HTTP Protocol

Handling Requests, Constructing Responses, HTTP/2 & HTTP/3

HTTP

SoftUni Team

Technical Trainers

Software University

SoftUni

Software University

https://softuni.bg

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Questions?

sli.do

#csharp-web

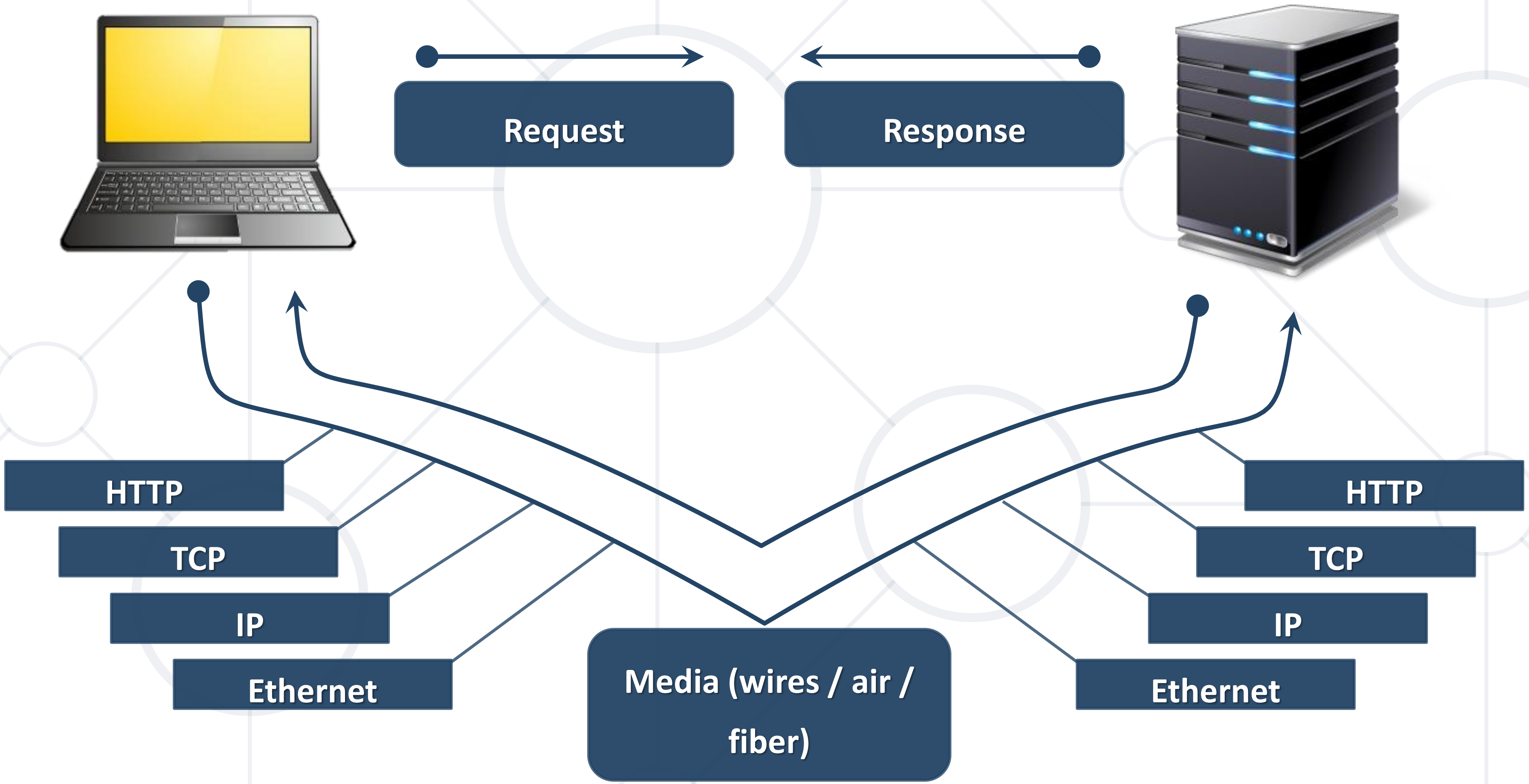
HTTP Basics

Basic Concepts

What is a Protocol?

- A **communication** protocol == **set of rules**, which define how two or more parties are talking to each other
- It is like a common language used for communication between machines

Hyper Text Transfer Protocol



Request

Response

HTTP

TCP

IP

Ethernet

Media (wires / air / fiber)

HTTP

TCP

IP

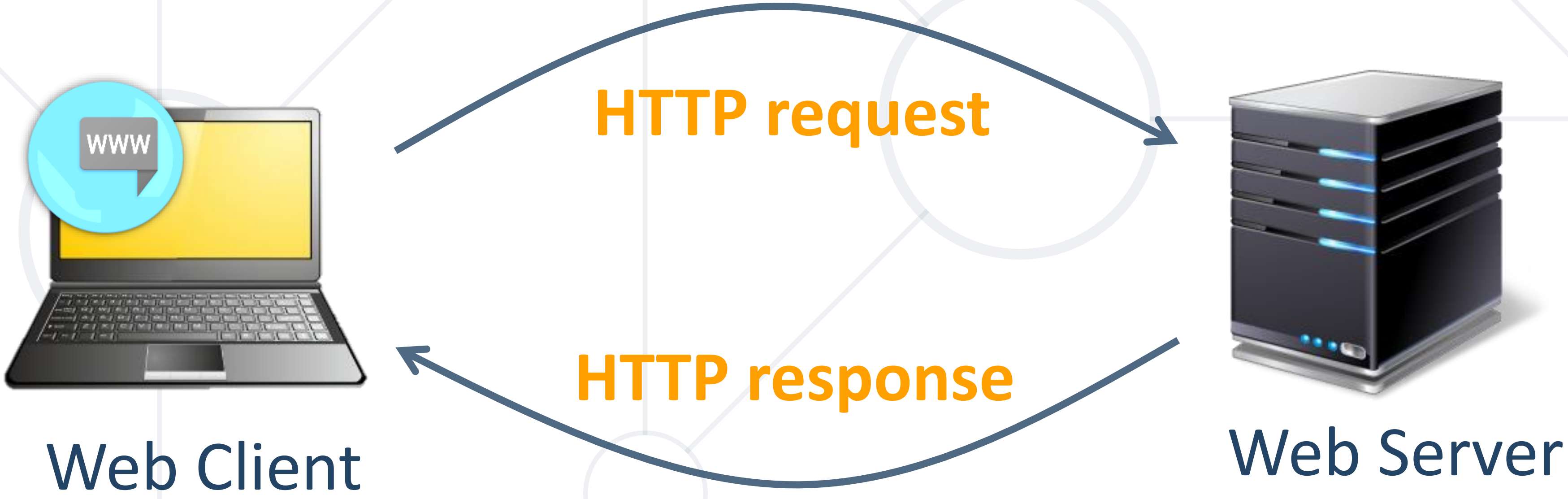
Ethernet

HTTP Protocol (1)

- **H**yper**T**ext **T**ransfer **P**rotocol
- **Text-based client-server** protocol
- **General-purpose client-server** protocol used to **transmit data** across the web
  - For transferring Web resources (HTML files, images, styles, etc.)
- Relies on **URLs**

HTTP Protocol (2)

- Stateless
  - Each HTTP request is **independent** from the others
  - Cookies and Web storages can overcome this
- Uses the **request-response model**



HTTP request

HTTP response

Web Client

Web Server

HTTP Conversation: Example

- HTTP request

```
GET /courses/javascript HTTP/1.1
Host: www.softuni.bg
User-Agent: Mozilla/5.0
<CRLF>
```

The empty line denotes the end of the **request** header

- HTTP response

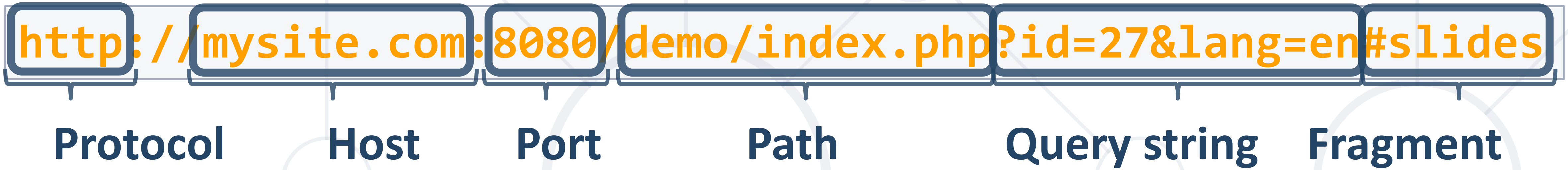
```
HTTP/1.1 200 OK
Date: Mon, 5 Jul 2020 13:09:03 GMT
Server: Microsoft-HTTPAPI/2.0
Last-Modified: Mon, 12 Jul 2014 15:33:23 GMT
Content-Length: 54
<CRLF>
<html><title>Hello</title>
Welcome to our site</html>
```

The empty line denotes the end of the **response** header

URL

Uniform Resource Locator

Uniform Resource Locator (URL)



`http://mysite.com:8080/demo/index.php?id=27&lang=en#slides`

- URL == formatted string, consisting of
  - **Network protocol** (**`http`**, **`ftp`**, **`https`**…) – HTTP in most cases
  - **Host** or **IP** address (**`softuni.org`**, **`gmail.com`**, **`127.0.0.1`**, **`web`**)
  - **Port** (the default port is **80**) – integer in the range [**0…65535**]
  - **Path** (**`/forum`**, **`/path/index.php`**)
  - **Query string** (**`?id=27&lang=en`**)
  - **Fragment** (**`#slides`**) – navigate to some section in the page

URL Encoding

- URLs are encoded according RFC 1738
- Safe URL characters: [0-9a-zA-Z], $, -, _, . , +, *, ', (,), ,, !
- All other characters are escaped by

```
%[character hex code]
```

  - Space is encoded as "+" or "%20"

```
Наков-爱-SoftUni
```

  - URL-encoded string

```
%D0%9D%D0%B0%D0%BA%D0%BE%D0%B2-%E7%88%B1-SoftUni
```

Char	URL Encoding
space	%20
щ	%D1%89
"	%22
#	%23
$	%24
%	%25
&	%26

Valid and Invalid URLs – Examples

- Some valid URLs

```
http://www.google.bg/search?sourceid=navclient&ie=UTF-8&rlz=1T4GGLL_enBG369BG369&q=http+get+vs+post
```

```
http://bg.wikipedia.org/wiki/%D0%A1%D0%BE%D1%84%D1%82%D1%83%D0%B5%D1%80%D0%BD%D0%B0_%D0%B0%D0%BA%D0%B0%D0%B4%D0%B5%D0%BC%D0%B8%D1%8F
```

- Some invalid URLs

```
http://www.google.bg/search?&q=C# .NET 6.0
```

Should be `?q=C%23+.NET+6.0`

```
http://www.google.bg/search?&q=бира
```

Should be `?q=%D0%B1%D0%B8%D1%80%D0%B0`

HTTP Request

What is a HTTP Request?

HTTP Request Message

- Request message sent by a client consists of
  - HTTP **request line**
    - Request method (**GET** / **POST** / **PUT** / **DELETE** / …)
    - Resource URI (**URL**)
    - Protocol **version**
  - HTTP **request headers**
    - Additional parameters
  - HTTP **request body** – optional data, e.g., posted form fields

```
<method> <resource> HTTP/<version>
<headers>
(empty line)
<body>
```

HTTP Request Methods

- **HTTP** defines **methods** to indicate the desired action to be performed on the identified resource

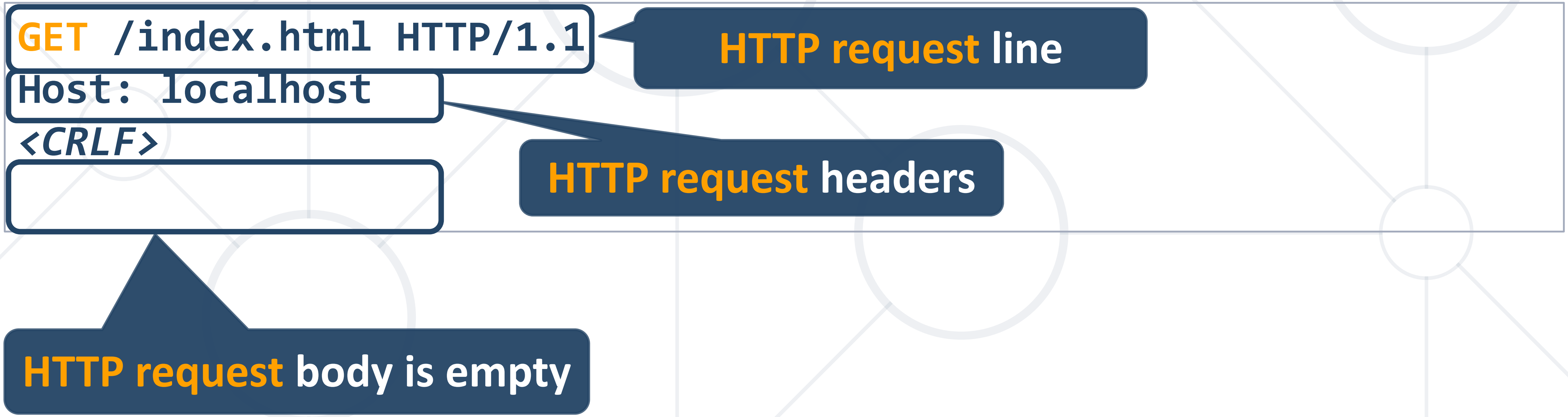
Method	Description
GET	Retrieve a resource
POST	Create / store a resource
PUT	Update (replace) a resource
DELETE	Delete (remove) a resource
PATCH	Update resource partially (modify)
HEAD	Retrieve the resource's headers

CRUD == the four main functions of persistent storage

Other Methods
CONNECT
OPTIONS
TRACE

HTTP GET Request

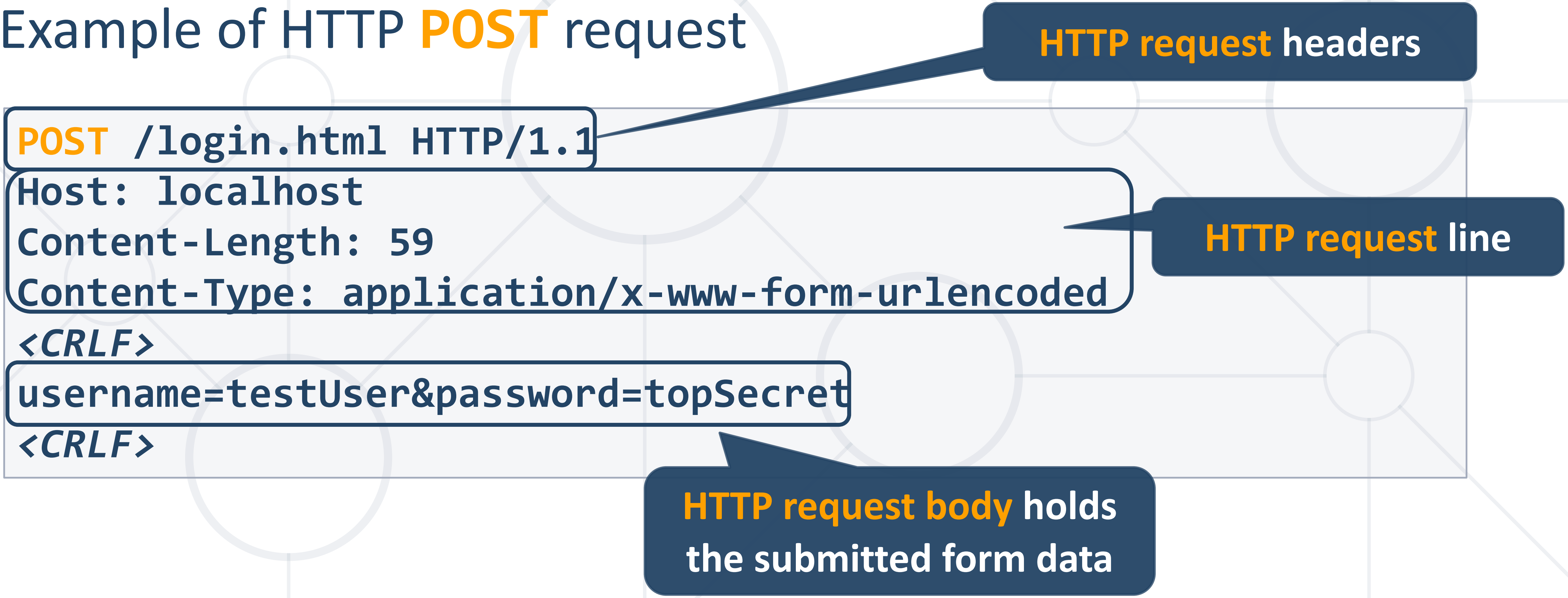
- **GET** is used to request data from a specified resource
- Example of HTTP **GET** request



```
GET /index.html HTTP/1.1
Host: localhost
<CRLF>
```

HTTP POST Request

- The **POST** method transfers data in the HTTP **body**
- Example of HTTP **POST** request



```
POST /login.html HTTP/1.1
Host: localhost
Content-Length: 59
Content-Type: application/x-www-form-urlencoded
<CRLF>
username=testUser&password=topSecret
<CRLF>
```

HTTP request headers

HTTP request line

HTTP request body holds the submitted form data

HTTP Response

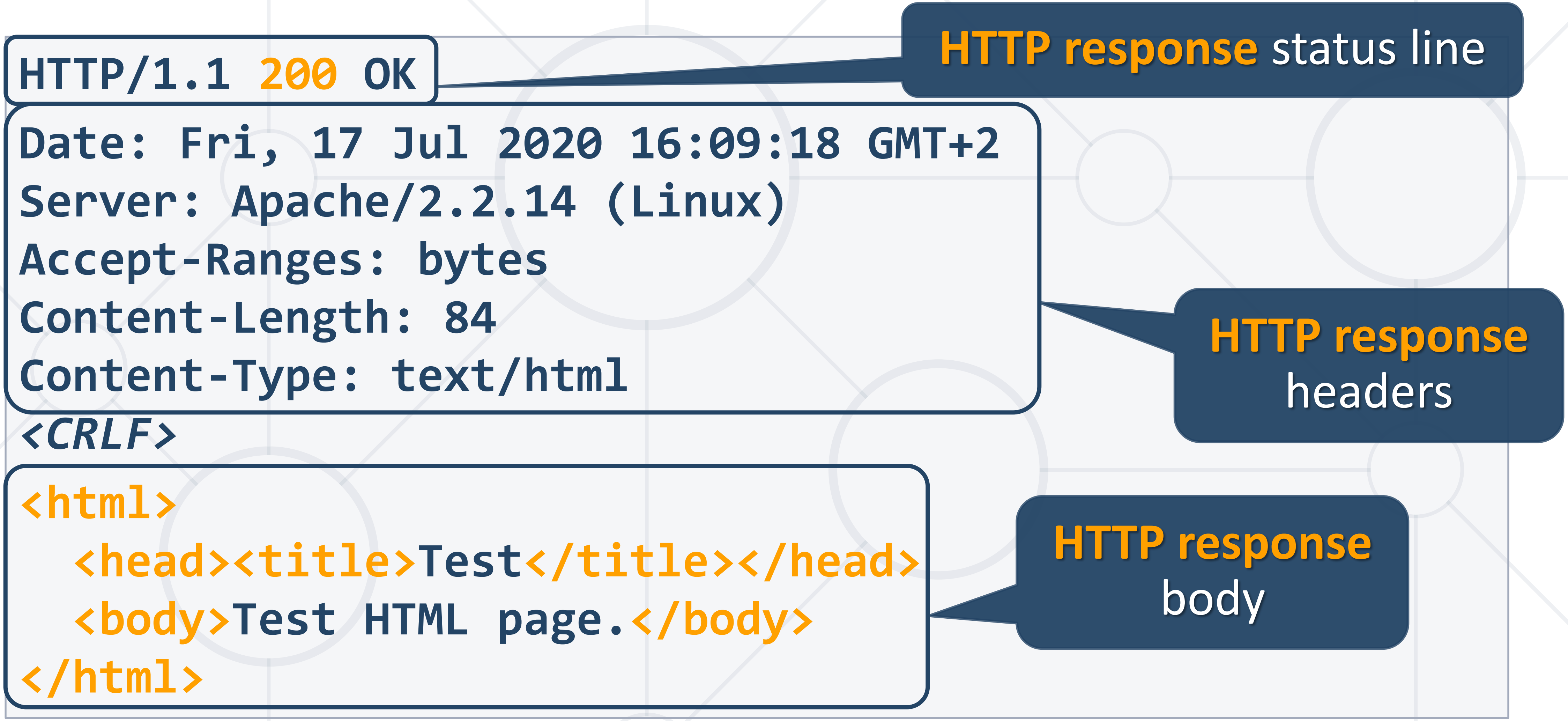
What is a HTTP Response?

HTTP Response Message

- The **response message** sent by the HTTP server consists of
  - HTTP response **status line**
    - Protocol **version**
    - Status **code**
    - Status **phrase**
  - Response **headers**
    - Provide meta data about the returned resource
  - Response **body**
    - The content of the HTTP response (data)

```
HTTP/<version> <status code> <status text>
<headers>
(empty line)
<response body – the requested resource>
```

HTTP Response – Example



```
HTTP/1.1 200 OK
Date: Fri, 17 Jul 2020 16:09:18 GMT+2
Server: Apache/2.2.14 (Linux)
Accept-Ranges: bytes
Content-Length: 84
Content-Type: text/html
<CRLF>
<html>
  <head><title>Test</title></head>
  <body>Test HTML page.</body>
</html>
```

HTTP response status line

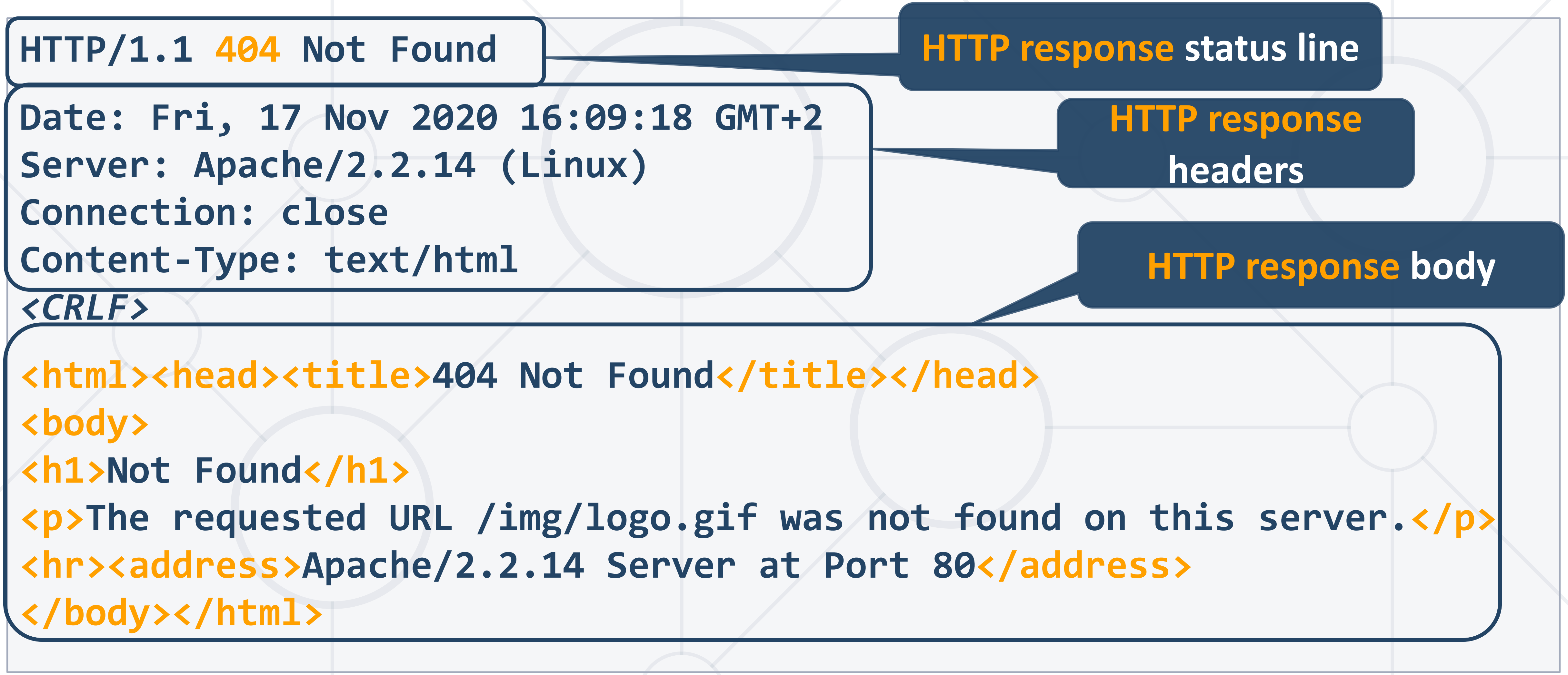
HTTP response headers

HTTP response body

HTTP Response Status Codes

- HTTP response **code** classes
  - **1xx**: informational (e.g., "**100** Continue")
  - **2xx**: successful (e.g., "**200** OK", "**201** Created")
  - **3xx**: redirection (e.g., "**304** Not Modified", "**301** Moved Permanently", "**302** Found")
  - **4xx**: client error (e.g., "**400** Bad Request", "**404** Not Found", "**401** Unauthorized", "**409** Conflict")
  - **5xx**: server error (e.g., "**500** Internal Server Error", "**503** Service Unavailable")

HTTP Error Response – Example



```
HTTP/1.1 404 Not Found
Date: Fri, 17 Nov 2020 16:09:18 GMT+2
Server: Apache/2.2.14 (Linux)
Connection: close
Content-Type: text/html
<CRLF>
<html><head><title>404 Not Found</title></head>
<body>
<h1>Not Found</h1>
<p>The requested URL /img/logo.gif was not found on this server.</p>
<hr><address>Apache/2.2.14 Server at Port 80</address>
</body></html>
```

HTTP response status line

HTTP response headers

HTTP response body

Browser Redirection

- HTTP **GET** requesting a moved URL

```
GET / HTTP/1.1
Host: http://softuni.org
User-Agent: Gecko/20100115 Firefox/3.6
<CRLF>
```

- The following HTTP response (**301** Moved Permanently) tells the browser to request another URL

```
HTTP/1.1 301 Moved Permanently
Location: http://softuni.bg
…
```

Content-Type and Disposition

- The **Content-Type** response header specifies how the output should be processed
- Examples

UTF-8 encoded HTML page. Will be shown in the browser.

```
Content-Type: text/html; charset=utf-8
```

```
Content-Type: application/pdf
Content-Disposition: attachment; filename="Report-April-2020.pdf"
```

This will download a PDF file named **Report-April-2020.pdf**

MIME and Media Types

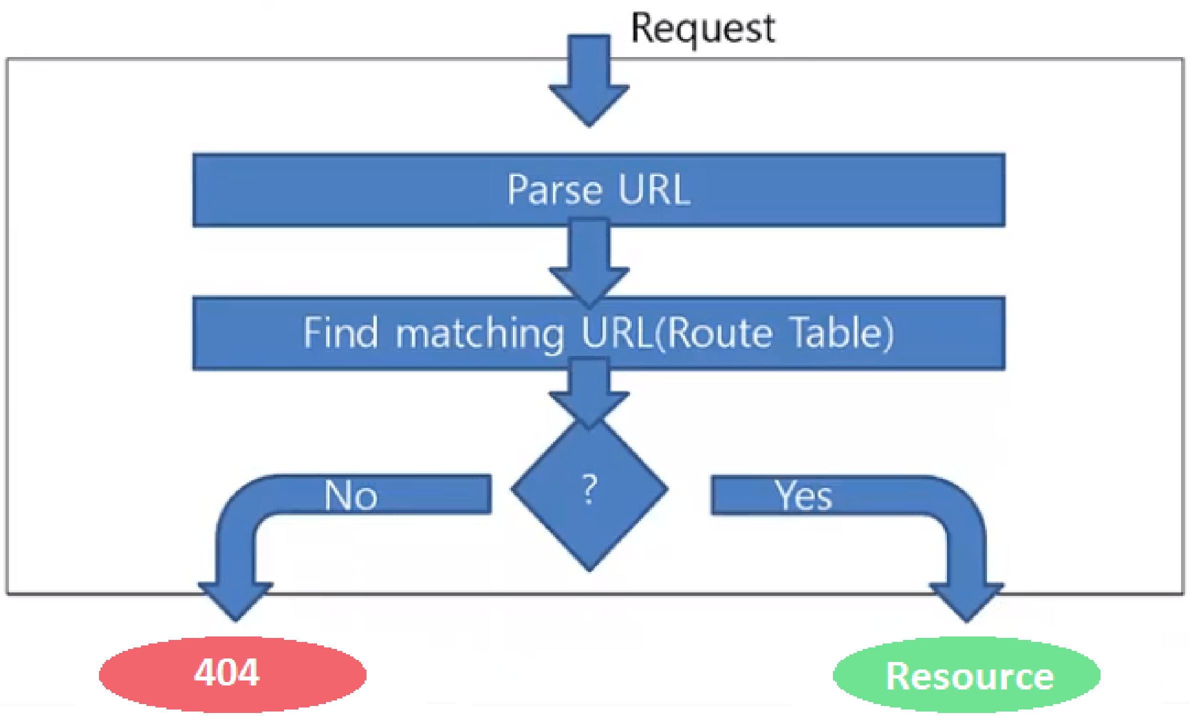
Multi-Purpose Internet Mail Extensions

What is MIME?

- MIME == Multi-Purpose Internet Mail Extensions
  - Internet standard for encoding resources
  - Originally developed for email attachments
  - Used in many Internet protocols like HTTP and SMTP
- MIME defines several concepts
  - **`Content-Type`**, e.g. **`text/html`**, **`image/gif`**, **`application/pdf`**
    - Content **`charset`**, e.g. **`utf-8`**, **`ascii`**, **`windows-1251`**
  - **`Content-Disposition`**, e.g. **`attachment; filename=logo.jpg`**
  - Multipart messages (multiple resources in a single document)

Common MIME Media Types

MIME Type / Subtype	Description
application/json	JSON data
image/png	PNG image
image/gif	GIF image
text/html	HTML
text/plain	Text
text/xml	XML
video/mp4	MP4 video
application/pdf	PDF document

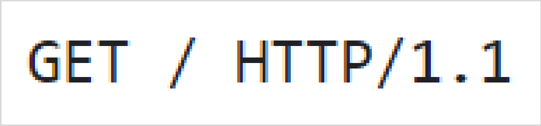


Routing

Mapping HTTP Request to HTTP Responses

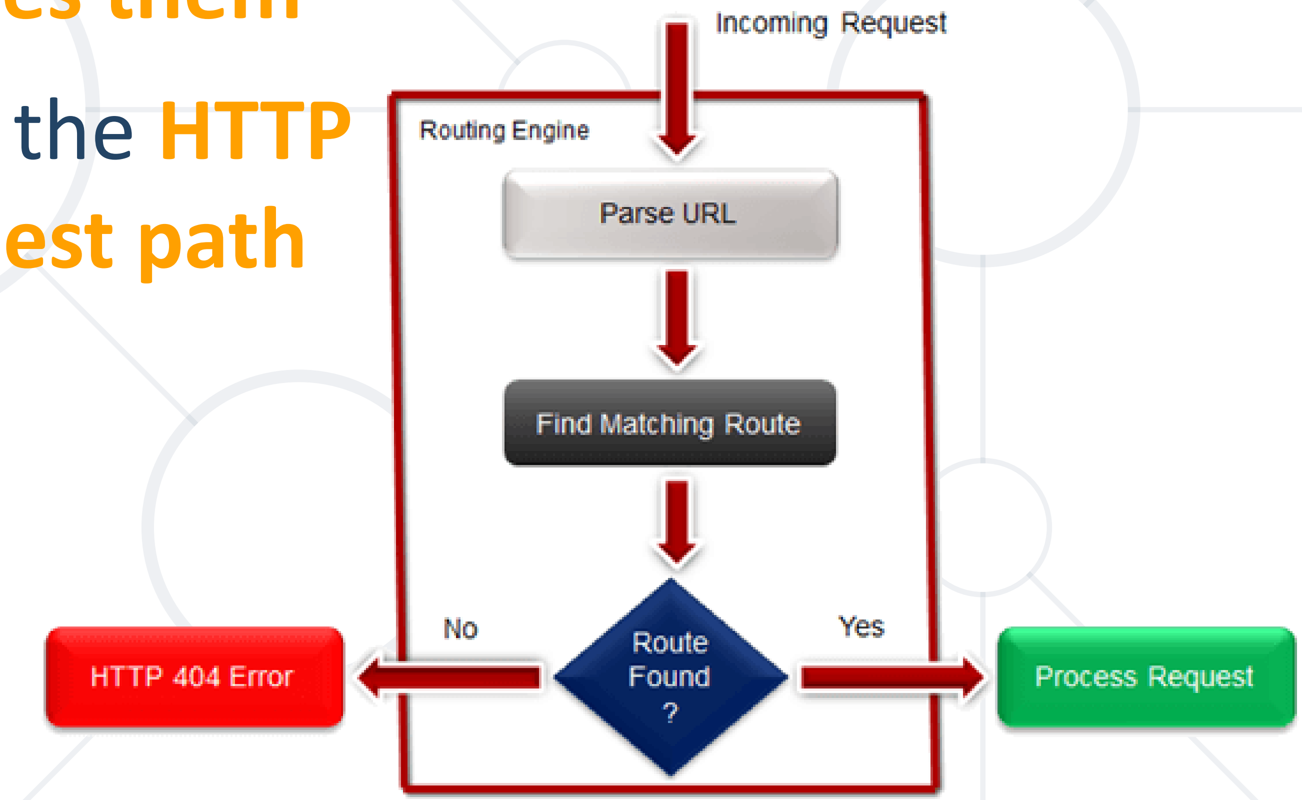
What is Web Routing?

- Web Routing is a mechanism where **HTTP requests** are **routed** to the **code that handles them**
- Requests are routed based on the **HTTP request method** and the **request path**



```
GET / HTTP/1.1
```

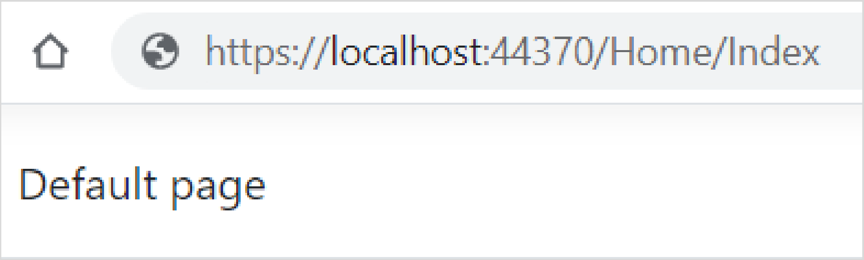
- **HTTP requests** are mapped to **HTTP responses**
- Example: route "**/**" is often mapped to the app's **Home page**



Mapping Physical Files

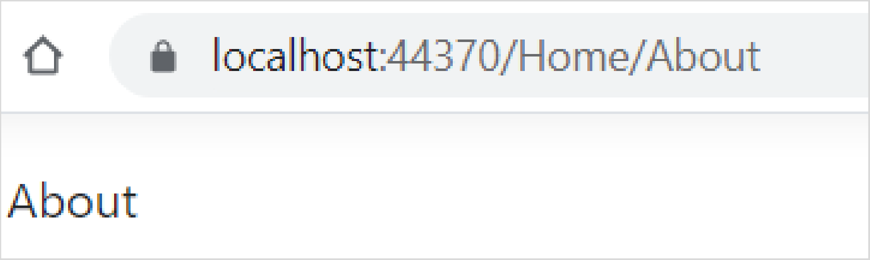
RouteTable.Routes.MapPageRoute		
Route Name	Route URL	Physical File Name
Home	Home/Index	Index.html
About	Home/About	About.html

User-friendly **URL replacement** of the physical file name



https://localhost:44370/Home/Index

Default page



localhost:44370/Home/About

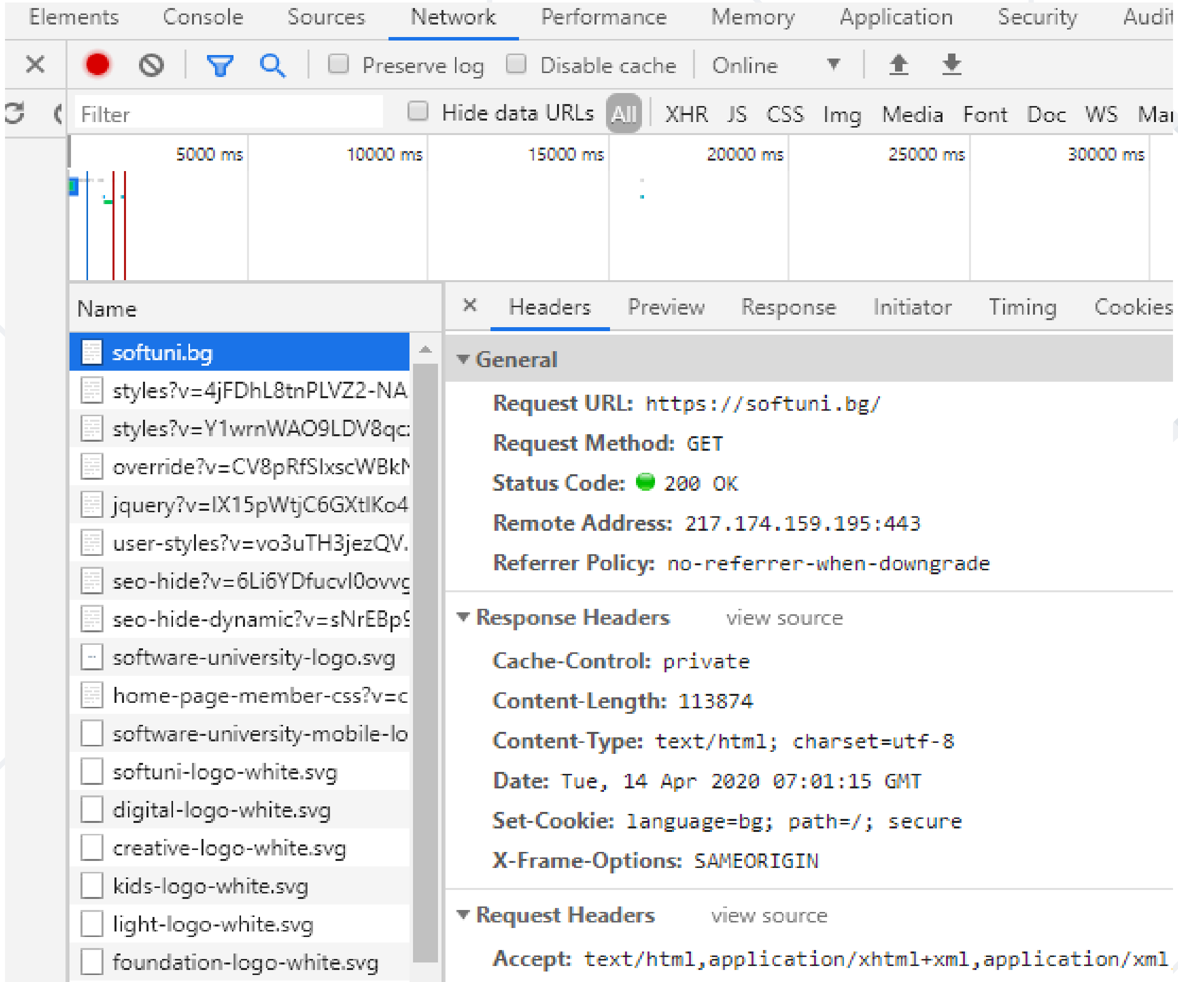
About

```
void RegisterRoutes(RouteCollection routes)
{
  routes.MapPageRoute("Home","Home/Index","/wwwroot/Home/Index.html");
  routes.MapPageRoute("About","Home/About","/wwwroot/Home/About.html");
}
```

HTTP Tools

Tools for Developers

HTTP Tools for Developers – Browser



Name

- softuni.bg
- styles?v=4jFDhL8tnPLVZ2-NA
- styles?v=Y1wrnWAO9LDV8qc:
- override?v=CV8pRfSIxscWBkN
- jquery?v=lX15pWtjC6GXtlKo4
- user-styles?v=vo3uTH3jezQV.
- seo-hide?v=6Li6YDfucvl0ovvg
- seo-hide-dynamic?v=sNrEBp9
- software-university-logo.svg
- home-page-member-css?v=c
- software-university-mobile-lo
- softuni-logo-white.svg
- digital-logo-white.svg
- creative-logo-white.svg
- kids-logo-white.svg
- light-logo-white.svg
- foundation-logo-white.svg

▼ General

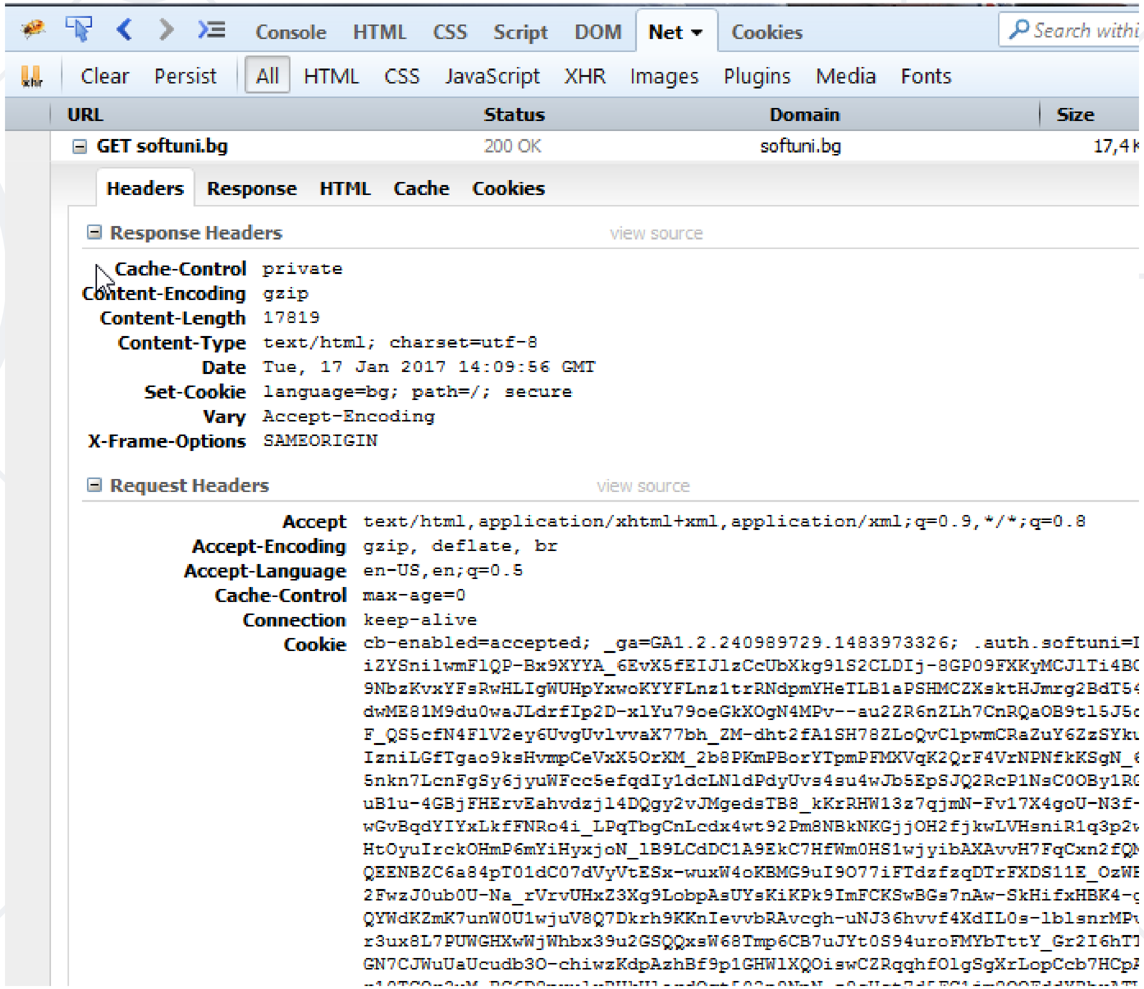
Request URL: `https://softuni.bg/`
Request Method: `GET`
Status Code: ● `200 OK`
Remote Address: `217.174.159.195:443`
Referrer Policy: `no-referrer-when-downgrade`

▼ Response Headers   view source

Cache-Control: `private`
Content-Length: `113874`
Content-Type: `text/html; charset=utf-8`
Date: `Tue, 14 Apr 2020 07:01:15 GMT`
Set-Cookie: `language=bg; path=/; secure`
X-Frame-Options: `SAMEORIGIN`

▼ Request Headers   view source

Accept: `text/html,application/xhtml+xml,application/xml`



URL	Status	Domain	Size
⊟ GET softuni.bg	200 OK	softuni.bg	17,4 k

⊟ Response Headers   view source

```
    Cache-Control  private
 Content-Encoding  gzip
   Content-Length  17819
     Content-Type  text/html; charset=utf-8
             Date  Tue, 17 Jan 2017 14:09:56 GMT
       Set-Cookie  language=bg; path=/; secure
             Vary  Accept-Encoding
  X-Frame-Options  SAMEORIGIN
```

⊟ Request Headers   view source

```
          Accept  text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
 Accept-Encoding  gzip, deflate, br
 Accept-Language  en-US,en;q=0.5
   Cache-Control  max-age=0
      Connection  keep-alive
          Cookie  cb-enabled=accepted; _ga=GA1.2.240989729.1483973326; .auth.softuni=I
                  iZYSnilwmF1QP-Bx9XYYA_6EvX5fEIJlzCcUbXkg91S2CLDIj-8GP09FXKyMCJlTi4BC
                  9NbzKvxYFsRwHLIgWUHpYxwoKYYFLnz1trRNdpmYHeTLB1aPSHMCZXsktHJmrg2BdT54
                  dwME81M9du0waJLdrfIp2D-xlYu79oeGkXOgN4MPv--au2ZR6nZLh7CnRQaOB9tl5J5c
                  F_QS5cfN4FlV2ey6UvgUvlvvaX77bh_ZM-dht2fA1SH78ZLoQvClpwmCRaZuY6ZzSYku
                  IzniLGfTgao9ksHvmpCeVxX5OrXM_2b8PKmPBorYTpmPFMXVqK2QrF4VrNPNfkKSgN_6
                  5nkn7LcnFgSy6jyuWFcc5efqdIy1dcLNldPdyUvs4su4wJb5EpSJQ2RcP1NsC0OBy1RC
                  uB1u-4GBjFHErvEahvdzjl4DQgy2vJMgedsTB8_kKrRHW13z7qjmN-Fv17X4goU-N3f-
                  wGvBqdYIYxLkfFNRo4i_LPqTbgCnLcdx4wt92Pm8NBkNKGjjOH2fjkwLVHsniR1q3p2w
                  HtOyuIrckOHmP6mYiHyxjoN_1B9LCdDC1A9EkC7HfWm0HS1wjyibAXAvvH7FqCxn2fQN
                  QEENBZC6a84pT01dC07dVyVtESx-wuxW4oKBMG9uI9O77iFTdzfzqDTrFXDS11E_OzWE
                  2FwzJ0ub0U-Na_rVrvUHxZ3Xg9LobpAsUYsKiKPk9ImFCKSwBGs7nAw-SkHifxHBK4-q
                  QYWdKZmK7unW0U1wjuV8Q7Dkrh9KKnIevvbRAvcgh-uNJ36hvvf4XdIL0s-lblsnrMPu
                  r3ux8L7PUWGHXwWjWhbx39u2GSQQxsW68Tmp6CB7uJYt0S94uroFMYbTttY_Gr2I6hTT
                  GN7CJWuUaUcudb3O-chiwzKdpAzhBf9p1GHW1XQOiswCZRqqhfOlgSgXrLopCcb7HCpA
```

[Chrome Developer Tools](#)

[Firebug](#)

HTTP Tools for Developers

Insomnia Rest

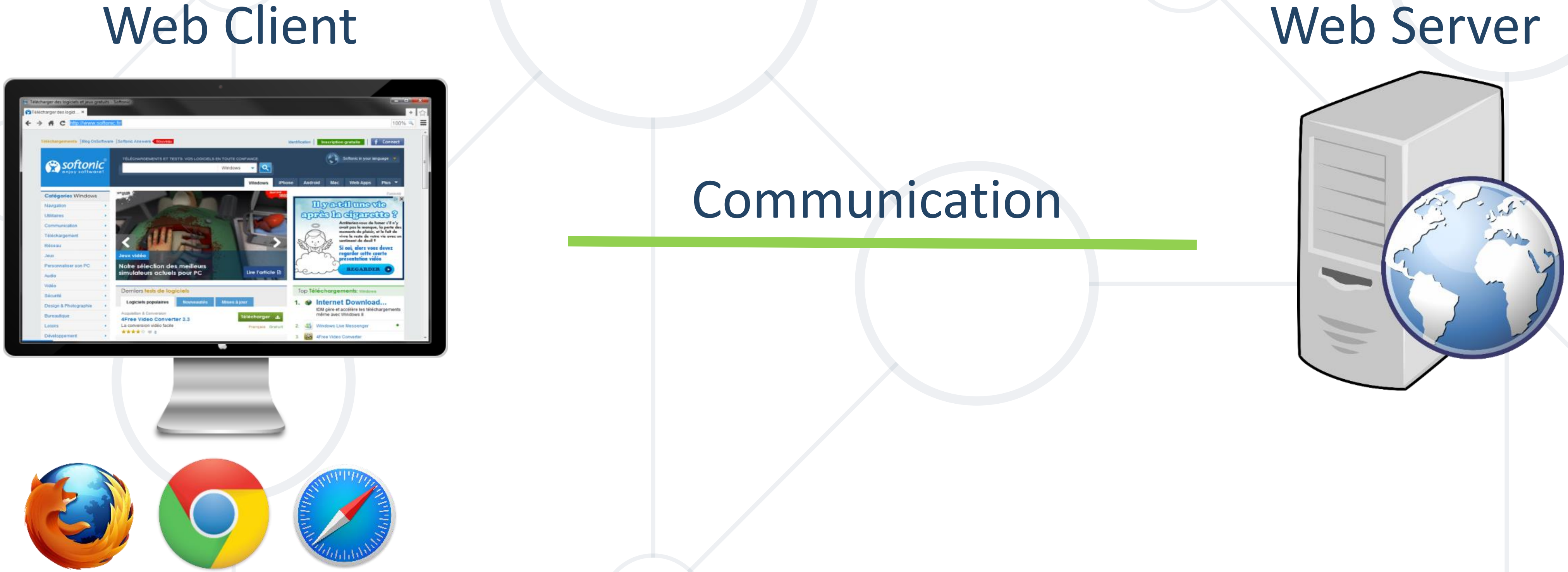
Postman

RESTClient

Web Server

What is a Web Server?

- Computer system that processes requests via **HTTP**, the basic network protocol

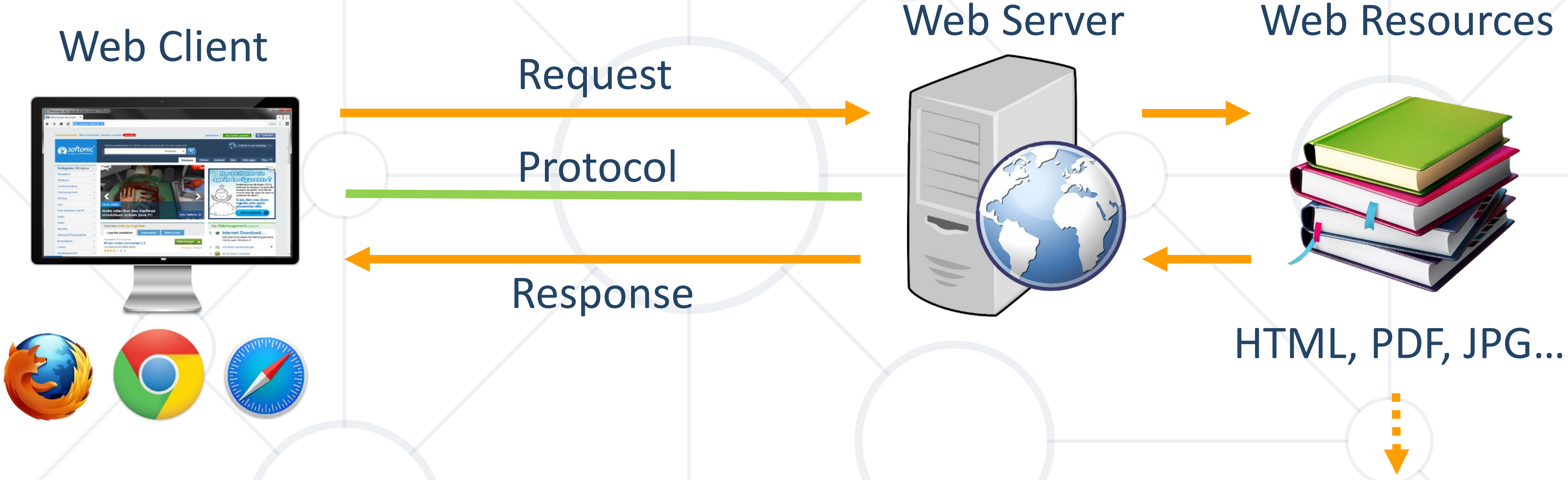


Web Client

Communication

Web Server

Web Server Work Model (1)



Protocols:

HTTP

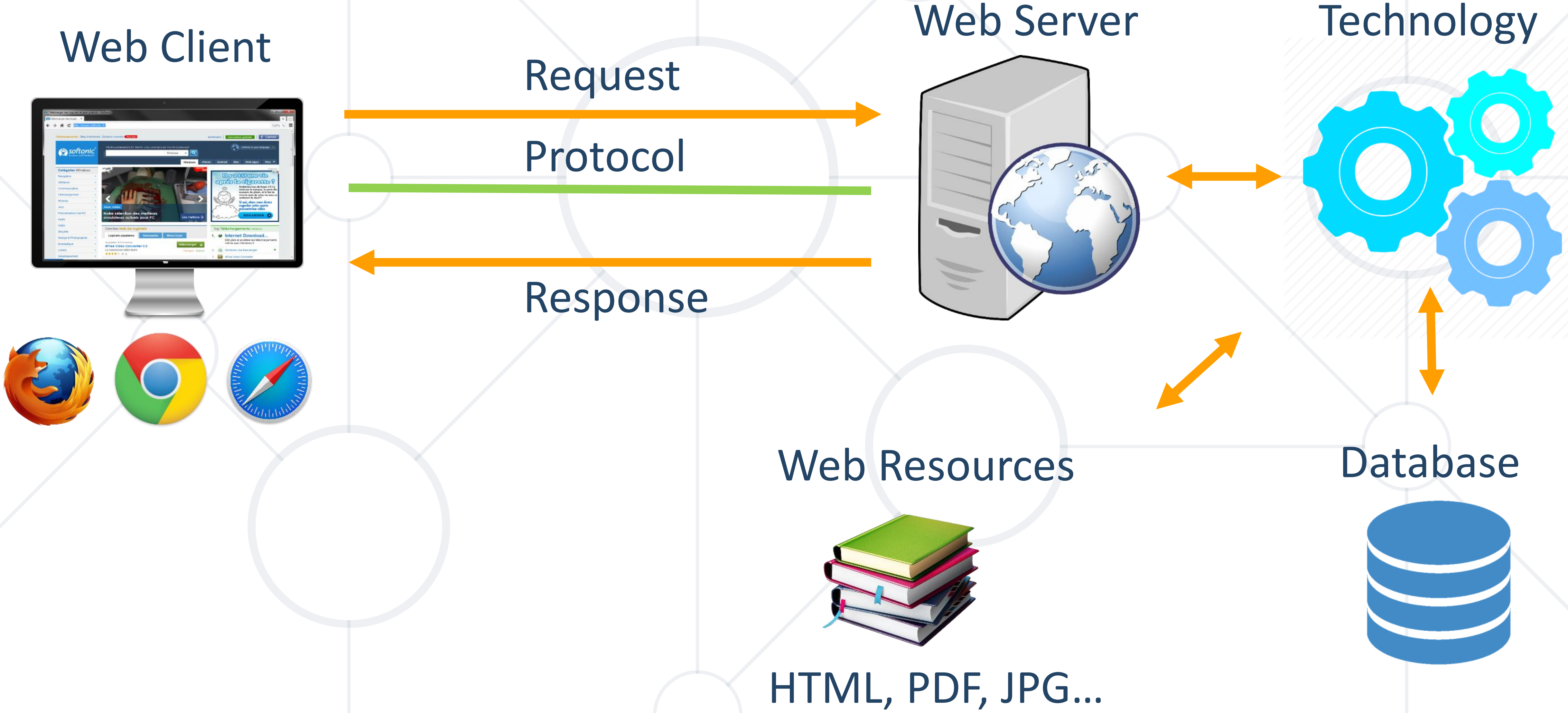
FTP

WebSocket

Protocol Host Port Resource URL

```
http://localhost:8000/softuni.jpg
```

Web Server Work Model (2)



Web Client

Request

Protocol

Response

Web Server

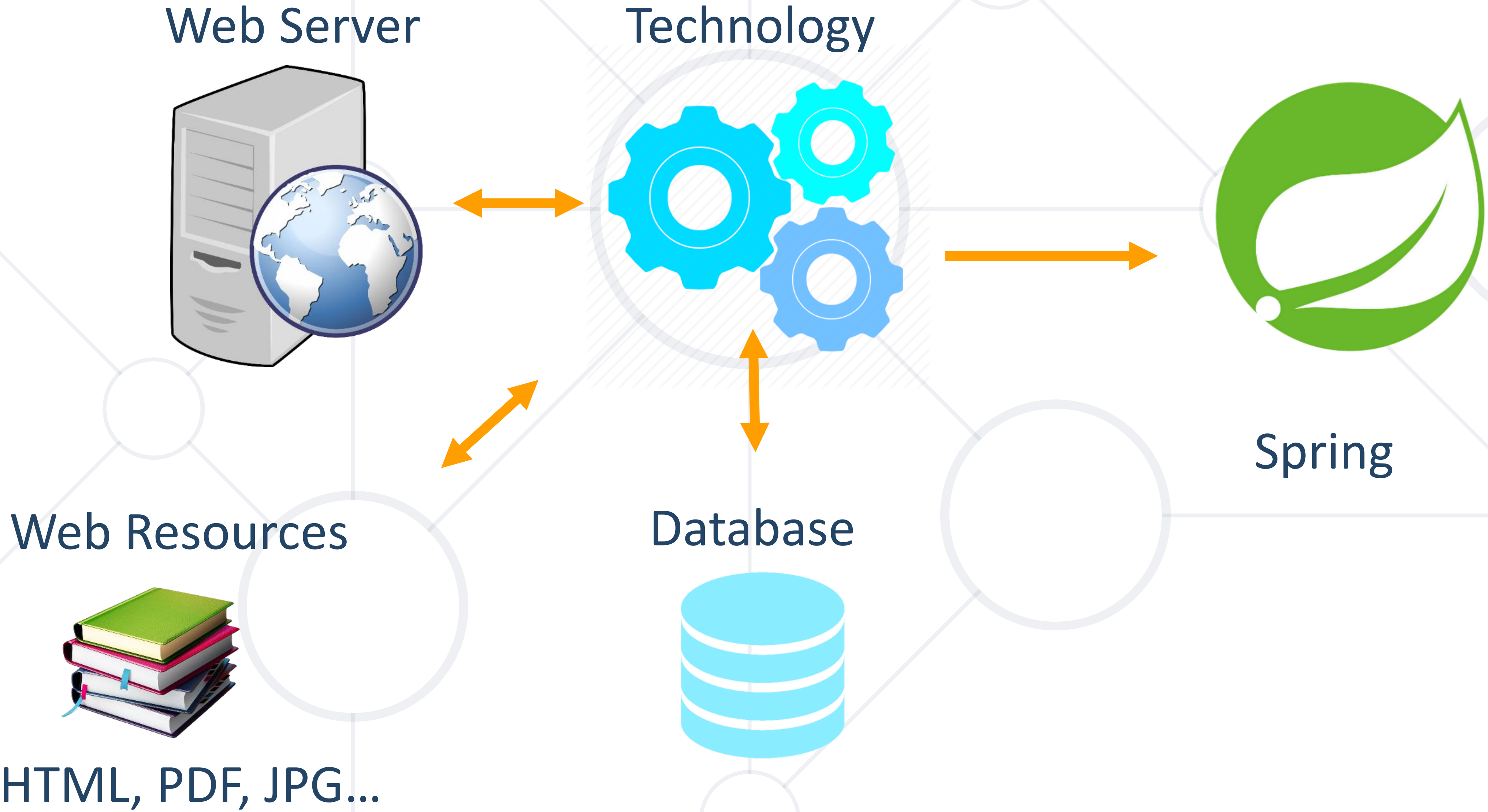
Technology

Web Resources

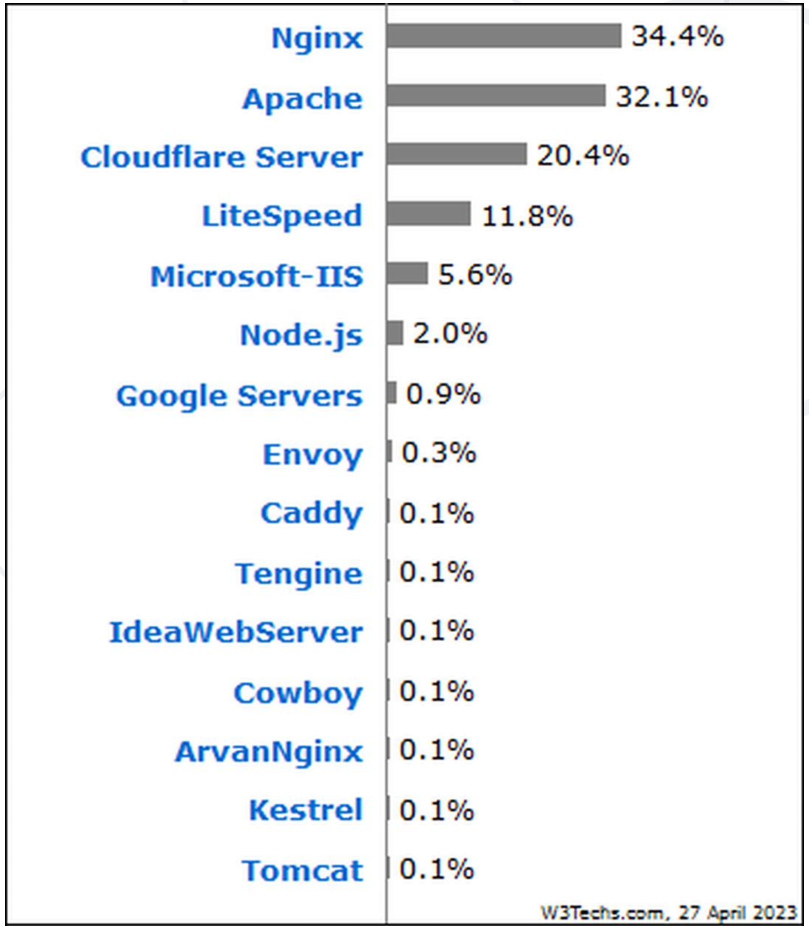
HTML, PDF, JPG…

Database

Web Server Work Model (3)



Most Popular Web Servers (W3Techs)



W3Techs.com, 27 April 2023

Percentages of websites using various web servers
Note: a website may use more than one web server

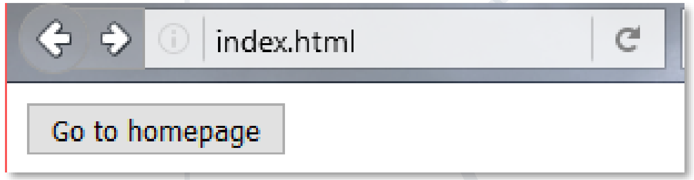
HTML Forms

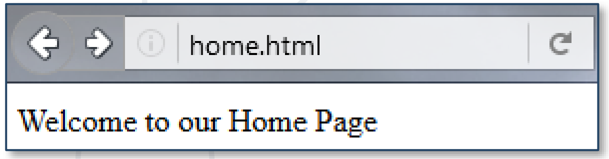
Form Method and Action

HTML Forms – Action Attribute

- Defines where to submit the form data

```
<form action="home.html">
  <input type="submit" value="Go to homepage"/>
</form>
```





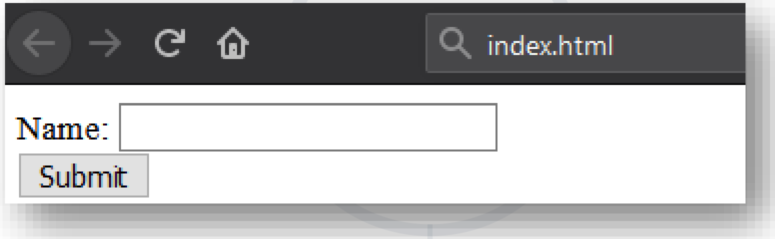
Welcome to our Home Page

HTML Forms – Method Attribute (1)

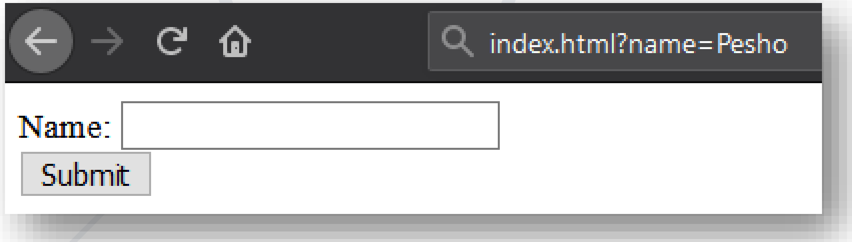
- Specifies the HTTP method to use when sending form data

```
<form action="/" method="get">
  Name: <input type="text" name="name">
  <br>
  <input type="submit" value="Submit">
</form>
```

The form data is in the URL



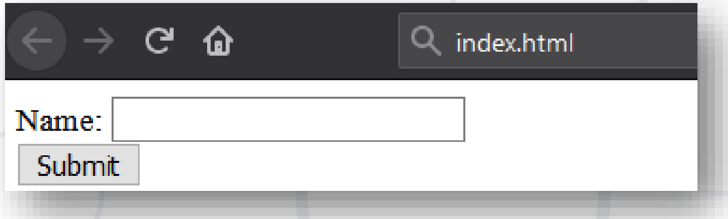
index.html



index.html?name=Pesho

HTML Forms – Method Attribute (2)

```
<form action="/" method="post">
  Name: <input type="text" name="name">
  <br>
  <input type="submit" value="Submit">
</form>
```



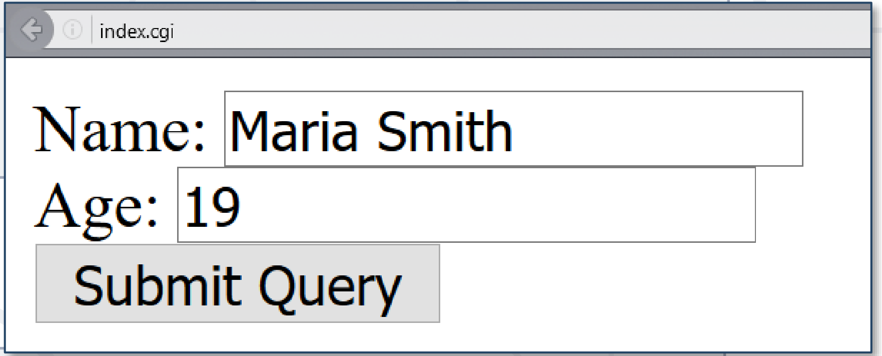
```
POST http://localhost/index.html HTTP/1.1
Host: localhost
Content-Type: application/x-www-form-urlencoded
Content-Length: 10

name=Pesho
```

HTTP request body holds the form data

URL Encoded Form Data – Example

```
<form action="/" method="post">
  Name: <input type="text" name="name"/> <br/>
  Age: <input type="text" name="age"/> <br/>
  <input type="submit" />
</form>
```



Name: Maria Smith

Age: 19

```
POST http://localhost/cgi-bin/index.cgi HTTP/1.1
Host: localhost
Content-Type: application/x-www-form-urlencoded
Content-Length: 23

name=Maria+Smith&age=19
```

File uploads are not supported

GET vs. POST Method

- **GET**
  - Values are contained in the **URL**
  - Has a length limitation of **255 characters**
  - It is **often** cacheable
  - Supports only **string data types**
  - Parameters **are saved** in browser history
  - Results **can** be bookmarked

- **POST**
  - Values are contained in the **message's body**
  - Does **not have** a length limitation
  - It is **hardly** cacheable
  - Supports **different data types**
  - Parameters **are not saved** in browser history
  - Results **cannot** be bookmarked

HTTP/2

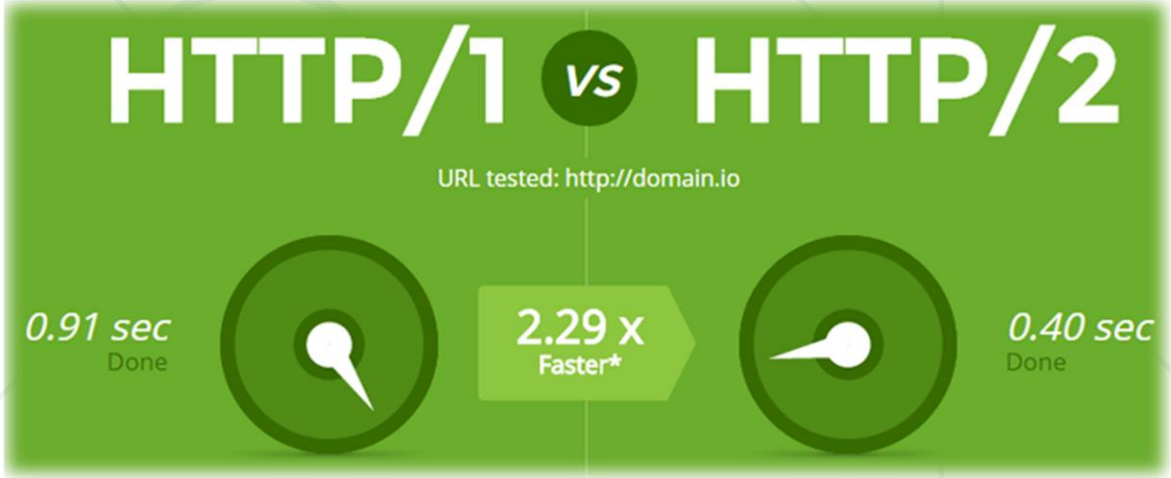
What's New? What's Better? What's HTTP/2

What's HTTP/2

- **HTTP/2** (originally named **HTTP/2.0**) is a major revision of the **HTTP** network protocol used by the **World Wide Web**
  - Supported by most of the popular web browsers (Chrome, Mozilla, Opera, ...)
  - Fast & optimized
  - Meets modern web usage requirements
  - Completely Backwards-Compatible
- As of Apr 2023, **40%** of all the websites support **HTTP/2** (W3Techs statistics)

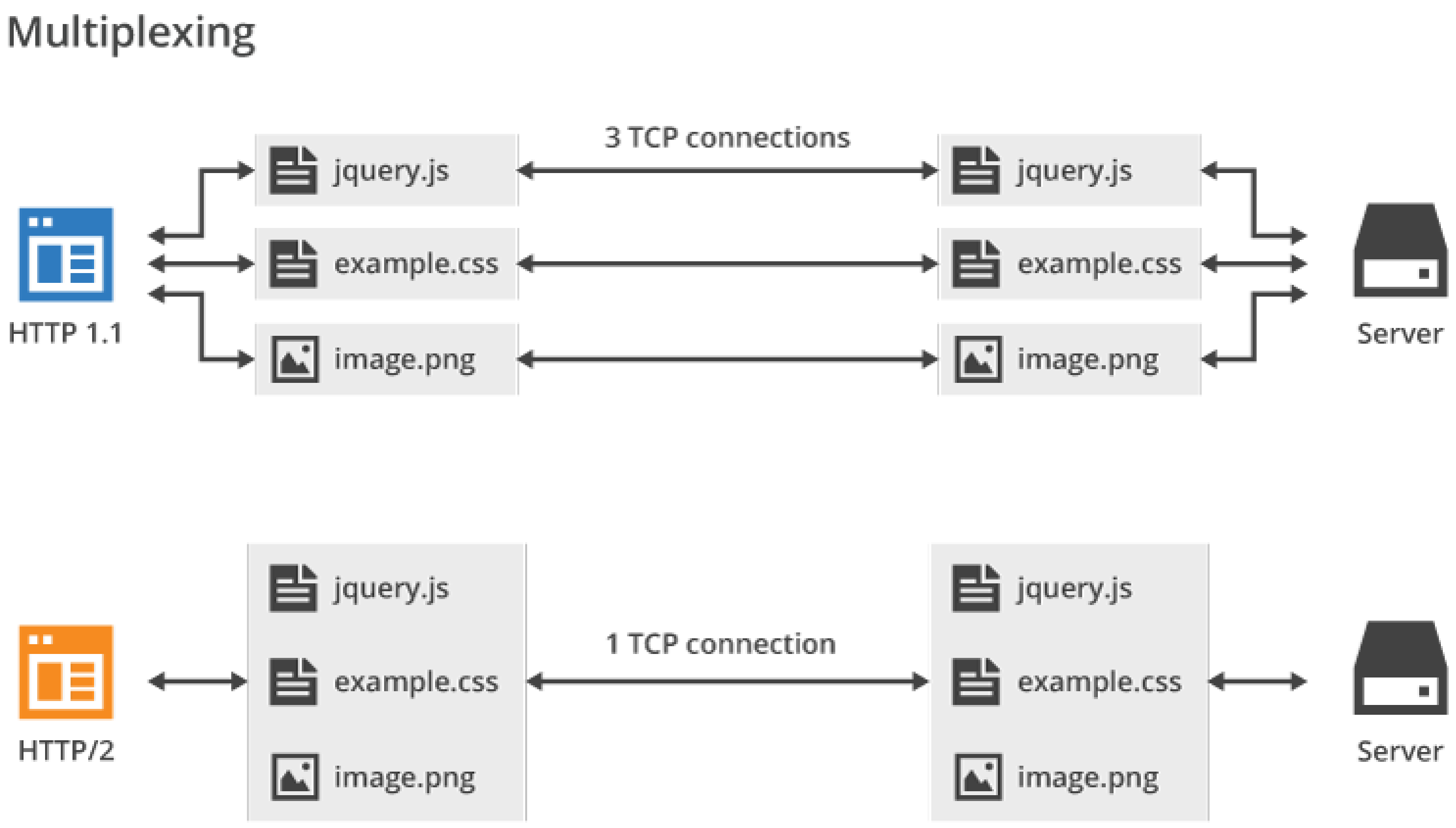
What's New?

- **HTTP/2** is meant to erase the need of maintaining complex server infrastructures in order to perform well
- **HTTP/2** communicates in binary data frames
- **HTTP/2** introduces several new important elements
  - HTTP/2 Multiplexing
  - HTTP/2 Header Compression
  - HTTP/2 Server Push



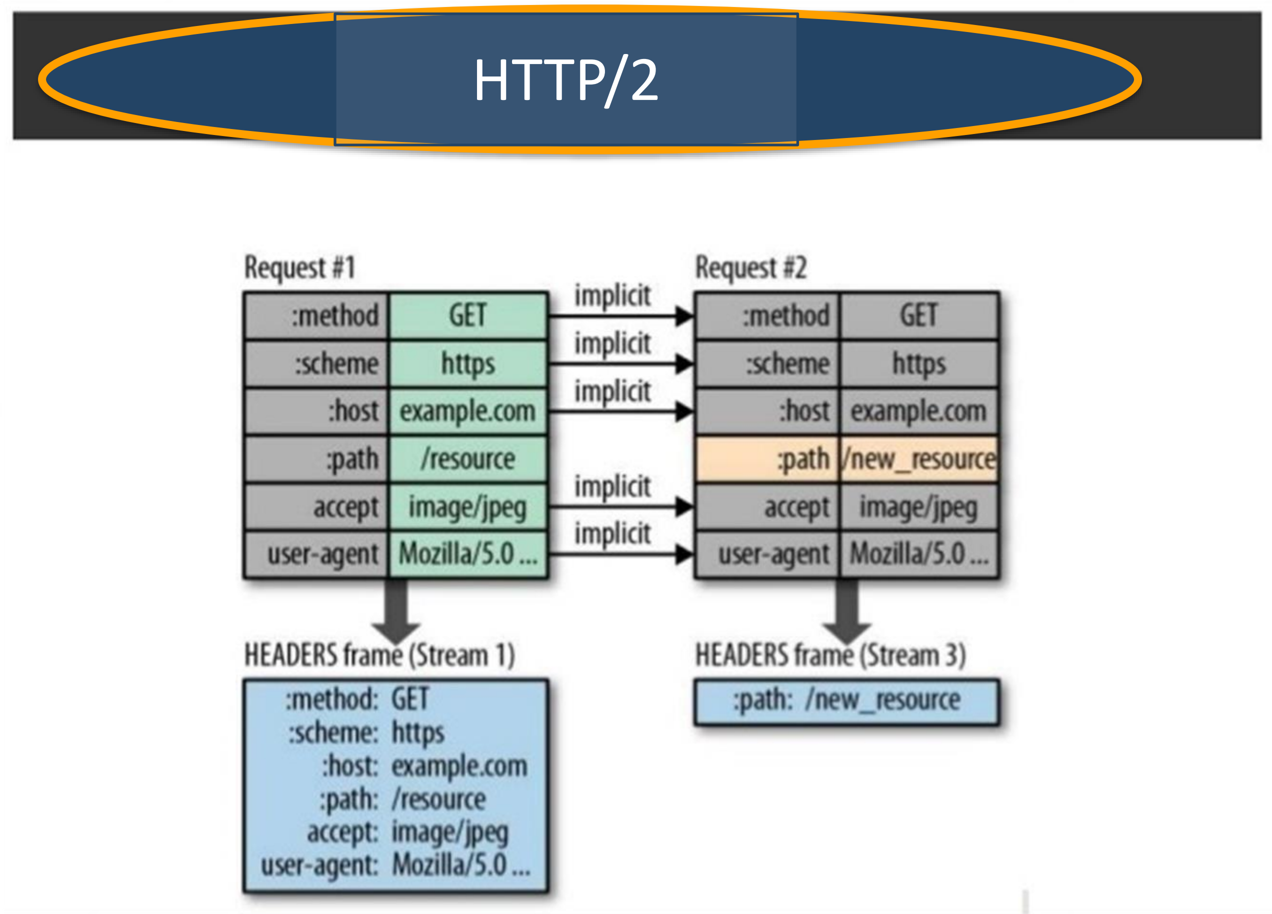
HTTP/2 Multiplexing

- The art of handling multiple streams over a **single** TCP connection



HTTP/2 Header Compression

- **HTTP/2** maintains a **HTTP Header Table** across requests
- Optimizes communication drastically
- The process is essentially a **de-duplication**, rather than compression



HTTP/2

Request #1

:method	GET
:scheme	https
:host	example.com
:path	/resource
accept	image/jpeg
user-agent	Mozilla/5.0 ...

Request #2

:method	GET
:scheme	https
:host	example.com
:path	/new_resource
accept	image/jpeg
user-agent	Mozilla/5.0 ...

HEADERS frame (Stream 1)

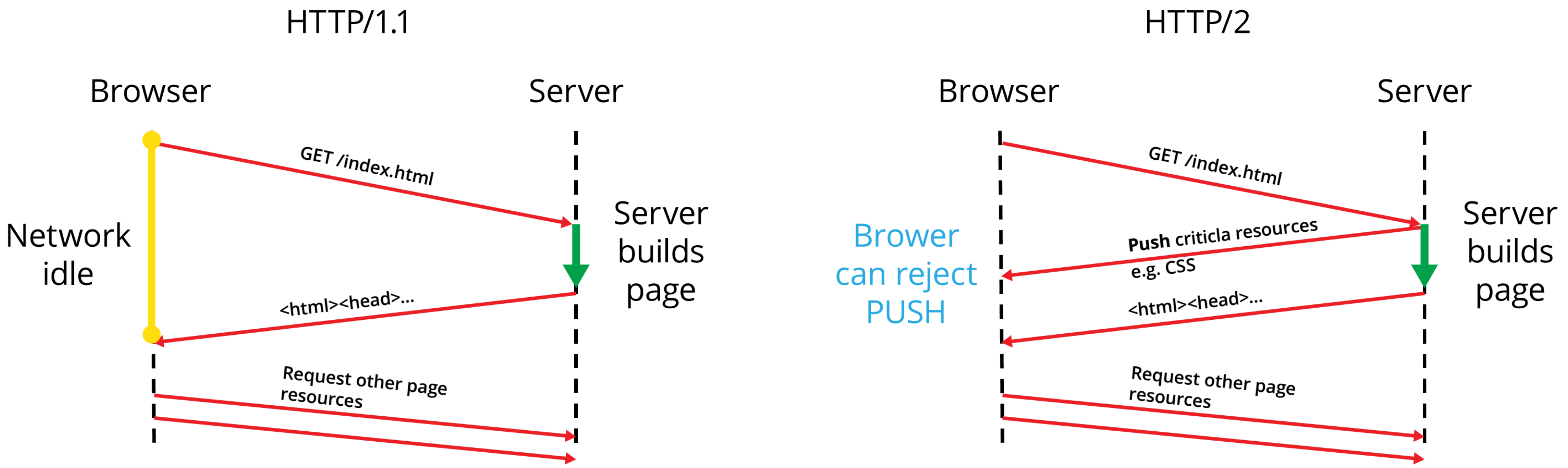
```
   :method:  GET
   :scheme:  https
     :host:  example.com
     :path:  /resource
    accept:  image/jpeg
user-agent:  Mozilla/5.0 ...
```

HEADERS frame (Stream 3)

```
:path:  /new_resource
```

HTTP/2 Server Push

- **HTTP/2 Server Push** == the process of sending resources to clients, without them having to ask for it.



HTTP/3

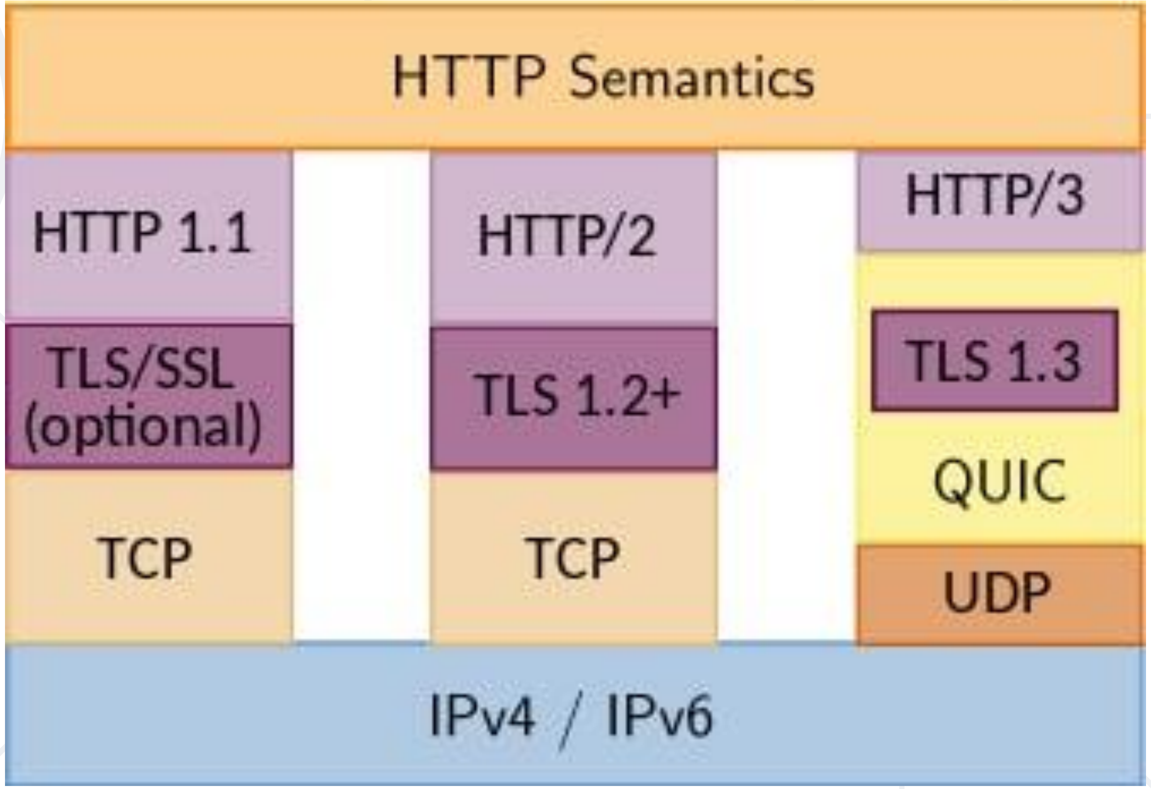
What's HTTP/3

What's HTTP/3

- **HTTP/3** is a new standard in development that will affect how web browsers and servers communicate
- As of Apr 2023, HTTP/3 is supported by 26% of web browsers (W3Techs statistics)
- Uses **QUIC** Protocol

What's new?

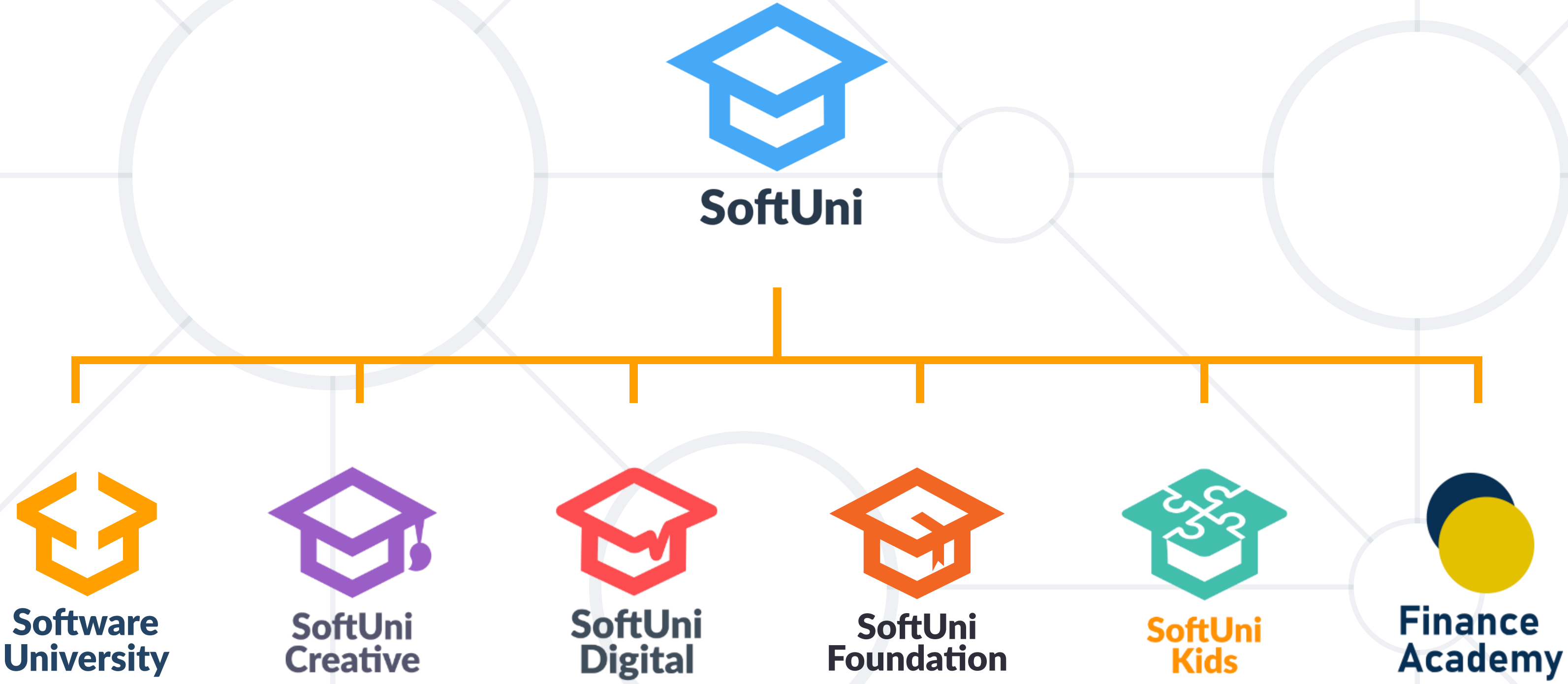
- **Significant upgrades** for user experience
  - Decreasing the effects of packet loss
  - Workaround for the slow performance, e. g. when a smartphone switches from Wi-Fi to cellular data
- **Performance**, **Reliability** and **Security**



Summary

- **HTTP**
  - HTML **Forms** & **Actions**
  - **URLs**
  - **Request & Response**
  - **MIME & Media Types**
- **Web Server**
  - **Web Communication**

Questions?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SoftUni Creative
SoftUni Digital
SoftUni Foundation
SoftUni Kids
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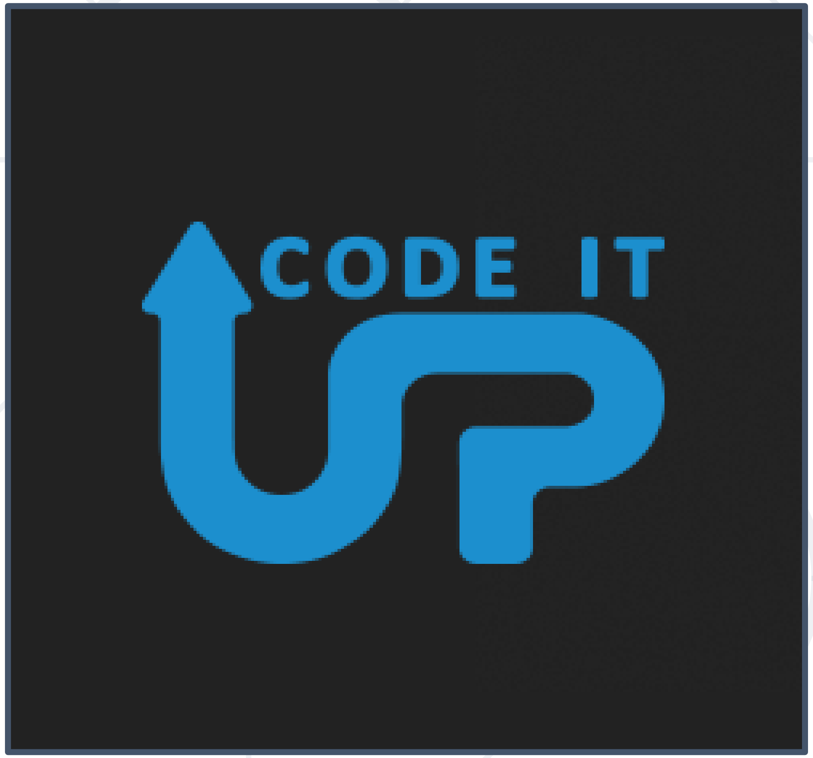

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