HTTP Protocol

Handling Requests,
Constructing Responses, HTTP/2

HTTP

SoftUni Team

Technical Trainers

Software
University

SoftUni

Software University

https://softuni.bg

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Questions?

Software University

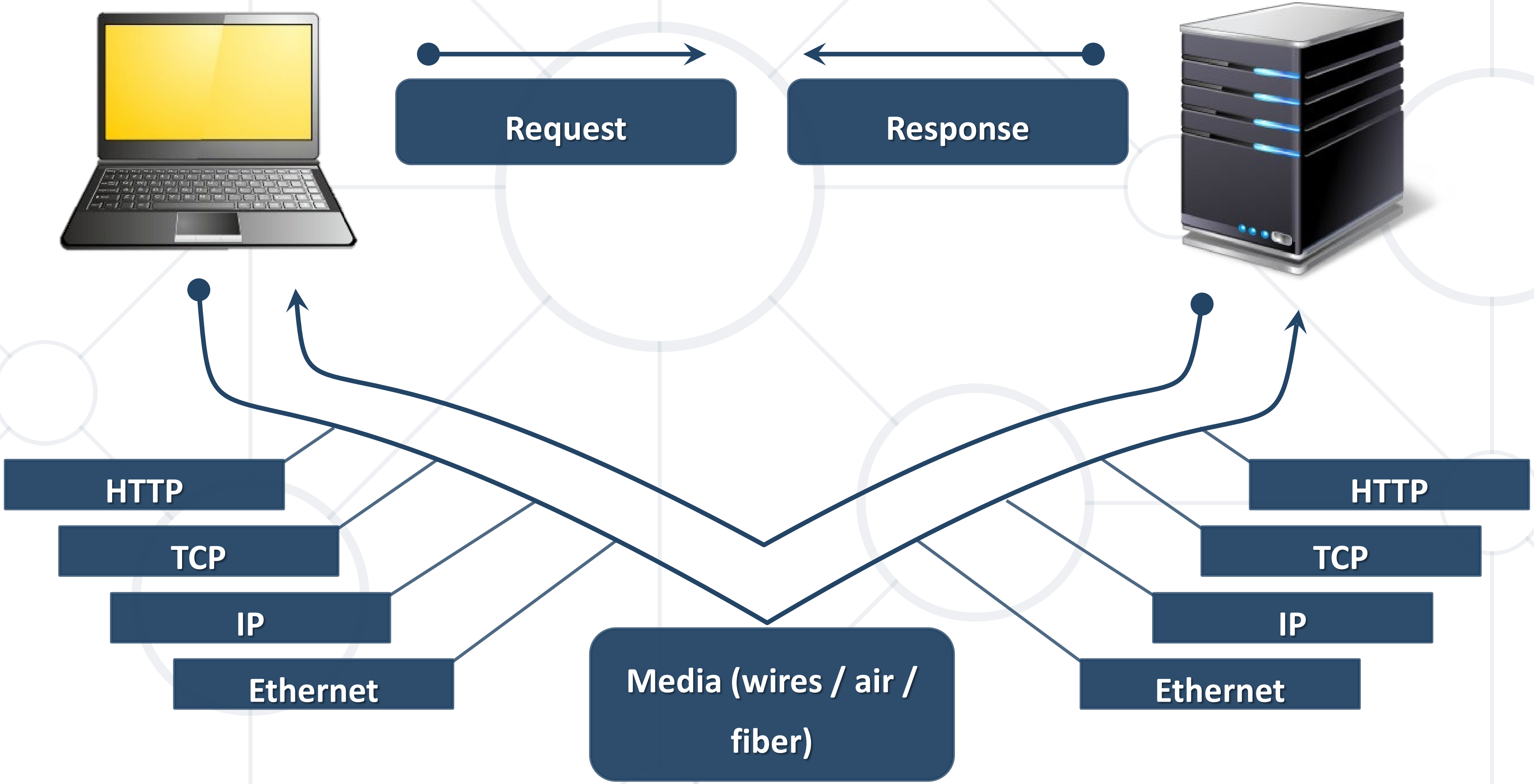
sli.do

#java-web

HTTP Basics

Request and Responses

Hyper Text Transfer Protocol



HTTP Request Methods

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

Method	Description
GET	Retrieve / load a resource
POST	Create / store a resource
PUT	Update a resource
DELETE	Remove a resource

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:

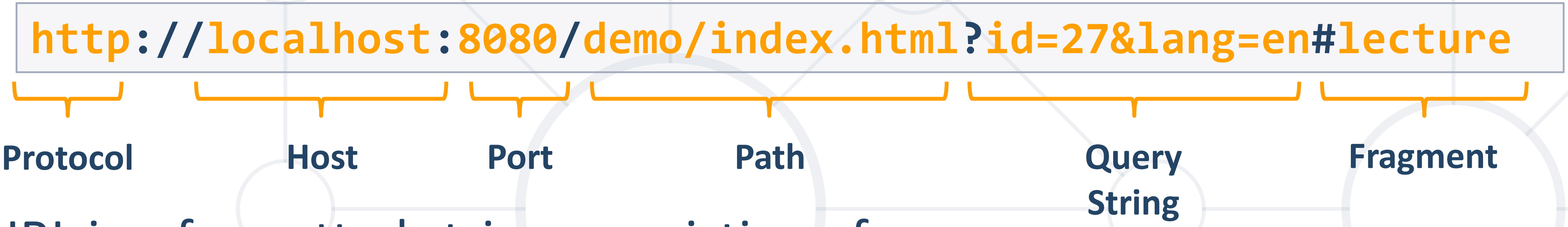
```
HTTP/1.1 200 OK
Date: Mon, 5 Jul 2020 13:09:03 GMT
Server: Microsoft-HTTPAPI/2.0
Last-Modified: Mon, 12 Jul 2014 15:33:23 GMT
Content-Length: 54
<CRLF>
<html><title>Hello</title>
Welcome to our site</html>
```

The empty line denotes the end of the response header

URL

Uniform Resource Locator

Uniform Resource Locator (URL)



`http://localhost:8080/demo/index.html?id=27&lang=en#lecture`

Protocol

Host

Port

Path

Query String

Fragment

- URL is a formatted string, consisting of:
  - Protocol for communicating (**http**, **ftp**, **https**...) – HTTP in most cases
  - Host or IP address (**www.softuni.bg**, **gmail.com**, **127.0.0.1**, **web**)
  - Port (the default port is **80**) – a number in range [0…65535]
  - Path (**/forum**, **/path/index.html**)
  - Query string (**?id=27&lang=en**)
  - Fragment (**#lectures**) – used on the client to navigate to some section

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 4.0
```

Should be: `?q=C%23+.NET+4.0`

```
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?

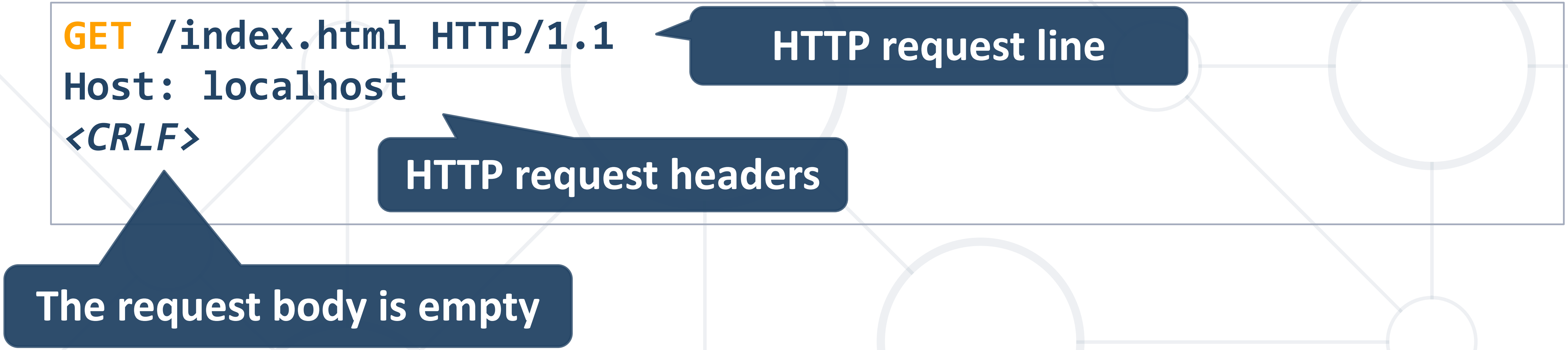
HTTP Request Message

- 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 GET Request – Example

- Example of HTTP **GET** request:



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

HTTP request line

HTTP request headers

The request body is empty

HTTP POST Request – Example

- 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 line

HTTP request headers

The request body holds the submitted form data

HTTP Response

What is a HTTP Response?

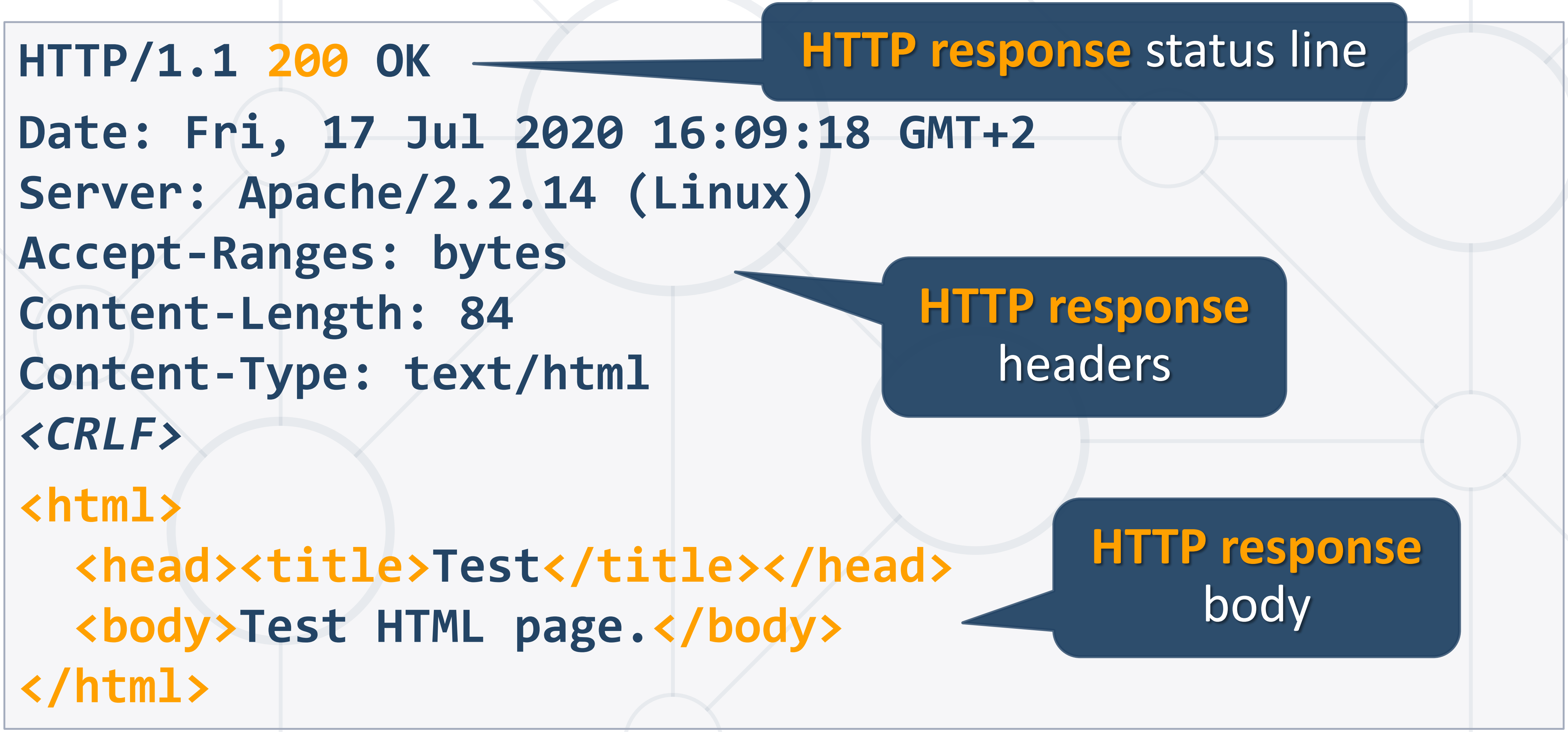
HTTP Response Message

- 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

- Example of HTTP **response** from the Web server:



```
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 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

- Example of **HTTP response** with error result:

```
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

The 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

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- The **Content-Type** response header the server 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)

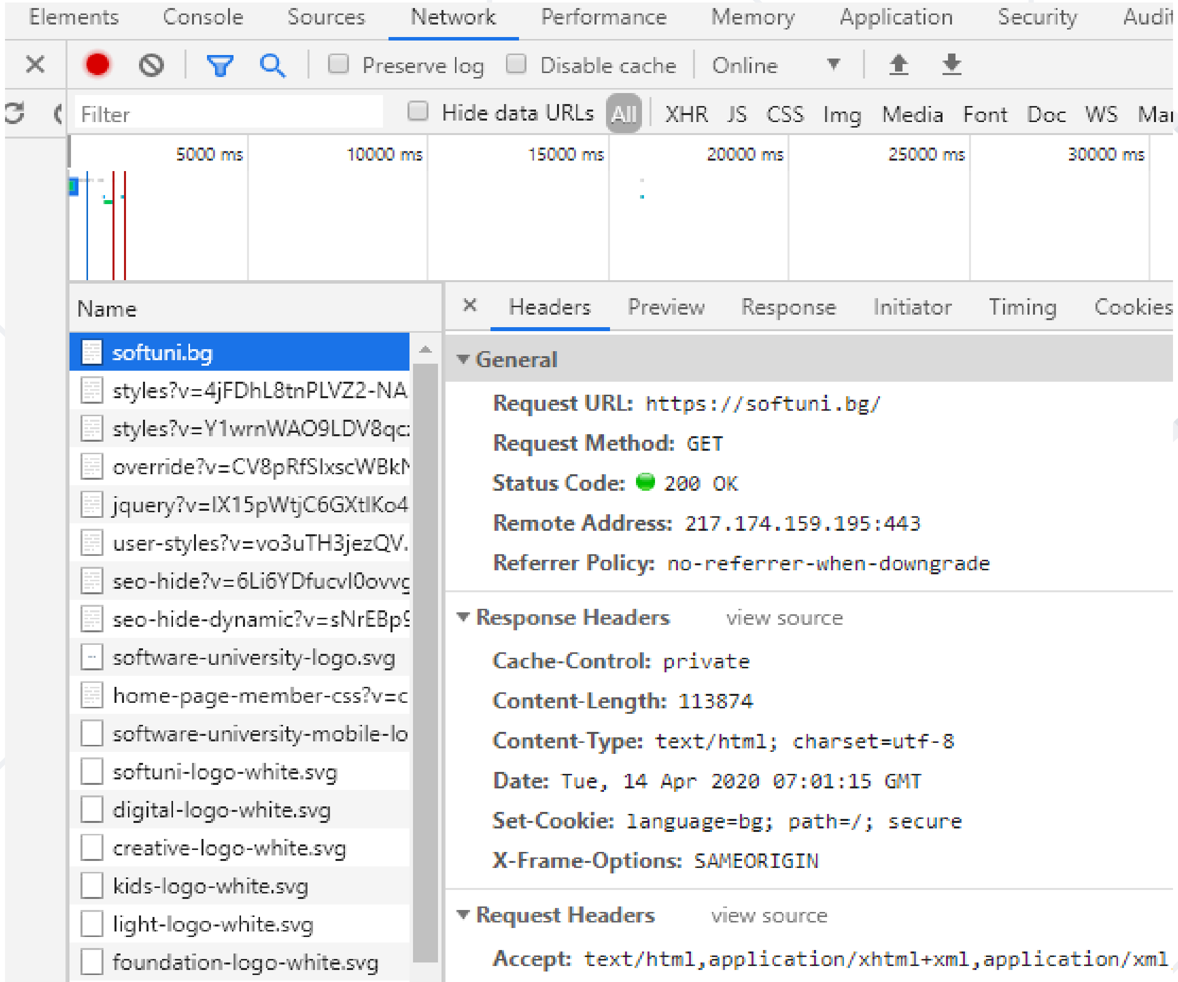
Common MIME Media Types

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

HTTP Tools

Tools for Developers

HTTP Tools for Developers – Browser (1)



softuni.bg
styles?v=4jFDhL8tnPLVZ2-NA
styles?v=Y1wrnWAO9LDV8qc
override?v=CV8pRfSlxscWBkN
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
```

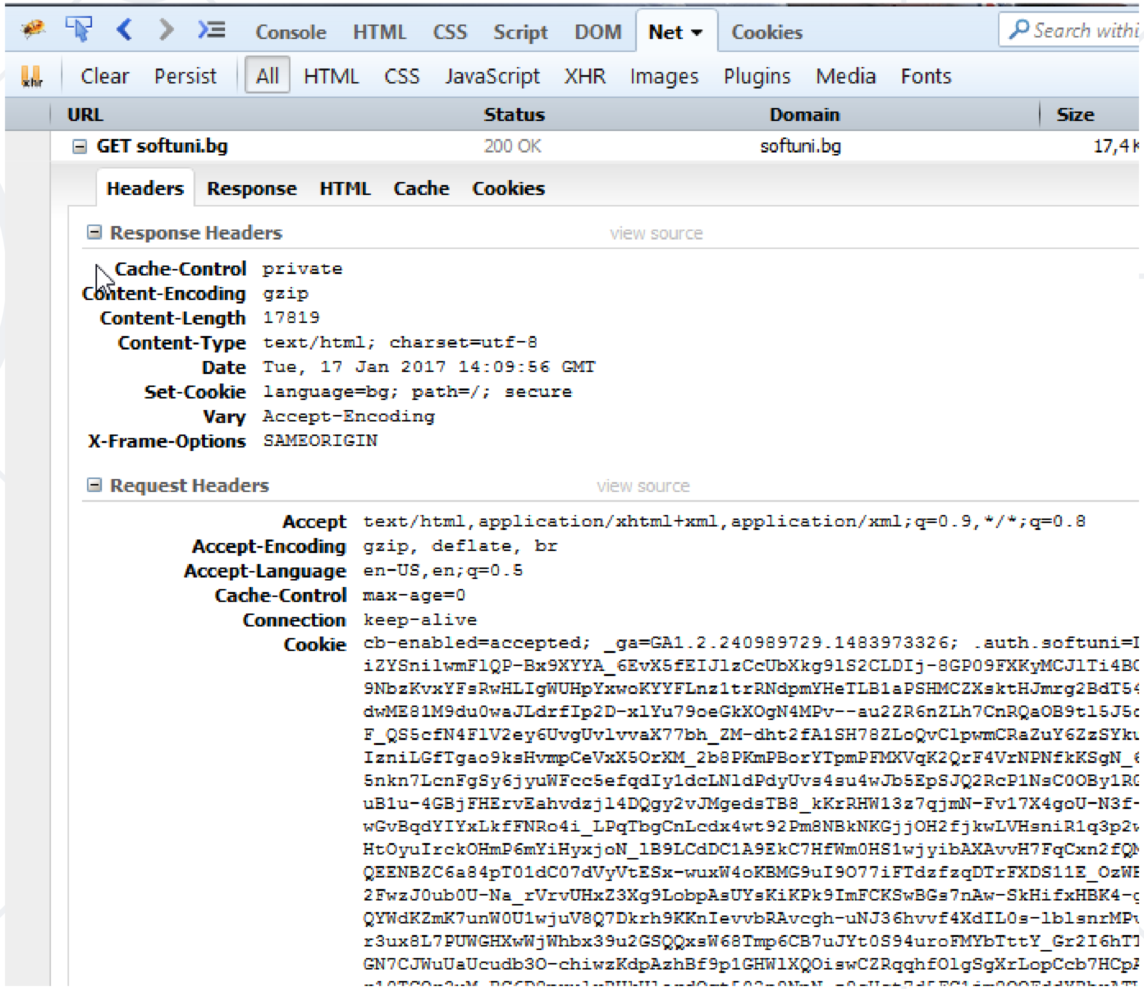
▼ Response Headers view source

```
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
```

[Chrome Developer Tools](https://developers.google.com/web/tools/chrome-devtools)



```
⊟ GET softuni.bg    200 OK    softuni.bg    17,4
```

⊟ 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
                  iZYSnilwmFlQP-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-chiwzKdpAzhBf9p1GHW1XQOiswCZRqqhf0lgSgXrLopCcb7HCpA
```

[Firebug](http://getfirebug.com/)

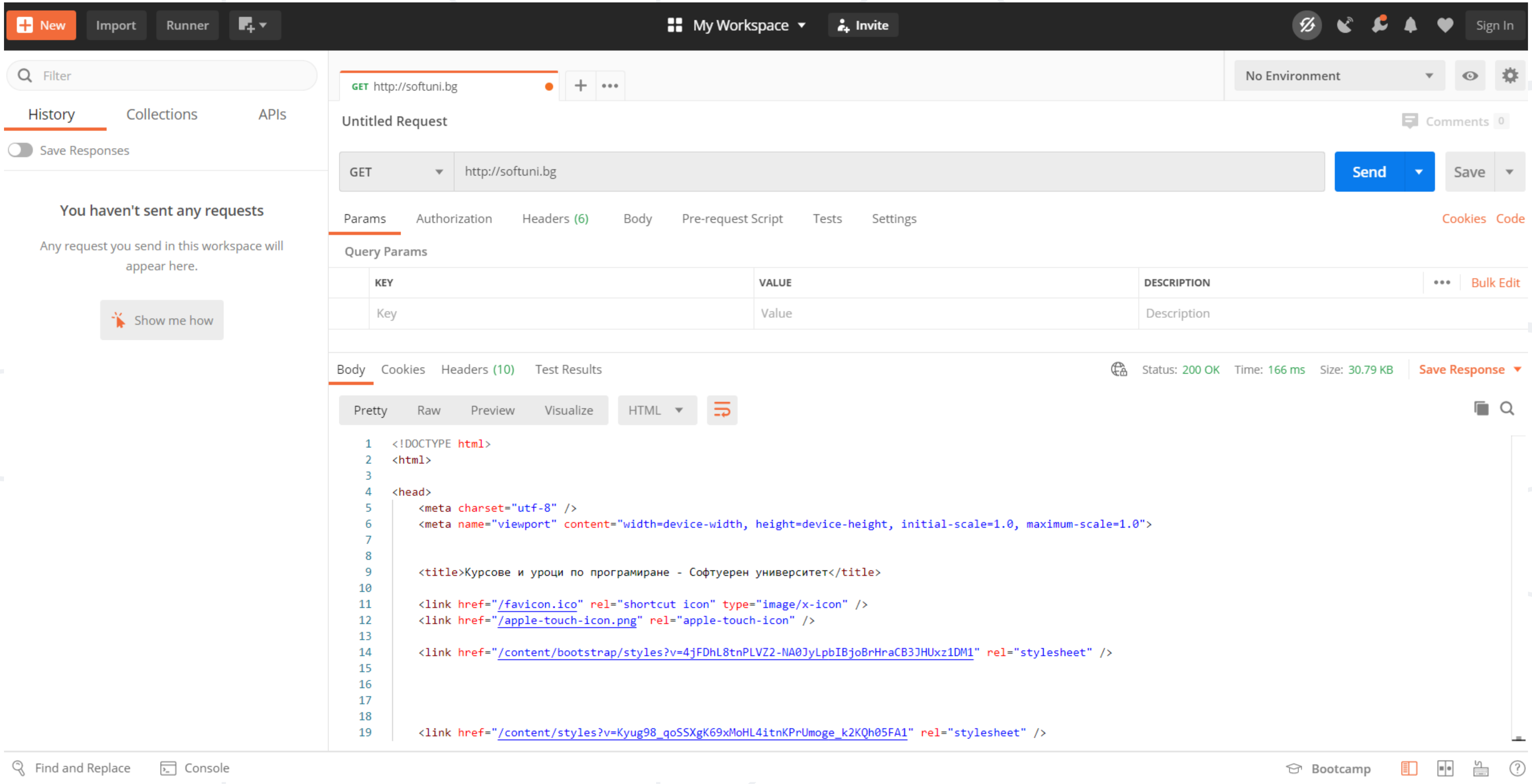
HTTP Tools for Developers – Browser (2)

Insomnia Rest

Postman

RESTClient

HTTP Tools for Developers – Postman



GET http://softuni.bg

Untitled Request

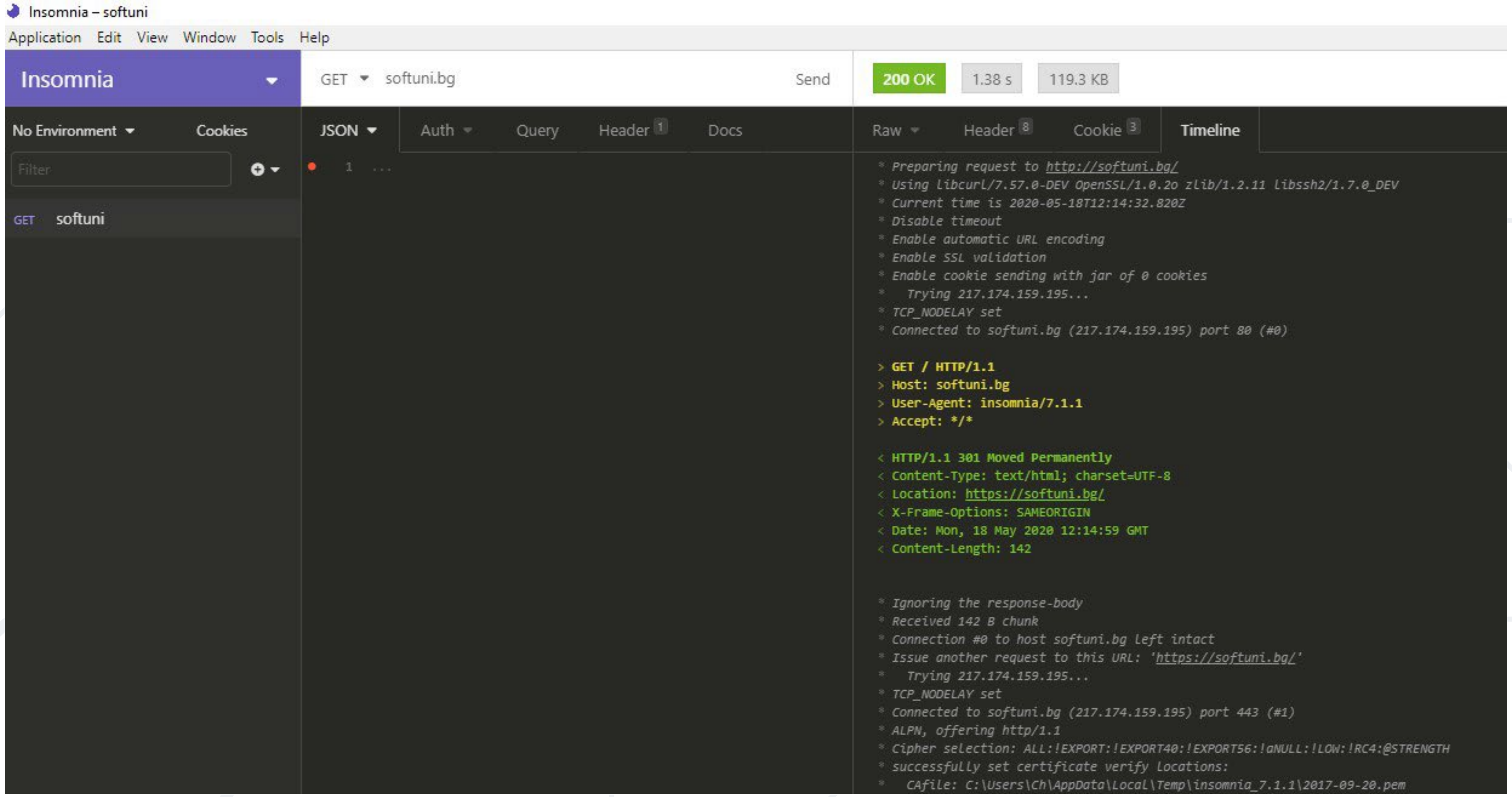
GET http://softuni.bg

Status: 200 OK Time: 166 ms Size: 30.79 KB

```
<!DOCTYPE html>
<html>

<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, height=device-height, initial-scale=1.0, maximum-scale=1.0">


    <title>Курсове и уроци по програмиране - Софтуерен университет</title>

    <link href="/favicon.ico" rel="shortcut icon" type="image/x-icon" />
    <link href="/apple-touch-icon.png" rel="apple-touch-icon" />

    <link href="/content/bootstrap/styles?v=4jFDhL8tnPLVZ2-NA0JyLpbIBjoBrHraCB3JHUxz1DM1" rel="stylesheet" />




    <link href="/content/styles?v=Kyug98_qoSSXgK69xMoHL4itnKPrUmoge_k2KQh05FA1" rel="stylesheet" />
```

Postman

HTTP Tools for Developers – Insomnia



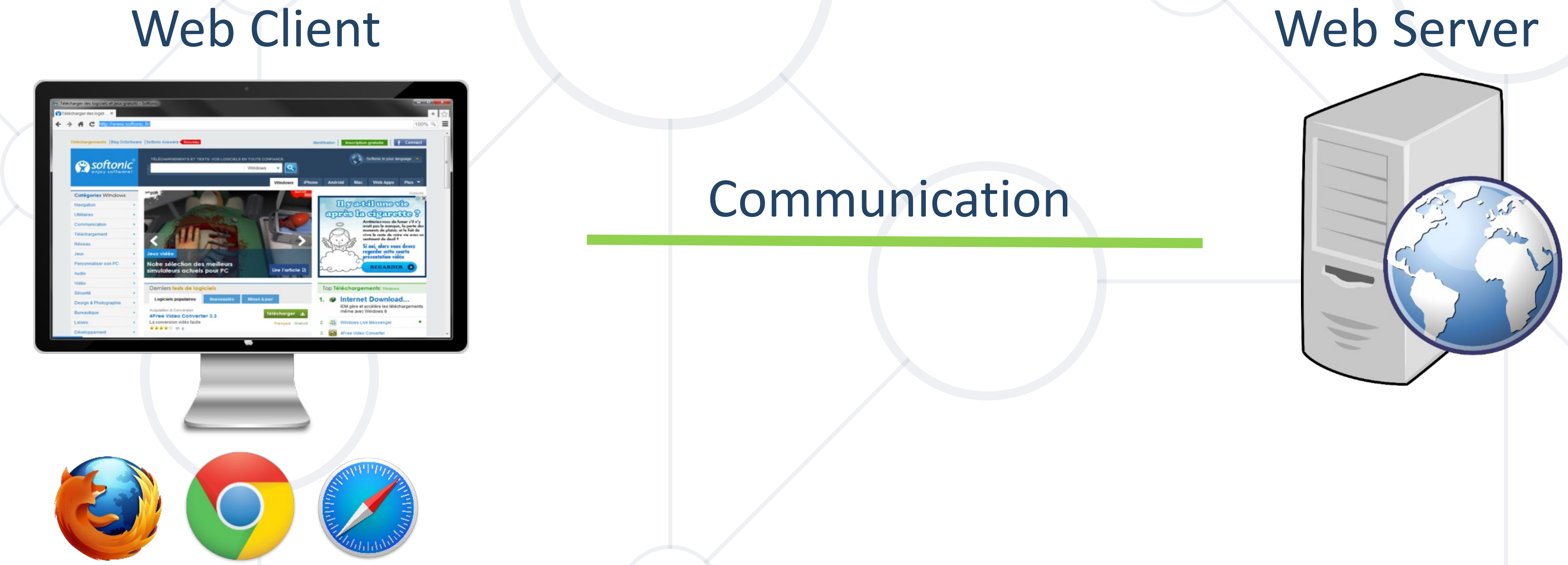
```
* Preparing request to http://softuni.bg/
* Using libcurl/7.57.0-DEV OpenSSL/1.0.2o zlib/1.2.11 libssh2/1.7.0_DEV
* Current time is 2020-05-18T12:14:32.820Z
* Disable timeout
* Enable automatic URL encoding
* Enable SSL validation
* Enable cookie sending with jar of 0 cookies
*   Trying 217.174.159.195...
* TCP_NODELAY set
* Connected to softuni.bg (217.174.159.195) port 80 (#0)

> GET / HTTP/1.1
> Host: softuni.bg
> User-Agent: insomnia/7.1.1
> Accept: */*

< HTTP/1.1 301 Moved Permanently
< Content-Type: text/html; charset=UTF-8
< Location: https://softuni.bg/
< X-Frame-Options: SAMEORIGIN
< Date: Mon, 18 May 2020 12:14:59 GMT
< Content-Length: 142


* Ignoring the response-body
* Received 142 B chunk
* Connection #0 to host softuni.bg left intact
* Issue another request to this URL: 'https://softuni.bg/'
*   Trying 217.174.159.195...
* TCP_NODELAY set
* Connected to softuni.bg (217.174.159.195) port 443 (#1)
* ALPN, offering http/1.1
* Cipher selection: ALL:!EXPORT:!EXPORT40:!EXPORT56:!aNULL:!LOW:!RC4:@STRENGTH
* successfully set certificate verify locations:
*   CAfile: C:\Users\Ch\AppData\Local\Temp\insomnia_7.1.1\2017-09-20.pem
```

Insomnia Rest

Web Server

What is a Web Server?

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

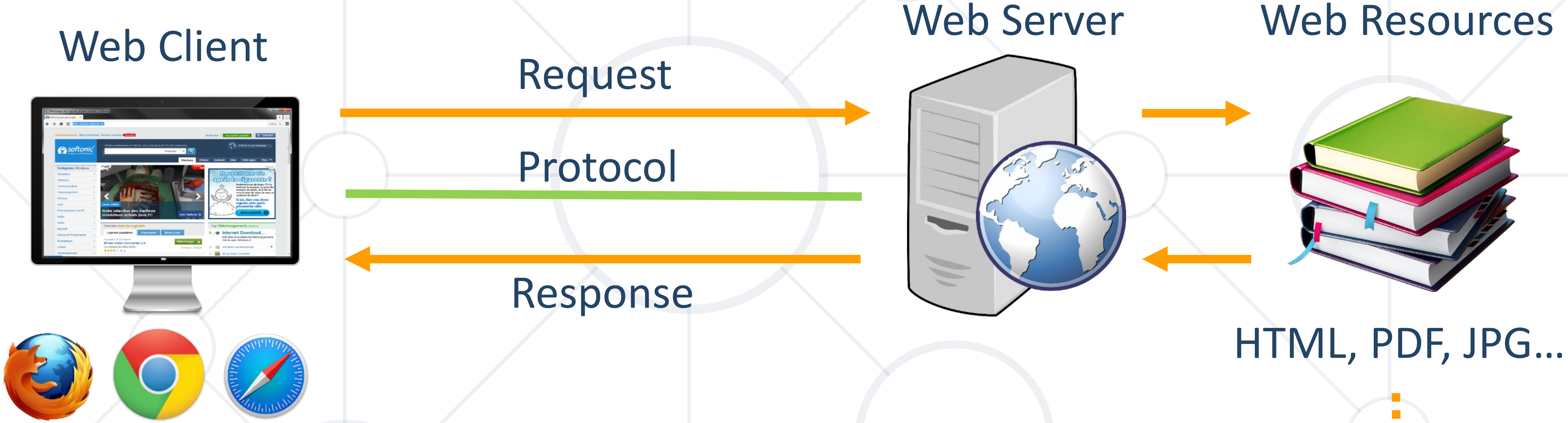


Web Client

Communication

Web Server

Web Server Work Model (1)



HTML, PDF, JPG…

Protocols:

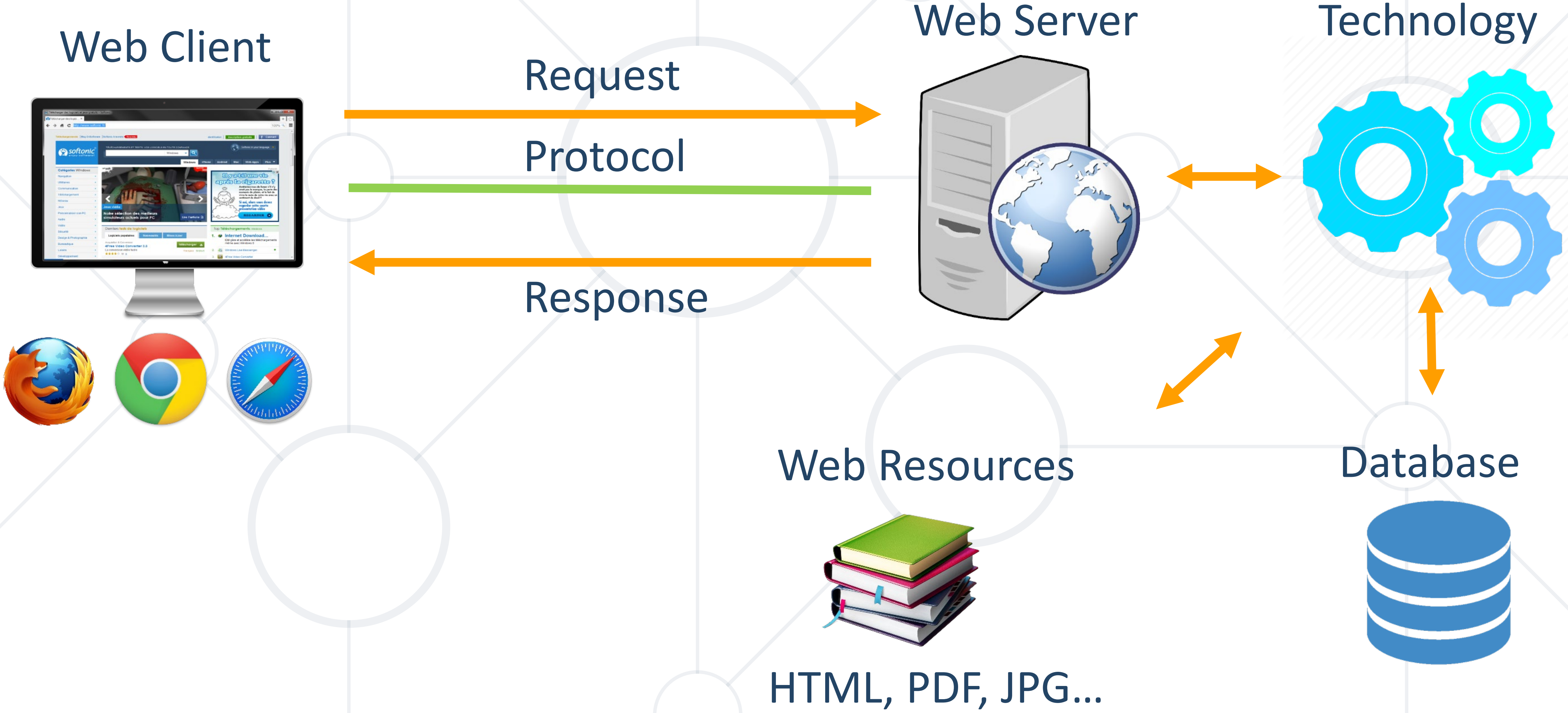
- HTTP
- FTP
- WebSocket

Protocol | Host | Port | Resource

URL

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

Web Server Work Model (2)



Web Client

Request

Protocol

Response

Web Server

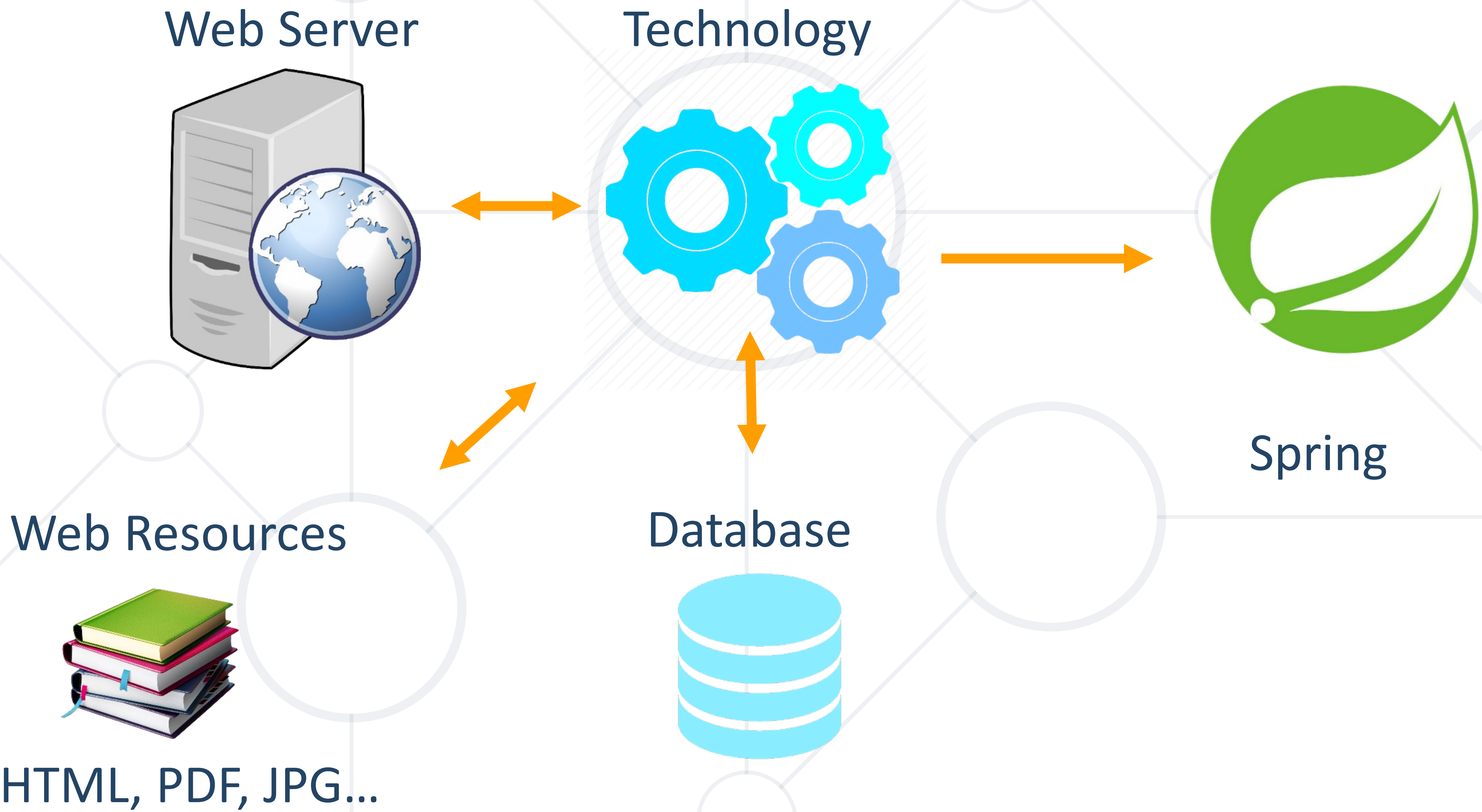
Technology

Web Resources

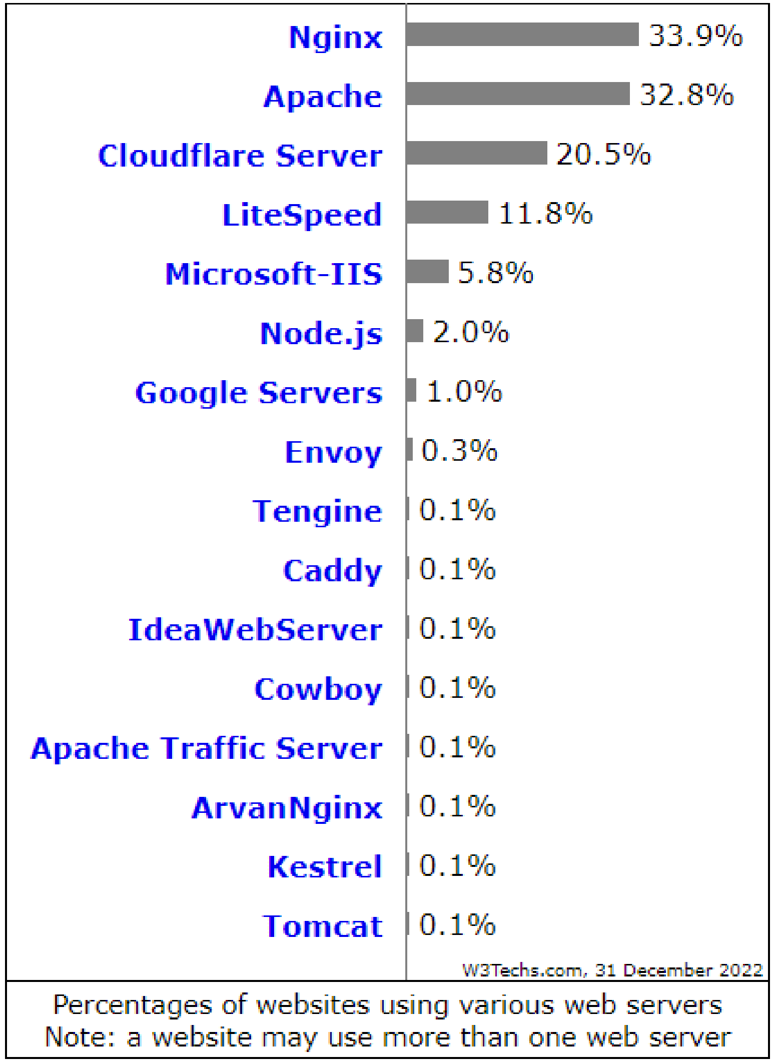
HTML, PDF, JPG…

Database

Web Server Work Model (3)

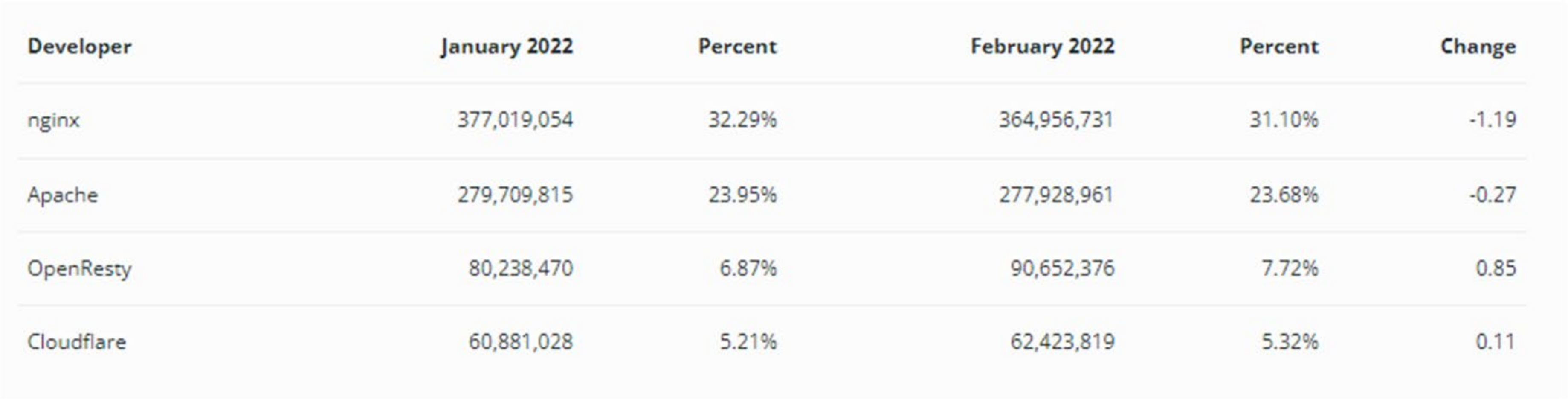


Most Popular Web Servers (W3Techs)

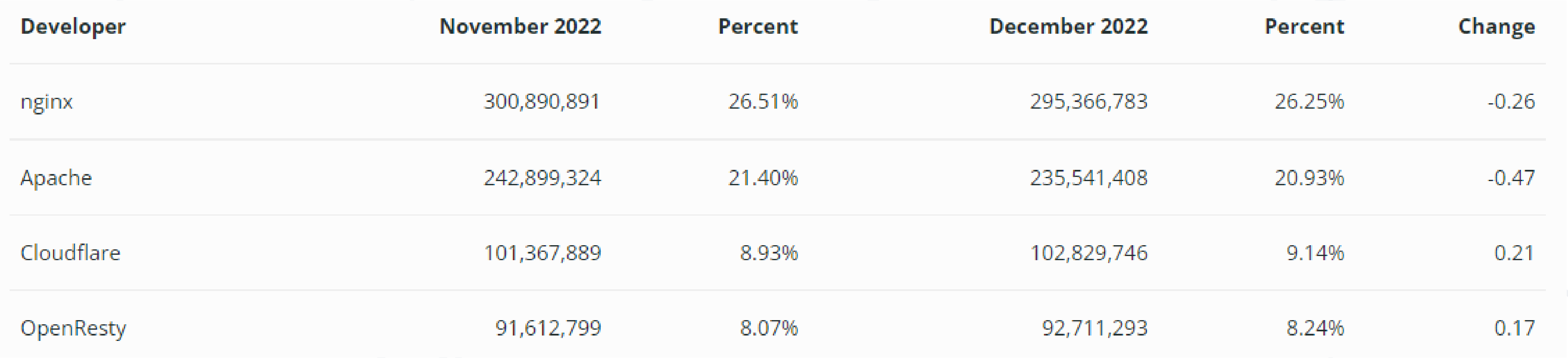


Percentages of websites using various web servers
Note: a website may use more than one web server

Most Popular Web Servers (NetCraft)



Developer	January 2022	Percent	February 2022	Percent	Change
nginx	377,019,054	32.29%	364,956,731	31.10%	-1.19
Apache	279,709,815	23.95%	277,928,961	23.68%	-0.27
OpenResty	80,238,470	6.87%	90,652,376	7.72%	0.85
Cloudflare	60,881,028	5.21%	62,423,819	5.32%	0.11



Developer	November 2022	Percent	December 2022	Percent	Change
nginx	300,890,891	26.51%	295,366,783	26.25%	-0.26
Apache	242,899,324	21.40%	235,541,408	20.93%	-0.47
Cloudflare	101,367,889	8.93%	102,829,746	9.14%	0.21
OpenResty	91,612,799	8.07%	92,711,293	8.24%	0.17

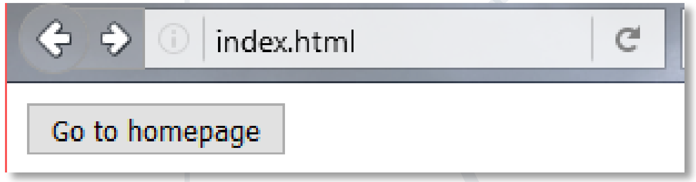
HTML Forms

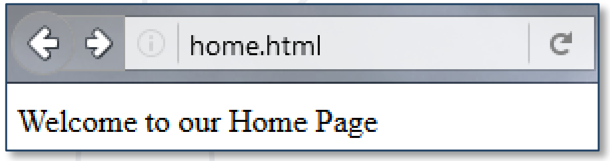
Form Method and Action

HTML Forms – Action Attribute

- Defines where to submit the form data:

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





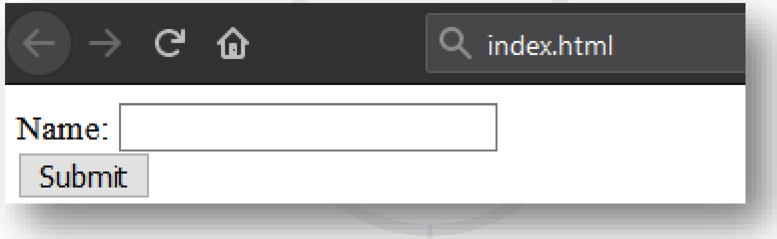
Welcome to our Home Page

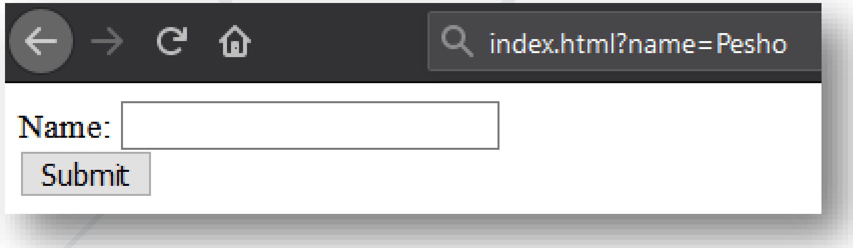
HTML Forms – Method Attribute (1)

- 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>
```

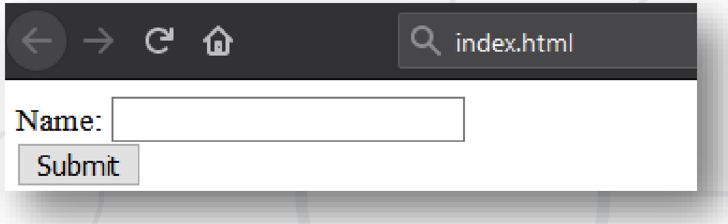
The form data is in the URL





HTML Forms – Method Attribute (2)

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

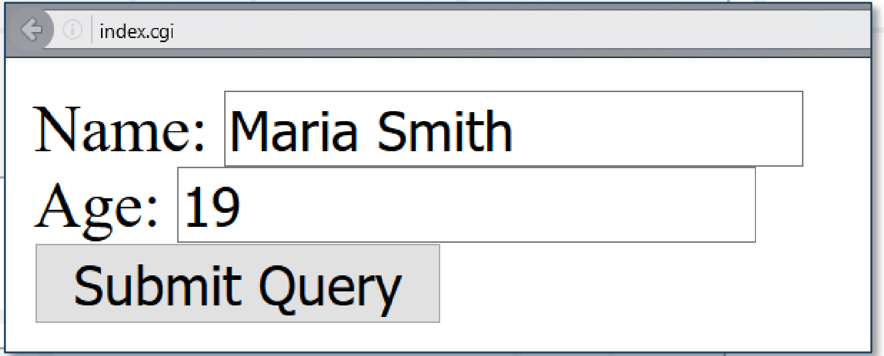


```
POST http://localhost/index.html HTTP/1.1
Host: localhost
Content-Type: application/x-www-form-urlencoded
Content-Length: 10

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

HTTP/2

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

What's HTTP/2

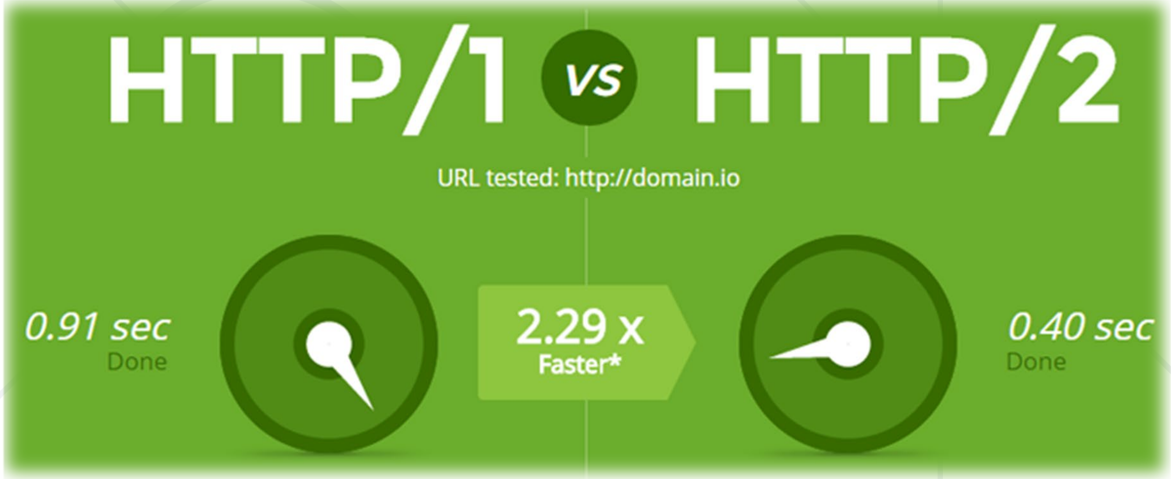
- **HTTP/2** (originally named **HTTP/2.0**) major revision of the **HTTP** network protocol used by the **World Wide Web**.
  - Supported by most of the popular web browsers (Chrome, Mozilla, Opera...)
  - Fast & Optimized. Meets modern web usage requirements.
  - Completely Backwards-Compatible.

- As of Jan 2021, **50%** of all the websites support **HTTP/2** (W3Techs statistics).

What's New?

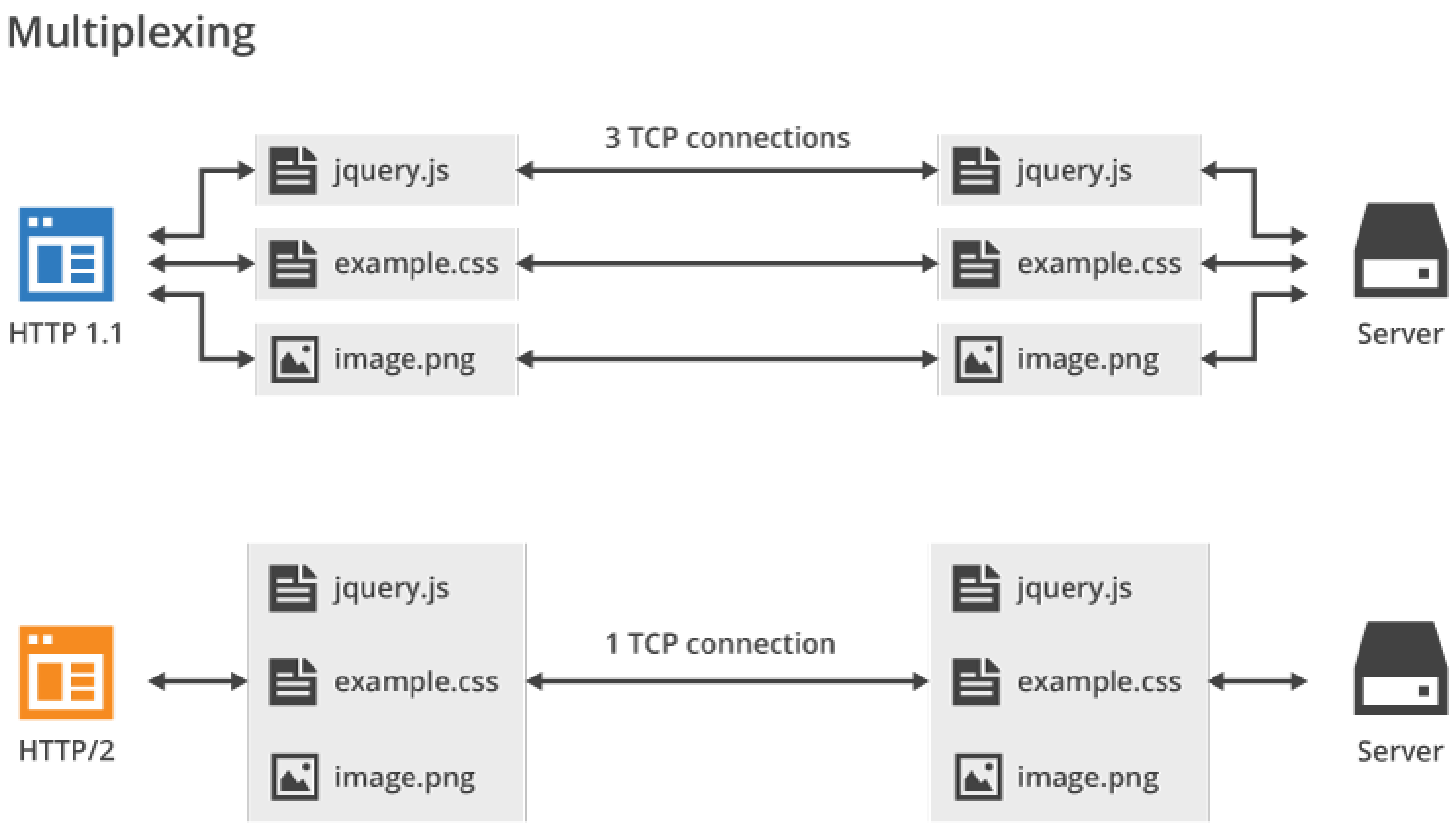
- **HTTP/2** is meant to erase the need of maintaining complex server infrastructures in order to perform well.
- **HTTP/2** communicates in binary data frames.

- **HTTP/2** introduces several new important elements
  - HTTP/2 Multiplexing
  - HTTP/2 Header Compression
  - HTTP/2 Server Push



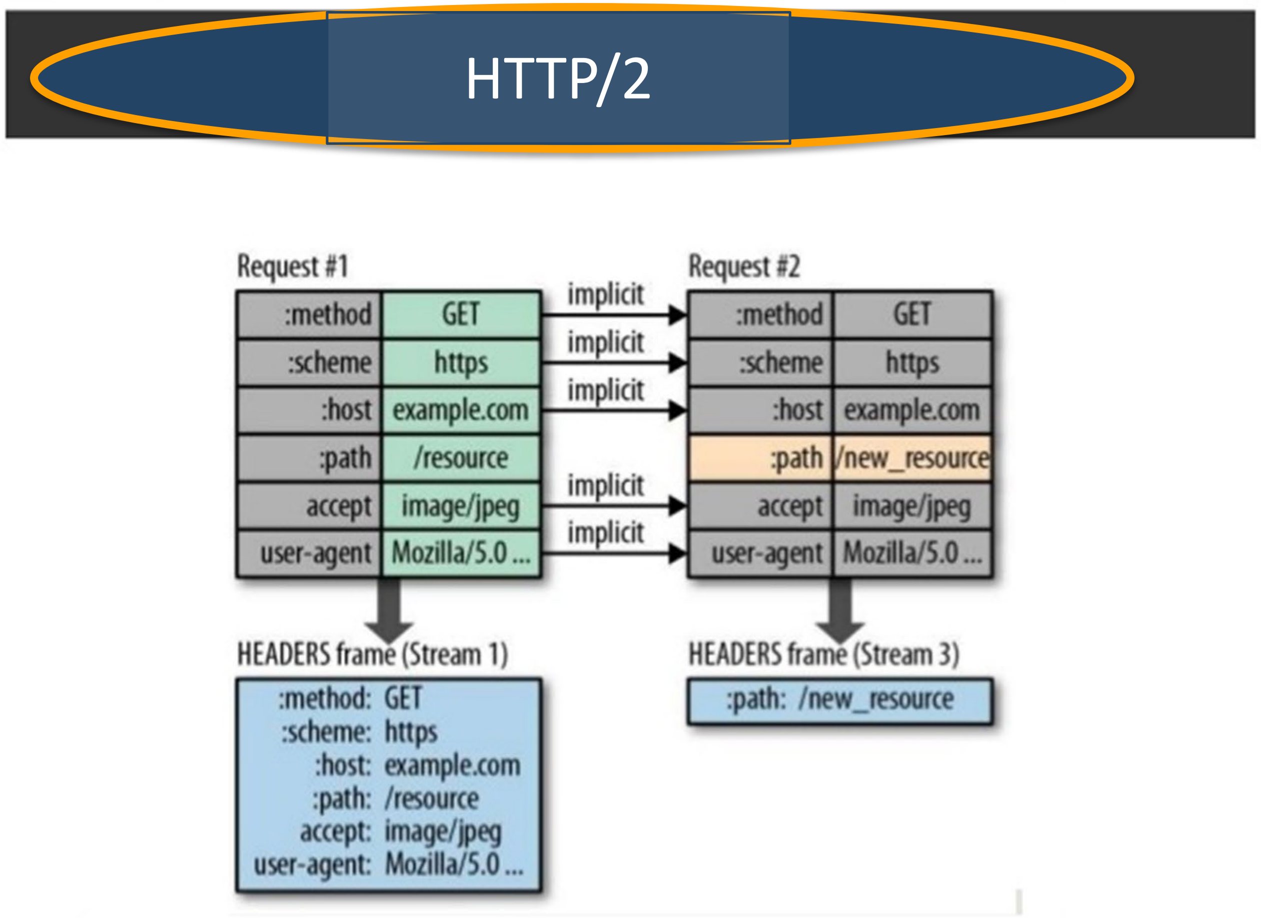
HTTP/2 Multiplexing

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



HTTP/2

- **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)

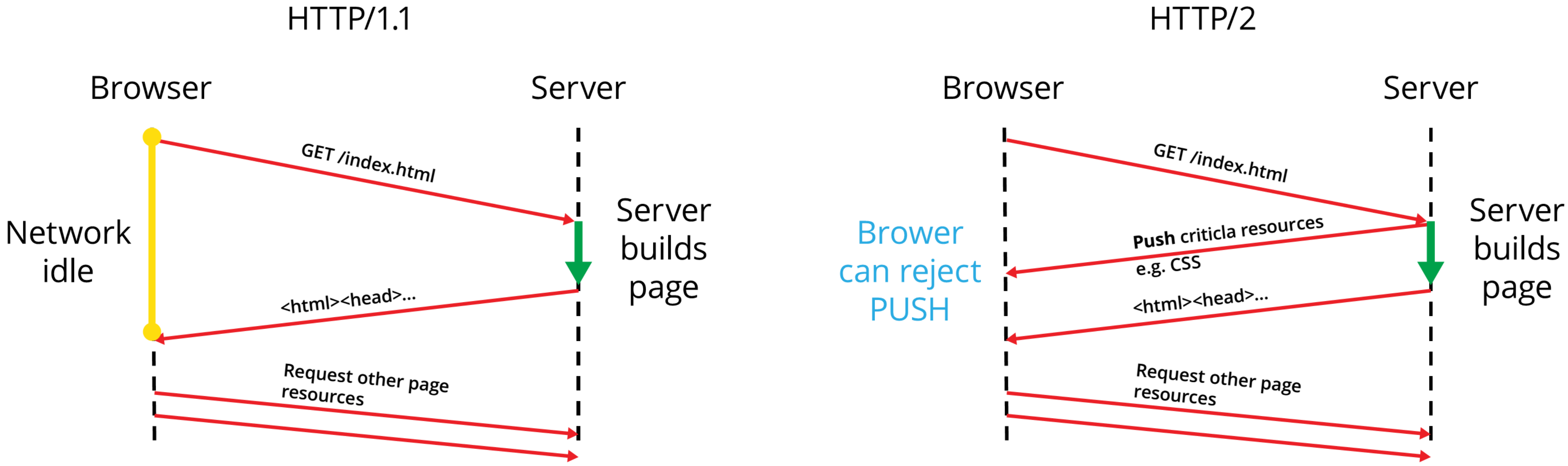
:method: GET
:scheme: https
:host: example.com
:path: /resource
accept: image/jpeg
user-agent: Mozilla/5.0 ...

HEADERS frame (Stream 3)

:path: /new_resource

HTTP/2 Server Push

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



What's HTTP/3

- **HTTP/3** is a new standard in development that will affect how web browsers and servers communicate.
- Significant upgrades for user experience
- **Performance**, **Reliability**, and **Security**

- **HTTP/3** runs on **QUIC**, a new transport protocol designed for **mobile-heavy** Internet usage.

Summary

- **HTTP:**
  - **HTML** Forms & Actions.
  - **URLs**
  - **Request**
  - **Response**
- **Web Server:**
  - **Web Communication**

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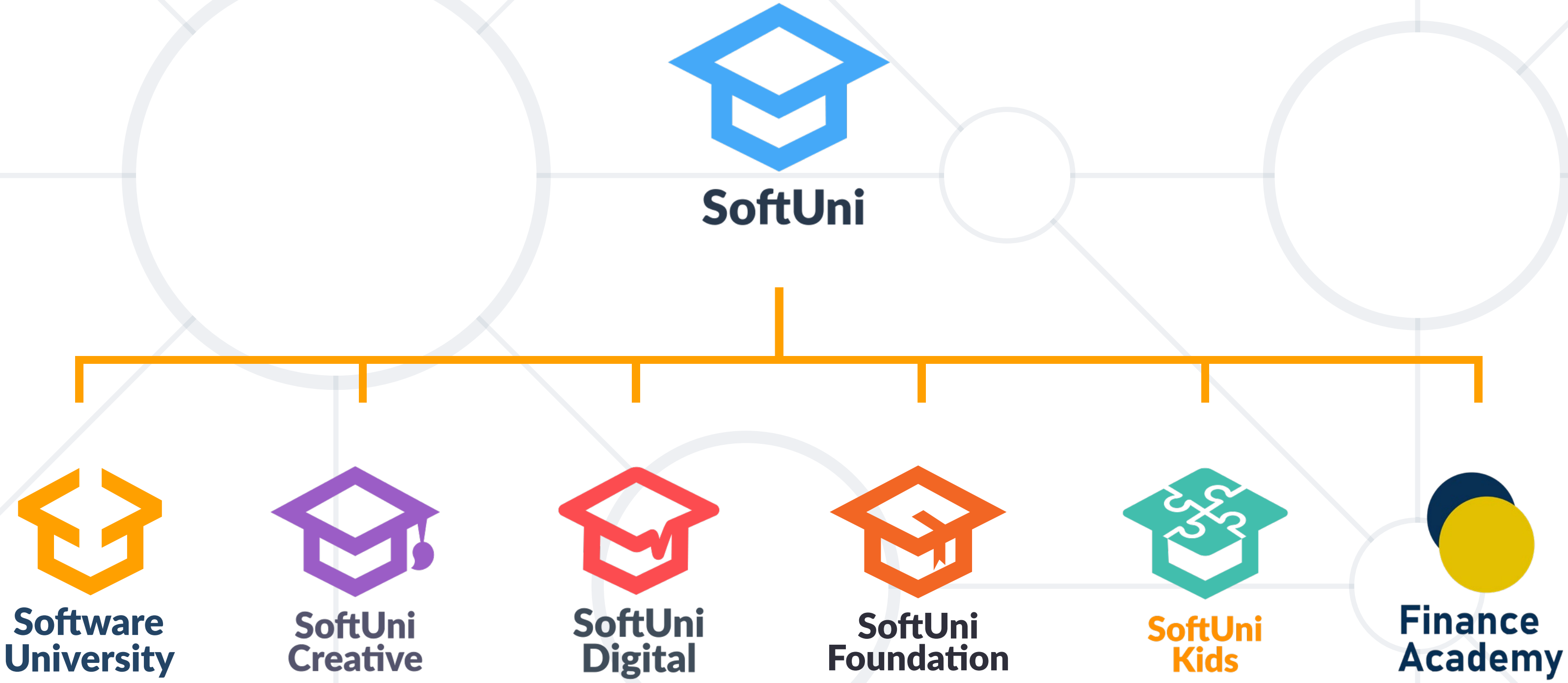
Questions?



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