Servlets,Event Listeners & Filters

Java Server Side Programming

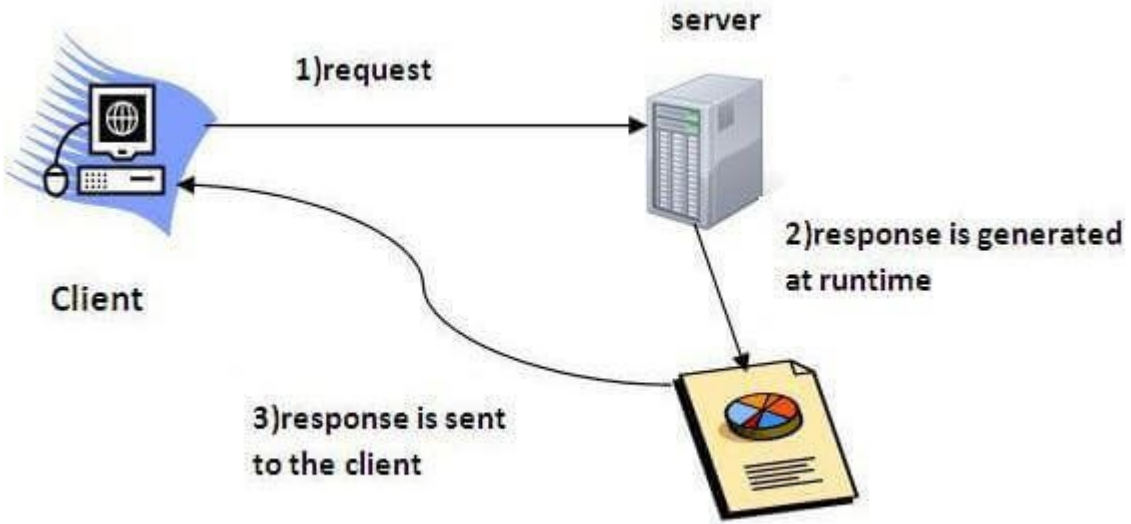
Prof.Trupesh Patel

Points to be discussed

- Servlets : Exploring javax. servlet and javax.servlet.http packages;
- Servlet Life cycle; Creating a servlet; ServletConfig and Servletcontext objects;
- HttpServletRequest and HttpServletResponse Interfaces;
- Session Tracking Mechanisms;
- Event Handling; Creating and Configuring filters;
- Parameter initialization in Filters;
- Manipulating Responses using Filter.

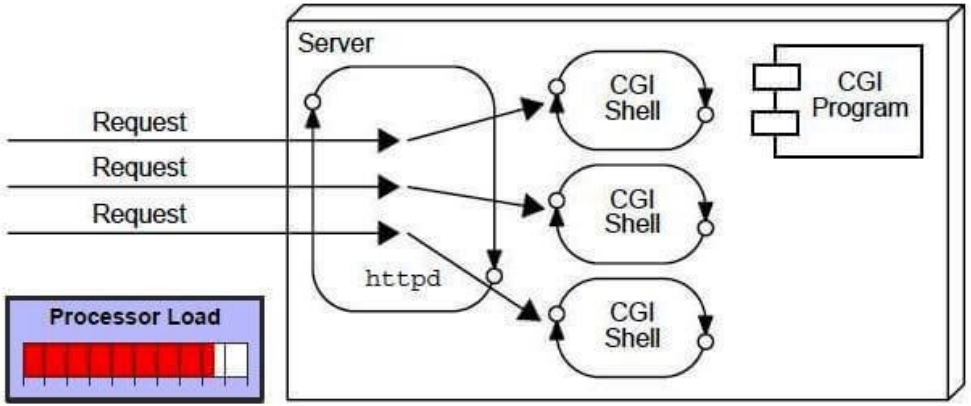
Servlets

- **Servlet** technology is used to create a web application (resides at server side and generates a dynamic web page).
- **Servlet** technology is robust and scalable because of java language. Before Servlet, CGI (Common Gateway Interface) scripting language was common as a server-side programming language.



Servlets

- **What is a web application?**
- A web application is an application accessible from the web. A web application is composed of web components like Servlet, JSP, Filter, etc. and other elements such as HTML, CSS, and JavaScript. The web components typically execute in Web Server and respond to the HTTP request.
- **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.



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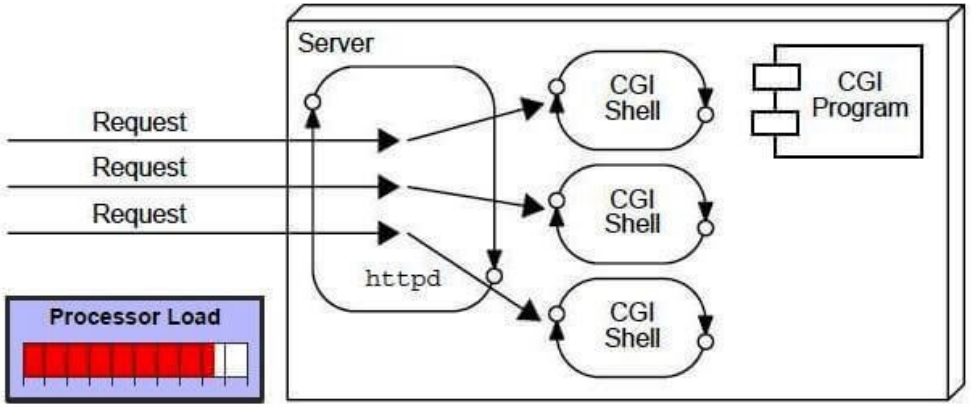


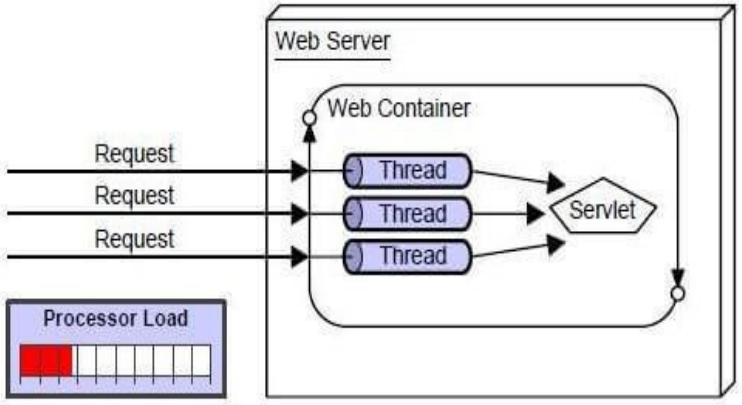
Disadvantages of CGI

1. If the number of clients increases, it takes more time for sending the response.
2. For each request, it starts a process, and the web server is limited to start processes.
3. It uses platform dependent language e.g. C, C++, perl.

Servlets

Advantages of Servlet

1. **Better performance:** because it creates a thread for each request, not process.
2. **Portability:** because it uses Java language.
3. **Robust:** JVM manages Servlets, so we don't need to worry about the memory leak, garbage collection, etc.
4. **Secure:** because it uses java language.



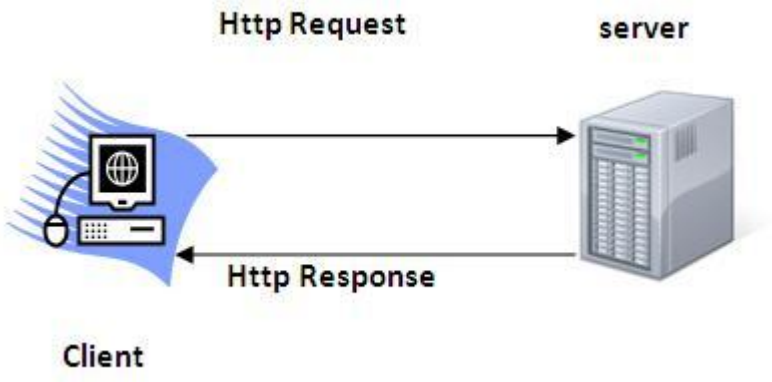
Web Terminology

Servlet Terminology	Description
Website: static vs dynamic	It is a collection of related web pages that may contain text, images, audio and video.
HTTP	It is the data communication protocol used to establish communication between client and server.
HTTP Requests	It is the request send by the computer to a web server that contains all sorts of potentially interesting information.
Get vs Post	It gives the difference between GET and POST request.
Container	It is used in java for dynamically generating the web pages on the server side.
Server: Web vs Application	It is used to manage the network resources and for running the program or software that provides services.
Content Type	It is HTTP header that provides the description about what are you sending to the browser.

HTTP (Hypertext Transfer Protocol)

The Hypertext Transfer Protocol (HTTP) is application-level protocol for collaborative, distributed, hypermedia information systems. It is the data communication protocol used to establish communication between client and server.

HTTP is TCP/IP based communication protocol, which is used to deliver the data like image files, query results, HTML files etc on the World Wide Web (WWW) with the default port is TCP 80. It provides the standardized way for computers to communicate with each other.



HTTP (Hypertext Transfer Protocol)

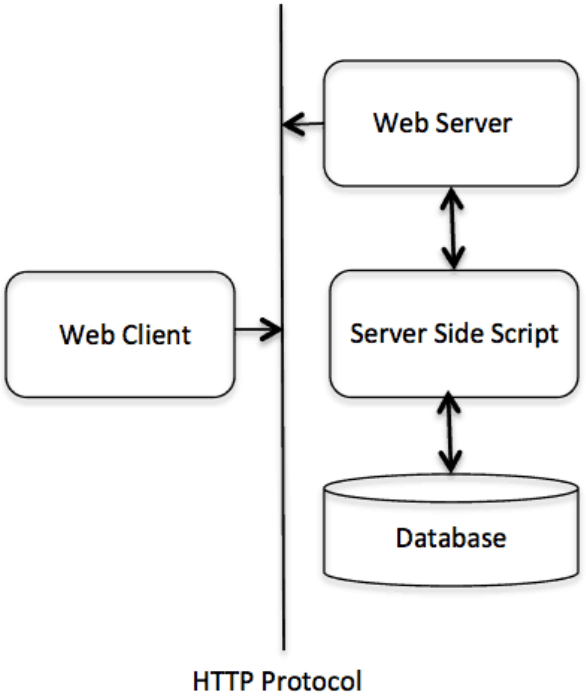
The Basic Characteristics of HTTP (Hypertext Transfer Protocol):

- It is the protocol that allows web servers and browsers to exchange data over the web.
- It is a request response protocol.
- It uses the reliable TCP connections by default on TCP port 80.
- It is stateless means each request is considered as the new request. In other words, server doesn't recognize the user by default.

Features

- **HTTP is media independent:** It specifies that any type of media content can be sent by HTTP as long as both the server and the client can handle the data content.
- **HTTP is connectionless:** It is a connectionless approach in which HTTP client i.e., a browser initiates the HTTP request and after the request is sent the client disconnects from server and waits for the response.
- **HTTP is stateless:** The client and server are aware of each other during a current request only. Afterwards, both of them forget each other. Due to the stateless nature of protocol, neither the client nor the server can retain the information about different request across the web pages.

The Basic Architecture of HTTP (Hypertext Transfer Protocol):



HTTP Request

The request sent by the computer to a web server, contains all sorts of potentially interesting information; it is known as HTTP requests.

The HTTP client sends the request to the server in the form of request message which includes following information:

- The Request-line
- The analysis of source IP address, proxy and port
- The analysis of destination IP address, protocol, port and host
- The Requested URI (Uniform Resource Identifier)
- The Request method and Content
- The User-Agent header
- The Connection control header
- The Cache control header

HTTP Request

The HTTP request method indicates the method to be performed on the resource identified by the **Requested URI (Uniform Resource Identifier)**. This method is case-sensitive and should be used in uppercase.

The HTTP request methods are:

HTTP Request	Description
GET	Asks to get the resource at the requested URL.
POST	Asks the server to accept the body info attached. It is like GET request with extra info sent with the request.
HEAD	Asks for only the header part of whatever a GET would return. Just like GET but with no body.
TRACE	Asks for the loopback of the request message, for testing or troubleshooting.
PUT	Says to put the enclosed info (the body) at the requested URL.
DELETE	Says to delete the resource at the requested URL.
OPTIONS	Asks for a list of the HTTP methods to which the thing at the request URL can respond

GET vs POST

The HTTP request method indicates the method to be performed on the resource identified by the **Requested URI (Uniform Resource Identifier)**. This method is case-sensitive and should be used in uppercase.

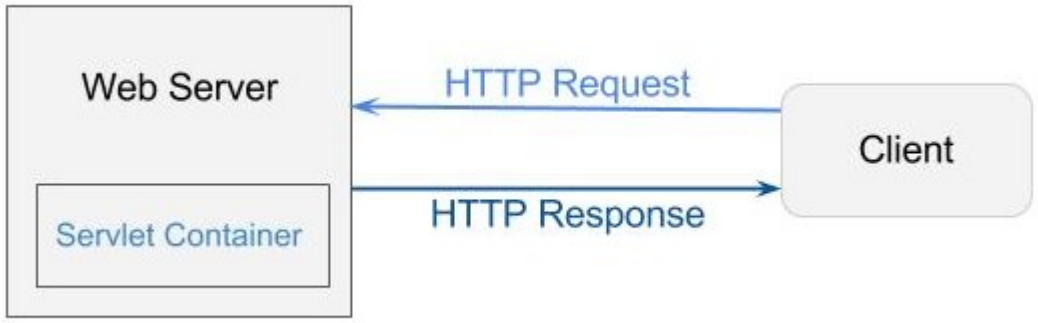
The HTTP request methods are:

GET	POST
1) In case of Get request, only **limited amount of data** can be sent because data is sent in header.	In case of post request, **large amount of data** can be sent because data is sent in body.
2) Get request is **not secured** because data is exposed in URL bar.	Post request is **secured** because data is not exposed in URL bar.
3) Get request **can be bookmarked.**	Post request **cannot be bookmarked.**
4) Get request is **idempotent** . It means second request will be ignored until response of first request is delivered	Post request is **non-idempotent.**
5) Get request is **more efficient** and used more than Post.	Post request is **less efficient** and used less than get.

SERVLET Container

It provides the runtime environment for Java EE (j2ee) applications. The client/user can request only a static Web Pages from the server. If the user wants to read the web pages as per input then the servlet container is used in java.

The servlet container is the part of web server which can be run in a separate process. We can classify the servlet container states in three types:



SERVLET Container

Servlet Container States

The servlet container is the part of web server which can be run in a separate process. We can classify the servlet container states in three types:**Standalone:** It is typical Java-based servers in which the servlet container and the web servers are the integral part of a single program.

For example:- Tomcat running by itself

- **In-process:** It is separated from the web server, because a different program runs within the address space of the main server as a plug-in. For example:- Tomcat running inside the JBoss.
- **Out-of-process:** The web server and servlet container are different programs which are run in a different process. For performing the communications between them, web server uses the plug-in provided by the servlet container.

SERVLET Container

The Servlet Container performs many operations that are given below:

- Life Cycle Management
- Multithreaded support
- Object Pooling
- Security etc.

Server: Web vs. Application

Server is a device or a computer program that accepts and responds to the request made by other program, known as client. It is used to manage the network resources and for running the program or software that provides services.

There are two types of servers:

1. Web Server 2.Application Server

Web Server

Web server contains only web or servlet container. It can be used for servlet, jsp, struts, jsf etc. It can't be used for EJB.

It is a computer where the web content can be stored. In general web server can be used to host the web sites but there also used some other web servers also such as FTP, email, storage, gaming etc.

Examples of Web Servers are: **Apache Tomcat** and **Resin**.

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.

Let's see what are the interfaces of javax.servlet package.

ServletRequest Interface

An object of ServletRequest is used to provide the client request information to a servlet such as content type, content length, parameter names and values, header informations, attributes etc.

Method	Description
public String getParameter(String name)	is used to obtain the value of a parameter by name.
public String[] getParameterValues(String name)	returns an array of String containing all values of given parameter name. It is mainly used to obtain values of a Multi select list box.
java.util.Enumeration getParameterNames()	returns an enumeration of all of the request parameter names.
public int getContentLength()	Returns the size of the request entity data, or -1 if not known.
public String getCharacterEncoding()	Returns the character set encoding for the input of this request.
public String getContentType()	Returns the Internet Media Type of the request entity data, or null if not known.
public ServletInputStream getInputStream() throws IOException	Returns an input stream for reading binary data in the request body.
public abstract String getServerName()	Returns the host name of the server that received the request.
public int getServerPort()	Returns the port number on which this request was received.

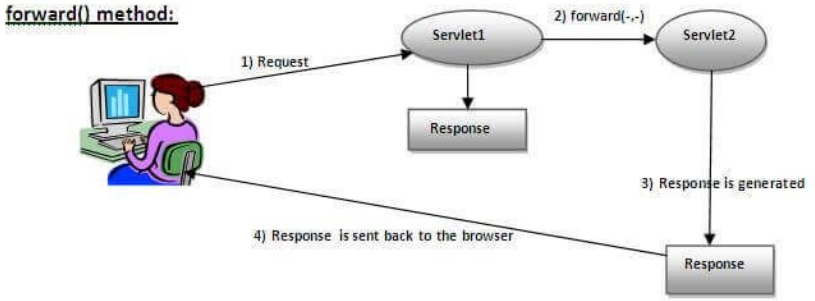
RequestDispatcher in Servlet

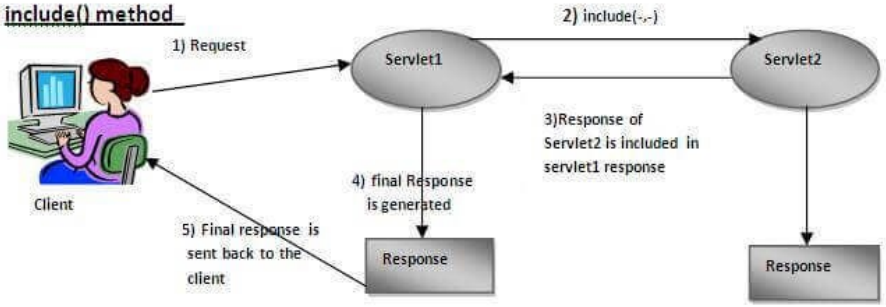
The RequestDispatcher interface provides the facility of dispatching the request to another resource it may be html, servlet or jsp. This interface can also be used to include the content of another resource also. It is one of the way of servlet collaboration.

There are two methods defined in the RequestDispatcher interface.

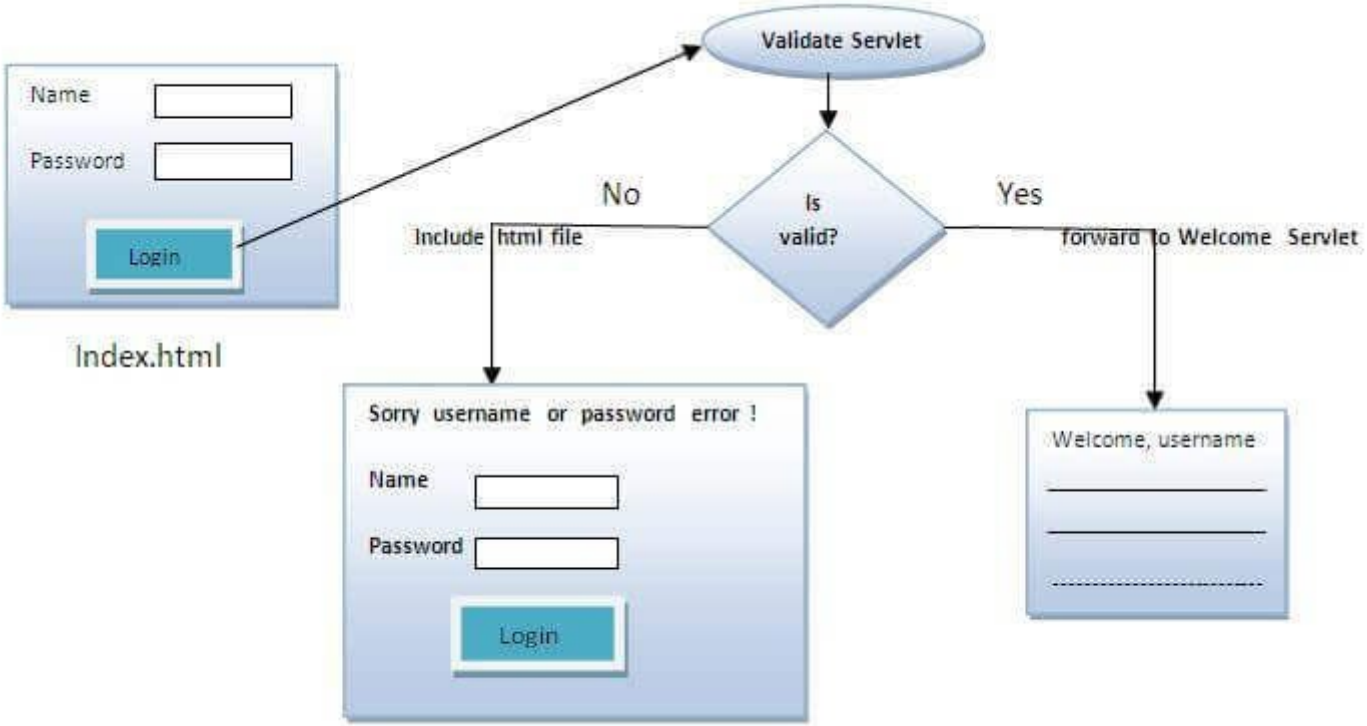
1. **public void forward(ServletRequest request,ServletResponse response)throws ServletException,java.io.IOException:**Forwards a request from a servlet to another resource (servlet, JSP file, or HTML file) on the server.
2. **public void include(ServletRequest request,ServletResponse response)throws ServletException,java.io.IOException:**Includes the content of a resource (servlet, JSP page, or HTML file) in the response.

RequestDispatcher in Servlet





Example


Validate Servlet
Name
Password
Login
Index.html
No
Is
valid?
Yes
Include html file
forward to Welcome Servlet
Sorry username or password error !
Name
Password
Login
Welcome, username

SendRedirect in servlet

The **sendRedirect()** method of **HttpServletResponse** interface can be used to redirect response to another resource, it may be servlet, jsp or html file.

It accepts relative as well as absolute URL.

It works at client side because it uses the url bar of the browser to make another request. So, it can work inside and outside the server.

forward() method	sendRedirect() method
The forward() method works at server side.	The sendRedirect() method works at client side.
It sends the same request and response objects to another servlet.	It always sends a new request.
It can work within the server only.	It can be used within and outside the server.
Example: request.getRequestDispacher("servlet2").forward(request,response);	Example: response.sendRedirect("servlet2");

ServletConfig Interface

An object of ServletConfig is created by the web container for each servlet. This object can be used to get configuration information from web.xml file.

If the configuration information is modified from the web.xml file, we don't need to change the servlet. So it is easier to manage the web application if any specific content is modified from time to time.

Advantage of ServletConfig

The core advantage of ServletConfig is that you don't need to edit the servlet file if information is modified from the web.xml file.

Methods of ServletConfig interface

1. **public String getInitParameter(String name):**Returns the parameter value for the specified parameter name.
2. **public Enumeration getInitParameterNames():**Returns an enumeration of all the initialization parameter names.
3. **public String getServletName():**Returns the name of the servlet.
4. **public ServletContext getServletContext():**Returns an object of ServletContext.

Example of ServletConfig to get initialization parameter

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

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

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

   ServletConfig config=getServletConfig();
   String driver=config.getInitParameter("driver");
   out.print("Driver is: "+driver);

   out.close();
   }
```

web.xml

```
<web-app>

<servlet>
<servlet-name>DemoServlet</servlet-name>
<servlet-class>DemoServlet</servlet-class>

<init-param>
<param-name>driver</param-name>
<param-value>sun.jdbc.odbc.JdbcOdbcDriver</param-value>
</init-param>

</servlet>

<servlet-mapping>
<servlet-name>DemoServlet</servlet-name>
<url-pattern>/servlet1</url-pattern>
</servlet-mapping>

</web-app>
```

ServletContext Interface

An object of ServletContext is created by the web container at time of deploying the project. This object can be used to get configuration information from web.xml file. There is only one ServletContext object per web application.

If any information is shared to many servlet, it is better to provide it from the web.xml file using the **<context-param>** element.

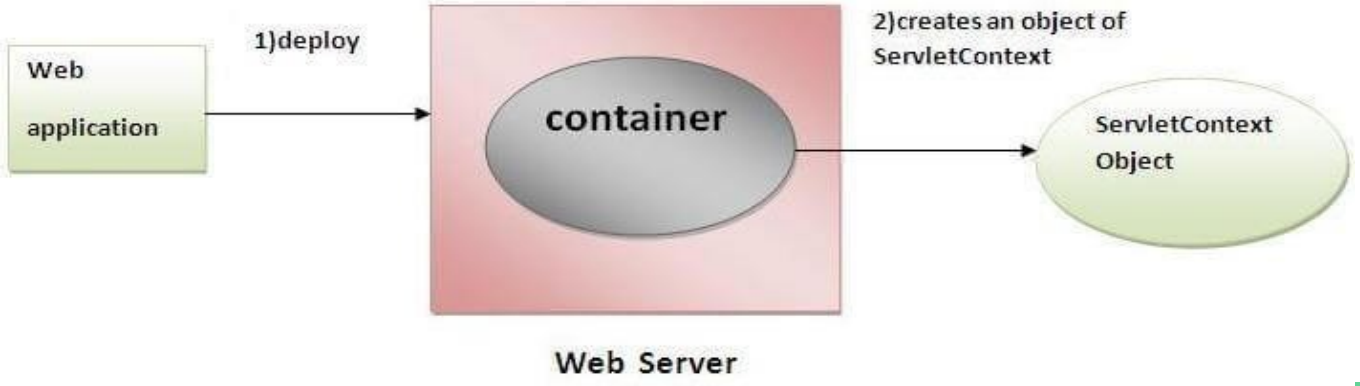
Advantage of ServletContext

Easy to maintain if any information is shared to all the servlet, it is better to make it available for all the servlet. We provide this information from the web.xml file, so if the information is changed, we don't need to modify the servlet. Thus it removes maintenance problem.

ServletContext Interface

Usage of ServletContext Interface

1. The object of ServletContext provides an interface between the container and servlet.
2. The ServletContext object can be used to get configuration information from the web.xml file.
3. The ServletContext object can be used to set, get or remove attribute from the web.xml file.
4. The ServletContext object can be used to provide inter-application communication.



ServletContext Interface

There is given some commonly used methods of ServletContext interface.

1. **public String getInitParameter(String name):**Returns the parameter value for the specified parameter name.
2. **public Enumeration getInitParameterNames():**Returns the names of the context's initialization parameters.
3. **public void setAttribute(String name,Object object):**sets the given object in the application scope.
4. **public Object getAttribute(String name):**Returns the attribute for the specified name.
5. **public Enumeration getInitParameterNames():**Returns the names of the context's initialization parameters as an Enumeration of String objects.
6. **public void removeAttribute(String name):**Removes the attribute with the given name from the servlet context.

ServletContext Interface

```
<web-app>
.....

 <context-param>
  <param-name>parametername</param-name>
  <param-value>parametervalue</param-value>
 </context-param>
.....
</web-app>
```

```
//creating ServletContext object
ServletContext context=getServletContext();

//Getting the value of the initialization parameter and printing it
String driverName=context.getInitParameter("dname");
pw.println("driver name is="+driverName);
```

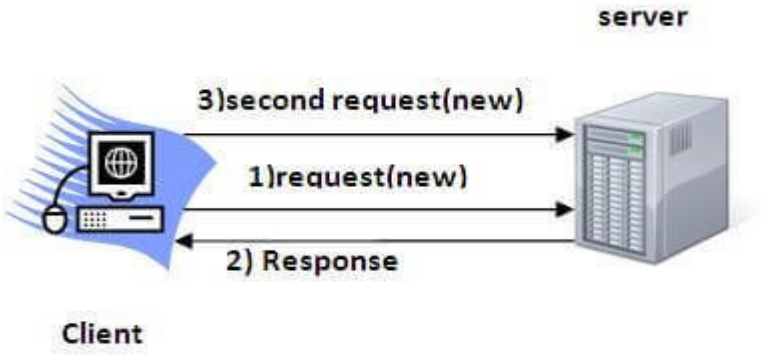
Session Tracking in Servlets

Session simply means a particular interval of time.

Session Tracking is a way to maintain state (data) of an user. It is also known as **session management** in servlet.

Http protocol is a stateless so we need to maintain state using session tracking techniques. Each time user requests to the server, server treats the request as the new request. So we need to maintain the state of an user to recognize to particular user.

HTTP is stateless that means each request is considered as the new request. It is shown in the figure given below:



Session Tracking Techniques

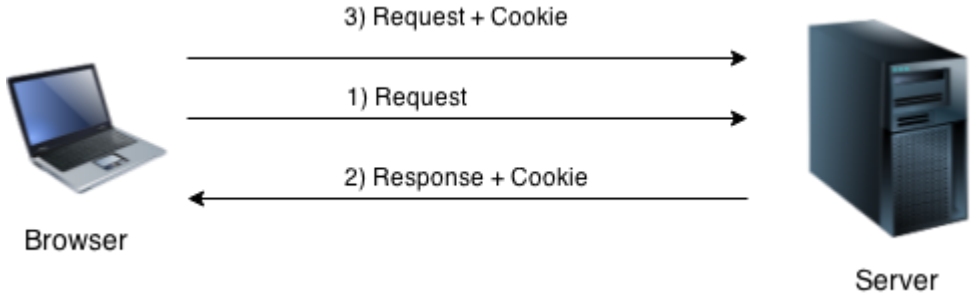
1. **Cookies**
2. **Hidden Form Field**
3. **URL Rewriting**
4. **HttpSession**

Cookies in Servlet

A **cookie** is a small piece of information that is persisted between the multiple client requests.

A cookie has a name, a single value, and optional attributes such as a comment, path and domain qualifiers, a maximum age, and a version number.

How Cookie works



Cookies in Servlet

1. Non-persistent cookie
2. Persistent cookie

Non-persistent cookie

It is **valid for single session** only. It is removed each time when user closes the browser.

Persistent cookie

It is **valid for multiple session** . It is not removed each time when user closes the browser. It is removed only if user logout or signout.

Cookies in Servlet

Advantage of Cookies

1. Simplest technique of maintaining the state.
2. Cookies are maintained at client side.

Disadvantage of Cookies

1. It will not work if cookie is disabled from the browser.
2. Only textual information can be set in Cookie object.

Cookies in Servlet

How to create Cookie?

Let's see the simple code to create cookie.

```
1. Cookie ck=new Cookie("user","sampleText");//creating cookie object
2. response.addCookie(ck);//adding cookie in the response
```

How to delete Cookie?

Let's see the simple code to delete cookie. It is mainly used to logout or signout the user.

```
1. Cookie ck=new Cookie("user","");//deleting value of cookie
2. ck.setMaxAge(0);//changing the maximum age to 0 seconds
3. response.addCookie(ck);//adding cookie in the response
```

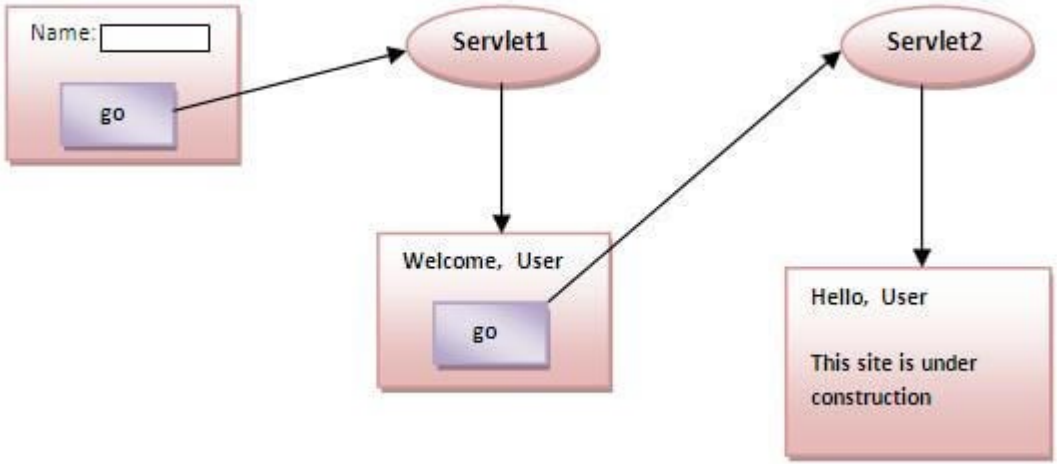
Cookies in Servlet

How to get Cookies?

```
1. Cookie ck[]=request.getCookies();
2. for(int i=0;i<ck.length;i++){
3.  out.print("<br>"+ck[i].getName()+" "+ck[i].getValue());//printing name and value of cookie
4. }
```

Cookies in Servlet

we are storing the name of the user in the cookie object and accessing it in another servlet. As we know well that session corresponds to the particular user. So if you access it from too many browsers with different values, you will get the different value.



Example

Servlet Login and Logout Example using Cookies

Here, we are going to create a login and logout example using servlet cookies.

In this example, we are creating 3 links: login, logout and profile. User can't go to profile page until he/she is logged in. If user is logged out, he need to login again to visit profile.

1. index.html
2. link.html
3. login.html
4. LoginServlet.java
5. LogoutServlet.java
6. ProfileServlet.java
7. web.xml

Example

Hidden Form Field

In case of Hidden Form Field **a hidden (invisible) textfield** is used for maintaining the state of an user.

In such case, we store the information in the hidden field and get it from another servlet. This approach is better if we have to submit form in all the pages and we don't want to depend on the browser.

1. <input type="hidden" name="uname" value="Vimal Jaiswal">

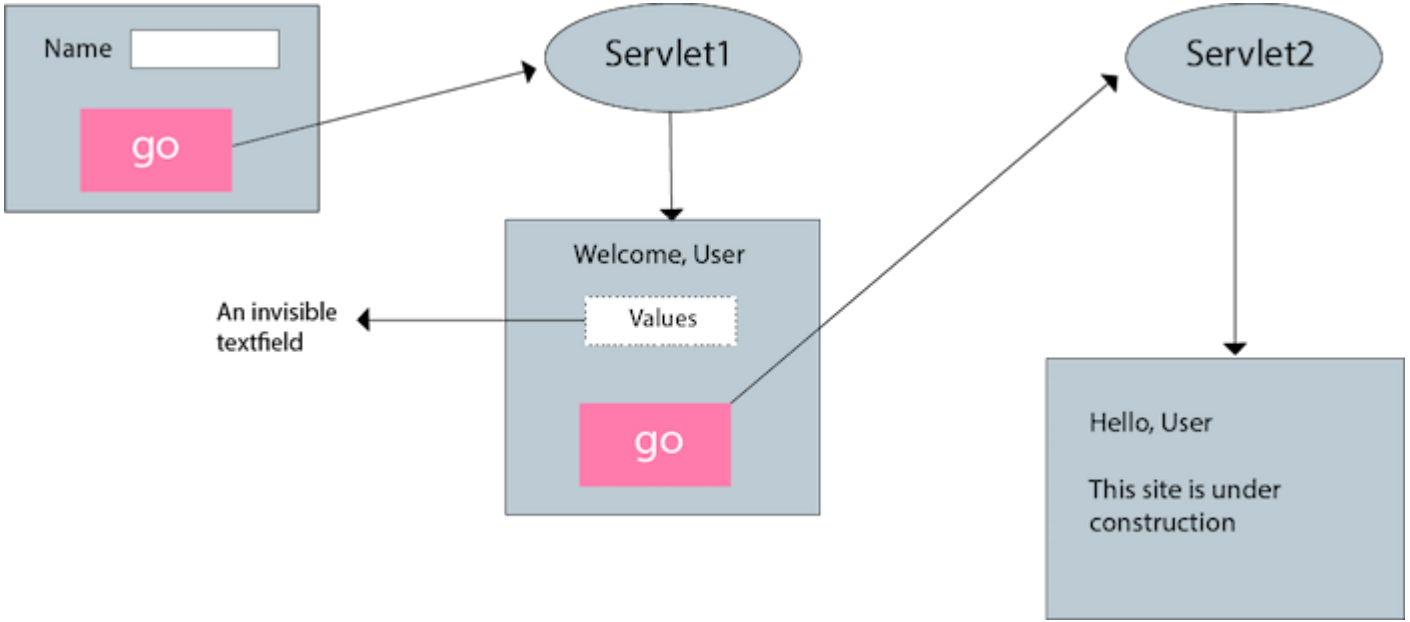
Advantage of Hidden Form Field

1. It will always work whether cookie is disabled or not.

Disadvantage of Hidden Form Field:

1. It is maintained at server side.
2. Extra form submission is required on each pages.
3. Only textual information can be used.

Example of using Hidden Form Field



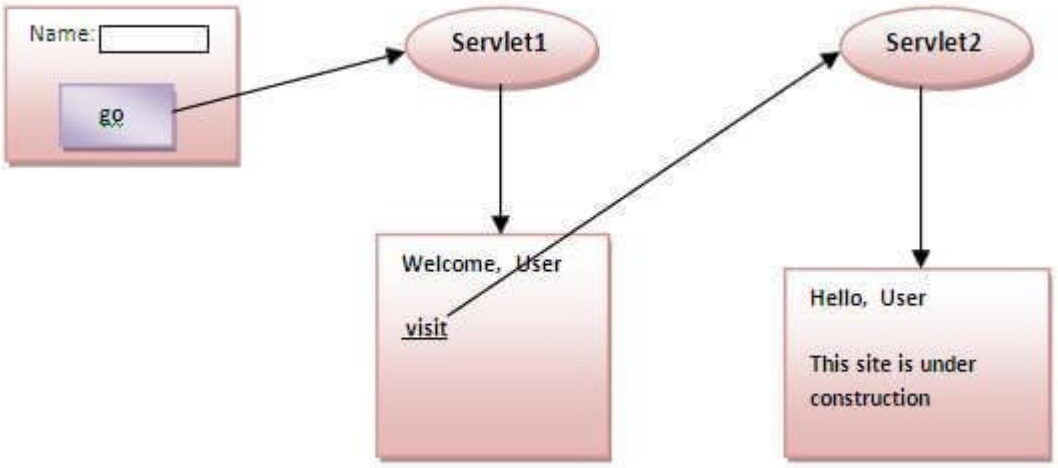
URL Rewriting

n URL rewriting, we append a token or identifier to the URL of the next Servlet or the next resource. We can send parameter name/value pairs using the following format:

url?name1=value1&name2=value2&??

A name and a value is separated using an equal = sign, a parameter name/value pair is separated from another parameter using the ampersand(&). When the user clicks the hyperlink, the parameter name/value pairs will be passed to the server. From a Servlet, we can use getParameter() method to obtain a parameter value.

URL Rewriting



Advantage of URL Rewriting

1. It will always work whether cookie is disabled or not (browser independent).
2. Extra form submission is not required on each pages.

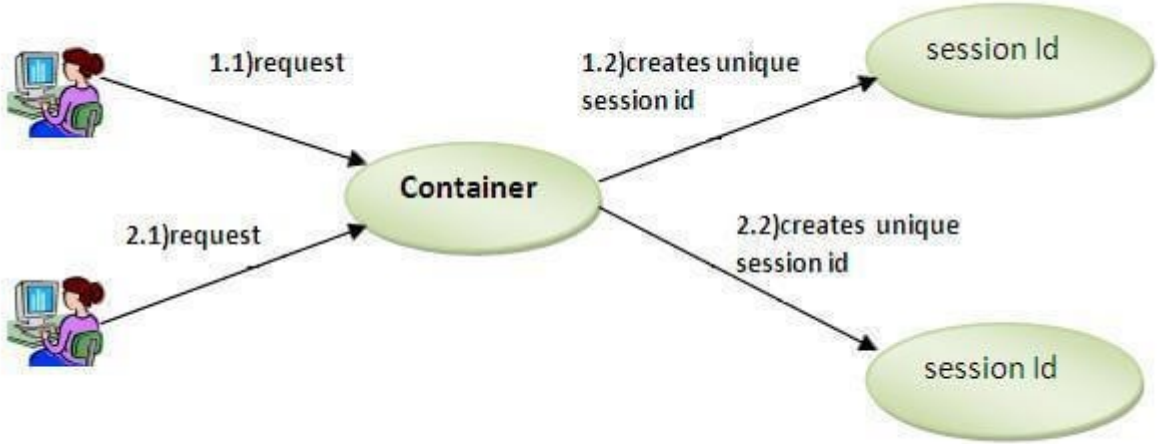
Disadvantage of URL Rewriting

1. It will work only with links.
2. It can send Only textual information.

HttpSession interface

container creates a session id for each user.The container uses this id to identify the particular user.An object of HttpSession can be used to perform two tasks:

1. bind objects
2. view and manipulate information about a session, such as the session identifier, creation time, and last accessed time.



HttpSession interface

How to get the HttpSession object ?

The HttpServletRequest interface provides two methods to get the object of HttpSession:

1. **public HttpSession getSession():**Returns the current session associated with this request, or if the request does not have a session, creates one.
2. **public HttpSession getSession(boolean create):**Returns the current HttpSession associated with this request or, if there is no current session and create is true, returns a new session.

Commonly used methods of HttpSession interface

1. **public String getId():**Returns a string containing the unique identifier value.
2. **public long getCreationTime():**Returns the time when this session was created, measured in milliseconds since midnight January 1, 1970 GMT.
3. **public long getLastAccessedTime():**Returns the last time the client sent a request associated with this session, as the number of milliseconds since midnight January 1, 1970 GMT.
4. **public void invalidate():**Invalidates this session then unbinds any objects bound to it.

Events

Events are basically occurrence of something. Changing the state of an object is known as an event.

We can perform some important tasks at the occurrence of these exceptions, such as counting total and current logged-in users, creating tables of the database at time of deploying the project, creating database connection object etc.

There are many Event classes and Listener interfaces in the javax.servlet and javax.servlet.http packages.

Events

Event classes

The event classes are as follows:

1. ServletRequestEvent
2. ServletContextEvent
3. ServletRequestAttributeEvent
4. ServletContextAttributeEvent
5. HttpSessionEvent
6. HttpSessionBindingEvent

Events

Event interfaces

The event interfaces are as follows:

1. ServletRequestListener
2. ServletRequestAttributeListener
3. ServletContextListener
4. ServletContextAttributeListener
5. HttpSessionListener
6. HttpSessionAttributeListener
7. HttpSessionBindingListener
8. HttpSessionActivationListener

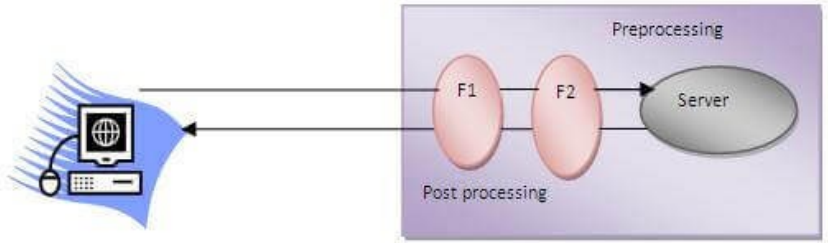
Filters

A **filter** is an object that is invoked at the preprocessing and postprocessing of a request.

It is mainly used to perform filtering tasks such as conversion, logging, compression, encryption and decryption, input validation etc.

The **servlet filter is pluggable**, i.e. its entry is defined in the web.xml file, if we remove the entry of filter from the web.xml file, filter will be removed automatically and we don't need to change the servlet.

So maintenance cost will be less



Filters

Usage of Filter

- recording all incoming requests
- logs the IP addresses of the computers from which the requests originate
- conversion
- data compression
- encryption and decryption
- input validation etc.

Advantage of Filter

1. Filter is pluggable.
2. One filter don't have dependency onto another resource.
3. Less Maintenance

Filters

Filter API

Like servlet filter have its own API. The javax.servlet package contains the three interfaces of Filter API.

1. Filter
2. FilterChain
3. FilterConfig

1) Filter interface

For creating any filter, you must implement the Filter interface. Filter interface provides the life cycle methods for a filter.

Method	Description
public void init(FilterConfig config)	init() method is invoked only once. It is used to initialize the filter.
public void doFilter(HttpServletRequest request,HttpServletResponse response, FilterChain chain)	doFilter() method is invoked every time when user request to any resource, to which the filter is mapped.It is used to perform filtering tasks.
public void destroy()	This is invoked only once when filter is taken out of the service.

Filters

2) FilterChain interface

The object of FilterChain is responsible to invoke the next filter or resource in the chain.This object is passed in the doFilter method of Filter interface.The FilterChain interface contains only one method:

1. **public void doFilter(HttpServletRequest request, HttpServletResponse response):** it passes the control to the next filter or resource.

How to define Filter

```
1.  <web-app>
2.
3.  <filter>
4.  <filter-name>...</filter-name>
5.  <filter-class>...</filter-class>
6.  </filter>
7.
8.  <filter-mapping>
9.  <filter-name>...</filter-name>
10. <url-pattern>...</url-pattern>
11. </filter-mapping>
12.
13. </web-app>
```

Authentication Filter

We can perform authentication in filter. Here, we are going to check to password given by the user in filter class, if given password is admin, it will forward the request to the WelcomeAdmin servlet otherwise it will display error message.

Here, we have created 4 files:

- index.html
- MyFilter.java
- AdminServlet.java
- web.xml

index.html

```
<form action="servlet1">
Name:<input type="text" name="name"/><br/>
Password:<input type="password" name="password"/><br/>

<input type="submit" value="login">

</form>
```

MyFilter.java

```
import java.io.IOException;
import java.io.PrintWriter;
import javax.servlet.*;

public class MyFilter implements Filter{

public void init(FilterConfig arg0) throws ServletException {}

public void doFilter(ServletRequest req, ServletResponse resp,
        FilterChain chain) throws IOException, ServletException {

    PrintWriter out=resp.getWriter();

    String password=req.getParameter("password");
    if(password.equals("admin")){
    chain.doFilter(req, resp);//sends request to next resource
    }
    else{
    out.print("username or password error!");
    RequestDispatcher rd=req.getRequestDispatcher("index.html");
    rd.include(req, resp);
    }

}
    public void destroy() {}

}
```

AdminServlet.java

```
import java.io.IOException;
import java.io.PrintWriter;

import javax.servlet.ServletException;
import javax.servlet.http.*;

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

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

        out.print("welcome ADMIN");
        out.close();
    }
}
```

web.xml

```
<web-app>
 <servlet>
   <servlet-name>AdminServlet</servlet-name>
   <servlet-class>AdminServlet</servlet-class>
 </servlet>

 <servlet-mapping>
   <servlet-name>AdminServlet</servlet-name>
   <url-pattern>/servlet1</url-pattern>
 </servlet-mapping>

<filter>
 <filter-name>f1</filter-name>
 <filter-class>MyFilter</filter-class>
 </filter>
 <filter-mapping>
 <filter-name>f1</filter-name>
 <url-pattern>/servlet1</url-pattern>
 </filter-mapping>

</web-app>
```

FilterConfig

An object of FilterConfig is created by the web container. This object can be used to get the configuration information from the web.xml file.

Methods of FilterConfig interface

There are following 4 methods in the FilterConfig interface.

1. **public void init(FilterConfig config):** init() method is invoked only once it is used to initialize the filter.
2. **public String getInitParameter(String parameterName):** Returns the parameter value for the specified parameter name.
3. **public java.util.Enumeration getInitParameterNames():** Returns an enumeration containing all the parameter names.
4. **public ServletContext getServletContext():** Returns the ServletContext object.