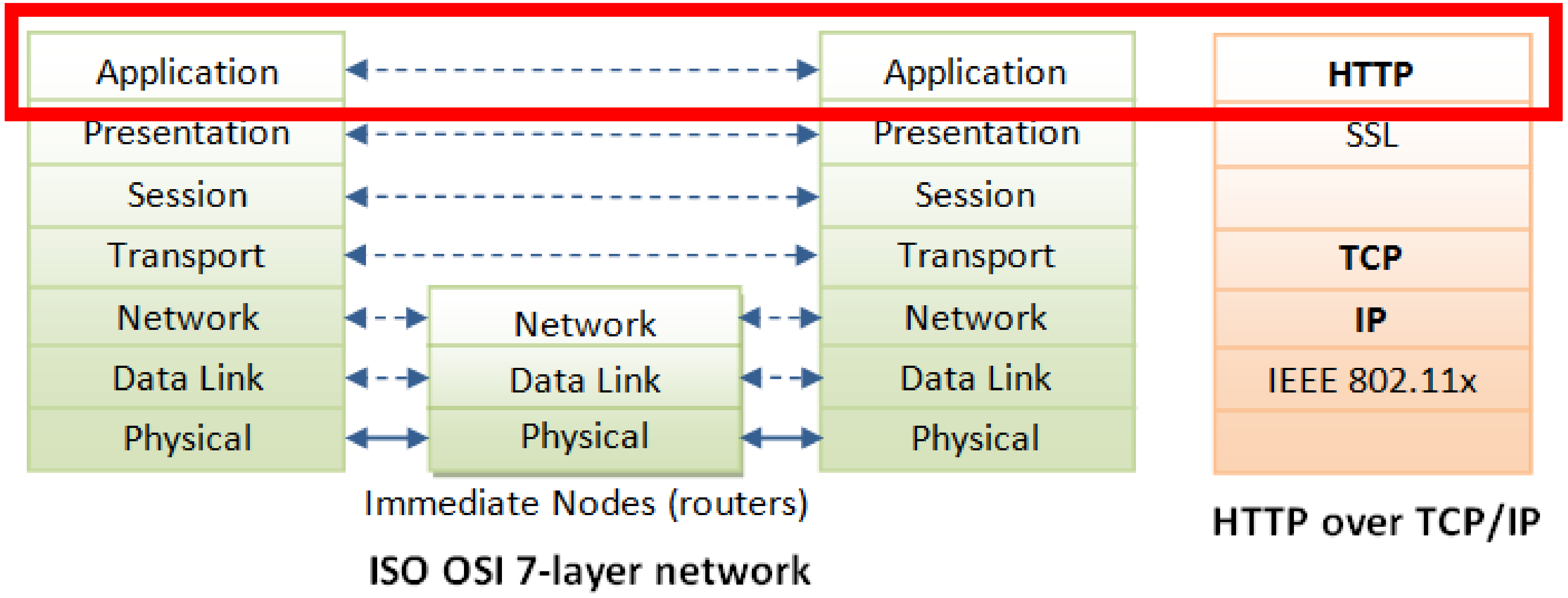
UNIZG-FER 86518

Service-Oriented Computing

HTTP
The Driver of the World Wide Web

HTTP Basics

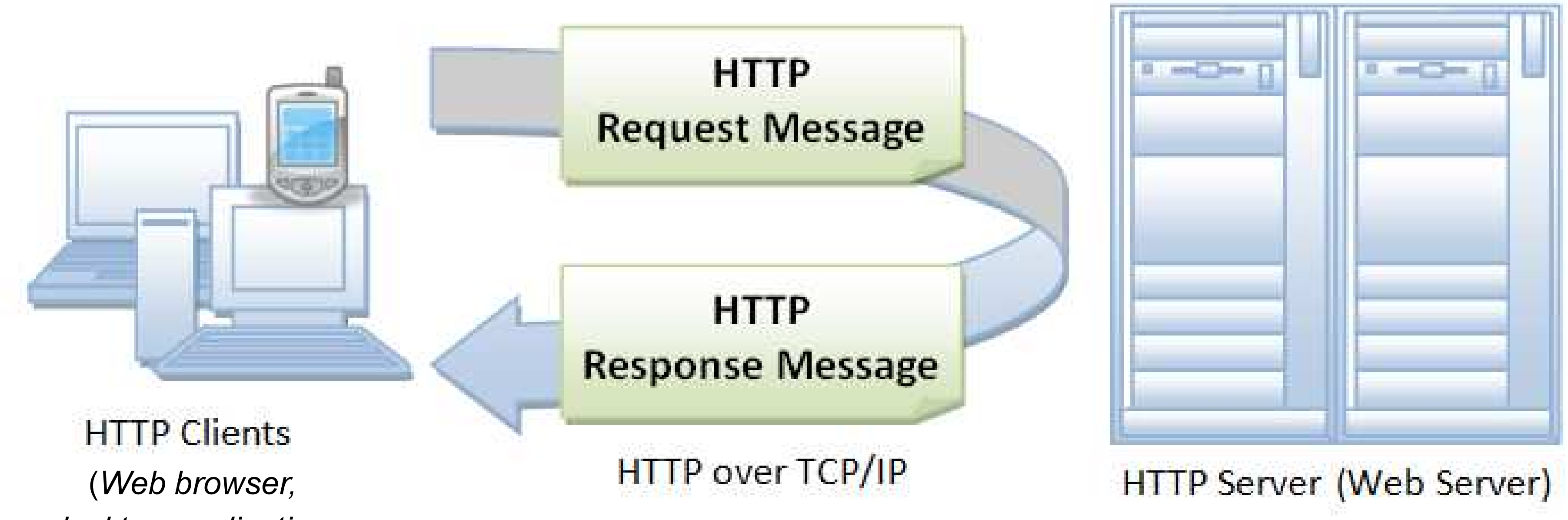
- HTTP (*HyperText Transfer Protocol*) protocol
  - Application-level protocol for distributed hypermedia information systems



- **World Wide Web**
  - Applications and services based on **HTTP protocol**

HTTP Basics

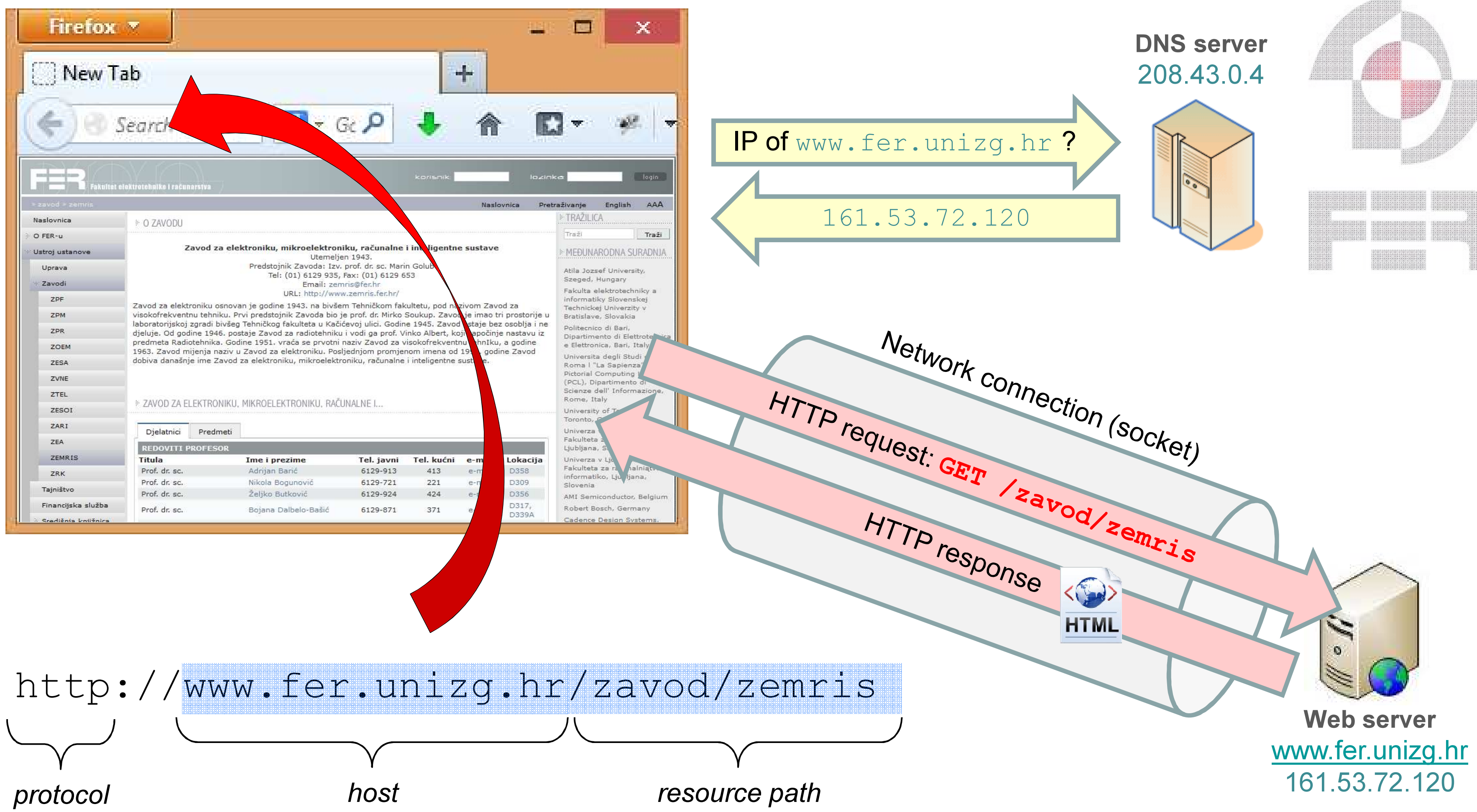
- HTTP (*HyperText Transfer Protocol*) protocol
  - Client-server architecture
  - Asymmetric request-response protocol
    - Client *pulls* information from the server
      (instead of server *pushes* information down to the client)



(*Web browser, desktop application, mobile application, any program using HTTP*)

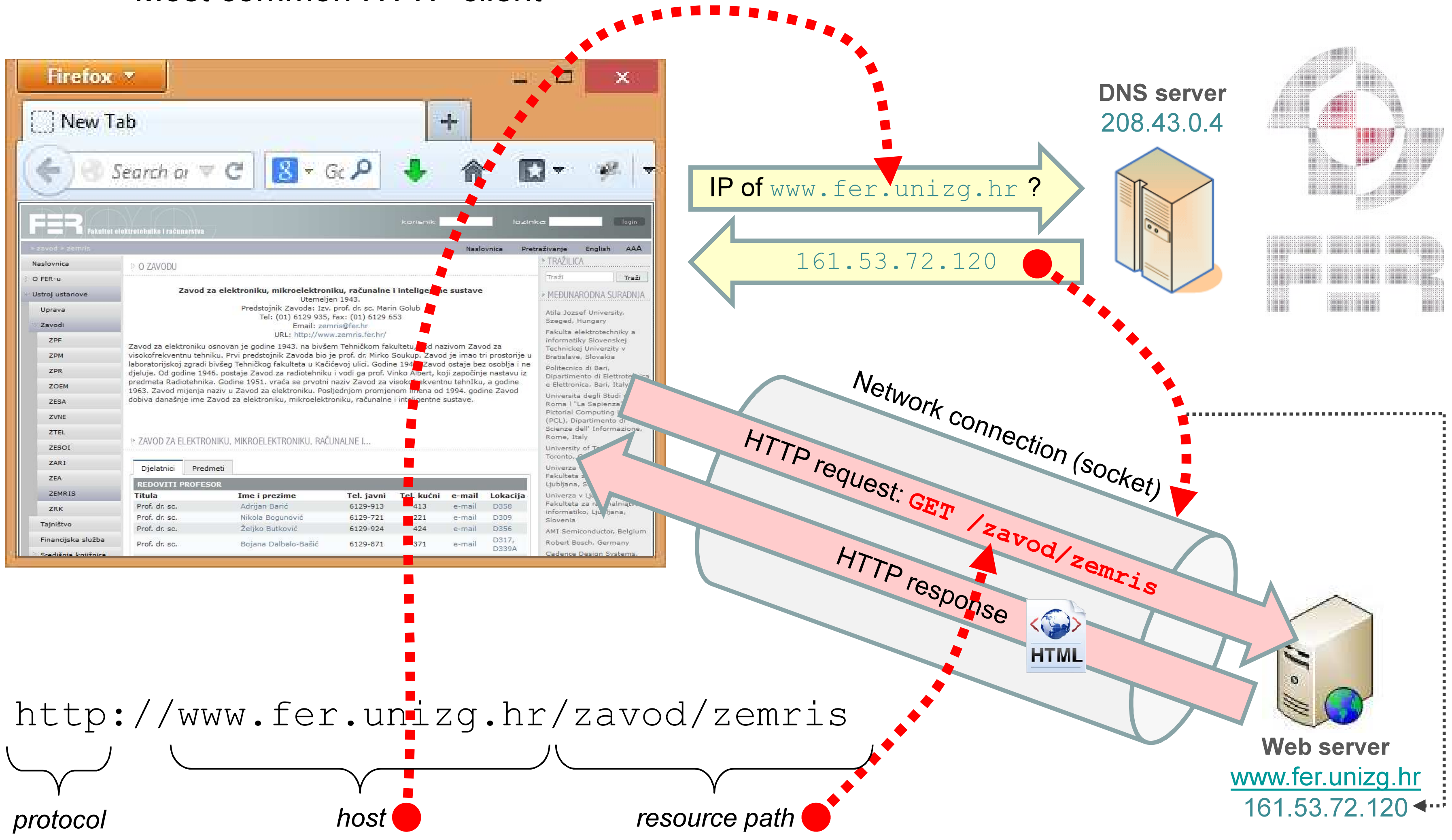
HTTP Basics

- Web browser
  - Most common HTTP client



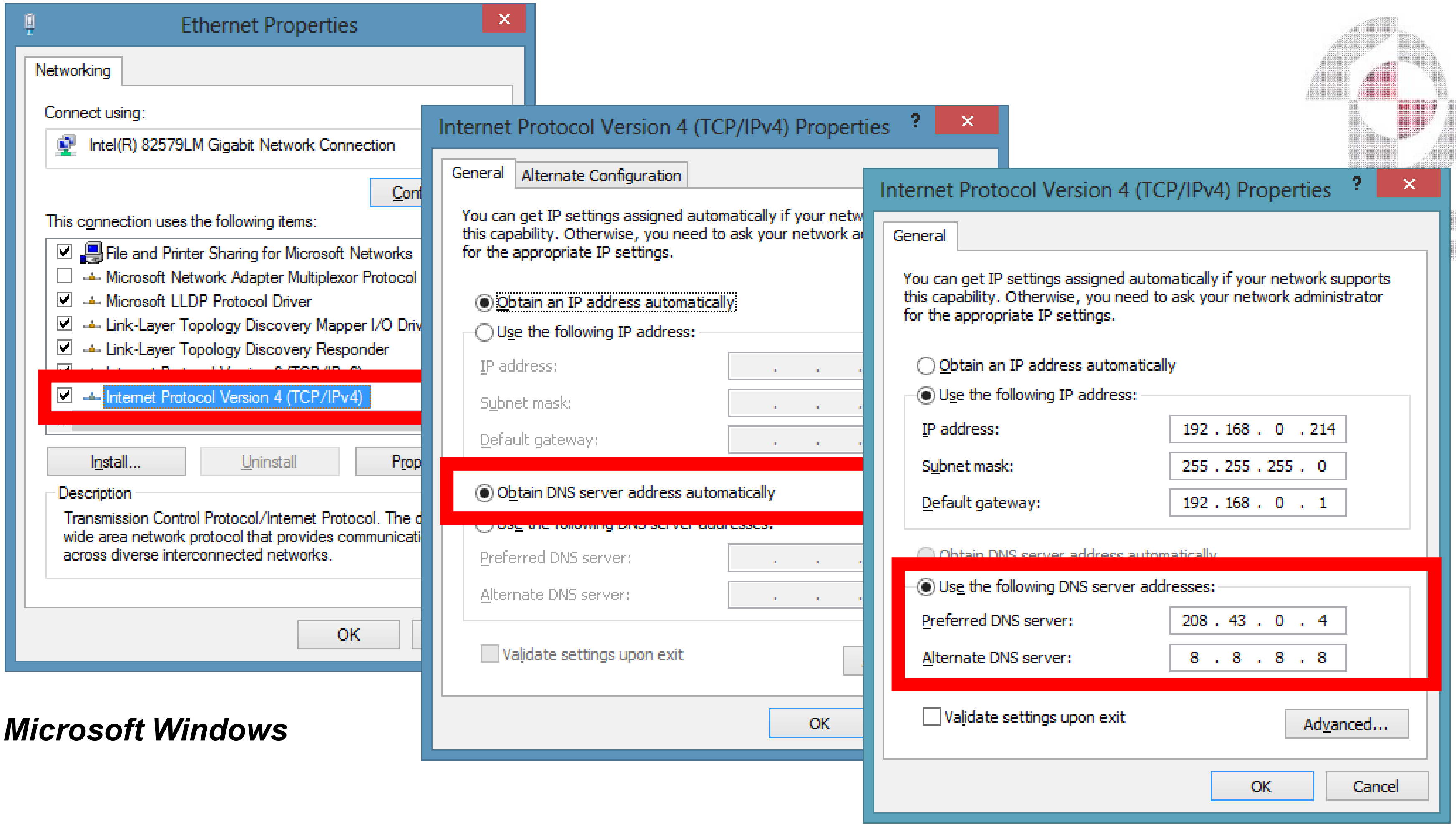
HTTP Basics

- Web browser
  - Most common HTTP client



HTTP Basics

- How web browser finds the DNS server?
  - Operating system network configuration



Ethernet Properties

Networking

Connect using:

Intel(R) 82579LM Gigabit Network Connection

Conf

This connection uses the following items:

- ☑ File and Printer Sharing for Microsoft Networks
- ☐ Microsoft Network Adapter Multiplexor Protocol
- ☑ Microsoft LLDP Protocol Driver
- ☑ Link-Layer Topology Discovery Mapper I/O Driv
- ☑ Link-Layer Topology Discovery Responder
- ☑ Internet Protocol Version 4 (TCP/IPv4)

Install... Uninstall Prop

Description

Transmission Control Protocol/Internet Protocol. The d
wide area network protocol that provides communicati
across diverse interconnected networks.

OK

Internet Protocol Version 4 (TCP/IPv4) Properties

General | Alternate Configuration

You can get IP settings assigned automatically if your netw
this capability. Otherwise, you need to ask your network a
for the appropriate IP settings.

[✓ Obtain an IP address automatically]
Use the following IP address:

IP address:	. . .
Subnet mask:	. . .
Default gateway:	. . .

[✓ Obtain DNS server address automatically]
Use the following DNS server addresses:

Preferred DNS server:	. . .
Alternate DNS server:	. . .

☐ Validate settings upon exit

OK

Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports
this capability. Otherwise, you need to ask your network administrator
for the appropriate IP settings.

Obtain an IP address automatically
[✓ Use the following IP address:]

IP address:	192 . 168 . 0 . 214
Subnet mask:	255 . 255 . 255 . 0
Default gateway:	192 . 168 . 0 . 1

Obtain DNS server address automatically
[✓ Use the following DNS server addresses:]

Preferred DNS server:	208 . 43 . 0 . 4
Alternate DNS server:	8 . 8 . 8 . 8

☐ Validate settings upon exit

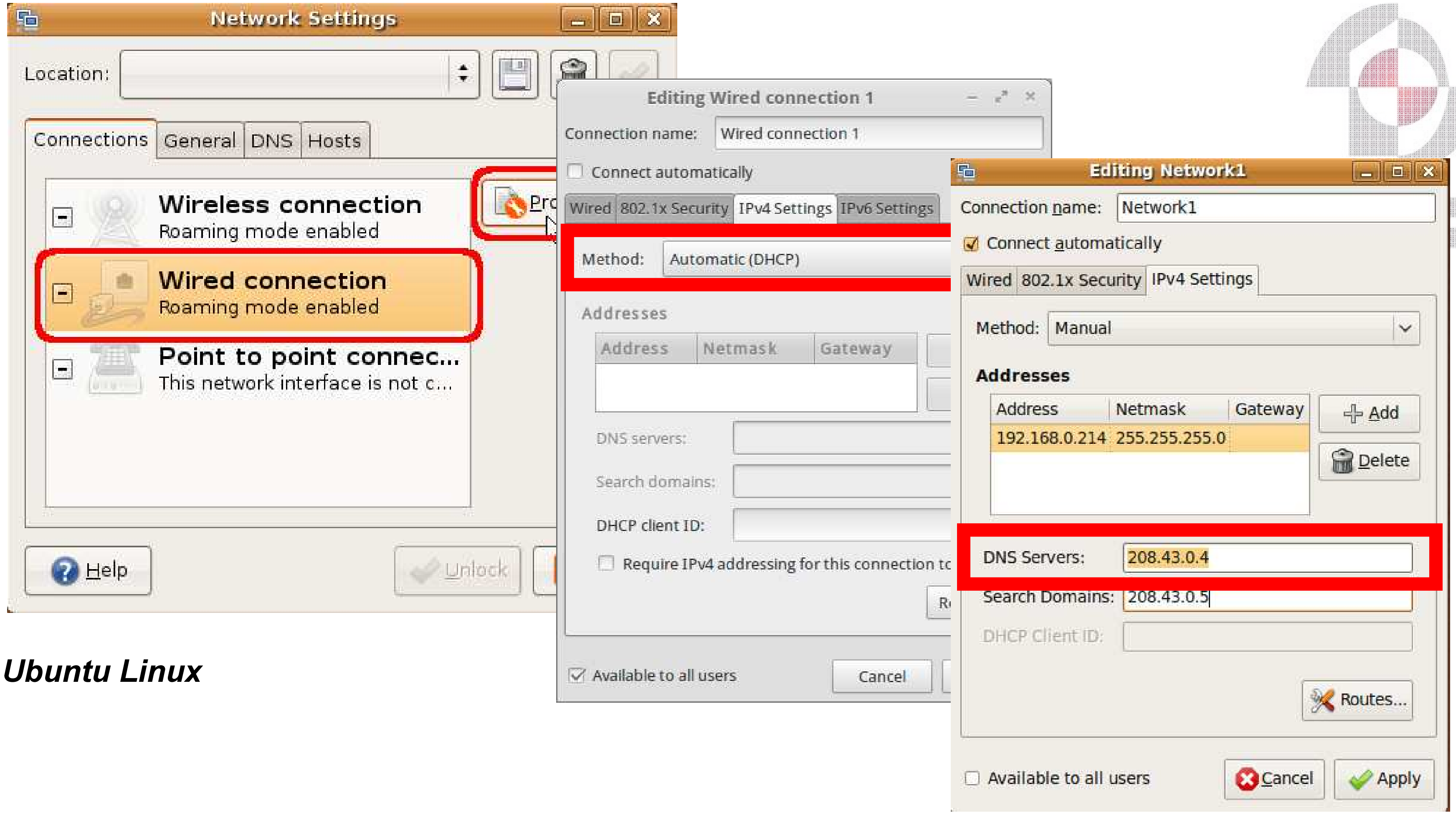
Advanced...

OK Cancel

Microsoft Windows

HTTP Basics

- How web browser finds the DNS server?
  - Operating system network configuration



Ubuntu Linux

HTTP Basics

- Uniform Resource Identifier (URI)
  - String used to uniquely identify a resource over the web

- URI syntax

```
protocol://hostname:port/path-and-file-name?parameters
```

protocol

- The application-level protocol used by the client and server
  e.g. HTTP, HTTPS, FTP, telnet

hostname

- The DNS domain name or IP address of the server
  e.g. www.fer.unizg.hr, 161.53.72.120

port

- The TCP port number the server is listening for incoming requests from the clients

path-and-file-name

- The name and location of the requested resource under the server document base directory
  e.g. static file on disk or program that dynamically renders the response

parameters

- Optional, used to additionally describe the resource (*we'll come back to this later*)

HTTP Basics

- URI examples

1) `http://www.fer.unizg.hr/zavod/zemris` (default HTTP port is 80)
   `http://www.fer.unizg.hr:80/zavod/zemris`
   `http://161.53.72.120/zavod/zemris`
   `http://161.53.72.120:80/zavod/zemris`

2) `http://www.example.com:1234/europe/croatia/home.html`

3) `https://www.fer.unizg.hr/predmet/rznu` (default HTTPS port is 443)
   `https://www.fer.unizg.hr:443/predmet/rznu`

4) `https://www.fer.unizg.hr:987/predmet/rznu`

5) `ftp://www.ftp.org/docs/test.txt` (default FTP port is 21)

6) `telnet://www.test101.com/` (default TELNET port is 23)

HTTP Basics

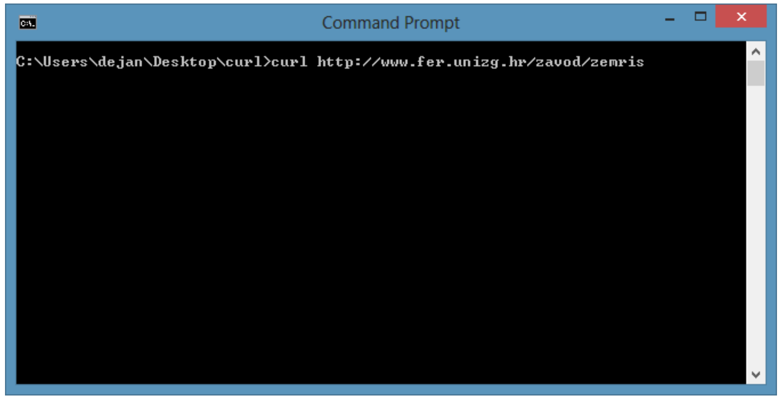
General HTTP client algorithm

1. The user enters URI of a desired web page
2. Browser parses the URI
   3. Browser asks the DNS server for web server's IP address
   4. DNS server responds with IP address

   (*steps 3 and 4 are not necessary if user enters web server's IP address instead of DNS name*)
5. Browser opens a network connection to given IP address and TCP port
6. Browser sends a HTTP request message to the web server
7. Server maps the URI to a local file or program
8. Server returns a HTTP response message
9. Browser formats the response, renders GUI, and displays a web page

HTTP Basics

- Other HTTP clients
  - `curl`



Command Prompt

```
C:\Users\dejan\Desktop\curl>curl http://www.fer.unizg.hr/zavod/zemris
```

  - Command line syntax

    `curl [options] <url>`

  - Usage instructions

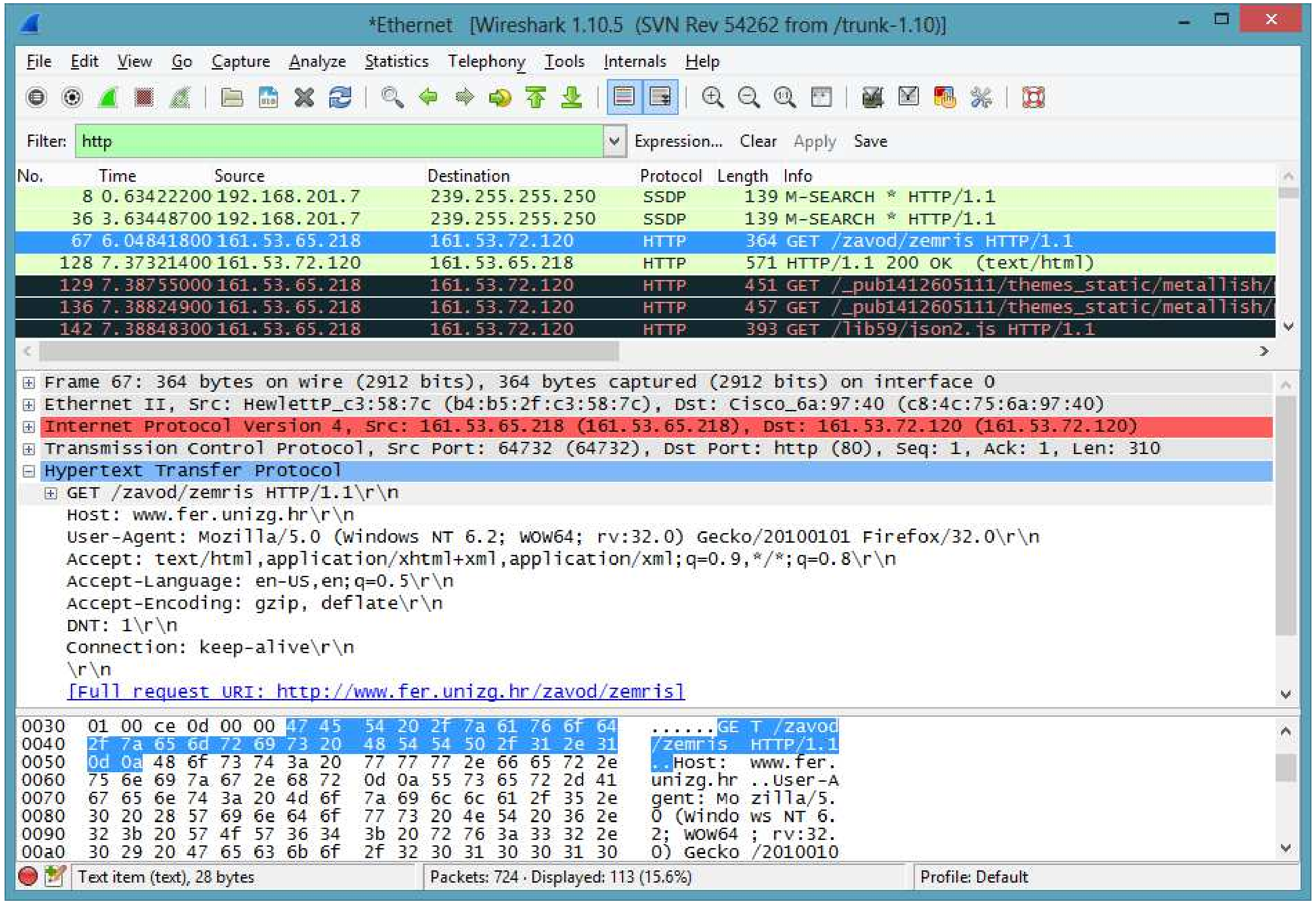
    `curl -help`

  - Simple HTTP request

    `curl http://www.fer.unizg.hr/zavod/zemris`

HTTP Basics

- What happens on the network level?
  - Network monitoring & capture tool


*Ethernet [Wireshark 1.10.5 (SVN Rev 54262 from /trunk-1.10)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter: http
Expression... Clear Apply Save

```
No.     Time       Source          Destination      Protocol Length Info
      8 0.63422200 192.168.201.7   239.255.255.250  SSDP        139 M-SEARCH * HTTP/1.1
     36 3.63448700 192.168.201.7   239.255.255.250  SSDP        139 M-SEARCH * HTTP/1.1
     67 6.04841800 161.53.65.218   161.53.72.120    HTTP        364 GET /zavod/zemris HTTP/1.1
    128 7.37321400 161.53.72.120   161.53.65.218    HTTP        571 HTTP/1.1 200 OK  (text/html)
    129 7.38755000 161.53.65.218   161.53.72.120    HTTP        451 GET /_pub1412605111/themes_static/metallish/
    136 7.38824900 161.53.65.218   161.53.72.120    HTTP        457 GET /_pub1412605111/themes_static/metallish/
    142 7.38848300 161.53.65.218   161.53.72.120    HTTP        393 GET /lib59/json2.js HTTP/1.1
```

```
⊞ Frame 67: 364 bytes on wire (2912 bits), 364 bytes captured (2912 bits) on interface 0
⊞ Ethernet II, Src: HewlettP_c3:58:7c (b4:b5:2f:c3:58:7c), Dst: Cisco_6a:97:40 (c8:4c:75:6a:97:40)
⊞ Internet Protocol Version 4, Src: 161.53.65.218 (161.53.65.218), Dst: 161.53.72.120 (161.53.72.120)
⊞ Transmission Control Protocol, Src Port: 64732 (64732), Dst Port: http (80), Seq: 1, Ack: 1, Len: 310
⊟ Hypertext Transfer Protocol
  ⊞ GET /zavod/zemris HTTP/1.1\r\n
    Host: www.fer.unizg.hr\r\n
    User-Agent: Mozilla/5.0 (Windows NT 6.2; WOW64; rv:32.0) Gecko/20100101 Firefox/32.0\r\n
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8\r\n
    Accept-Language: en-US,en;q=0.5\r\n
    Accept-Encoding: gzip, deflate\r\n
    DNT: 1\r\n
    Connection: keep-alive\r\n
    \r\n
    [Full request URI: http://www.fer.unizg.hr/zavod/zemris]
```

```
0030  01 00 ce 0d 00 00 47 45  54 20 2f 7a 61 76 6f 64   ......GE T /zavod
0040  2f 7a 65 6d 72 69 73 20  48 54 54 50 2f 31 2e 31   /zemris  HTTP/1.1
0050  0d 0a 48 6f 73 74 3a 20  77 77 77 2e 66 65 72 2e   ..Host:  www.fer.
0060  75 6e 69 7a 67 2e 68 72  0d 0a 55 73 65 72 2d 41   unizg.hr ..User-A
0070  67 65 6e 74 3a 20 4d 6f  7a 69 6c 6c 61 2f 35 2e   gent: Mo zilla/5.
0080  30 20 28 57 69 6e 64 6f  77 73 20 4e 54 20 36 2e   0 (Windo ws NT 6.
0090  32 3b 20 57 4f 57 36 34  3b 20 72 76 3a 33 32 2e   2; WOW64 ; rv:32.
00a0  30 29 20 47 65 63 6b 6f  2f 32 30 31 30 30 31 30   0) Gecko /2010010
```

Text item (text), 28 bytes | Packets: 724 · Displayed: 113 (15.6%) | Profile: Default

HTTP Basics

- What happens on the network level?

HTTP request message

Web browser (Firefox)

```
GET /zavod/zemris HTTP/1.1
Host: www.fer.unizg.hr
User-Agent: Mozilla/5.0 (Windows NT 6.2; WOW64; rv:23.0) Gecko/20100101 Firefox/23.0
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
DNT: 1
Cookie: __utma=161902635.17065694.1374136092.1377600687.1377615217.13; __utmz=...
Connection: keep-alive
```

curl

```
GET /zavod/zemris HTTP/1.1
User-Agent: curl/7.32.0
Host: www.fer.unizg.hr
Accept: */*
```

HTTP Basics

- What happens on the network level?

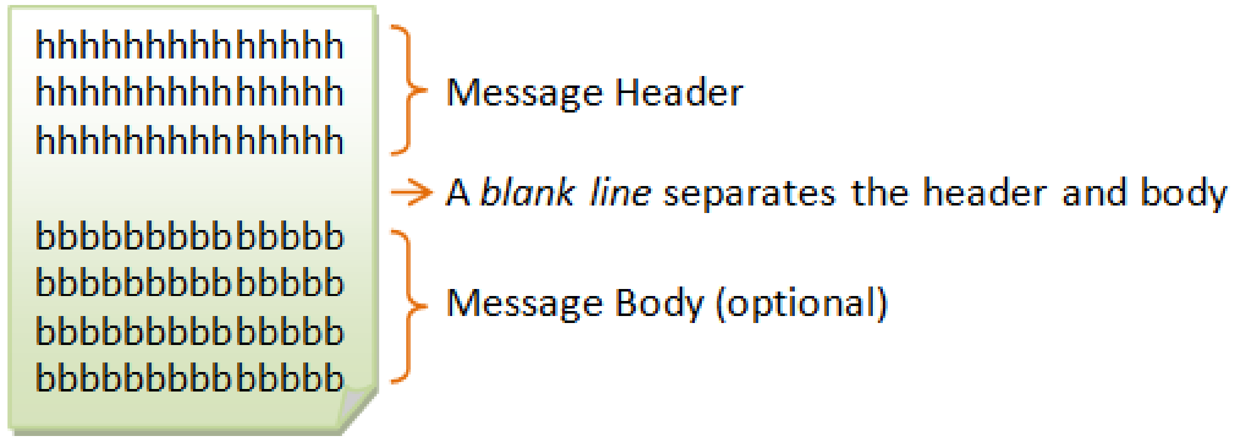
HTTP response message

```
HTTP/1.1 200 OK
Date: Wed, 28 Aug 2013 10:49:28 GMT
Server: Apache/2.2.23 (FreeBSD) mod_fcgid/2.3.6 mod_ssl/2.2.23 OpenSSL/0.9.8x
X-Powered-By: PHP/5.3.19
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-check=0
Pragma: no-cache
P3P: CP="NOI CURa ADMa DEVa TAIa PSAa PSDa IVAa IVDa HISa OTPa ..."
Set-Cookie: CMS=vhtenqteedgso8d9u618h8vgq6; expires=Wed, 04-Sep-2013...
Content-Length: 73120
Content-Type: text/html; charset=utf-8

<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" lang="hr"><head><meta http-equiv="Content-
Type" content="text/html; charset=utf-8" /><meta http-equiv="Content-Language"
content="hr" /><meta name="generator" content="QuiltCMS 2.0, http://www.fer.hr/" />
<!--meta name="robots" content="noindex" /--><meta name="keywords" content="„ />
<title>Zavod za elektroniku, mikroelektroniku, računalne i inteligentne sustave - FER
e-Campus v1</title><base href="http://www.fer.unizg.hr/zavod/zemris"><link
rel="alternate" type="application/rss+xml" title="FER: Zavod za elektroniku,
mikroelektroniku...
```

HTTP Basics

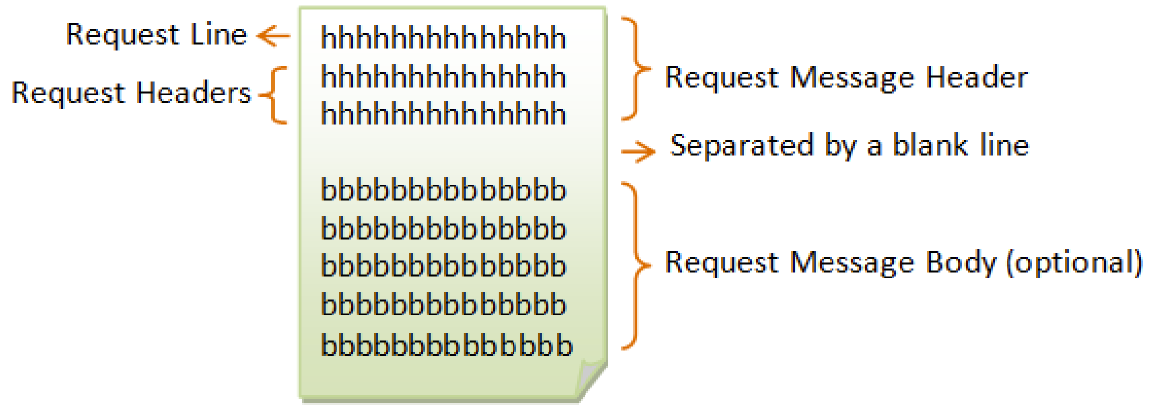
- HTTP messages
  - General form
  - Each HTTP message (either request or response) follows this general form



HTTP Messages

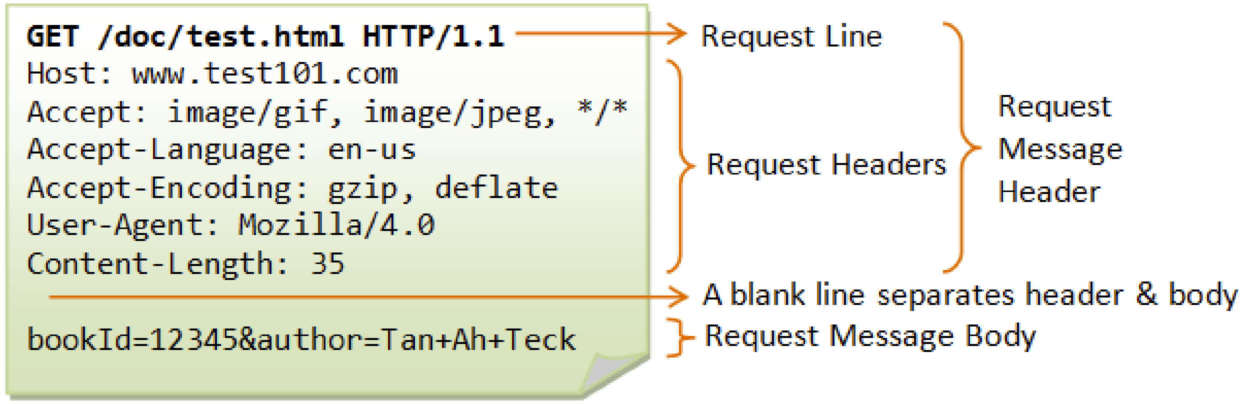
HTTP Basics

- HTTP request message



HTTP Request Message

Example:

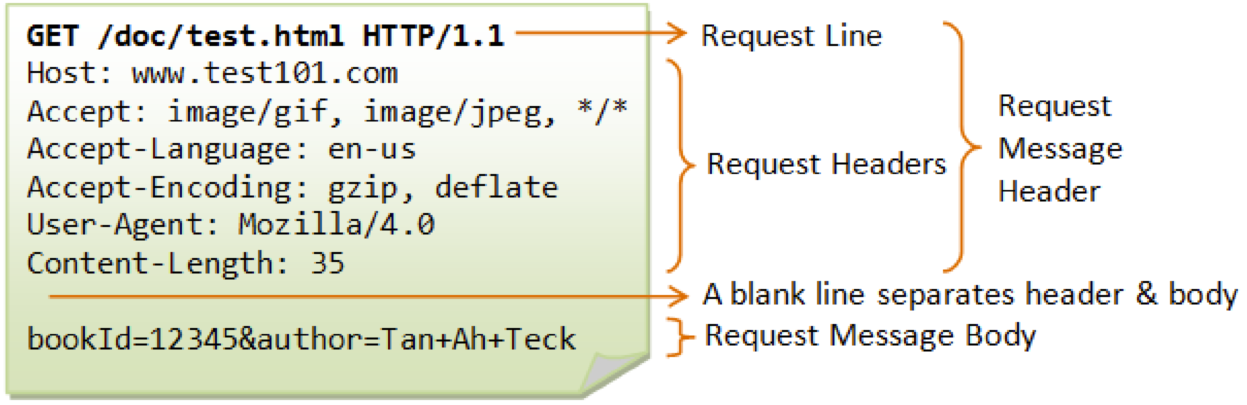


```
GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

HTTP Basics

- HTTP request message



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GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

Request line:

`request-method-name    request-URI    HTTP-version    CRLF`

`request-method-name`

Informs the server which operation to perform over the resource
HTTP protocol defines a set of request methods: `GET`, `PUT`, `POST`, `DELETE`, `HEAD`, and `OPTIONS`
The client uses one of these methods to send a request to the server

`request-URI`

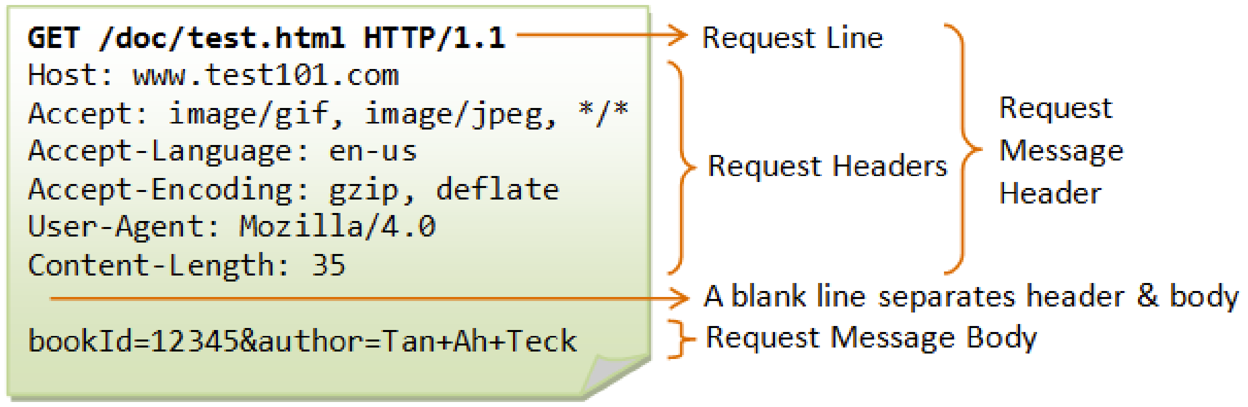
Specifies the resource on a web server over which the server should perform the requested operation

`HTTP-version`

Client specifies the version of HTTP protocol it understands
Two versions are currently in use: `HTTP/1.0` and `HTTP/1.1`

HTTP Basics

- HTTP request message



```
GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

Request line:

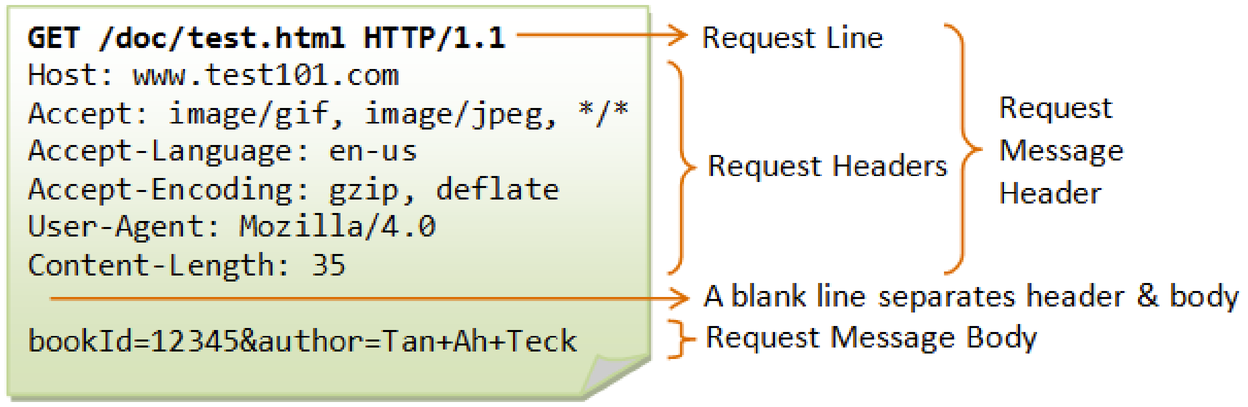
`request-method-name    request-URI    HTTP-version    CRLF`

Examples:

```
GET /zavod/zemris HTTP/1.1
GET /zavod/zemris HTTP/1.0
HEAD /zavod/zemris HTTP/1.1
PUT /photoalbum/image03.jpg HTTP/1.0
DELETE /photoalbum/image03.jpg HTTP/1.0
POST /news/article/comments HTTP/1.1
```

HTTP Basics

- HTTP request message



```
GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

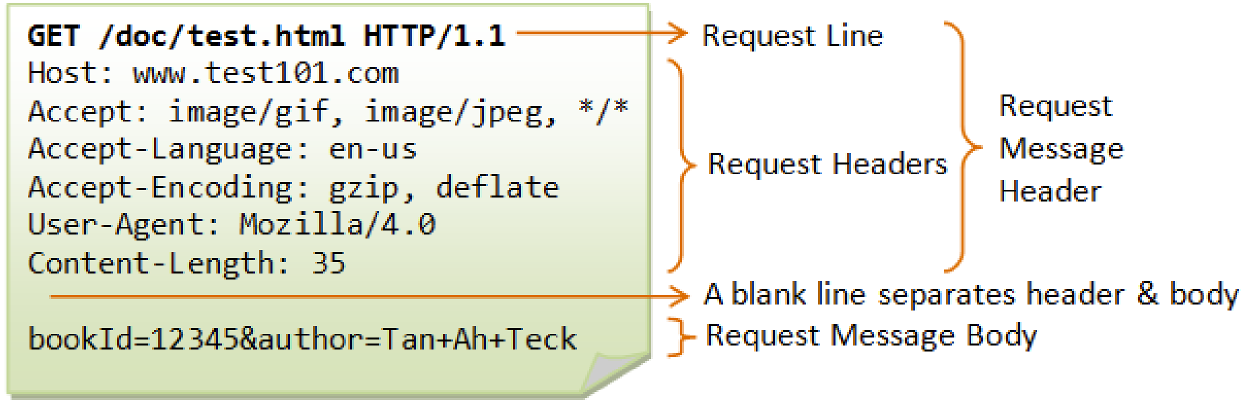
Request header:

`request-header-name: request-header-value1, request-header-value2, ... CRLF`

- The request headers are in the form of `name: value` pairs
- Multiple header values, separated by commas, can be specified
- Each request header ends with a new line (`CRLF`)
- HTTP allows arbitrary number of request headers in single request
- HTTP also allows custom non-standard header names
  (*custom web servers might process custom headers, standard web servers ignore them*)

HTTP Basics

- HTTP request message



```
GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

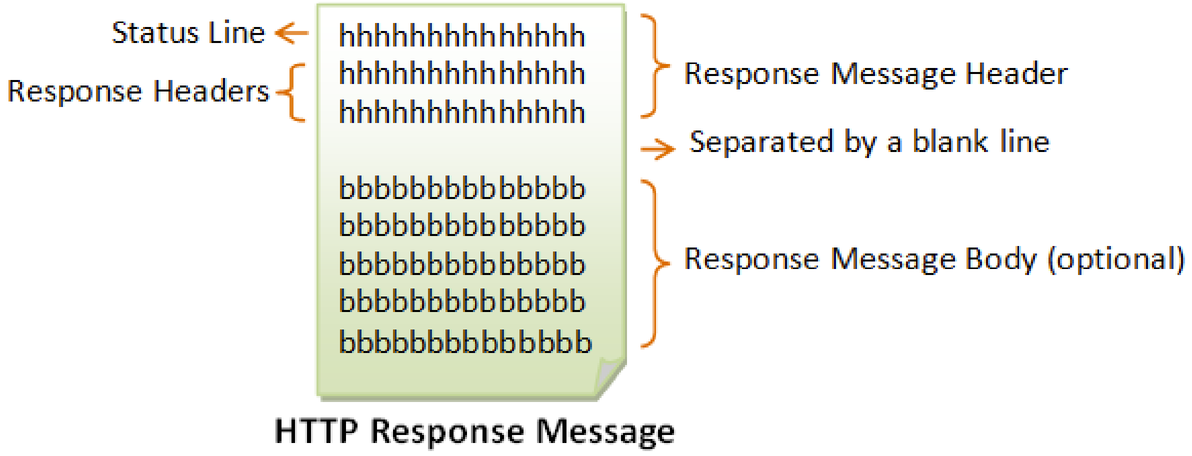
Request message body:

no defined structure, free format, arbitrary length

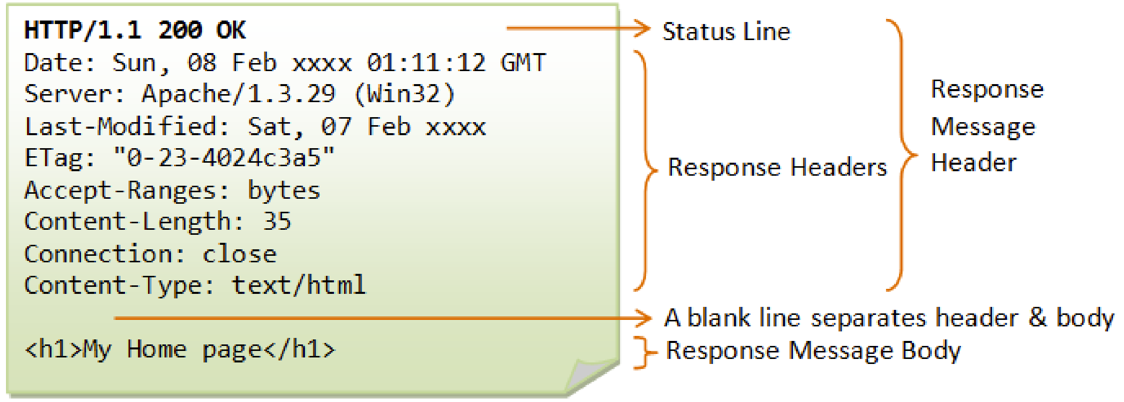
- Optional part of HTTP request message
- Used to send extra data with the request that cannot be specified in request headers (*for example, user-defined parameters*)
- HTTP protocol does not define the structure of request message body
- HTTP headers specify how to interpret the body (*for example,* `Content-Type` *header*)

HTTP Basics

- HTTP response message



Example:

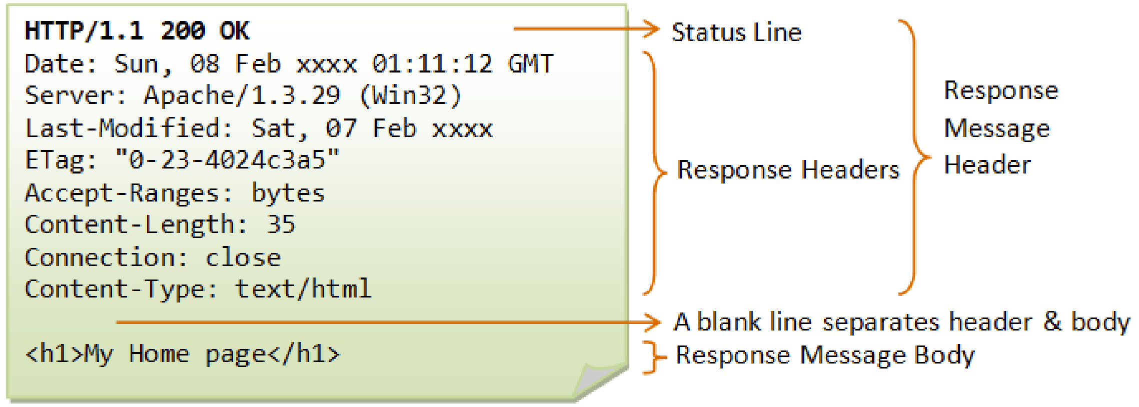


```
HTTP/1.1 200 OK
Date: Sun, 08 Feb xxxx 01:11:12 GMT
Server: Apache/1.3.29 (Win32)
Last-Modified: Sat, 07 Feb xxxx
ETag: "0-23-4024c3a5"
Accept-Ranges: bytes
Content-Length: 35
Connection: close
Content-Type: text/html

<h1>My Home page</h1>
```

HTTP Basics

- HTTP response message



```
HTTP/1.1 200 OK
Date: Sun, 08 Feb xxxx 01:11:12 GMT
Server: Apache/1.3.29 (Win32)
Last-Modified: Sat, 07 Feb xxxx
ETag: "0-23-4024c3a5"
Accept-Ranges: bytes
Content-Length: 35
Connection: close
Content-Type: text/html

<h1>My Home page</h1>
```

Status line:

`HTTP-version    status-code    reason-phrase    CRLF`

`HTTP-version`

Server specifies the version of the HTTP protocol used in response
Version chosen by server should be equal or lower than the version specified in client’s request
Two versions are currently in use: `HTTP/1.0` and `HTTP/1.1`

`status-code`

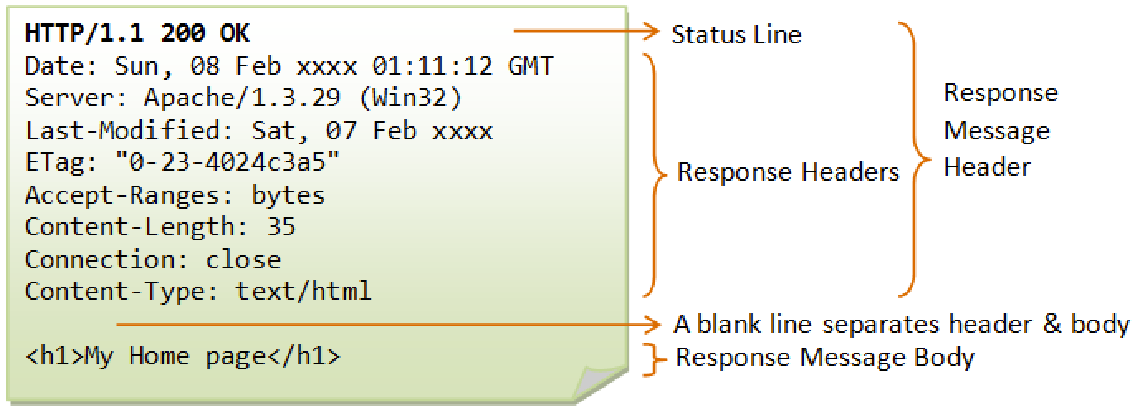
A 3-digit number generated by the server to reflect the outcome of the request
Informs the client whether request is served successfully, some error occurred, etc.

`reason-phrase`

Gives a short explanation to the status code

HTTP Basics

- HTTP response message



```
HTTP/1.1 200 OK
Date: Sun, 08 Feb xxxx 01:11:12 GMT
Server: Apache/1.3.29 (Win32)
Last-Modified: Sat, 07 Feb xxxx
ETag: "0-23-4024c3a5"
Accept-Ranges: bytes
Content-Length: 35
Connection: close
Content-Type: text/html

<h1>My Home page</h1>
```

Status line:

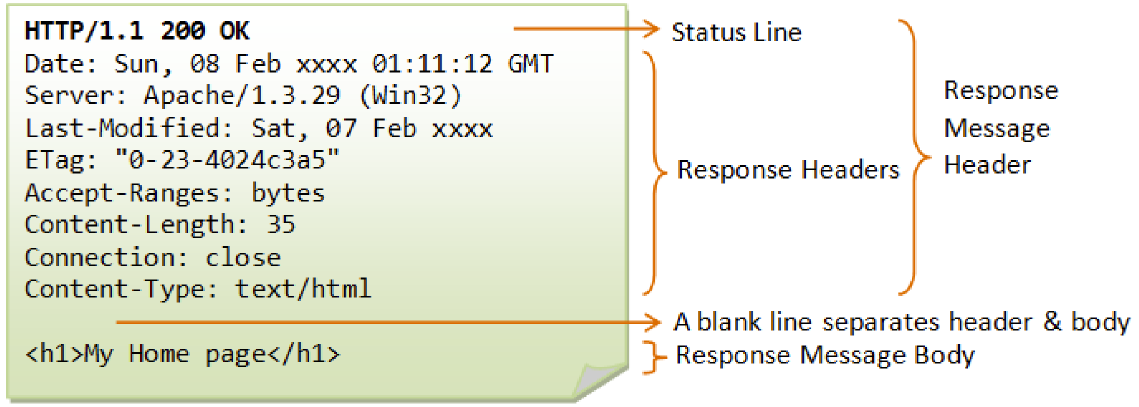
`HTTP-version    status-code    reason-phrase    CRLF`

Examples:

```
HTTP/1.1 200 OK
HTTP/1.0 404 Not Found
HTTP/1.1 403 Forbidden
HTTP/1.1 500 Internal Server Error
```

HTTP Basics

- HTTP response message



```
HTTP/1.1 200 OK
Date: Sun, 08 Feb xxxx 01:11:12 GMT
Server: Apache/1.3.29 (Win32)
Last-Modified: Sat, 07 Feb xxxx
ETag: "0-23-4024c3a5"
Accept-Ranges: bytes
Content-Length: 35
Connection: close
Content-Type: text/html

<h1>My Home page</h1>
```

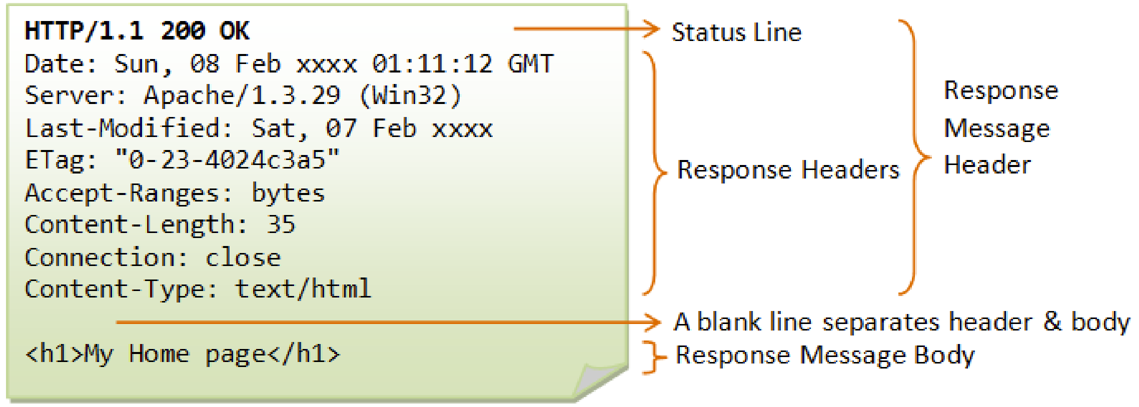
Response header:

`response-header-name: resp-header-value1, resp-header-value2, ... CRLF`

- Response headers follow the same form as request headers
  - The response headers are in the form of `name: value` pairs
  - Multiple header values, separated by commas, can be specified
  - Each response header ends with a new line (`CRLF`)
  - HTTP allows arbitrary number of response headers in single request
  - HTTP also allows custom non-standard header names
    (*custom clients might process custom headers, standard HTTP clients ignore them*)

HTTP Basics

- HTTP response message



```
HTTP/1.1 200 OK
Date: Sun, 08 Feb xxxx 01:11:12 GMT
Server: Apache/1.3.29 (Win32)
Last-Modified: Sat, 07 Feb xxxx
ETag: "0-23-4024c3a5"
Accept-Ranges: bytes
Content-Length: 35
Connection: close
Content-Type: text/html

<h1>My Home page</h1>
```

Response message body:

no defined structure, free format, arbitrary length

- Optional part of HTTP response message
- Used to send data from web server back to the client (*for example, web page's HTML, client-side script, image*)
- HTTP protocol does not define the structure of response message body
- HTTP response headers specify how to interpret the body (*for example,* `Content-Type` *header*)

HTTP Basics

- HTTP client socket-level programming

```
import java.net.*;
import java.io.*;

public class HttpClientSocket {
  public static void main(String[] args) throws IOException {
    // The host and port to be connected
    String host = "www.fer.unizg.hr";
    int port = 80;
    // Create a TCP socket and connect to the host:port
    Socket socket = new Socket(host, port);

    // Create the input and output streams for the network socket
    BufferedReader in = new BufferedReader(new InputStreamReader(socket.getInputStream()));
    PrintWriter out = new PrintWriter(socket.getOutputStream(), true);

    // Create request line
    out.println("GET /zavod/zemris HTTP/1.1");
    // Add some request headers
    out.println("Host: www.unizg.fer.hr");
    out.println("User-Agent: My custom HTTP client");
    // Add blank line separating header & body
    out.println();
    // Send request to the HTTP server
    out.flush();

    // Read the response and display on console
    String line;
    // readLine() returns null if server close the network socket
    while((line = in.readLine()) != null) {
      System.out.println(line);
    }
    // Close the I/O streams
    in.close();
    out.close();
   }
}
```

HTTP Basics

- HTTP client socket-level programming
  - Compile program

```
javac HttpClientSocket.java
```

  - Start program

```
java HttpClientSocket
```

HTTP Basics

- HTTP client programming using HTTP library

```
import java.net.*;
import java.io.*;

public class HttpClientHttpLib {
  public static void main(String[] args) throws IOException {
    // The URI of the remote resource
    String uri = "http://www.fer.unizg.hr/zavod/zemris";
    // Open a TCP connection for HTTP communication with a resource with given URI
    HttpURLConnection http = (HttpURLConnection) new URL(uri).openConnection();

    // Read response status
    System.out.println("Response status code: " + http.getResponseCode());
    System.out.println("Response reason phrase: " + http.getResponseMessage());

    // Read response data if any
    String line;
    BufferedReader in = new BufferedReader(new InputStreamReader(http.getInputStream()));
    while((line = in.readLine()) != null) {
      System.out.println(line);
    }

    // Close the connection
    http.disconnect();
  }
}
```

HTTP Basics

- HTTP client programming using HTTP library
  - Compile program

```
javac HttpClientHttpLib.java
```

  - Start program

```
java HttpClientHttpLib
```