Advanced Programming

Week 12

Servlets

- Overview of the web
- Servlet Technology
- CGI
- Servlet API
- Life Cycle of Servlet

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Objectives

At the end of this lecture, students will be able to:

- Explain how web clients and servers communicate through request and response processes.
- Describe how servlets and containers support dynamic web content, session management, persistence, and security.
- Identify the advantages of servlets over CGI, including performance, portability, and robustness.
- Differentiate between the javax.servlet and javax.servlet.http packages.
- Explain different ways to create a servlet and why extending the HttpServlet class is commonly used.

Introduction to Web

- Web consists of billions of clients and server connected through wires and wireless networks.
- The web clients make requests to web server.
- The web server receives the request, finds the resources and return the response to the client.
- When a server answers a request, it usually sends some type of content to the client.

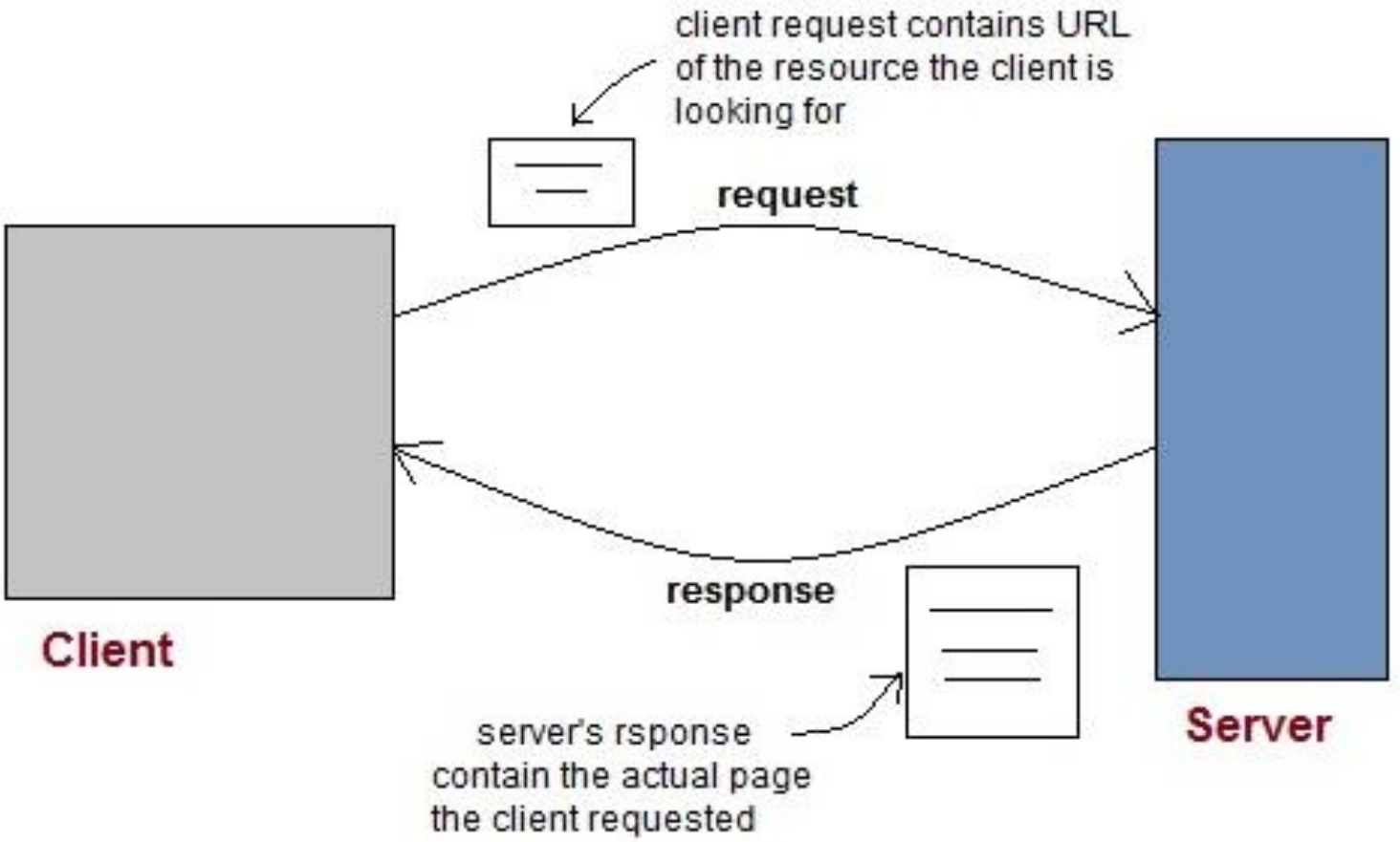
Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson Education.

Introduction to Web…

- The client uses web browser to send request to the server.
- The server often sends response to the browser with a set of instructions written in HTML(HyperText Markup Language).
- All browsers know how to display HTML page to the client.

Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson Education.

Introduction to Web…



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Introduction to Web…

- **Web Application**
  - A website is a collection of static files(webpages) such as HTML pages, images, graphics etc.
  - A **Web application** is a web site with dynamic functionality on the server.
  - **Google**, **Facebook**, **Twitter** are examples of web applications.

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Introduction to Web…

HTTP (Hypertext Transfer Protocol)

- HTTP is a protocol that clients and servers use on the web to communicate.
- It is similar to other internet protocols such as SMTP(Simple Mail Transfer Protocol) and FTP(File Transfer Protocol) but there is one fundamental difference.

Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson Education.

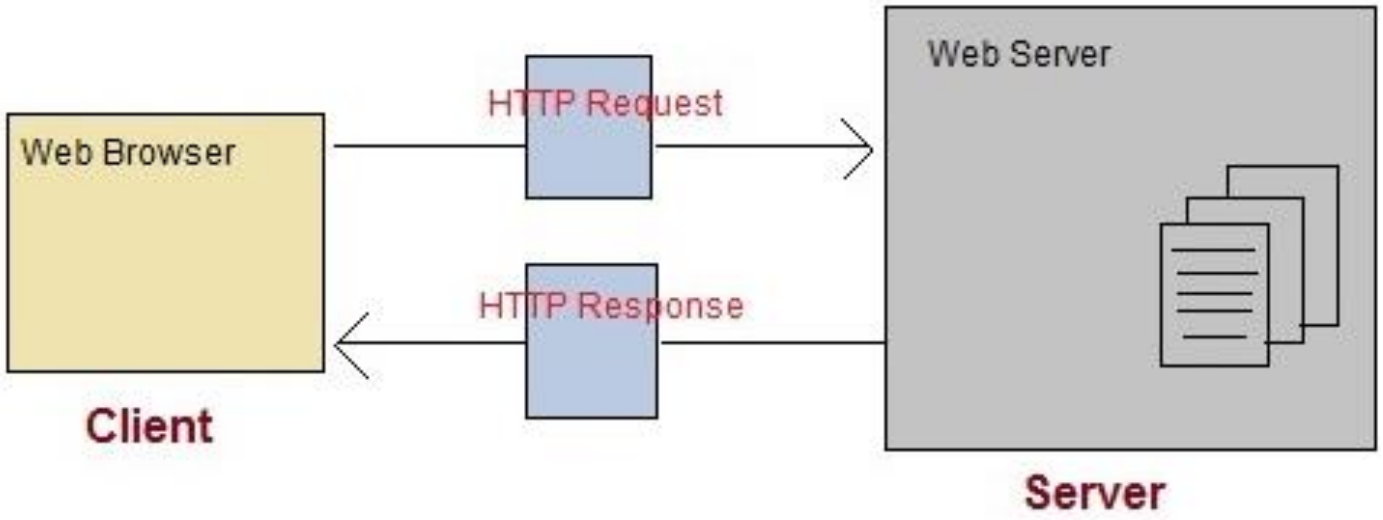
Introduction to Web…

- HTTP is a **stateless protocol** i.e HTTP supports only one request per connection.
- This means that with HTTP the clients connect to the server to send one request and then disconnects.
- This mechanism allows more users to connect to a given server over a period of time.

Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson Education.

Introduction to Web…

- The client sends an HTTP request and the server answers with an HTML page to the client, using HTTP.



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Servlet Technology

- **Servlet** technology is used to create web application (resides at server side and generates dynamic web page).
- **Servlet** technology is robust and scalable because of java language. Before Servlet, CGI (Common Gateway Interface) scripting language was popular as a server-side programming language. But there was many disadvantages of this technology. We have discussed these disadvantages below.
- There are many interfaces and classes in the servlet API such as Servlet,GenericServlet,HttpServlet,ServletRequest,ServletResponse etc.

Oracle. (2024). *Java Servlet technology overview*. Oracle.

Servlet Technology…

What is a Servlet?

- Servlet is a technology i.e. used to create web application.
- A servlet is a compiled Java class that run server-side under the control of the Web server.
- Servlets are managed by the ***servlet container***, or ***servlet engine***
- Servlets are called through HTML

Oracle. (2024). Java Servlet technology overview. Oracle.

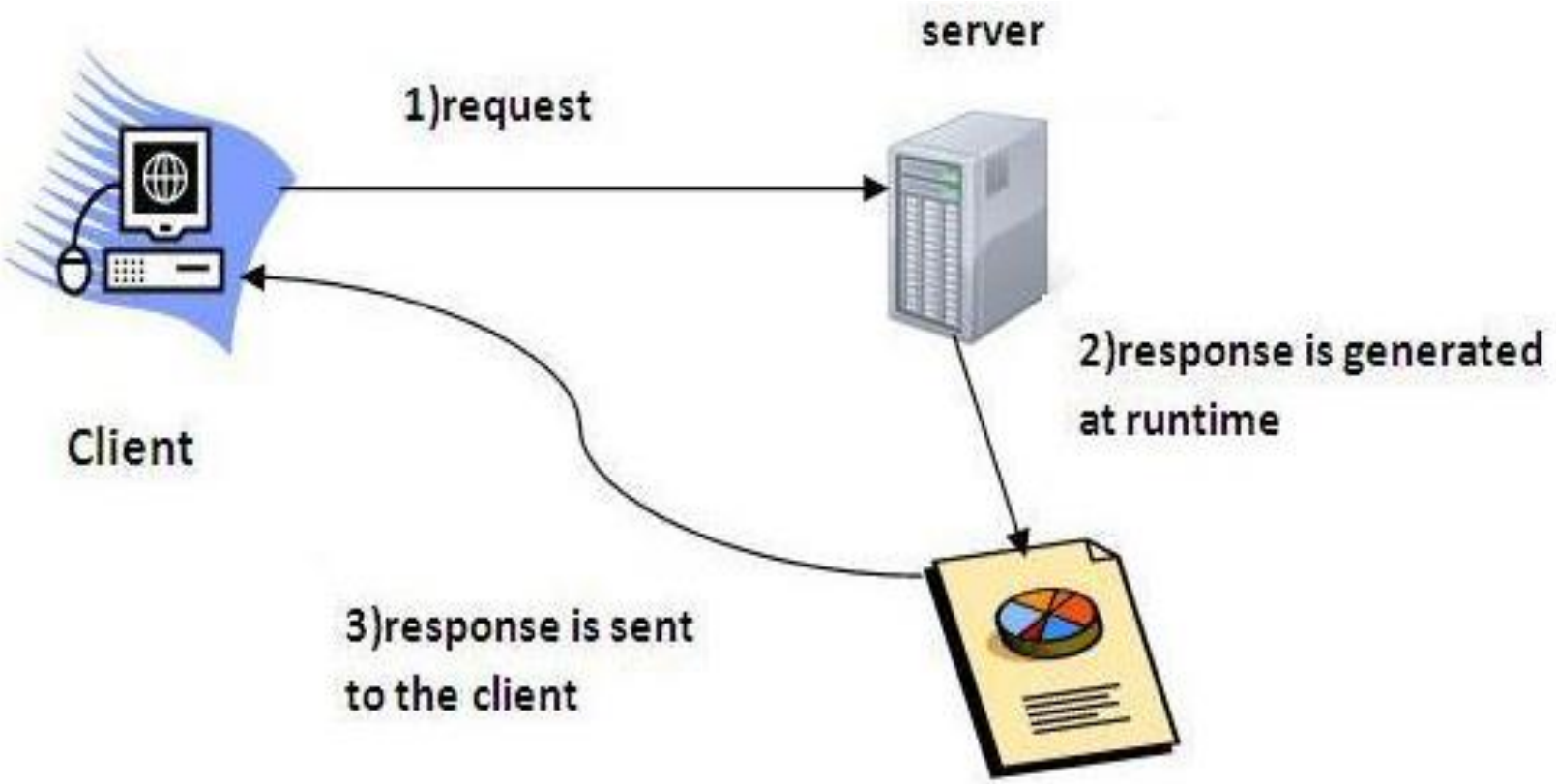
Servlet Technology…

What is a Servlet?

- Servlet is an API that provides many interfaces and classes including documentations.
- Servlet is a class that extend the capabilities of the servers and respond to the incoming request. It can respond to any type of requests.
- Servlet is a web component that is deployed on the server to create dynamic web page.

Oracle. (2024). Java Servlet technology overview. Oracle.

Servlet Technology…



Oracle. (2024). Java Servlet technology overview. Oracle.

Servlet Technology…

- Servlets receive requests and return responses, both of which are supported by the HTTP protocol
- When the Web Server receives a request that is for a servlet, the request is passed to the servlet container
  - The container makes sure the servlet is loaded and calls it
  - The servlet call has two parameter objects, one with the request and one for the response
  - When the servlet is finished, the container reinitializes itself and returns control to the Web server
- Servlets are used 1) as alternatives to CGI, and 2) as alternatives to Apache modules

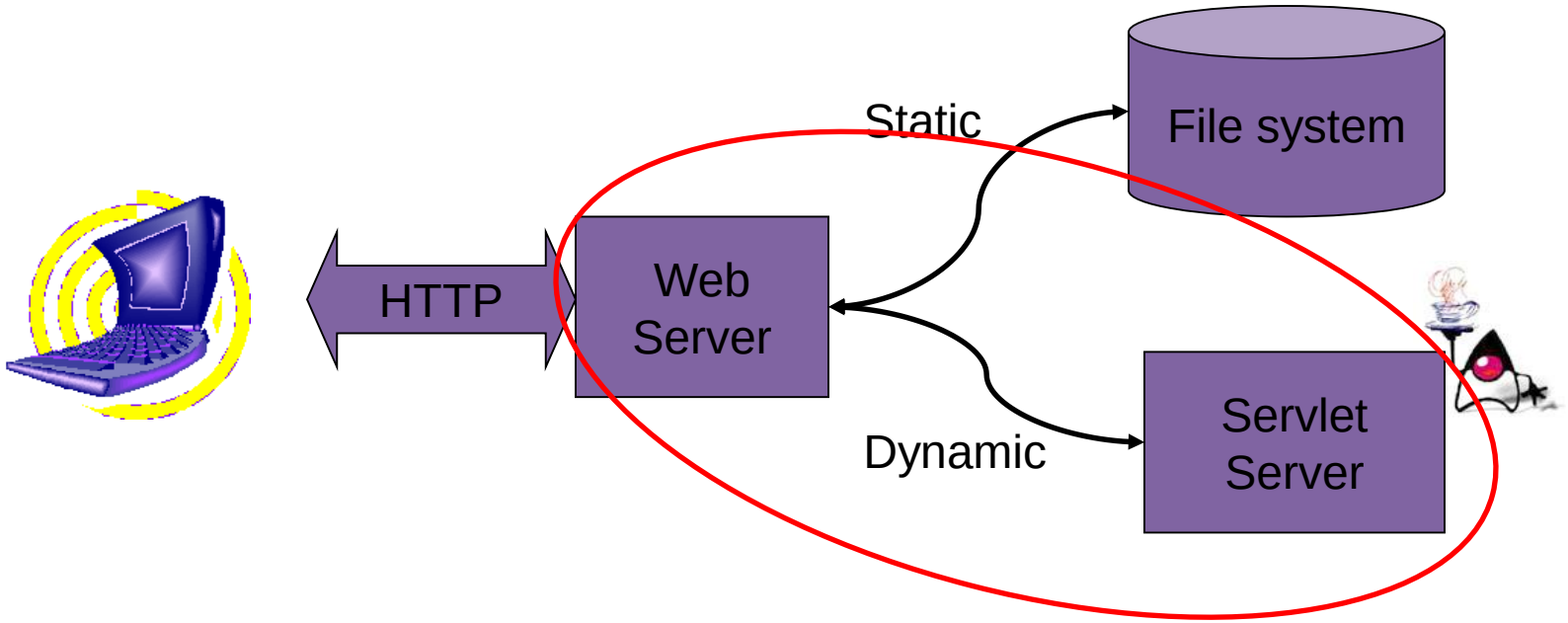
Oracle. (2024). Java Servlet technology overview. Oracle.

Why are Servlets?

- Web pages with dynamic content
- Easy coordination between Servlets to make Web applications
- Containers support many features
  - Sessions, persistence, resource management (e.g., database connections), security, etc.

Oracle. (2024). Java Servlet technology overview. Oracle.

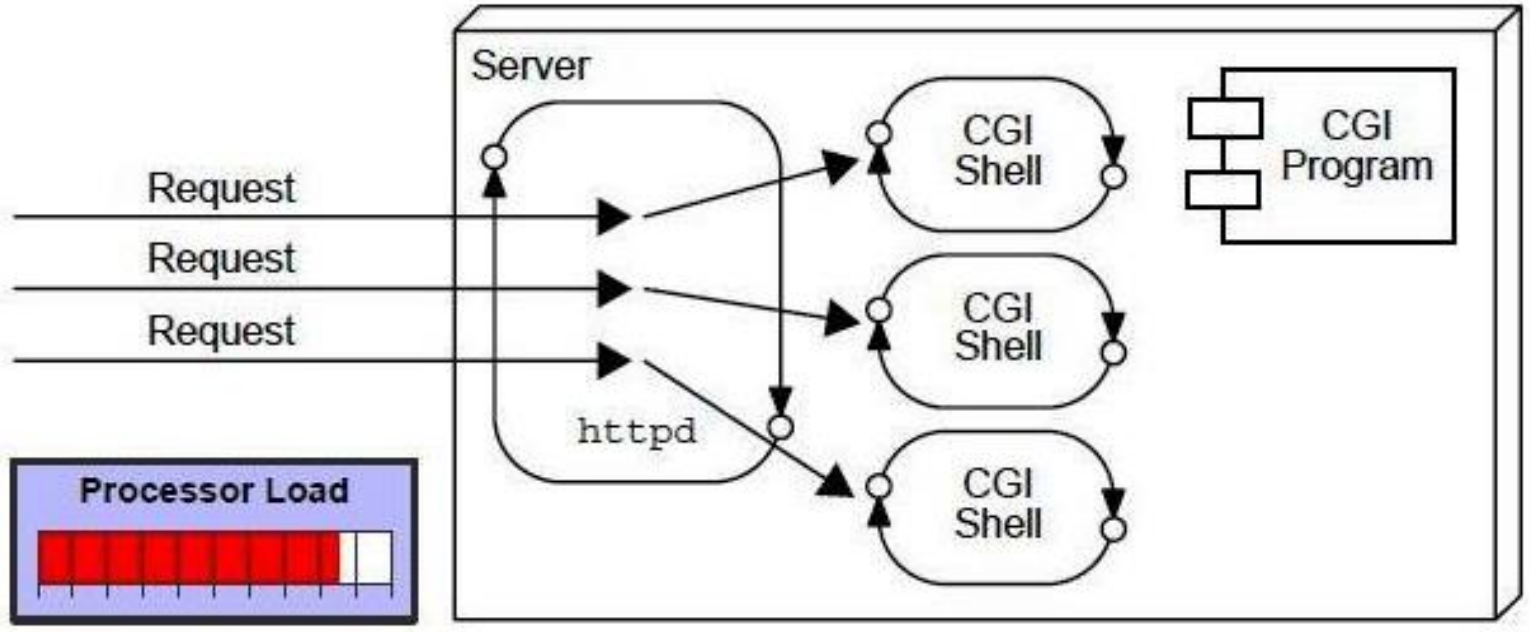
Why are Servlets?



Oracle. (2024). Java Servlet technology overview. Oracle.

CGI (Common Gateway Interface)

- CGI technology enables the web server to call an external program and pass HTTP request information to the external program to process the request. For each request, it starts a new process.



Sebesta, R. W. (2020). Programming the World Wide Web (9th ed.). Pearson Education.

CGI (Common Gateway Interface)…

Disadvantages of CGI

There are many problems in CGI technology:

- Inefficient: new process for each request!!!
  - If number of clients increases, it takes more time for sending response.
  - Servlets loaded “once”!
- Defines only the interface

  → no supporting infrastructure

  (security, sessions, persistence, etc.)
- It is platform dependent

Sebesta, R. W. (2020). *Programming the World Wide Web* (9th ed.). Pearson Education.

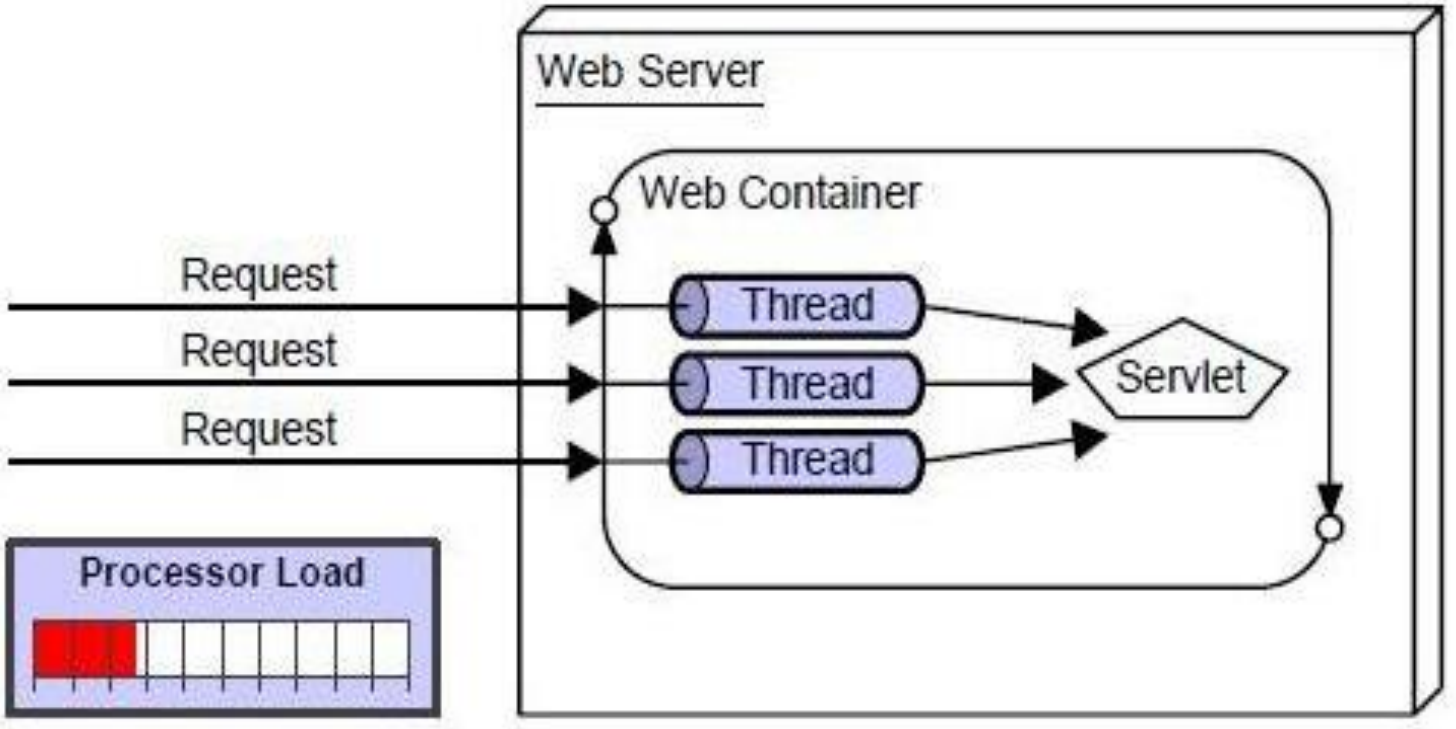
- **Advantages of Servlet**

There are many advantages of servlet over CGI. The web container creates threads for handling the multiple requests to the servlet. Threads have a lot of benefits over the Processes such as they share a common memory area, lightweight, cost of communication between the threads are low. The basic benefits of servlet are as follows:

- **better performance:** because it creates a thread for each request not process.
- **Portability:** because it uses java language.
- **Robust:** Servlets are managed by JVM so no need to worry about memory leak, garbage collection etc.
- **Secure:** because it uses java language.

Dinesh Rajput. (n.d.). Advantages of Servlets over CGI.

- **Advantages of Servlet**



Dinesh Rajput. (n.d.). Advantages of Servlets over CGI.

Servlet API

- The basic **terminology used in servlet** are given below:
  1. HTTP
  2. HTTP Request Types
  3. Get and Post method
  4. Container
  5. Web Server and Application Server
  6. Content Type
  7. XML
  8. Deployment

Oracle. (n.d.). Package javax.servlet and Package javax.servlet.http (Servlet API). In Java EE 7 API Documentation.

Servlet API…

- The javax.servlet and javax.servlet.http packages represent interfaces and classes for servlet api.
- The **javax.servlet** package contains many interfaces and classes that are used by the servlet or web container. These are not specific to any protocol.
- The **javax.servlet.http** package contains interfaces and classes that are responsible for http requests only.

Oracle. (n.d.). Package javax.servlet and Package javax.servlet.http (Servlet API). In Java EE 7 API Documentation.

Servlet API…

- **GenericServlet class**

GenericServlet class implements **Servlet**, **ServletConfig** and **Serializable** interfaces. It provides the implementaion of all the methods of these interfaces except the service method.

GenericServlet class can handle any type of request so it is protocol-independent.

You may create a generic servlet by inheriting the GenericServlet class and providing the implementation of the service method.

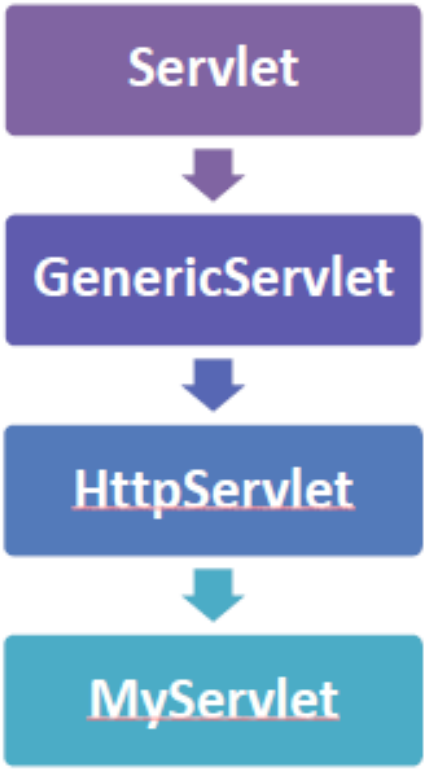
Oracle. (n.d.). Package javax.servlet and Package javax.servlet.http (Servlet API). In Java EE 7 API Documentation.

Servlet API…

HttpServlet class

- The HttpServlet class extends the GenericServlet class and implements Serializable interface. It provides http specific methods such as doGet, doPost, doHead, doTrace etc.
- Technically, a servlet is a program that extends either

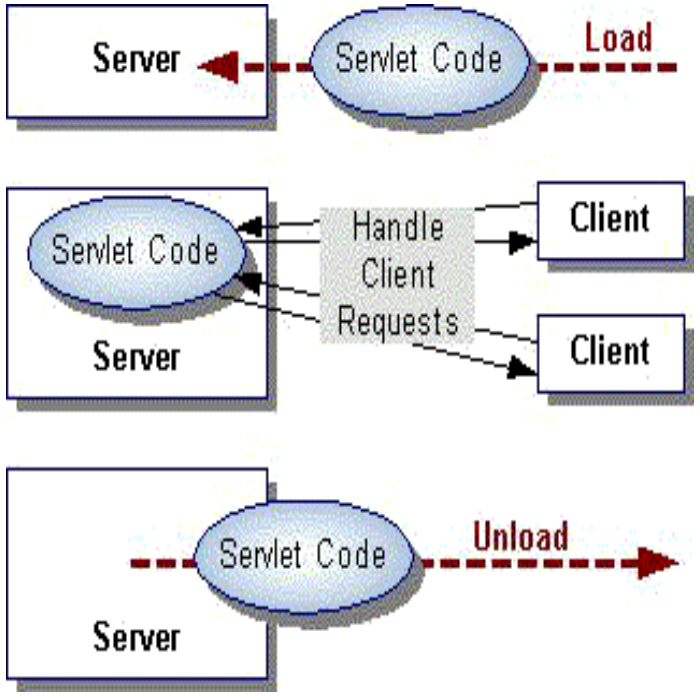
GenericServlet or HttpServlet.



Oracle. (n.d.). *Package javax.servlet and Package javax.servlet.http* (Servlet API). In *Java EE 7 API Documentation*.

Life Cycle of a Servlet

- The web container maintains the life cycle of a servlet instance.
- Servlets are controlled by servers
  1. A server loads and initializes the servlet
     - New thread created for each client.
  2. The servlet handles zero or more client requests
  3. The server terminates the servlet



Hall, M., & Brown, N. (2005). Core Servlets and JavaServer Pages: Volume 1 – Core Technologies (2nd ed.). Prentice Hall.

Life Cycle of a Servlet…

- Methods
  - public void init():

    Called only once when servlet is being created.

    Good place for set up, open Database, etc.
  - public void service():

    Called once for each request.

    In HttpServlet, it delegates requests to doGet, doPost, etc.
  - public void destroy():

    Called when server decides to terminate the servlet.

    Release resources.

Hall, M., & Brown, N. (2005). Core Servlets and JavaServer Pages: Volume 1 – Core Technologies (2nd ed.). Prentice Hall.

How To Create A Servlet

- The servlet can be created by three ways:
    1. By implementing Servlet interface,
    2. By inheriting GenericServlet class, (or)
    3. By inheriting HttpServlet class
- The mostly used approach is by extending HttpServlet because it provides http request specific method such as doGet(), doPost(), doHead() etc.

Oracle. (2024). Servlets - Life Cycle, interfaces and classes. In Java Platform, Enterprise Edition (Java EE) Documentation.

More on Servlets

- Most user-written servlet classes are extensions to HttpServlet (which is an extension of GenericServlet, which implements the Servlet Interface)
- Two other necessary interfaces:
  - ServletResponse – to encapsulate the communications, server to client
  - ServletRequest – to encapsulate the communications, client to server
    - Provides servlet access to ServletOutputStream

Oracle. (2024). *Java Servlet API documentation*. In *Java Platform, Enterprise Edition (Java EE) Documentation*.

More on Servlets…

- **HttpServlet** – an abstract class, extends GenericServlet
  - Every subclass of HttpServlet MUST override at least one of the methods of HttpServlet
    - doGet*
    - doPost*
    - doPut*
    - doDelete*
    - init
    - destroy
    - getServletInfo

* Called by the server

Oracle. (2024). Java Servlet API documentation. In Java Platform, Enterprise Edition (Java EE) Documentation.

HTTP Servlets

- For HTTP requests.
  - HTTP requests include
    - GET, conditional GET, HEAD, POST, PUT, DELETE, TRACE, OPTIONS
    - The default is GET.
- **Methods of HttpServlet and HTTP requests**

Methods	HTTP Requests	Comments
doGet	GET, HEAD	Usually overridden
doPost	POST	Usually overridden
doPut	PUT	Usually not overridden
doOptions	OPTIONS	Almost never overridden
doTrace	TRACE	Almost never overridden

- All methods take two arguments: an HttpServletRequest object and an HttpServletResponse object.

Oracle. (2024). Java Servlet API documentation. In Java Platform, Enterprise Edition (Java EE) Documentation.

HTTP Servlets…

- The protocol of **doGet** is:

protected void doGet(HttpServletRequest request, HttpServletResponse response) throws ServletException,java.io.IOException

  - ServletException is thrown if the GET request could not be handled.
- The protocol of **doPost** is similar to **doGet**
- *Servlet output* – HTML

1. Use the **setContentType** method of the response object to set the content type to **text/html**

```
response.setContentType("text/html");
```

2. Create a PrintWriter object with the getWriter method of the response object

```
PrintWriter Out = response.getWriter();
```

Oracle. (2024). *Java Servlet API documentation*. In *Java Platform, Enterprise Edition (Java EE) Documentation*.

HttpServletRequest Object

- javax.servlet.http.**HttpServletRequest** Objects
  - Extends the ServletRequest
  - Provide access to HTTP header data and the arguments of the request.
  - Can get values of individual parameters using the following methods
    - getParameterNames method provides the names of the parameters
    - getParameter method returns the value of a named parameter.
    - getParameterValues method returns an array of all values of a parameter if it has more than one values.

Oracle. (2024). *Java Servlet API documentation*. In *Java Platform, Enterprise Edition (Java EE) Documentation*.

HttpServletRequest Object…

- **HttpServletResponse** Objects
  - Provide two ways of returning data to the user:
    - getWriter method returns a PrintWriter for sending text data to client
    - getOutputStream method returns a ServletOutputStream for sending binary data to client.
    - Need to close the Writer or ServletOutputStream after you send the response.

Oracle. (2024). *Java Servlet API documentation*. In *Java Platform, Enterprise Edition (Java EE) Documentation*.

HttpServletRequest Object…

- **HttpServletResponse** Objects
  - HTTP Header Data
    - Must set HTTP header data before you access the Writer or OutputStream.
    - HttpServletResponse interface provides methods to manipulate the header data.
    - For example, the setContentType method sets the content type. (This header is often the only one manually set.)

Oracle. (2024). *Java Servlet API documentation*. In *Java Platform, Enterprise Edition (Java EE) Documentation*.

Summary

- In today's lecture we have discussed about;
  - Servlets enable efficient communication between web clients and servers through request and response handling.
  - They support dynamic web content, session management, persistence, and security.
  - Compared to CGI, servlets offer better performance, portability, and robustness.
  - The javax.servlet and javax.servlet.http packages define core and HTTP-specific functionality, and servlets are most commonly created by extending the HttpServlet class.

References

- Kurose, J. F., & Ross, K. W. (2021). Computer networking: A top-down approach (8th ed.). Pearson Education.
- Oracle. (2024). Java Servlet technology overview. Oracle.
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