

Web Programming

Web Servers & Protocols

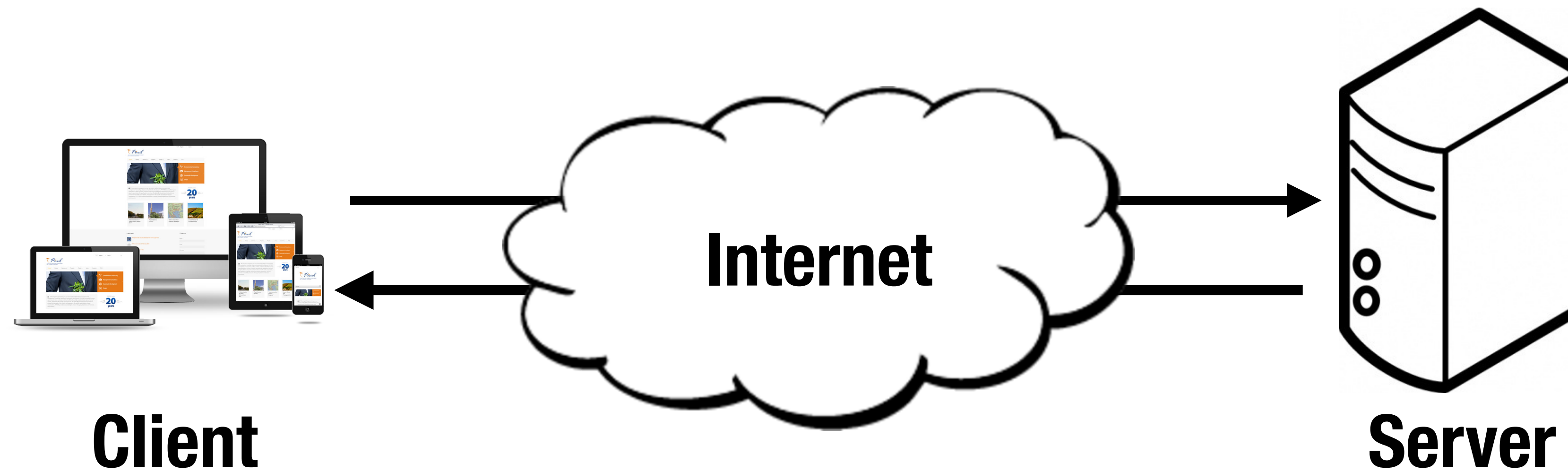
Krisztian Balog | University of Stavanger

Internet vs. Web

- Internet
 - Collection of computers and devices connected by equipment that allows them to communicate with each other
- World Wide Web
 - Collection of software and protocols
 - Most people use the Internet *through* the web

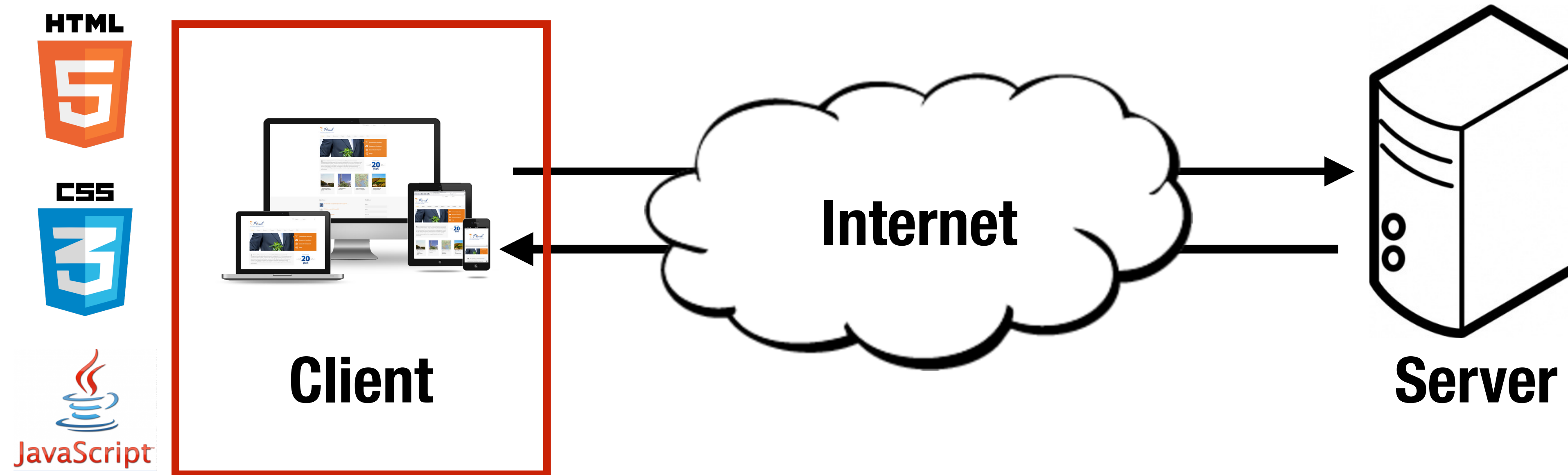
Web

- Client-server architecture

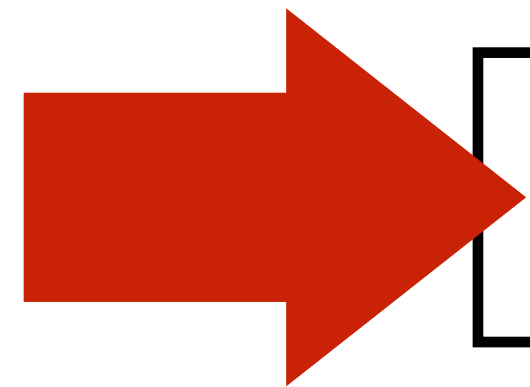


So far in this course

- Only client-side



Network layers



Application

Dictates the method used to send data.
E.g., HTTP, FTP, POP3, SMTP, SSL, ...

Transport

Dictates the format of data sent, exactly where it is sent to, and maintaining data integrity.
E.g., TCP, UDP

Internet

Purely transports data across the network.
E.g., IP, ICMP, IGMP

Physical

The physical/logical network components used to interconnect network nodes.
E.g., Ethernet, Wi-Fi, ...

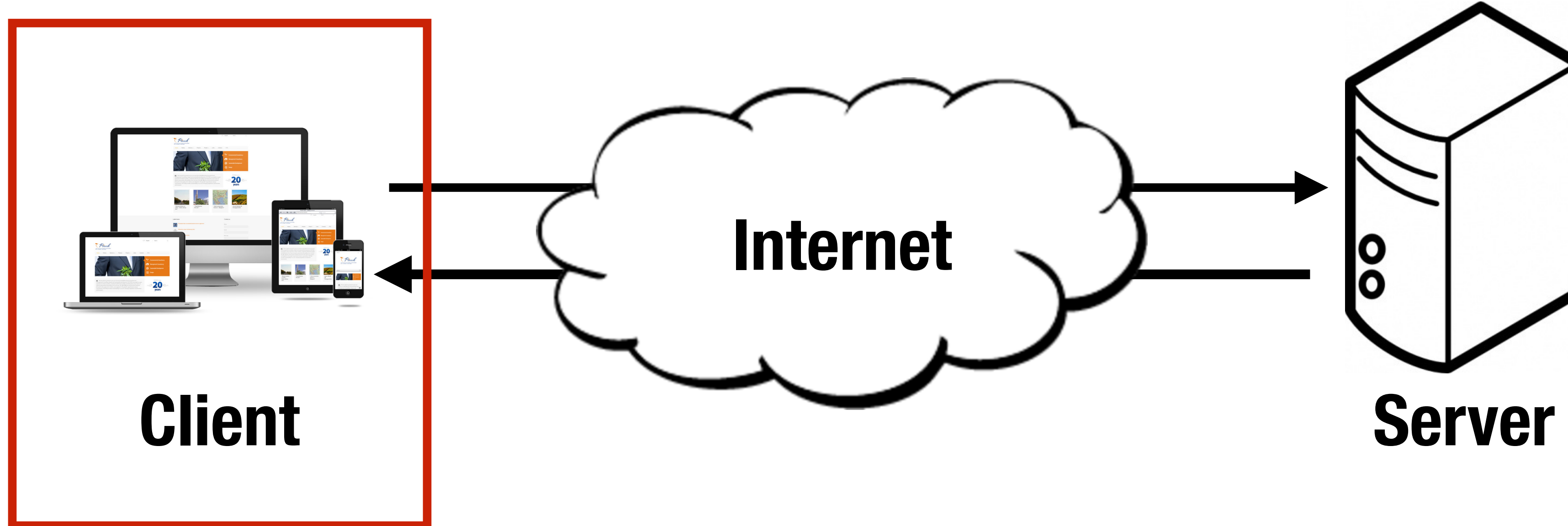
IP addresses

- Internet Protocol address
- Unique numerical label assigned to each device that is connected to the Internet
 - IPv4: 32-bit number (4x 1byte)
 - **172.16.254.1**
 - IPv6: 128 bits (8 groups of 4-hex digits)
 - **2001:0db8:0a0b:12f0:0000:0000:0000:0001**

Domain names

- Hostname: domain name assigned to a host computer
 - Combination of the host's local name with the parent's domain name
 - **www.idi.ntnu.no**
- Translated to an IP address via the Domain Name System (DNS) resolver
 - or via a local hosts file

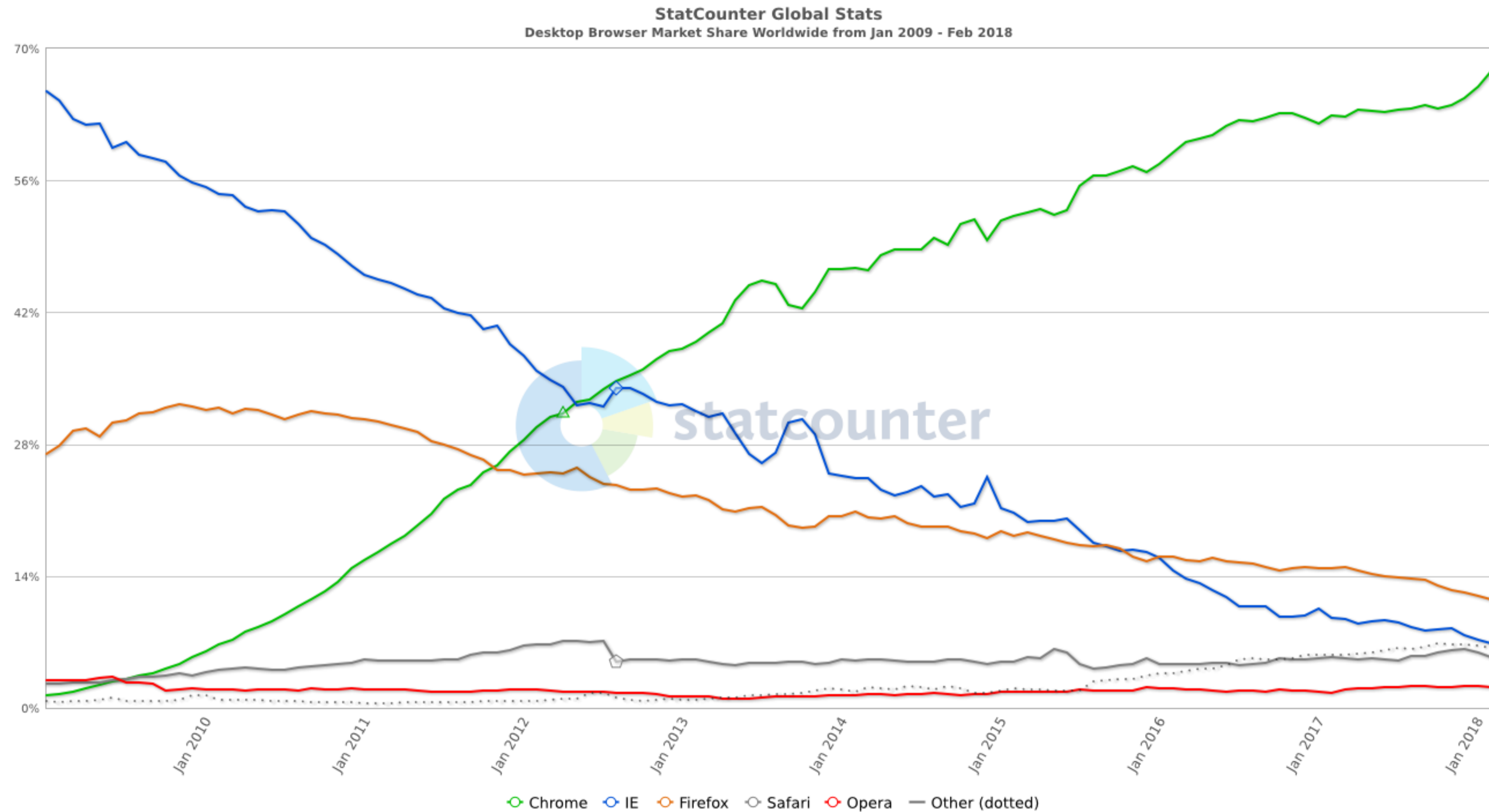
Web clients



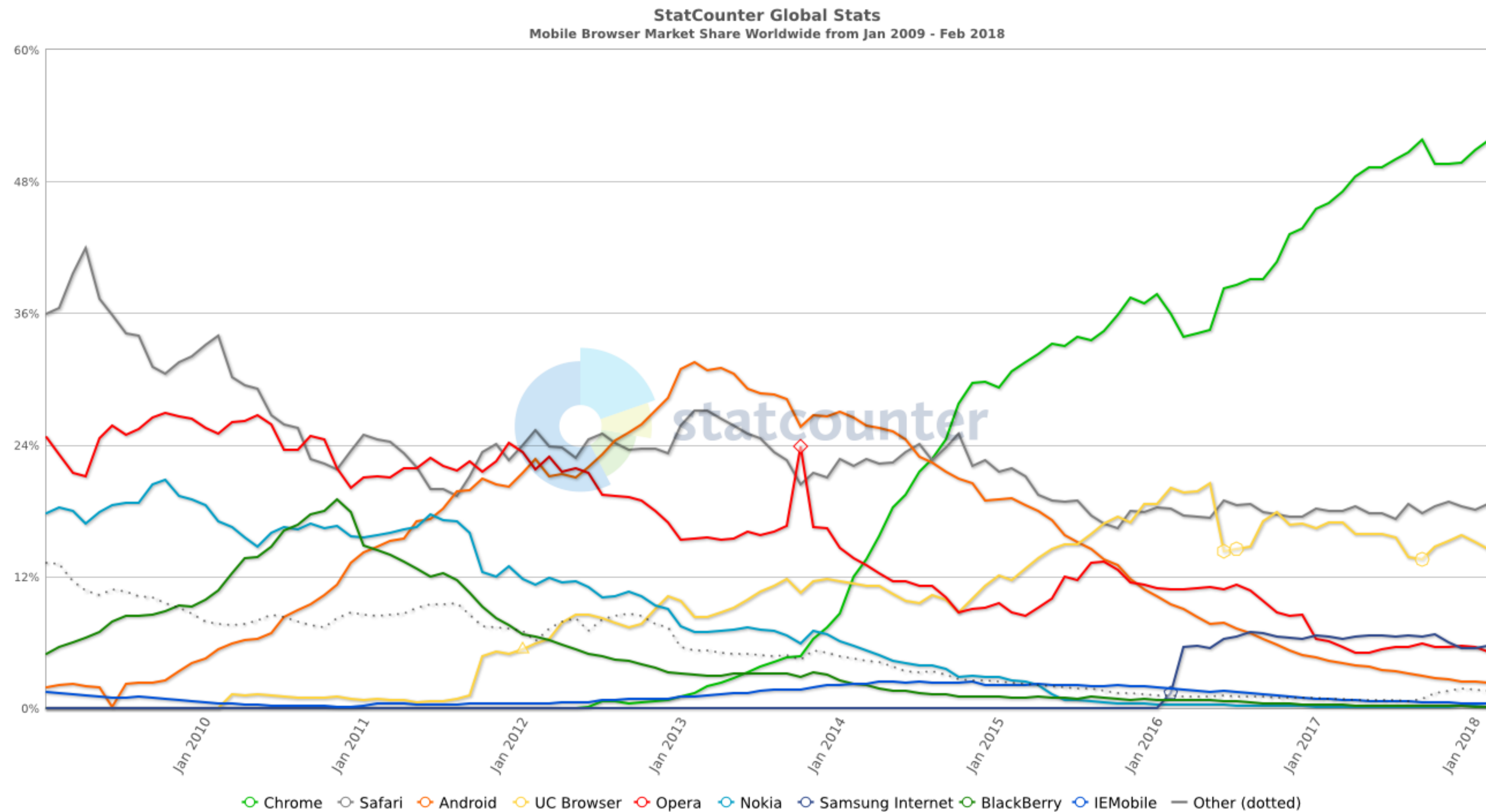
Web browsers

- Programs running on client machines
- Initiates the communication by requesting a document (resource)
- Displays the returned document

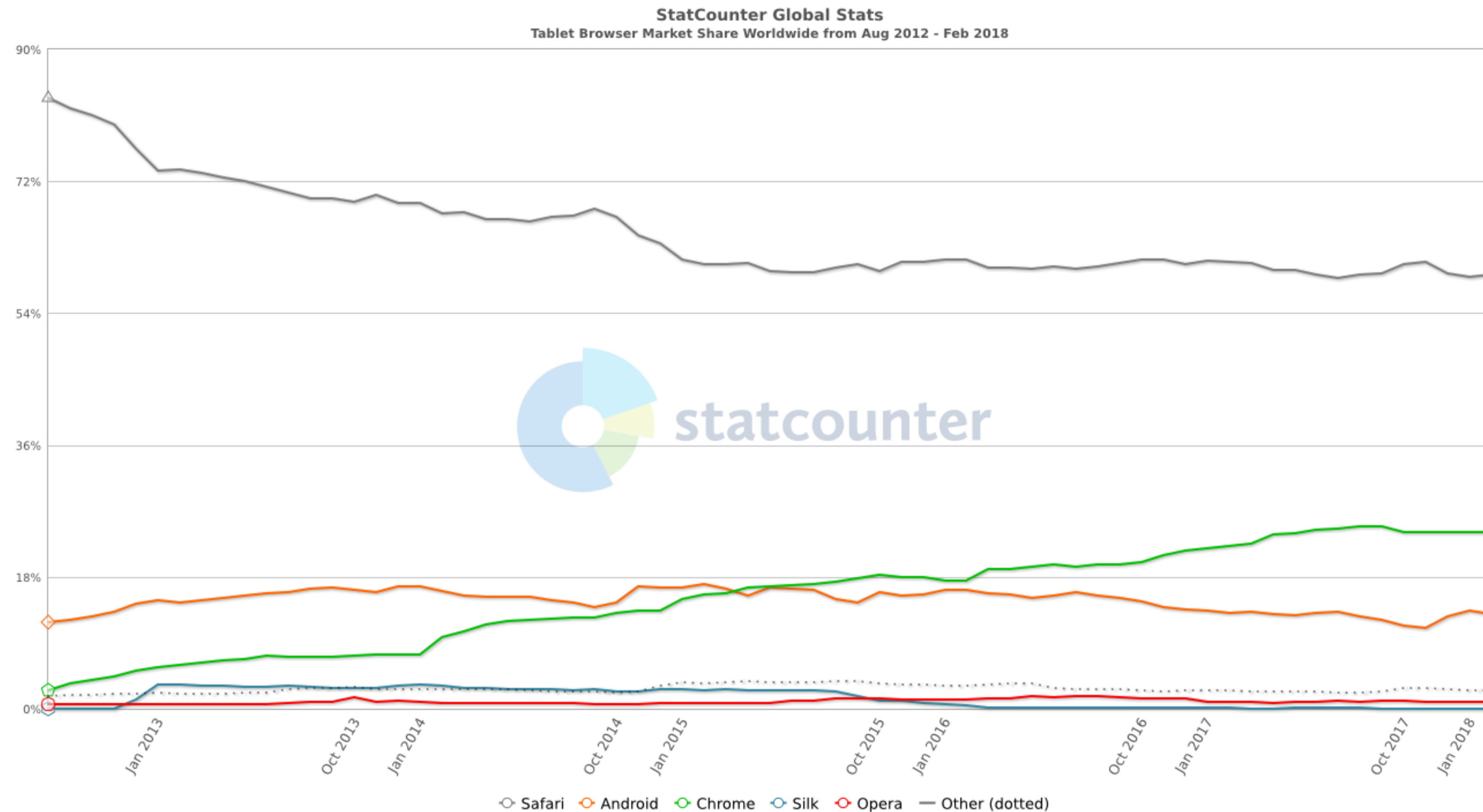
Web browsers market share - desktop



Web browsers market share - mobile

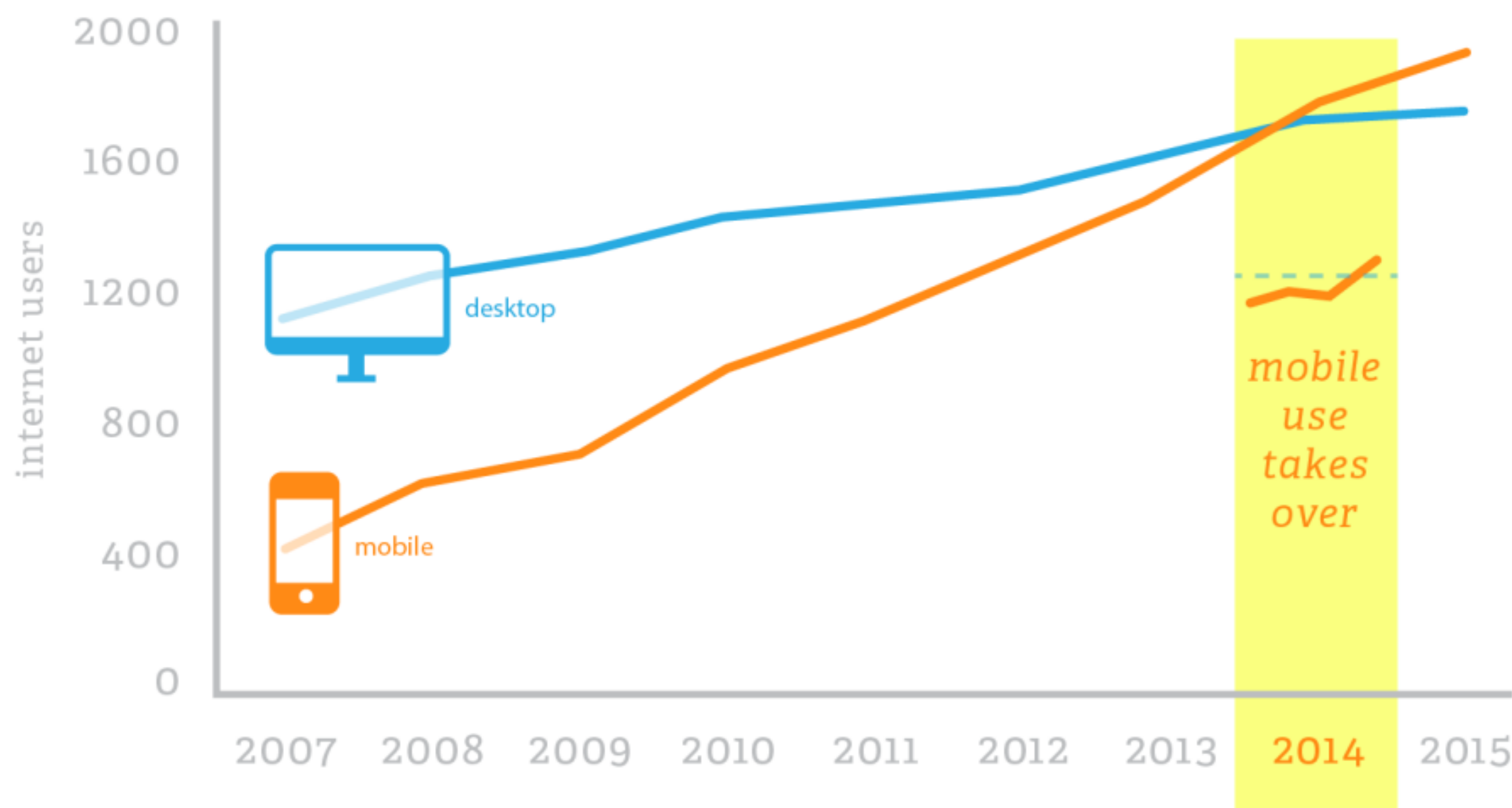


Web browsers market share - tablet



2014: YEAR OF THE Mobile Revolution

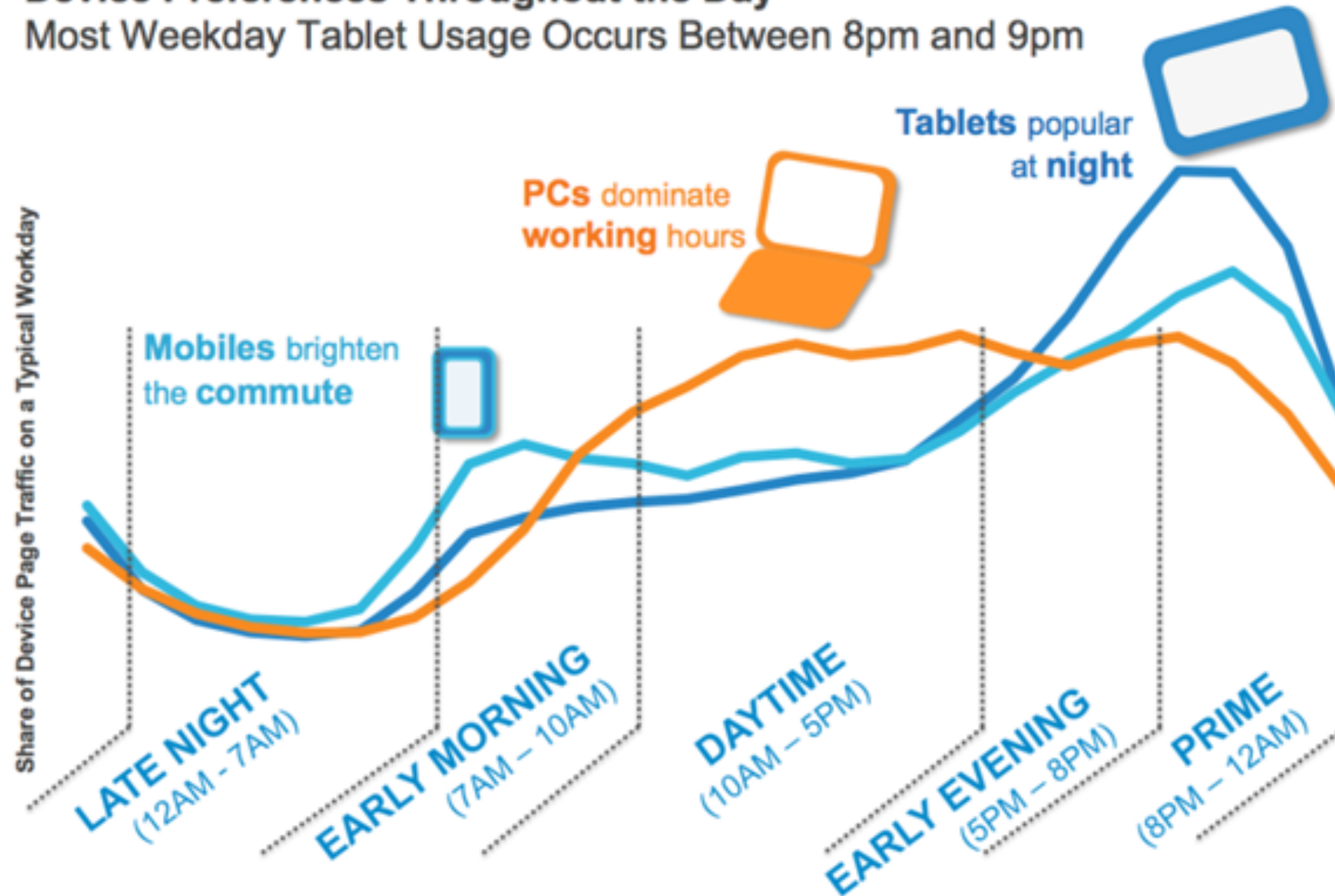
MOBILE INTERNET USE WILL OVERTAKE DESKTOPS THIS YEAR.



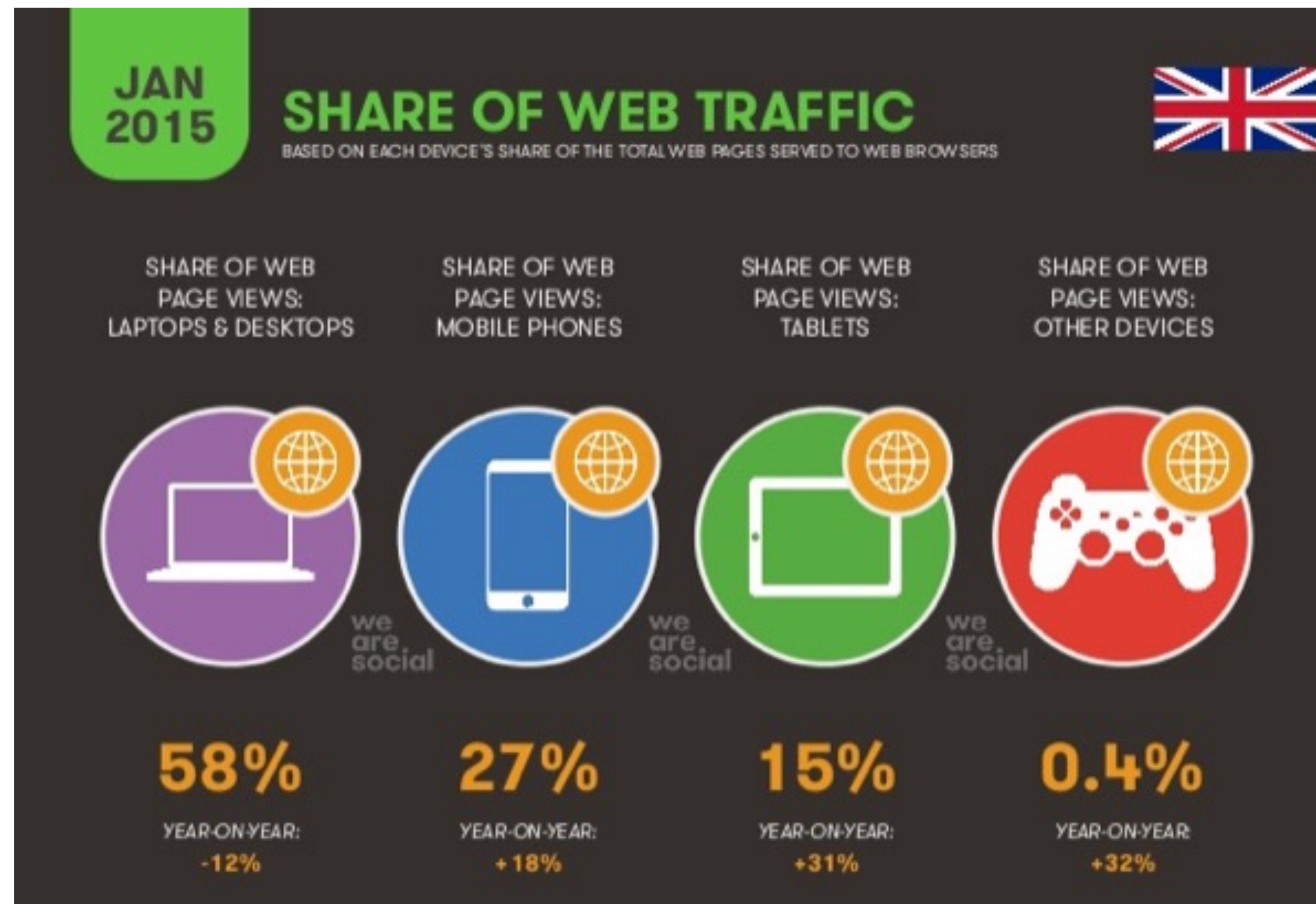
Source: ComScore

Device Preferences Throughout the Day

Most Weekday Tablet Usage Occurs Between 8pm and 9pm



Distribution of Web traffic



source: <http://www.mobileindustryreview.com/2015/01/3-billion-internet-users-2015.html>

Mobile web vs. apps (for shopping)

Search is the most common starting point for mobile research



48%
Start on
Search Engines

42%



Automotive

41%



Home &
Garden

38%



Apparel &
Beauty



33%
Start on
Branded Websites

31%



Finance

31%



Apparel &
Beauty

27%



Automotive



26%
Start on
Branded Apps

36%



Finance

22%



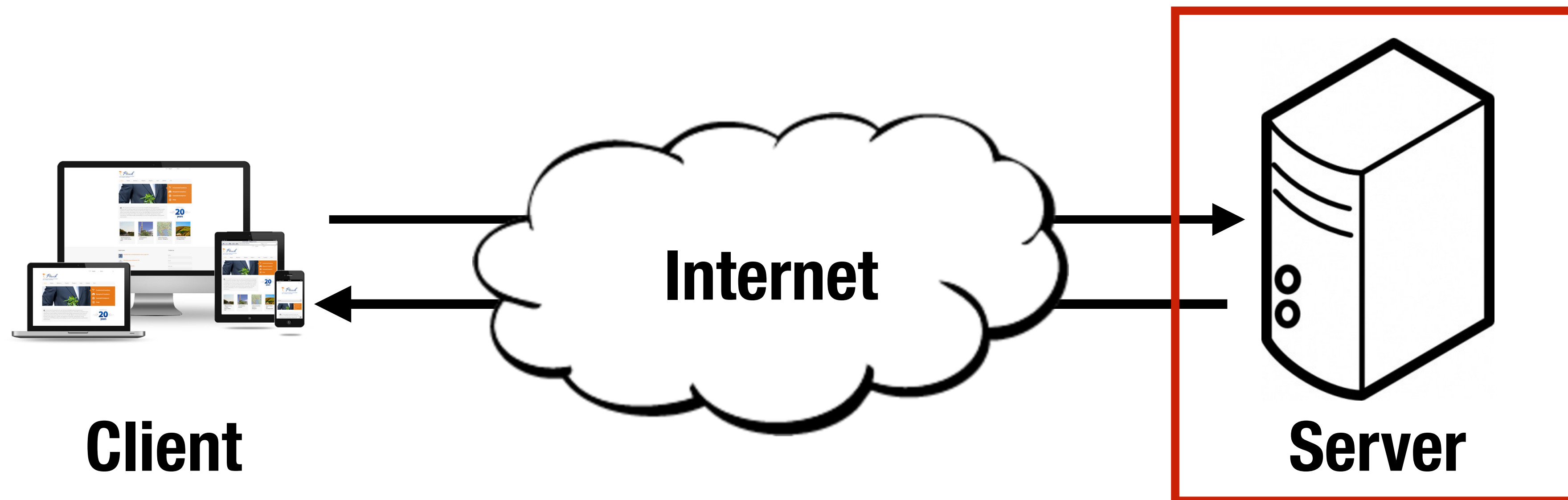
Electronics

21%



Apparel &
Beauty

Web servers



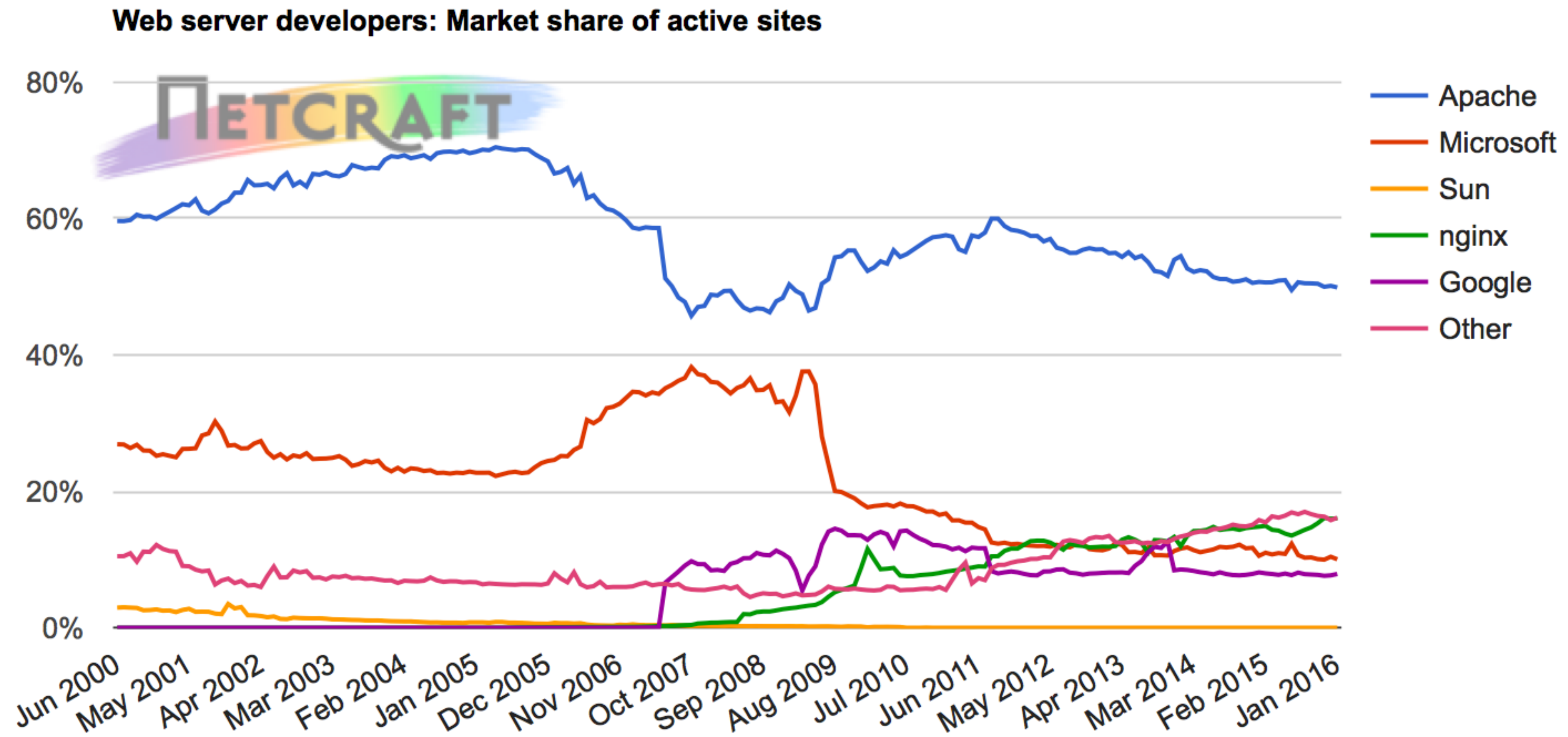
Web servers

- Programs that provide documents (resources) upon client requests
 - Files stored in the document root
 - Interact with databases through server-side scripts
- **Many servers host more than a single site, called virtual hosting**
 - Requires a dedicated IP per domain name served
 - Alternatively, port-based virtual hosting (rarely used)

Most popular web servers

- Apache
 - Fast, reliable, open source
 - One of the best available options for Unix-based systems, has also been ported to Windows
- IIS
 - Reasonably good, provides similar services to Apache
 - Supplied as part of Windows (but not turned on by default)
- nginx
 - For Unix-based systems (with proof-of-concept for Win)
 - Focus on high performance and low memory usage

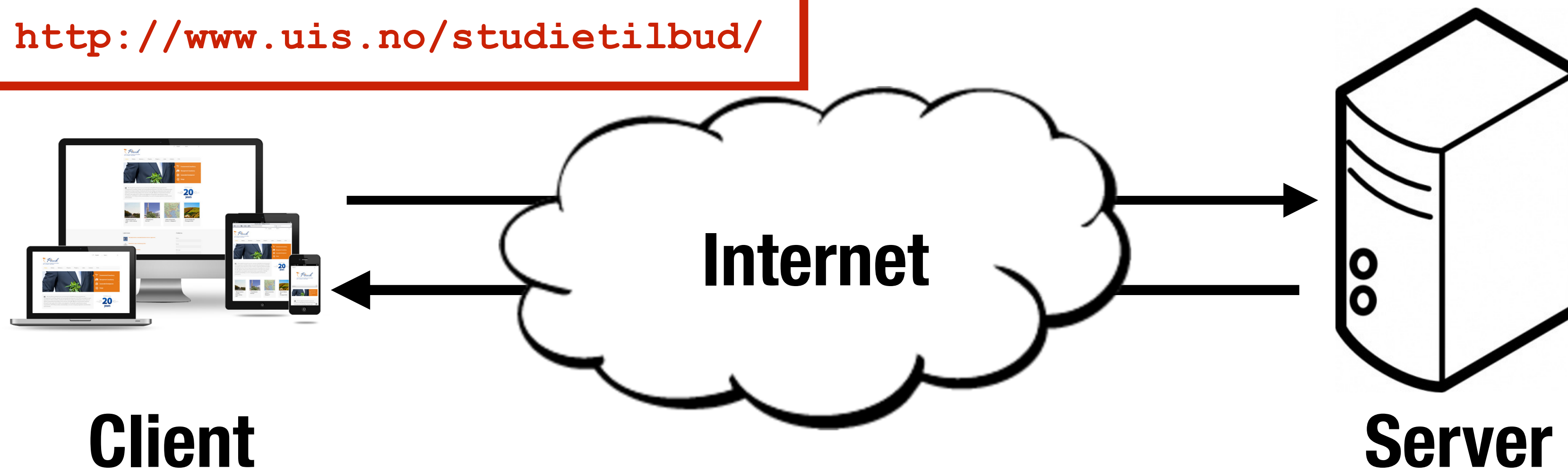
Web server market share



source: <http://news.netcraft.com/archives/2016/01/26/january-2016-web-server-survey.html>

URLs (Web addresses)

`http://www.uis.no/studietilbud/`



URLs

- Uniform Resource Locator (URL)
- Provides reference to a resource
- That is, a **web address**
- Scheme:

http : //www.uis.no / studietilbud /

communication
protocol

host (domain name
or IP address)

full path to document
(resource)

Communication protocol

- Most commonly reference to web pages (http), but can also refer to
 - Documents on the client machine (file)
`file:///Users/kbalog/work/teaching/DAT310/examples/css.html`
 - File transfer (ftp)
`ftp://apache.uib.no/pub/apache/lucene/solr/4.10.0`
 - Database access (jdbc)
`jdbc:mysql://localhost/mydatabase`

Port

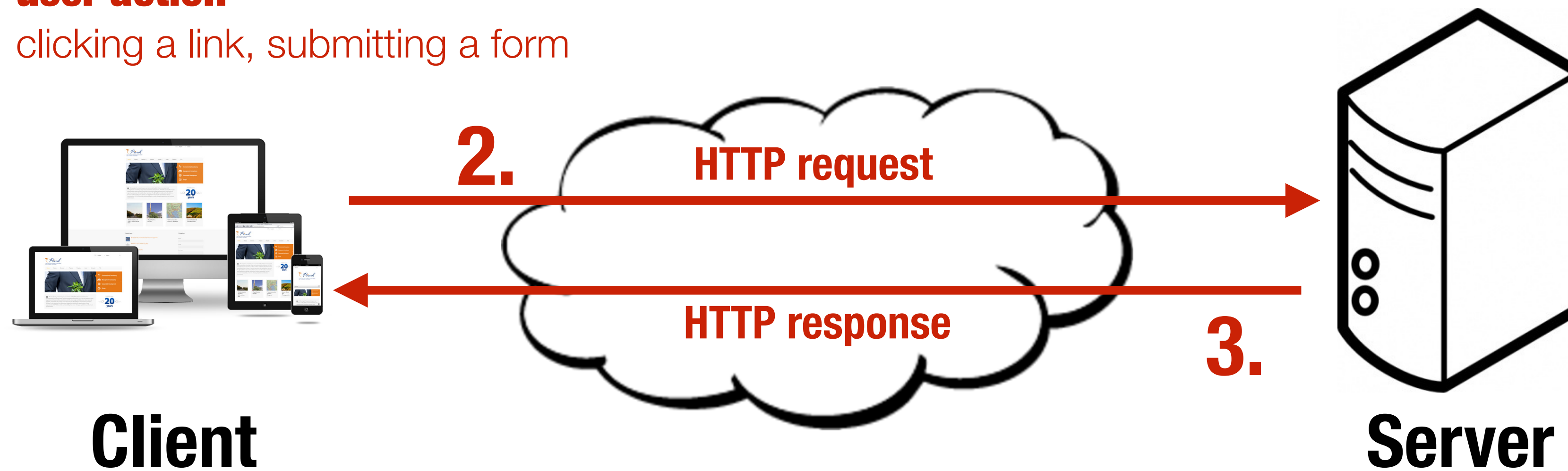
- HTTP default port is 80. Port only needs to be supplied if the web server is configured differently (e.g., on port 8000)
 - `http://domain.com:8000/some_document.html`

URLs

- Can not contain spaces
- Can not contain special characters (; , &)
- URL encoding is used to escape these
 - % followed by a 2-digit hexadecimal ASCII code
 - E.g., space => %20, & => %26
 - Conversion functions are available
 - JavaScript: **encodeURIComponent ()** , **decodeURI ()**
 - PHP: **urlencode ()** , **urldecode ()**

HTTP

- 1. user action**
 - clicking a link, submitting a form



HTTP

- Hypertext Transfer Protocol
 - Current version is 1.1
- Used by all Web transactions
- Consist of two phases: request and response
- Each consist of two parts: header and body
 - Header: information about the communication
 - Body: data of the communication (if any)

HTTP request

- Format

1. HTTP method, path to document, HTTP version
2. Header fields
3. Blank line
4. Message body

HTTP request

1. HTTP method, path to document, HTTP version

```
GET /om-uis/kontakt/ HTTP/1.1
```

- Request methods
 - GET, HEAD, POST, PUT DELETE
 - GET and POST are the most frequently used

HTTP request methods

- GET
 - Returns the contents of the specified document
 - Request has no body part
 - Can be bookmarked
 - Have length restrictions
 - About 2000 characters in practice
 - Submitting forms using GET
 - Variables (name-values pairs are sent in the URL)
 - **`http://.../index.php?page=booking&step=1`**
 - Should never be used when dealing with sensitive data

HTTP request methods

- POST

- Executes the specified document, using the enclosed data
- Data is sent in the body of the request
- No restrictions on data length
- Cannot be bookmarked
- Submitting forms using GET
 - Variables are sent in the HTTP body of the request
page=booking&step=1
 - (When form values are sent, the content-type is set to application/x-www-form-urlencoded)

HTTP request

2. Header fields

- Host is required

```
Host: www.uis.no
```

- What type of document is accepted

```
Accept: text/html
```

```
Accept: text/*
```

- If the request has a body, the length of the body in bytes is required

```
Content-length: 128
```


HTTP request from terminal

- Making a HTTP request from terminal

```
telnet www.uis.no 80
```

```
GET /om-uis/kontakt/ HTTP/1.1  
Host: www.uis.no
```

- Press two Enters (one for blank line, other for message body)

HTTP requests from the browser

- New URL in address bar: GET request



- Link: GET request

```
<a href="http://github.com/web-programming">Link</a>
```

- Form submission: GET or POST request
 - Default is GET

```
<form action="somepage">...</form>
```

- POST:

```
<form action="somepage" method="POST">...</form>
```

HTTP response

- Format

1. Status line
2. Header fields
3. Blank line
4. Response body

HTTP response

```
HTTP/1.1 200 OK
Date: Mon, 15 Sep 2014 08:59:42 GMT
Server: Apache/2.2.23 mod_ssl/2.2.23 OpenSSL/0.9.8x PHP/5.4.14
Status: 200 OK
Last-Modified: Mon, 15 Sep 2014 08:59:45 GMT
Content-Language: no_NO, no
Content-Type: text/html; charset=utf-8
```

```
<!DOCTYPE html>
<html lang="no" class="no-js">
<head>
[...]
```

HTTP response

HTTP/1.1 200 OK

Status line

Date: Mon, 15 Sep 2014 08:59:42 GMT

Server: Apache/2.2.23 mod_ssl/2.2.23 OpenSSL/0.9.8x PHP/5.4.14

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HTTP response

Header fields

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```



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[...]
```

HTTP response

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```

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<head>
[...]
```

Response body

Essential header fields

- Status code
- Content-type

HTTP status codes

```
HTTP/1.1 200 OK
Date: Mon, 15 Sep 2014 08:59:42 GMT
Server: Apache/2.2.23 mod_ssl/2.2.23 OpenSSL/0.9.8x PHP/5.4.14
Status: 200 OK
Last-Modified: Mon, 15 Sep 2014 08:59:45 GMT
Content-Language: no_NO, no
Content-Type: text/html; charset=utf-8

<!DOCTYPE html>
<html lang="no" class="no-js">
<head>
[...]
```

HTTP status codes

- First digit
 - **1**: Informational
 - **2**: Success
 - **3**: Redirection
 - **4**: Client error
 - **5**: Server error

HTTP status codes

**Steve Losh**
@stevelosh



HTTP status ranges in a nutshell:

1xx: hold on
2xx: here you go
3xx: go away
4xx: you fucked up
5xx: I fucked up

 Reply  Retweet  Favorite  More

4,382
RETWEETS

1,917
FAVORITES



8:20 AM - 28 Aug 13

Content-type

```
HTTP/1.1 200 OK
Date: Mon, 15 Sep 2014 08:59:42 GMT
Server: Apache/2.2.23 mod_ssl/2.2.23 OpenSSL/0.9.8x PHP/5.4.14
Status: 200 OK
Last-Modified: Mon, 15 Sep 2014 08:59:45 GMT
Content-Language: no NO, no
Content-Type: text/html charset=utf-8
```

```
<!DOCTYPE html>
<html lang="no" class="no-js">
<head>
[...]
```

MIME

- Multipurpose Internet Mail Extensions
 - Originally developed to specify the format of documents sent via e-mail
- Determines the format of documents transmitted over the Web
 - Browser can choose the appropriate procedure to process the received content
- MIME specification format:
 - **type/subtype**

MIME (2)

- A list of MIME specifications is stored in the Web server configuration file
 - Based on file extensions
- Browsers also maintain a conversion table
 - Only used when the server does not specify a MIME type
- Experimental subtypes are prefixed with x-
 - E.g., **application/x-gzip**

Example MIME types

- A list of MIME specifications is stored in the Web server configuration file
 - Based on file extensions

<code>.css</code>	<code>text/css</code>
<code>.doc</code>	<code>application/msword</code>
<code>.gif</code>	<code>image/gif</code>
<code>.html</code>	<code>text/html</code>
<code>.js</code>	<code>application/x-javascript</code>
<code>.txt</code>	<code>text/plain</code>
<code>.qt</code>	<code>video/quicktime</code>
<code>.mp3</code>	<code>audio/mpeg</code>

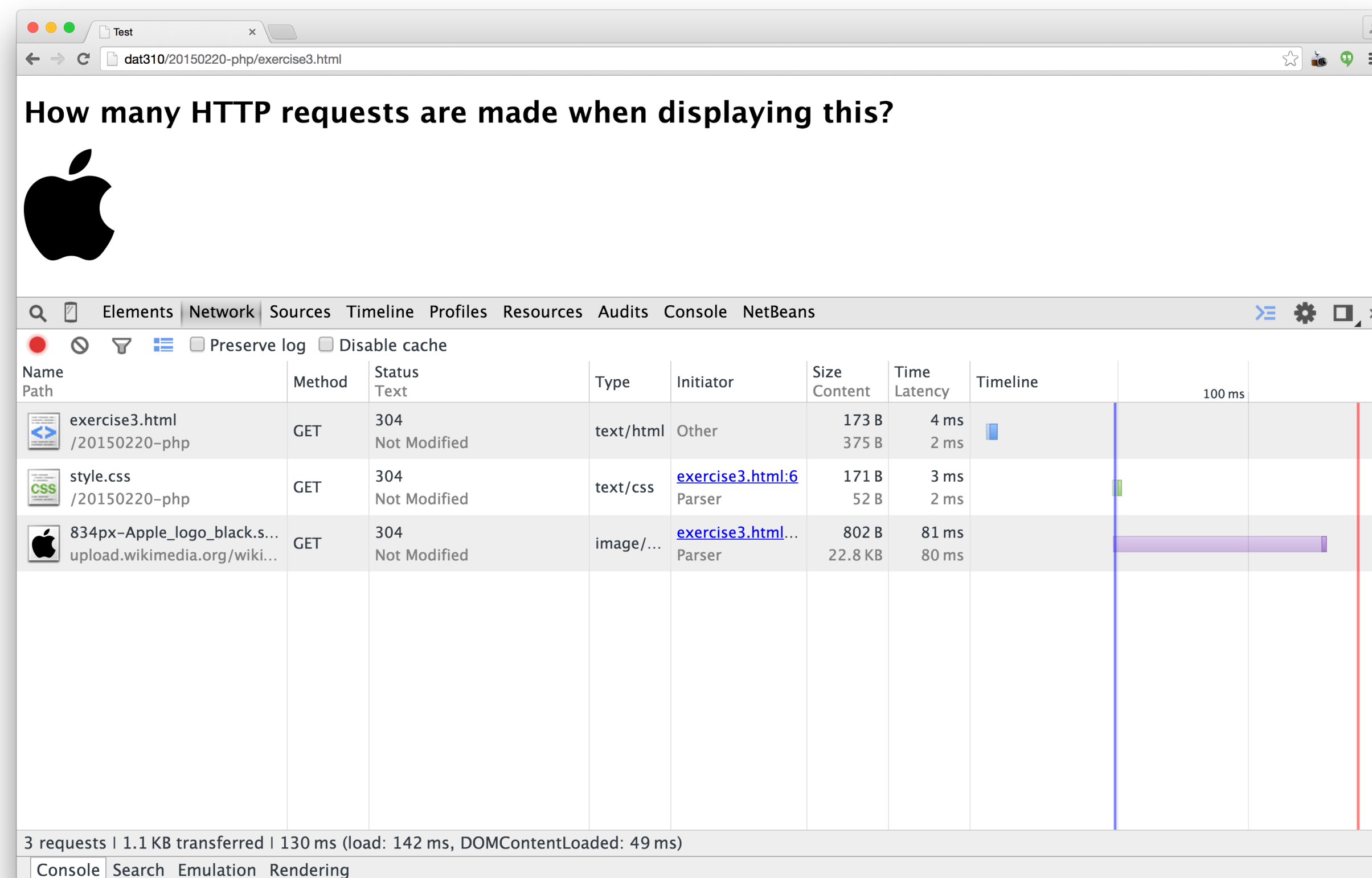
Exercise

- How many HTTP requests are made by the browser when displaying this page?

```
<!DOCTYPE html>
<html>
<head lang="en">
  <meta charset="UTF-8">
  <title>Test</title>
  <link rel="stylesheet" href="style.css">
</head>
<body>
  <h1>How many HTTP requests are made when displaying this?</h1>
  
</body>
</html>
```

Tracking HTTP requests (client-side)

- Network tab under Web developer tools

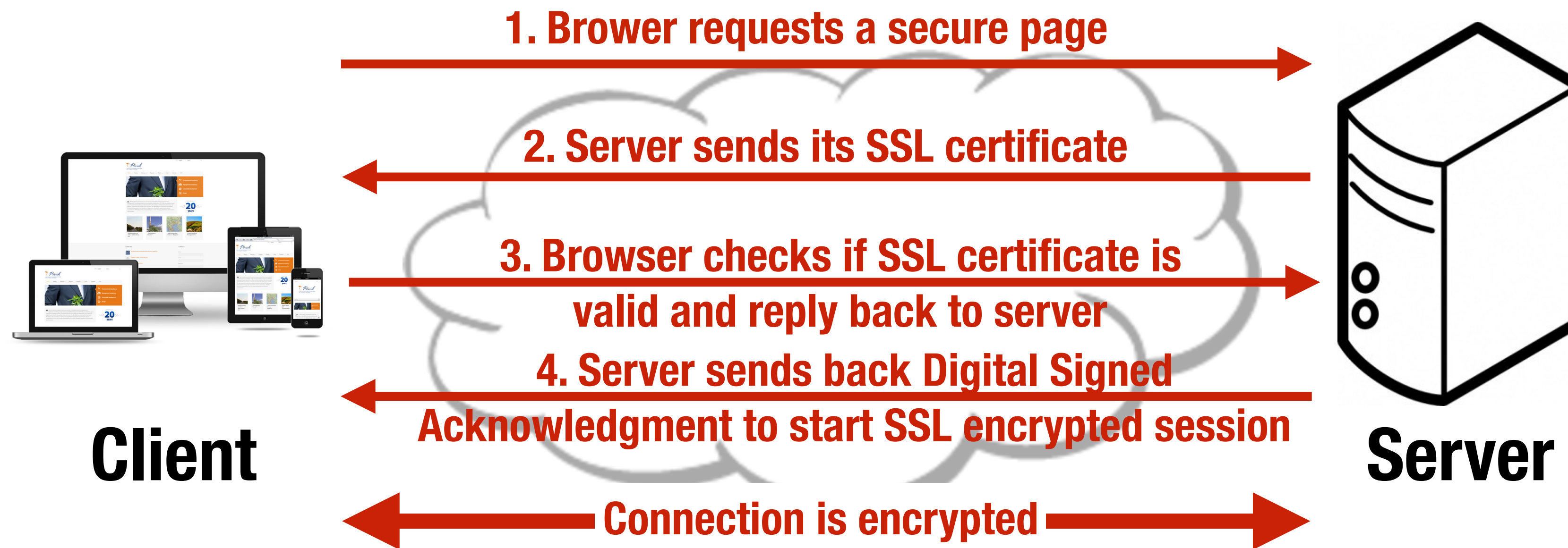


HTTPS

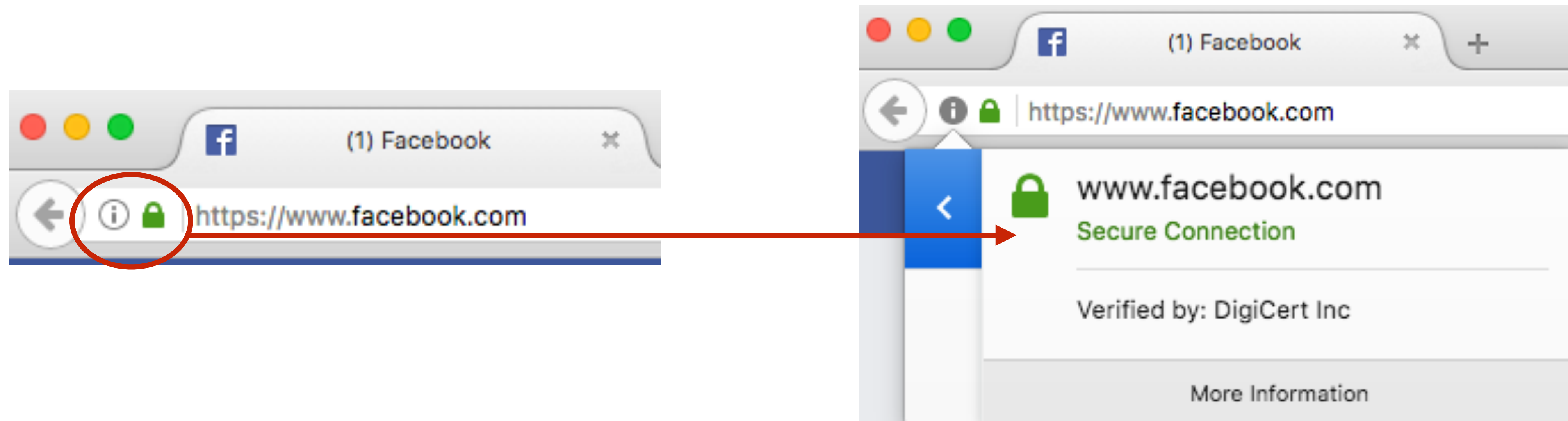
HTTPS

- Hyper Text Transfer Protocol **Secure** (https://)
 - Uses port 443 instead of the default port 80
- Data is transmitted securely on internet with the help of SSL/TLS
 - **Secure Socket Layer** (SSL) encrypts data between client and server using 128/256 bit key encryption
 - SSL/TSL also operates on the *Application* network layer
- Site requires an SSL certificate
 - Has to be issued by a recognized Certificate Authority (CA)
 - In cryptographic terms, the CA acts as *trusted party*
 - Consists of a public and private key

How HTTPS works



Find out info about the SSL certificate



Browsers alert if they receive an invalid certificate



Secure Connection Failed

svn.boost.org uses an invalid security certificate.

The certificate is not trusted because the issuer certificate is unknown.

(Error code: sec_error_unknown_issuer)

- This could be a problem with the server's configuration, or it could be someone trying to impersonate the server.
- If you have connected to this server successfully in the past, the error may be temporary, and you can try again later.

[Or you can add an exception...](#)

Making HTTP requests in Python

Overview



Using the requests package

🔗 `examples/python/http/request1.py`

```
import requests

r = requests.get("http://wiki.ux.uis.no/")

print(r.status_code)
print(r.headers)
print(r.content)
```

- Documentation: docs.python-requests.org

Using the requests package

🔗 [examples/python/http/request2.py](https://github.com/kennethreitz/requests/blob/master/examples/python/http/request2.py)

```
import urllib.request

u = urllib.request.urlopen("http://wiki.ux.uis.no/")

# u can be read as a file

# Read the entire page
print (u.read())

# Alternatively: read it line-by-line
for line in u:
    print(line)
```

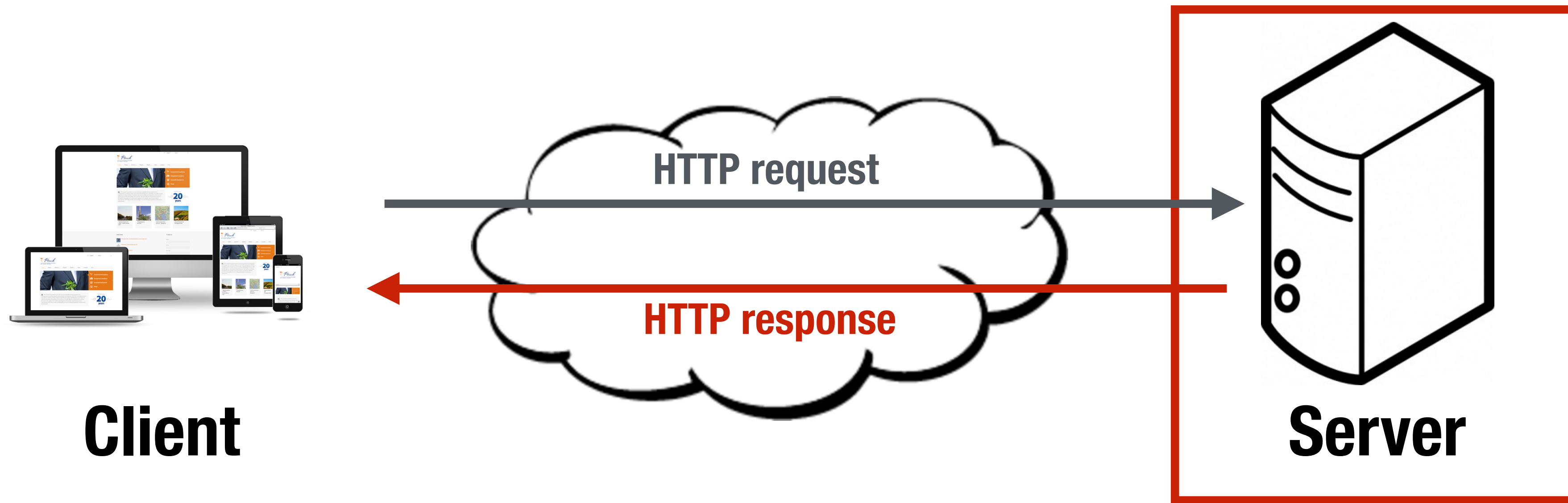
- Doc: <https://docs.python.org/3.5/library/urllib.request.html>

Web scraping

- Web scraping is used for extracting data from websites using HTTP (or a web browser)
 - First fetching a webpage
 - Then, extracting data from it (parsing, searching, etc.)
 - Data is typically stored in a local database
- Frequent usages include web indexing, data mining, product price or review comparison, reputation management, etc.
- Many other Python libraries for scraping, see, e.g.,
 - <https://elitedatascience.com/python-web-scraping-libraries>

Simple HTTP server in Python

Overview



Simple HTTP server

📄 examples/python/http/server.py

```
from http.server import BaseHTTPRequestHandler, HTTPServer

class myHTTPServer_RequestHandler(BaseHTTPRequestHandler):

    def do_GET(self):
        # Send response status code
        self.send_response(200)

        # Send headers
        self.send_header('Content-type', 'text/html')
        self.end_headers()

        message = "Hello world!"
        # Write message content as utf-8 data
        self.wfile.write(bytes(message, "utf8"))
        return

def main():
    server_address = ('127.0.0.1', 8080)
    httpd = HTTPServer(server_address, myHTTPServer_RequestHandler)
    print("running server...")
    httpd.serve_forever()
```

Sending requests using cURL

- cURL is a library and command line tool for transferring data using various protocols
- We use the command line curl tool to make HTTP requests
- GET request

```
curl http://localhost:8080
```

- POST request

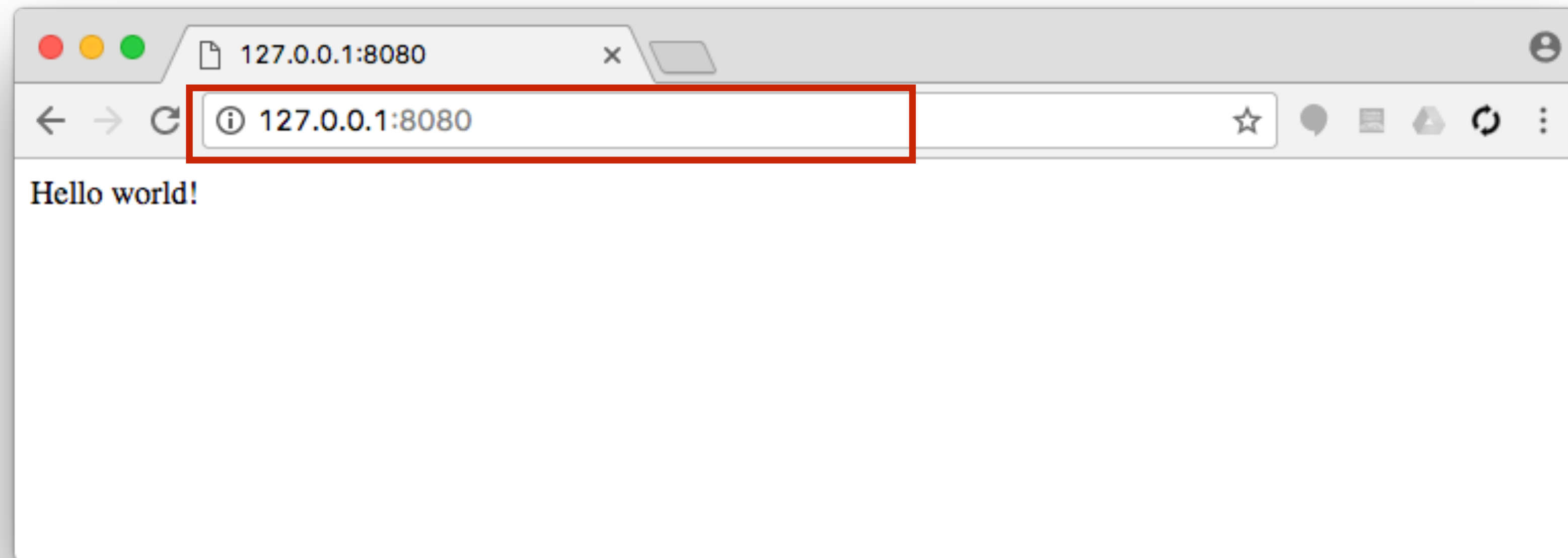
- without data

```
curl -X POST http://localhost:8080
```

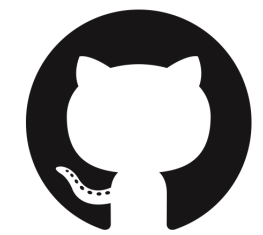
- with data

```
curl --data "param1=value1&param2=value2" http://localhost:8080
```


Sending requests from a browser



Exercises



[https://github.com/kbalog/web-programming/tree/master/](https://github.com/kbalog/web-programming/tree/master/exercises/python/http)
exercises/python/http