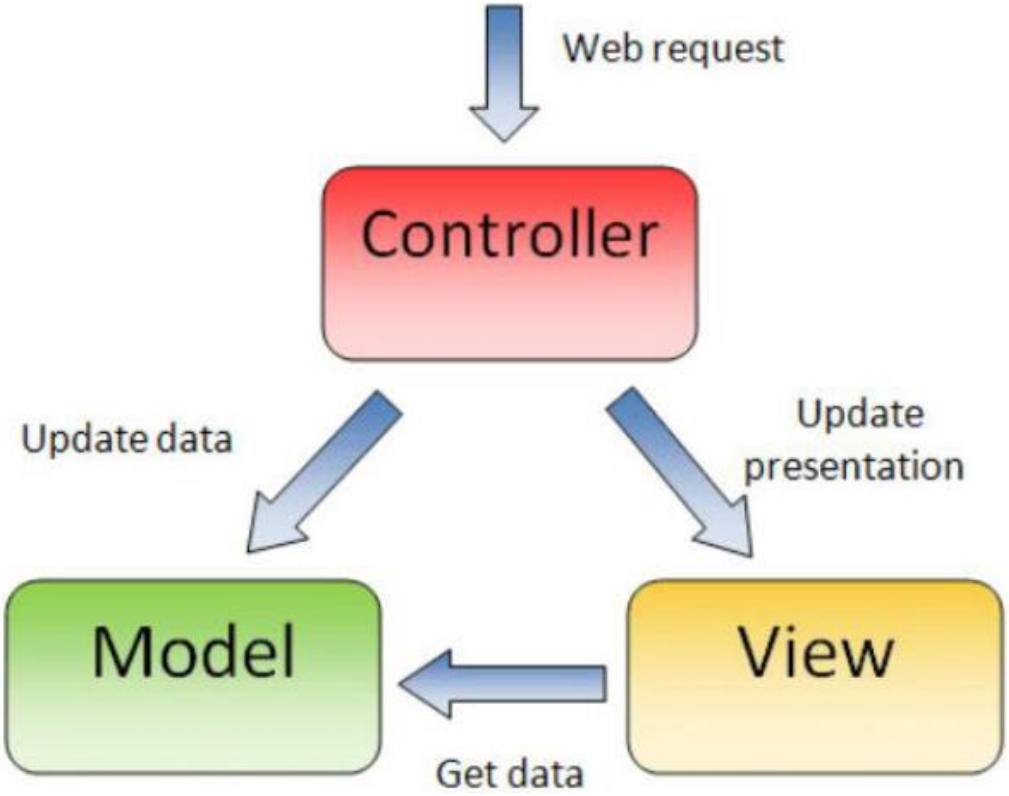
- **Web Server**-A web server processes HTTP Requests from web clients and responds back with Http Responses. A web server can process and respond to HTTP requests for static content, but it cannot process requests for dynamic content by itself.
- **Web Container**-In Java based web applications the dynamic content is processed by servlets that run in a ‘web container’, also called as ‘servlet container’. Web servers utilize web containers to respond and to requests for dynamic data.
- **Application Server**-An application server contains the web container or implements the Servlet API, contains the EJB container which manages EJBs, and implements the complete Java EE specification

# Java Frameworks (Patterns)

# Java EE Architecture …the big picture



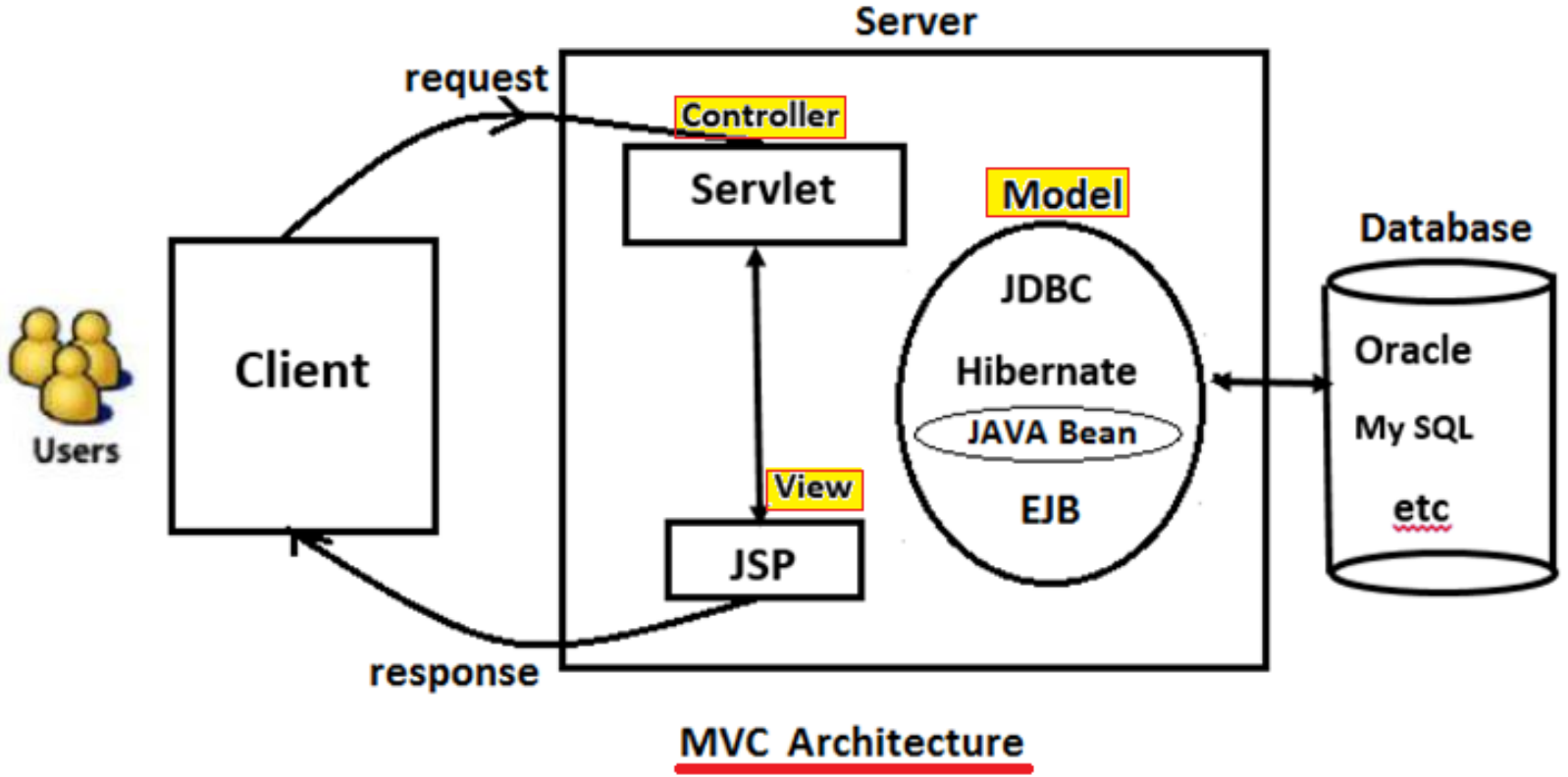
# Model View Controller



# Model View Controller

- **Model-View-Controller**(MVC) is a pattern used in software engineering to separate the application logic from the user interface. As the name implies, the MVC pattern has three layers.
- **The Model defines the business layer of the application, the Controller manages the flow of the application, and the View defines the presentation layer of the application.**
- Although the MVC pattern isn't specific to web applications, it fits very well in this type of applications.
- In a Java context, the **Model** consists of simple Java classes, the **Controller** consists of servlets and the **View** consists of JSP pages.

# Model View Controller Architecture



# The Model Layer

- This is the data layer which contains business logic of the system, and also represents the state of the application.
- It’s independent of the presentation layer, the controller fetches the data from the Model layer and sends it to the View layer.

# Example: Model layer

- To implement a web application based on MVC design pattern, we'll create the *Student* and *StudentService* classes –which will act as our Model layer.

```java
public class Student {
    private int id;
    private String firstName;
    private String lastName;

    // constructors, getters and setters goes here
}
```

```java
public class StudentService {

    public Optional<Student> getStudent(int id) {
        switch (id) {
            case 1:
                return Optional.of(new Student(1, "John", "Doe"));
            case 2:
                return Optional.of(new Student(2, "Jane", "Goodall"));
            case 3:
                return Optional.of(new Student(3, "Max", "Born"));
            default:
                return Optional.empty();
        }
    }
}
```

# The Controller Layer

- Controller layer acts as an interface between View and Model. It receives requests from the View layer and processes them, including the necessary validations.
- The requests are further sent to Model layer for data processing, and once they are processed, the data is sent back to the Controller and then displayed on the View.

# Example: Controller layer

```
@WebServlet(
  name = "StudentServlet",
  urlPatterns = "/student-record")
public class StudentServlet extends HttpServlet {

    private StudentService studentService = new StudentService();

    private void processRequest(
      HttpServletRequest request, HttpServletResponse response)
      throws ServletException, IOException {

        String studentID = request.getParameter("id");
        if (studentID != null) {
            int id = Integer.parseInt(studentID);
            studentService.getStudent(id)
              .ifPresent(s -> request.setAttribute("studentRecord", s));
        }

        RequestDispatcher dispatcher = request.getRequestDispatcher(
          "/WEB-INF/jsp/student-record.jsp");
        dispatcher.forward(request, response);
    }
```

# The View Layer

- This layer represents the output of the application, usually some form of UI. The presentation layer is used to display the Model data fetched by the Controller.

# Example: View layer

```
<html>
    <head>
        <title>Student Record</title>
    </head>
    <body>
    <%
        if (request.getAttribute("studentRecord") != null) {
            Student student = (Student) request.getAttribute("studentRecord");
    %>

    <h1>Student Record</h1>
    <div>ID: <%= student.getId()%></div>
    <div>First Name: <%= student.getFirstName()%></div>
    <div>Last Name: <%= student.getLastName()%></div>

    <%
        } else {
    %>

    <h1>No student record found.</h1>

    <% } %>
    </body>
```

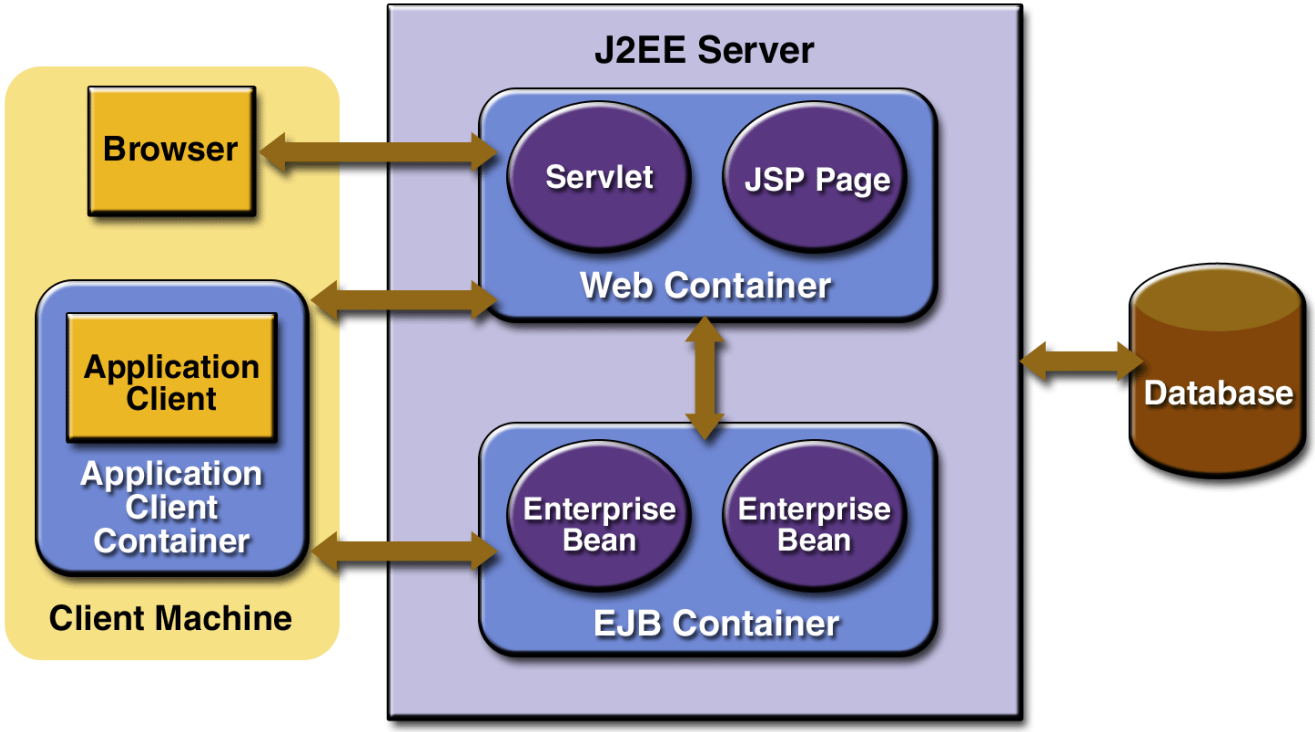
# Model View Controller

**Advantages of MVC architecture**

- Simultaneous development: Developers are able to work in parallel on different components without impacting or blocking one another.
- For example, a team might divide their developers between the front-end and the back-end. The back-end developers can design the structure of the data and how the user interacts with it without requiring the user interface to be completed. Conversely, the front-end developers are able to design and test the layout of the application prior to the data structure being available.
- By creating components that are independent of each other, developers are able to reuse components quickly and easily in other applications. The same (or similar) view for one application can be refactored for another application with different data because the view is simply handling how the data is being displayed to the user.

# Java EE Components (Web components, EJB)

# Java EE Components (Web components, EJB)



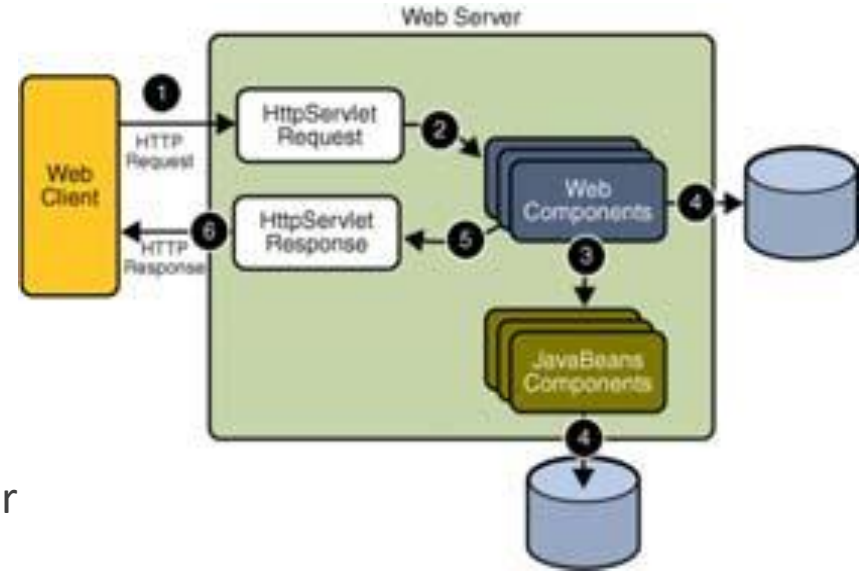
# Java EE Components

- Java EE applications are made up of components.
- The Java EE specification defines the following java EE components:
  - Application clients and applets are components that run on the client.
  - Java servlet, JavaServerFaces, and JavaServerPages (JSP) technology components are web components that run on the server.
  - Enterprise JavaBeans(EJB) components (enterprise beans) are business components that run on the server.

# Web Applications

**Client sends HTTP request**

- Web server that implements JavaServlet and JavaServer Pages technology converts request into an HTTPServletRequest object
- Object is delivered to a web component, which can interact with JavaBeans components or a database to generate dynamic content
- Web component can then generate an HTTPServletResponse or pass request to another web component
- Eventually a web component generates a HTTPServletResponse object, which is converted to an HTTP response and returned to the client

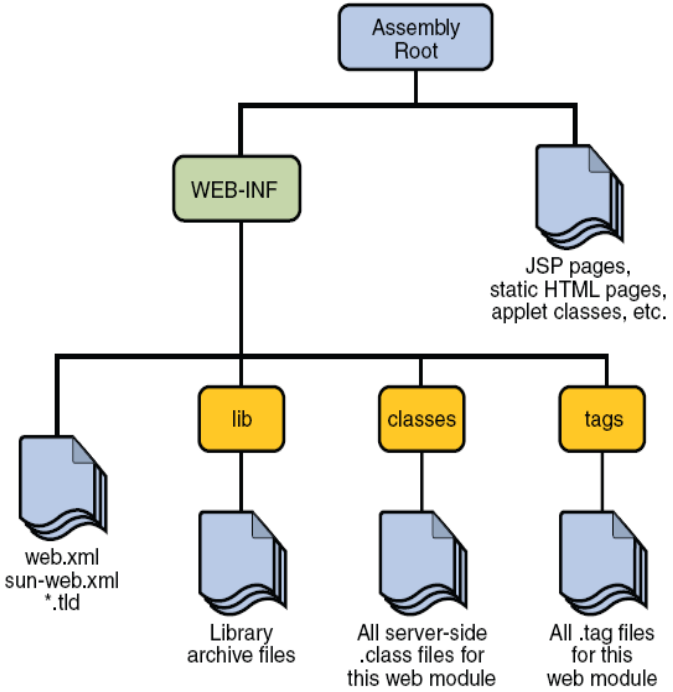


# Web Application Life Cycle

1. Develop the web component code
2. Develop the web application deployment descriptor
3. Compile the web application components and helper classes referenced by the components
4. Optionally package the application into a deployable unit
5. Deploy the application into a web container
6. Access a URL that references the web application

# Web Modules

- Smallest deployable and usable unit of web resources
- **web.xml**: Web application deployment descriptor
  - Not needed if module does not contain any servlets, filter, or listener components (i.e., only has JSP pages and static files)
- **sun-web.xml**: runtime deployment descriptor
  - Context root of web application, mapping of names of application resources to Application Server resources



# Java Servlets

- **Java Servlets** simplify web development by providing **infrastructure** for **component**, **communication**, and **session management** in a web container that is integrated with a **web server**.

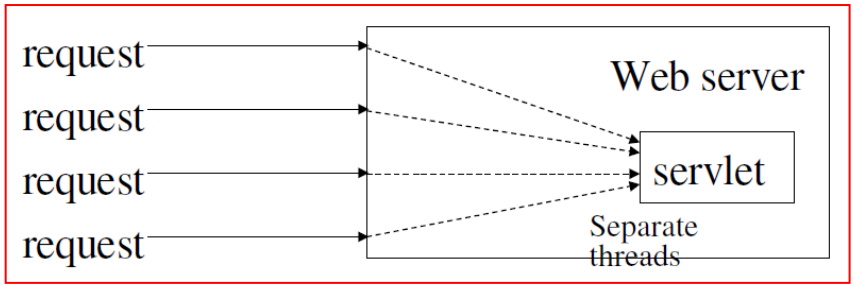
- Writing **Servlets** is like writing Java codes that place an HTML page inside a Java class (this is the **worst part** of Servlets!)

- (**Historically!**) requires a **deployment descriptor** (**DD**). This is in the form of an **XML file**.
- **Servlets** do not have a **main()** method.
- **Servlets** are under the control of another Java application called a **Container**

# Java Servlets

- **Servlets are Java classes that dynamically process requests and construct responses**

- Server side replacement for CGI (Common Gateway Interface)
- Extensions to Java enabled web-servers
- Inherently **multi-threaded**.
- One thread per request.
- Very efficient.
- Platform independent.

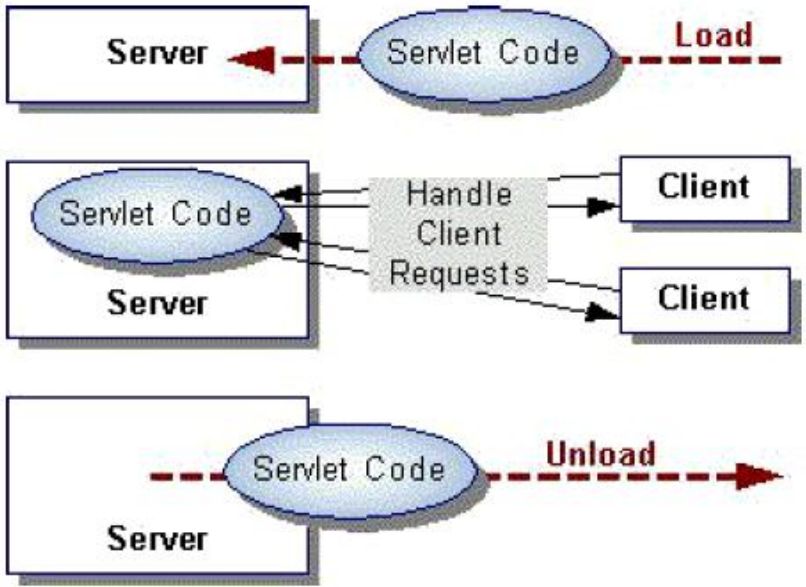


# How do Servlet work?

- **Servlets** run inside a **Web Container** -the component of the web server that runs and interacts with Servlets
- **Servlet** is running on the server listening for requests
- When a **request** comes in, a **new thread** is generated by the **web container**.

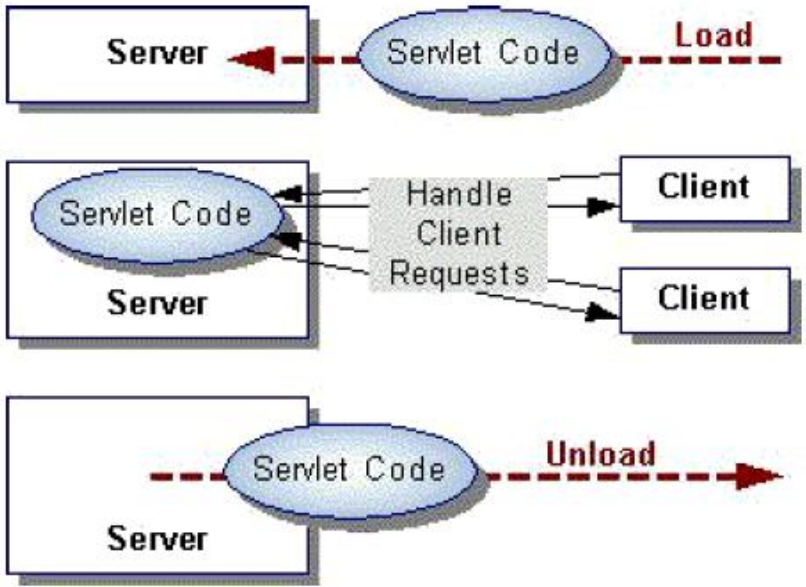
# Anatomy of a Servlet

- init() – the init() function is called when the servlet is initialized by the server. This often happens on the first doGet() or doPost() call of the servlet.
- destroy() –this function is called when the servlet is being destroyed by the server, typically when the server process is being stopped.



# Anatomy of a Servlet

- doGet() –the doGet() function is called when the servlet is called via an HTTP GET.
- doPost() –the doPost() function is called when the servlet is called via an HTTP POST.
- POSTs are a good way to get input from HTML forms



# JSP –JavaServer Pages

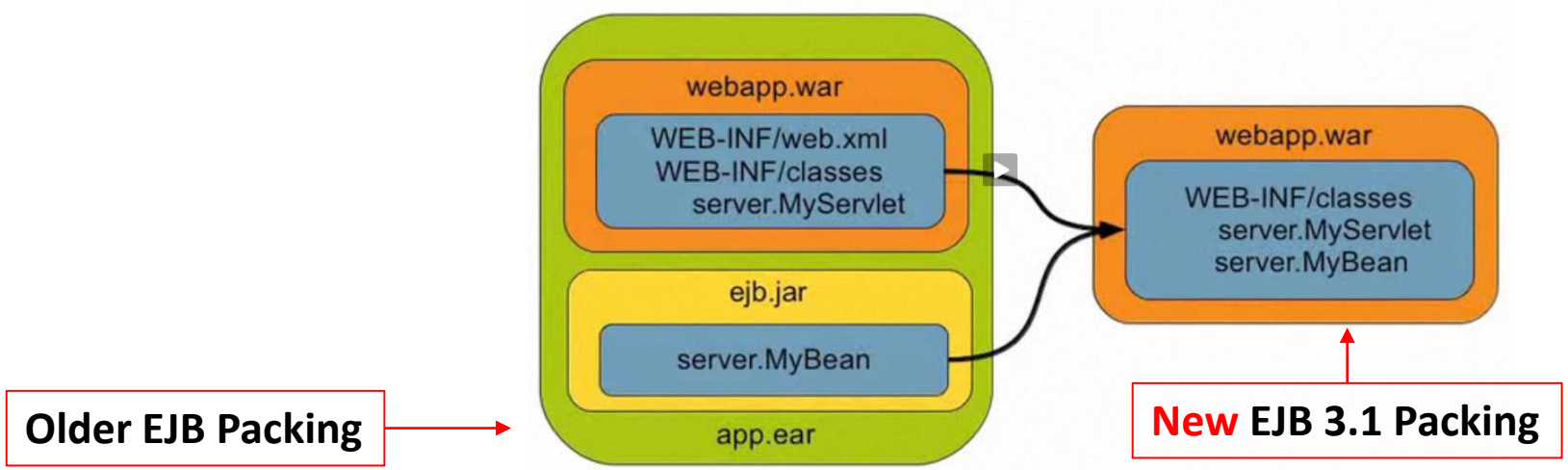
- JavaServer Pages technology uses XML-like tags and scriptlets written in the Java programming language to encapsulate the logic that generates the content for the page.
- Any and all formatting (HTML or XML) tags are passed directly back to the response page.
- By separating the page logic from its design and display and supporting a reusable component-based design, JSP technology makes it faster and easier than ever to build web-based applications.

# Sample JSP

```
<html>
    <head>
        <title>Student Record</title>
    </head>
    <body>
    <%
        if (request.getAttribute("studentRecord") != null) {
            Student student = (Student) request.getAttribute("studentRecord");
    %>

    <h1>Student Record</h1>
    <div>ID: <%= student.getId()%></div>
    <div>First Name: <%= student.getFirstName()%></div>
    <div>Last Name: <%= student.getLastName()%></div>

    <%
        } else {
    %>

    <h1>No student record found.</h1>

    <% } %>
    </body>
```

# Enterprise JavaBeans (EJB)

- **Enterprise JavaBeans** container handles:
  - distributed communication
  - threading
  - scaling
  - transaction management, etc.
- has a new packaging! (see figure)



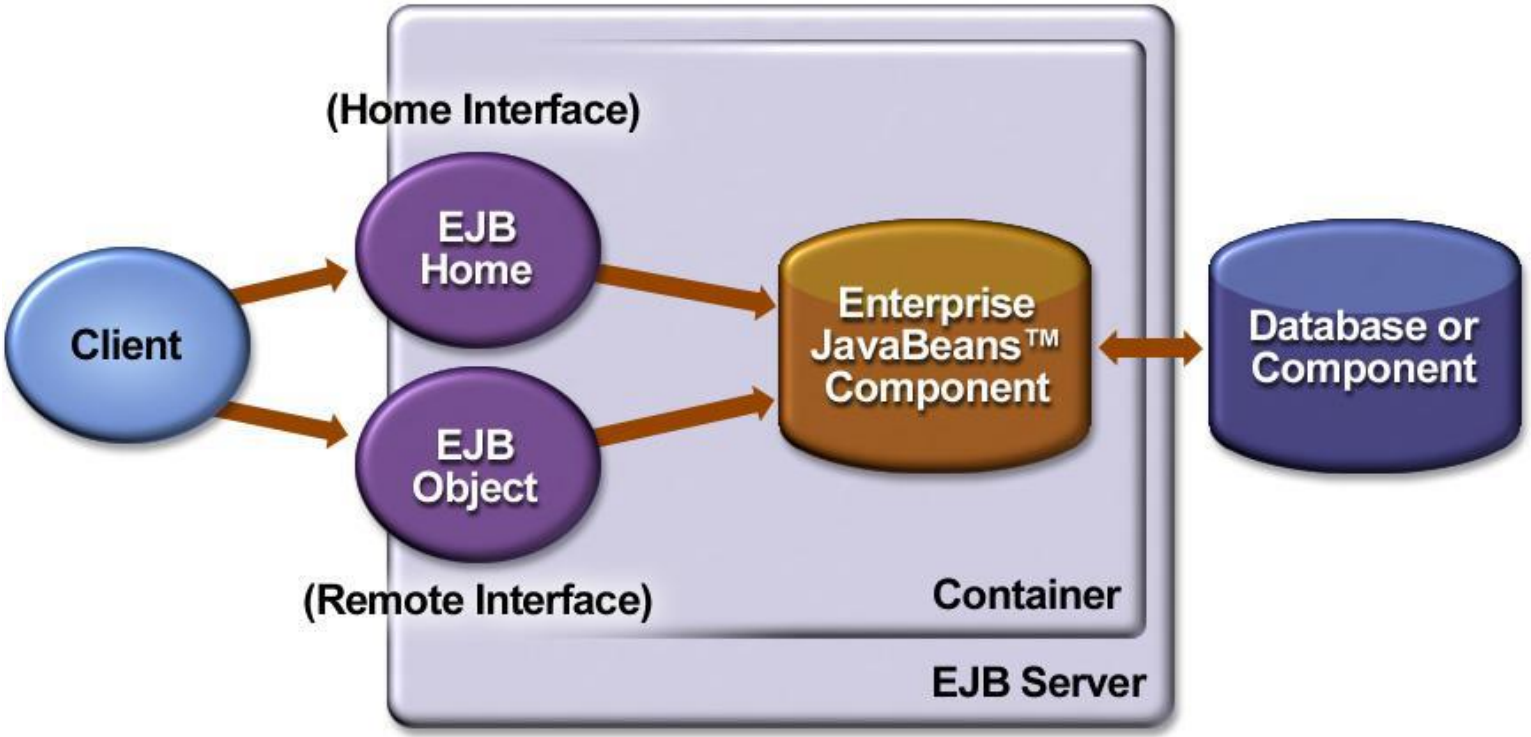
# JavaBeans

- **manage the data flow** between the following:

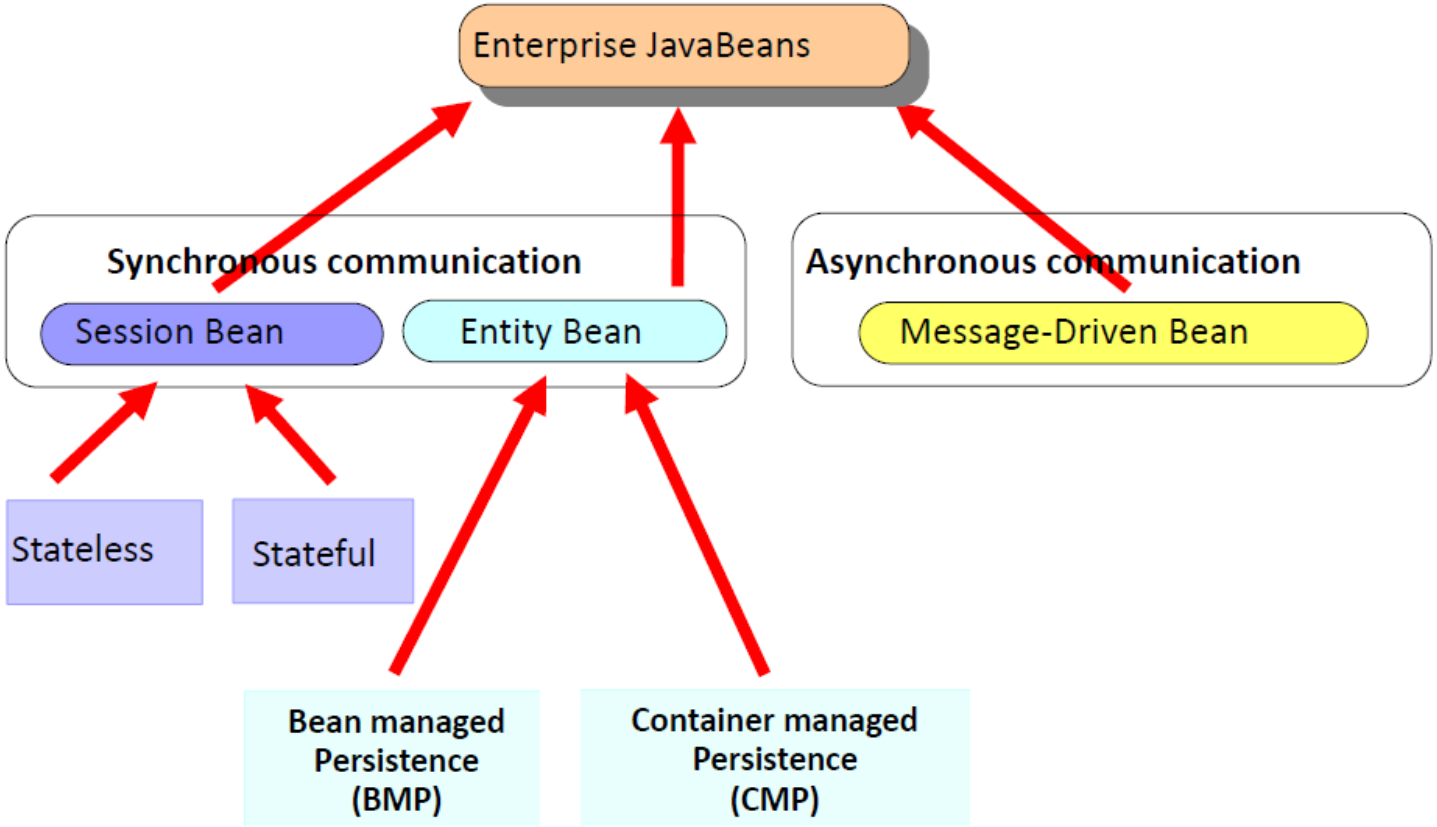
| Client/Database | Server |
| --- | --- |
| **application client** or **applet** | components running on the Java EE **server** |
| **database** | **Server** components |

- **JavaBeans** components are not considered Java EE components by the Java EE specification.
- **JavaBeans** components have properties and have **get** and **set methods** for accessing the **properties**.

# EJB Architecture



# Enterprise JavaBeans

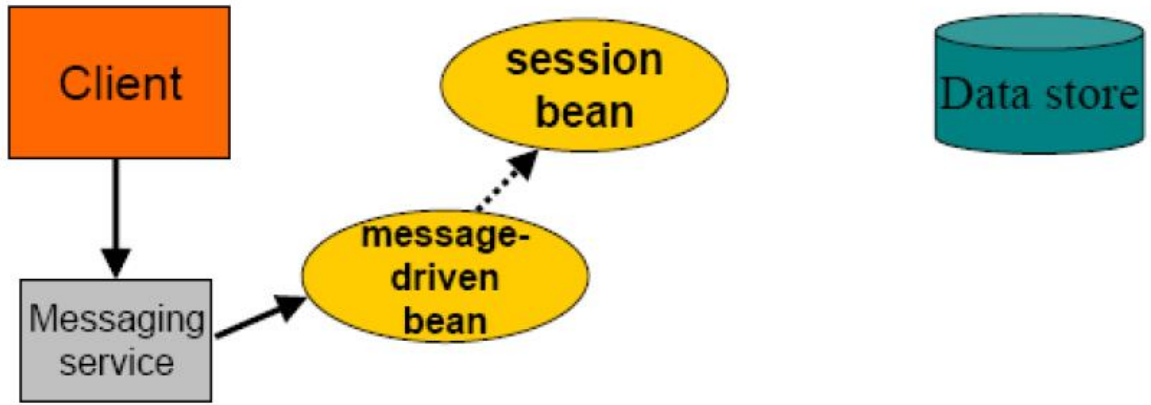


# Types of EJB -Session Bean

- A session bean instance is a non-persistent object that implements some business logic and runs on a server
- Session beans can be reused by different clients, but not shared concurrently
- Stateless session beans retain no conversational state between method calls
- Stateful session beans retain conversational state between method calls

# Types of EJB – Message-Driven Bean

- A message-driven bean instance is an asynchronous message consumer
- Message-driven beans have no client visibility



# Types of EJB – Entity Bean

- An entity bean instance represents an object-oriented view of data in a persistent storage
- Container-managed persistence (CMP) and bean-managed persistence (BMP) are available