互联网应用讲座安排

- 主讲人：马严教授
  主讲题目：下一代互联网发展趋势
  时间：5月17日7-8节（15：30-17：20）
  地点：教三-339

WWW (World Wide Web) Basics

BUPT/QMUL

2019-5-13

北京郵電大學
BEIJING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS

Electronic Engineering

Agenda

- Brief introduction to WWW
- WWW Components
- WWW Standards
- Summary

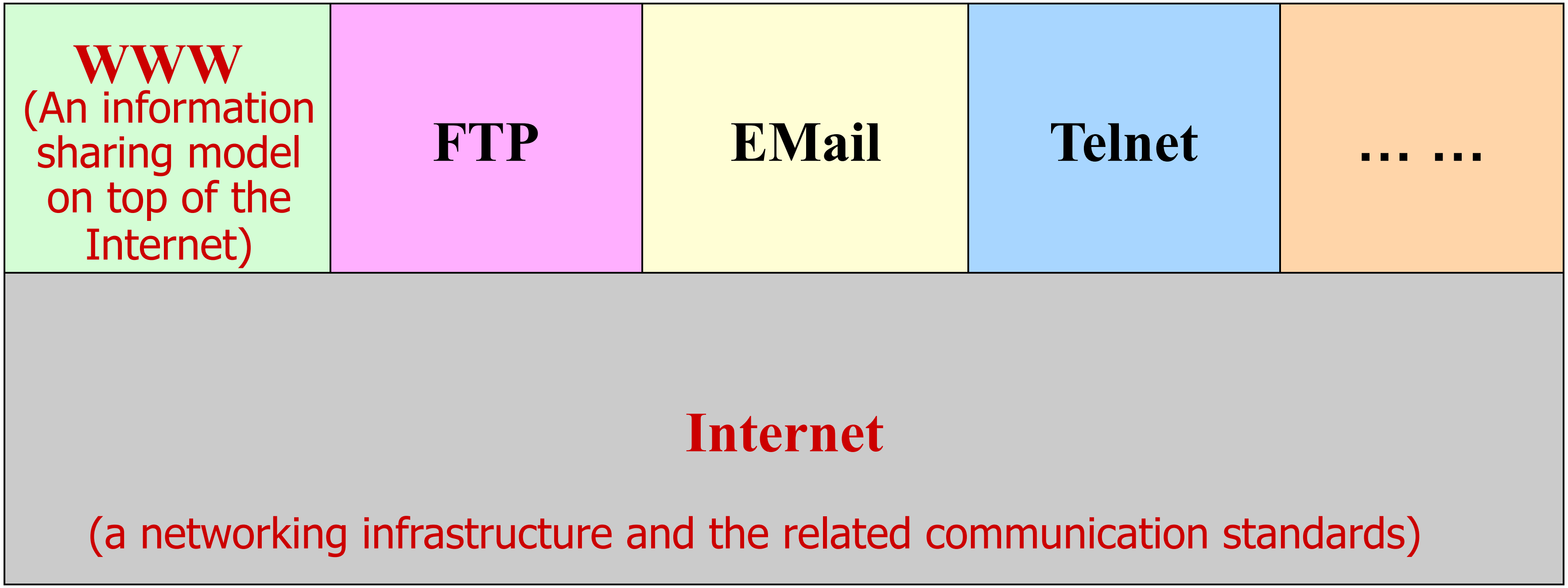
Refer to Chapter 27, textbook

Brief Introduction To WWW

What Is WWW?

- World Wide Web
  - WWW, the Web, W3
- A technical definition
  - All the resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP).
  - A system of interlinked hypertext documents accessed via the Internet. --*Wikipedia*
- A broader definition from W3C (World Wide Web Consortium)
  - The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge.

WWW vs. Internet



WWW
(An information sharing model on top of the Internet)

FTP

EMail

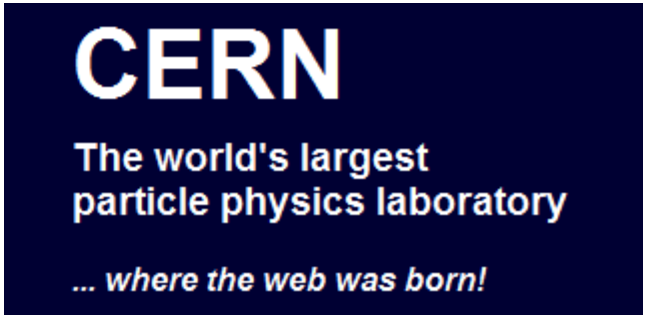
Telnet

… …

Internet

(a networking infrastructure and the related communication standards)

History Of WWW



CERN

The world's largest particle physics laboratory

... where the web was born!

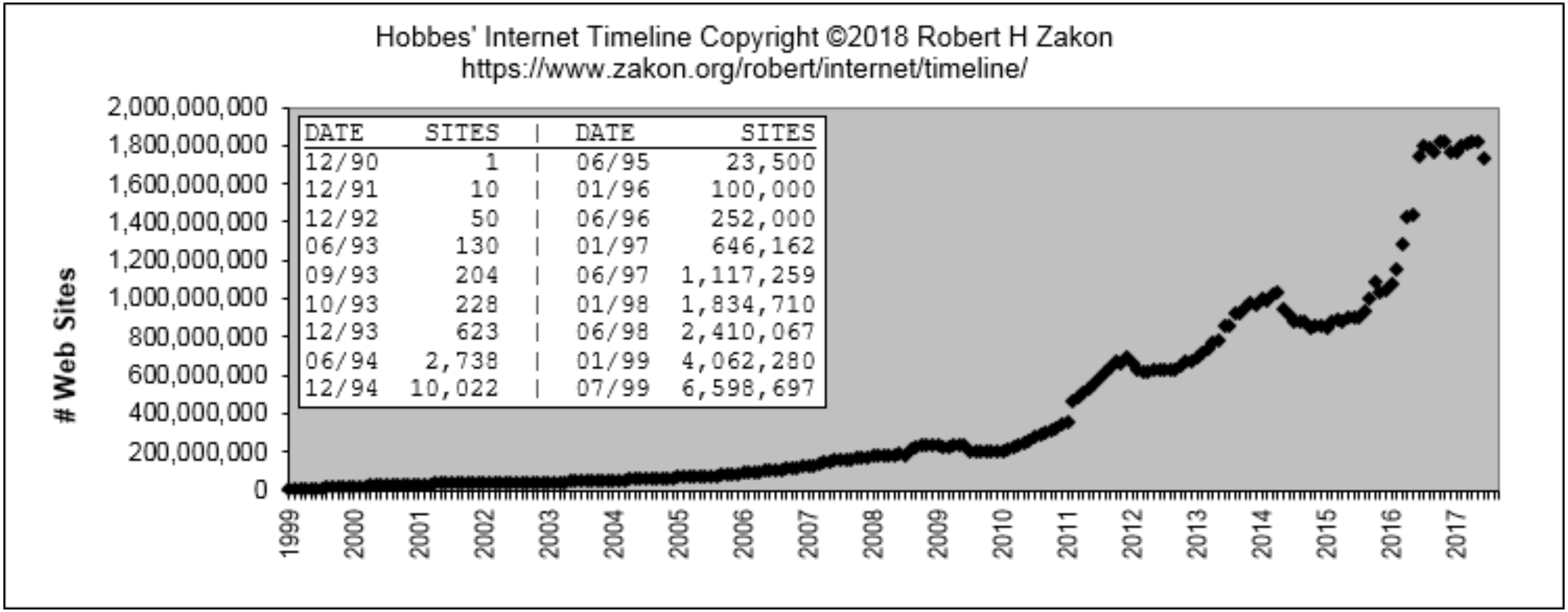
1989-03, Tim Berners Lee	proposed the idea of sharing information through hypertext in CERN
1989-12 , Tim Berners Lee	named his invention WWW (World Wide Web)
1990-11	The first (text-based) prototype was operational
1991-12	The first public demonstration was given at Hypertext '91 in San Antonio - Texas
1993-02, Marc Andreessen	The first GUI browser - Mosaic, at NCSA, Illinois
1994-95, Netscape, Microsoft	Netscape Navigator, Internet Explorer
Other browsers	Mozilla, Firefox, Opera, Chrome, Safari, …
Other technologies	HTML, JAVA, VRML, Web 2.0, …

Features of WWW

- Global
- Open
- Interactive
- Dynamic
- Platform-independent
- Multimedia
- …

WWW Growth

Figure: WWW Growth



DATE	SITES	DATE	SITES
12/90	1	06/95	23,500
12/91	10	01/96	100,000
12/92	50	06/96	252,000
06/93	130	01/97	646,162
09/93	204	06/97	1,117,259
10/93	228	01/98	1,834,710
12/93	623	06/98	2,410,067
06/94	2,738	01/99	4,062,280
12/94	10,022	07/99	6,598,697

Source: www.zakon.org/robert/internet/timeline/

WWW Terminologies

- **The Web**
  - Is a true information superhighway
- **URL** (Uniform Resource Locator)
  - Designates a specific webpage on a specific webserver
- **HTTP** (HyperText Transfer Protocol)
  - An application-level transfer protocol standard
- **HTML** (HyperText Markup Language)
  - A document format standard

WWW Components

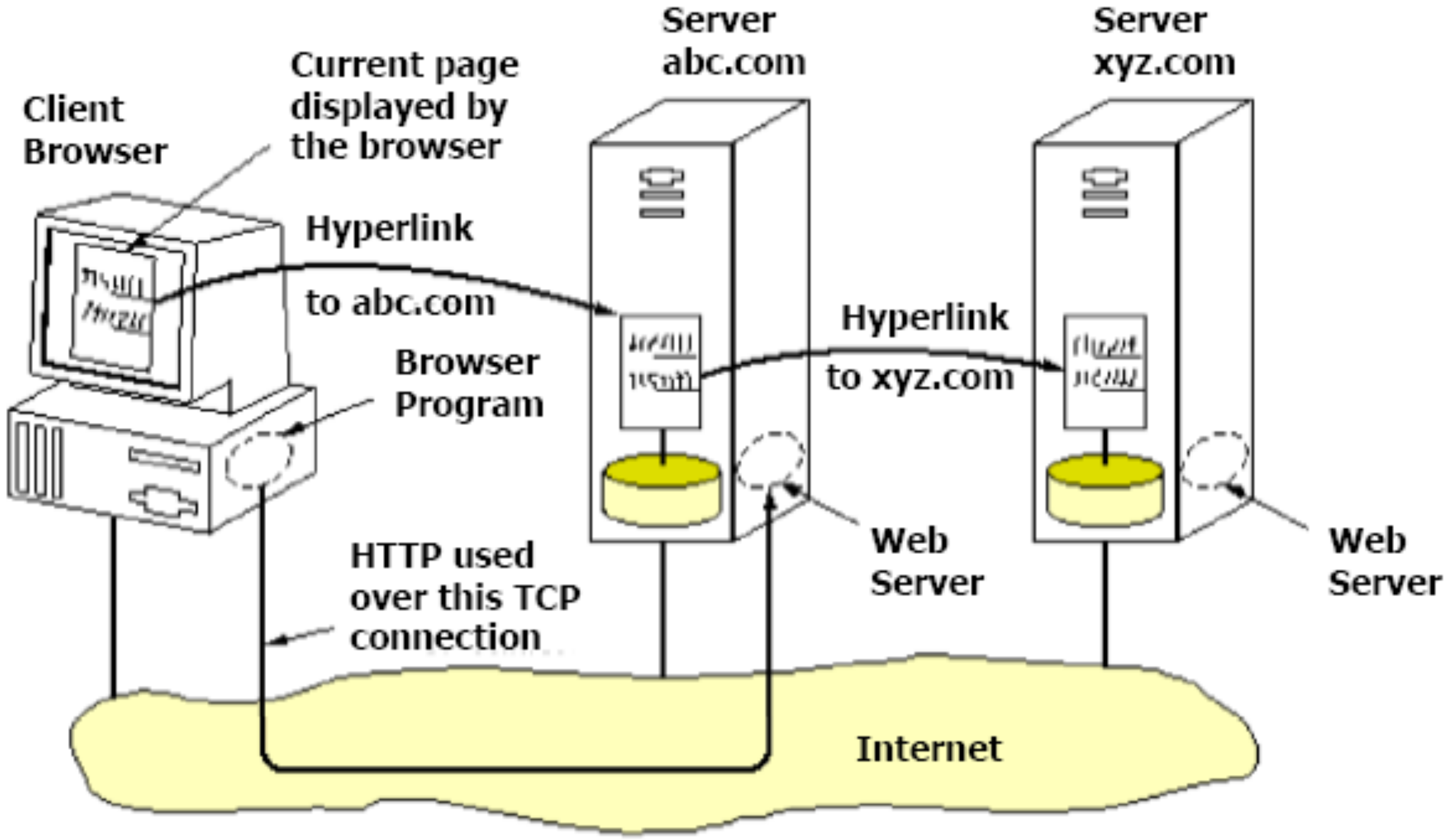
WWW Components

- Structural Components
  - Clients/browsers – various implementations
  - Servers – run on sophisticated hardware
  - Caches – used to improve response time
  - Internet – the global infrastructure which facilitates data transfer
- Semantic Components
  - Hyper Text Transfer Protocol (HTTP)
  - Hyper Text Markup Language (HTML)
    - eXtensible Markup Language (XML)
  - Uniform Resource Locators (URLs)

The Web

- The Web is actually an information superhighway
- The Web is a collection of electronic documents that are linked together like a spider web
- The Web is basically an information system that links data from many different Internet services under one set of protocols
- Web clients, also called **browsers**, interpret HTML delivered from Web servers
- These documents use **hypertext links** to connect different documents and information resources together; click on a link and the client software retrieves the linked document or jumps to a specific position in the current document
- HTTP is easily modified to incorporate new data formats and uses
- The Web model successfully unites the diverse Internet resources under a single system, relying on servers and Web-browsers to "**negotiate**" or handle data compatibility

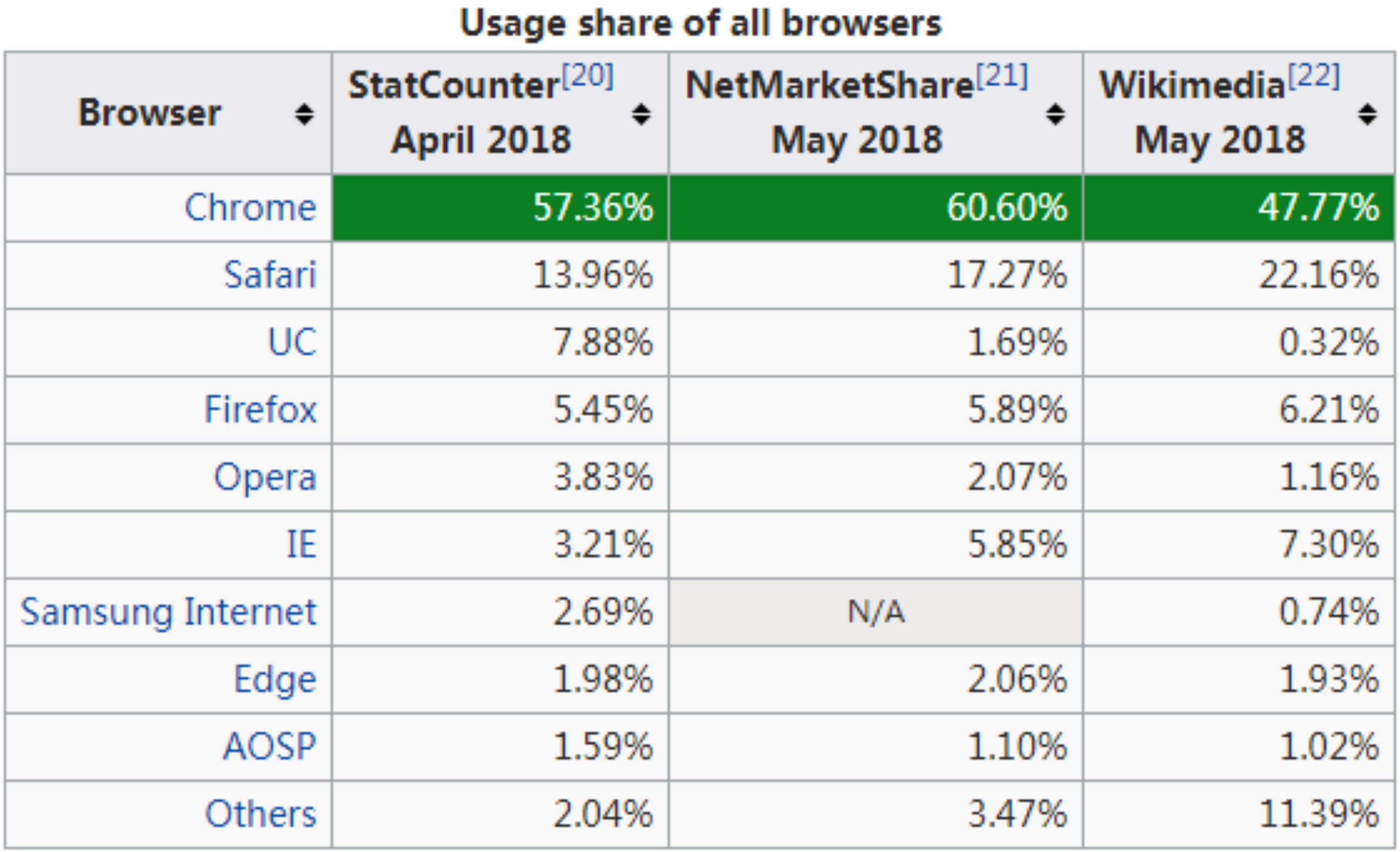
The Web Access Model



WWW Clients

- The Web is designed like all the client/server applications
  - The client is called a "browser"
  - The server is where the data is stored and it is software that runs on well known port (80) … usually
- The browser and server talk using a protocol – HTTP
- We already know from past experience that this architecture gives us client options
  - Netscape, Internet Explorer, Maxthon, Mozilla, Firefox, Lynx, …

Web Browsers Statistics(1)

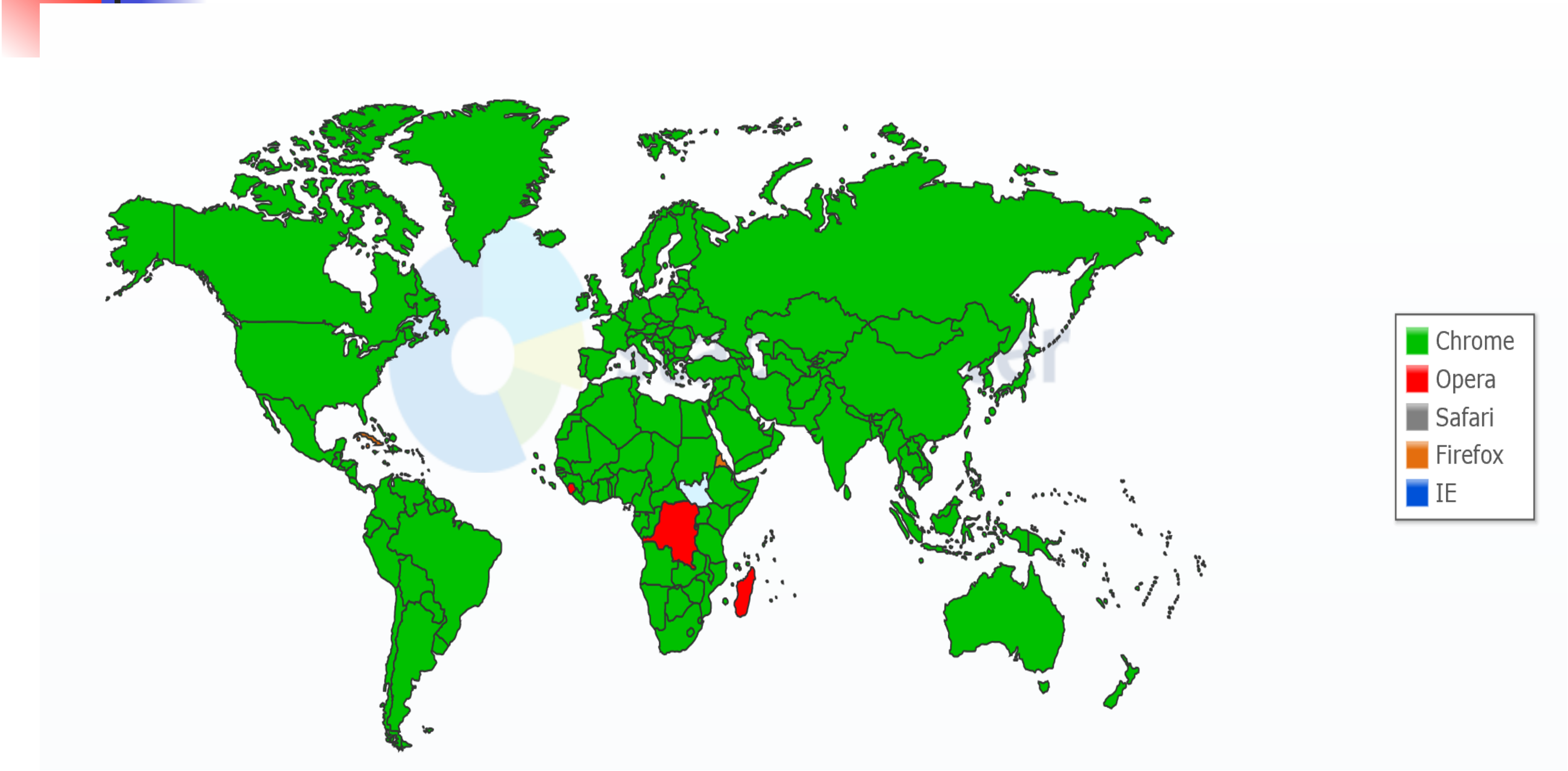


Usage share of all browsers

Browser	StatCounter[20] April 2018	NetMarketShare[21] May 2018	Wikimedia[22] May 2018
Chrome	57.36%	60.60%	47.77%
Safari	13.96%	17.27%	22.16%
UC	7.88%	1.69%	0.32%
Firefox	5.45%	5.89%	6.21%
Opera	3.83%	2.07%	1.16%
IE	3.21%	5.85%	7.30%
Samsung Internet	2.69%	N/A	0.74%
Edge	1.98%	2.06%	1.93%
AOSP	1.59%	1.10%	1.02%
Others	2.04%	3.47%	11.39%

http://en.wikipedia.org/wiki/Usage_share_of_web_browsers

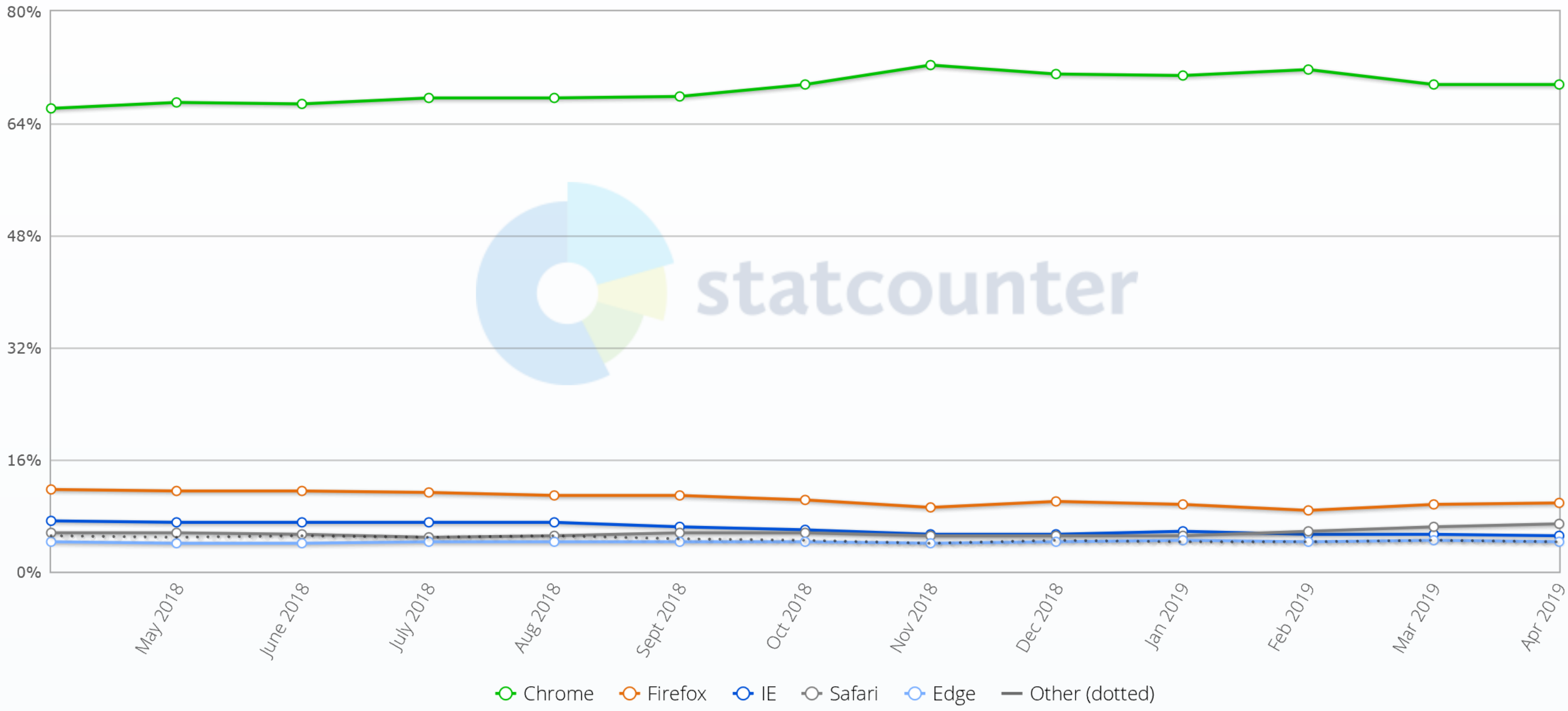
Web Browsers Statistics(2)



Most used web browsers in country or dependency as of April 2019, according to Statcounter

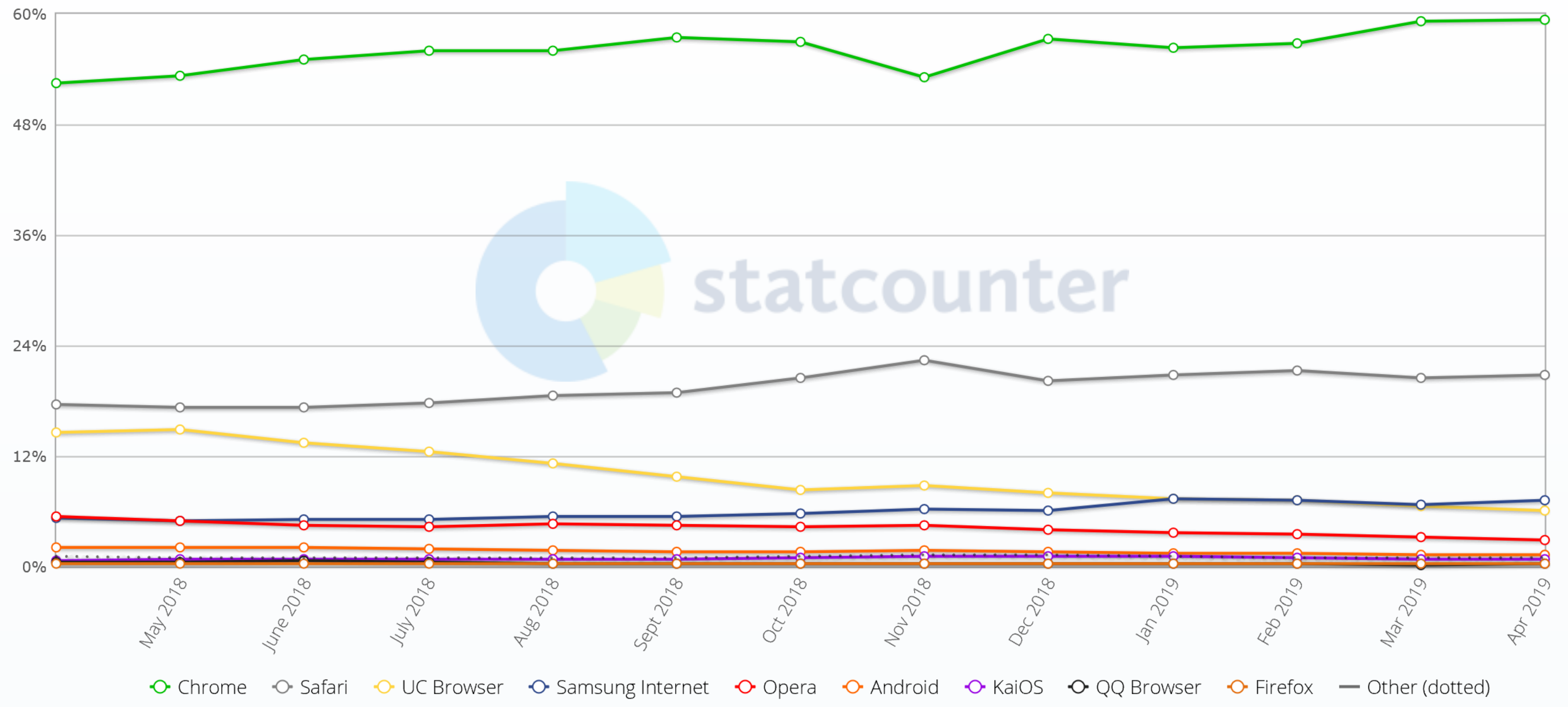
http://gs.statcounter.com/browser-market-share#monthly-201904-201904-map

Web Browsers Statistics(3)-Desktop



201804-201904, Desktop Browser Market Share
http://gs.statcounter.com/browser-market-share/desktop/worldwide

Web Browsers Statistics(4)-Mobile



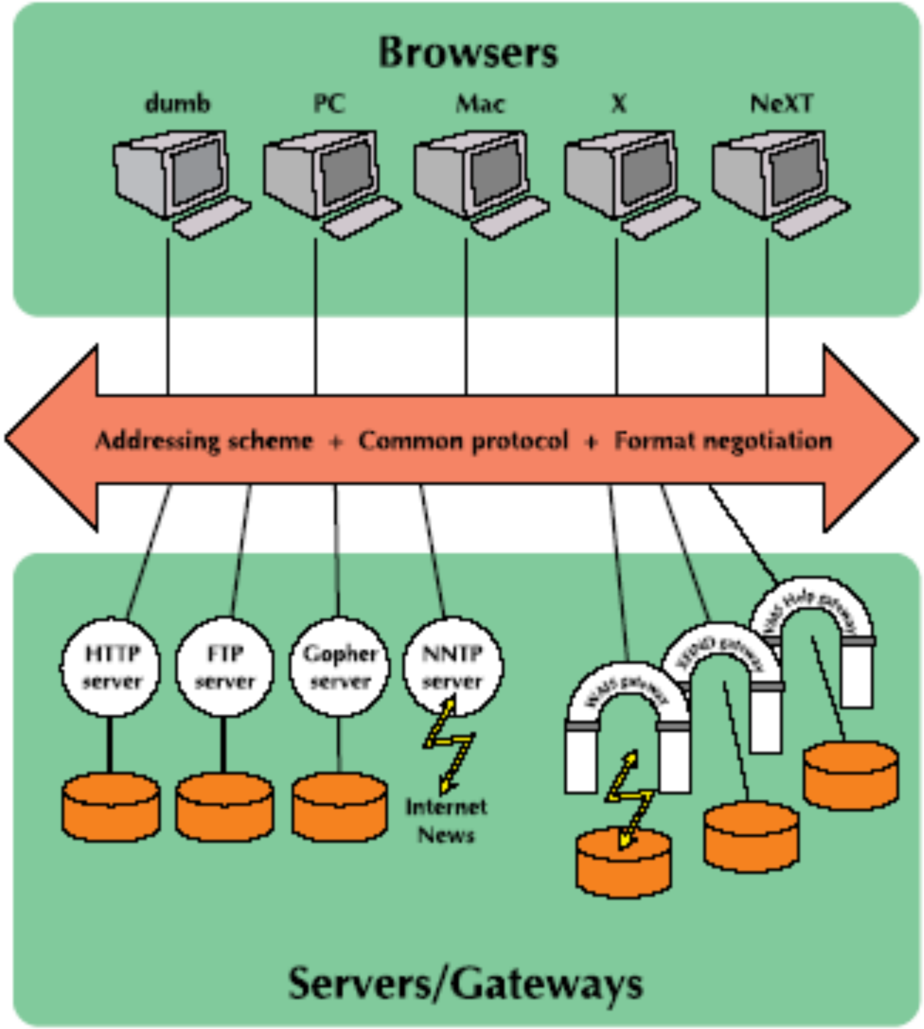
201804-201904, Mobile Browser Market Share
http://gs.statcounter.com/browser-market-share/mobile/worldwide

Basic Client Properties (1)

- All the different browsers show us the same information but they display it differently (depending on their capabilities)
- In front of each Web address there is an http:// to indicate to the browser that it is talking HTTP, the protocol of the Web
- A user on a client machine uses a browser to download a Web page by either entering a URL or clicking on a HyperLink

Basic Client Properties (2)

- Web browsers are often called Universal Clients because most can talk other protocols besides HTTP
  - ftp://home.domain: to use our Web browser as an FTP client
  - telnet://home.domain
  - ...
- The Web is capable of accessing data on many different Internet services:
  - Web pages, FTP, Email service, file directories, Telnet services, HTML, plain ASCII, etc.



WWW Servers (1)

- The server is software that is running on a remote location. Its job is to make “pages” available to the client - so when a client requests a page the server responds appropriately
- Web servers are typically on Unix or Windows NT boxes rather than on individual PCs
- Popular Web Servers:
  - On Unix - Apache, On Windows NT - IIS (Internet Information Server), Both - Netscape’s Web Server

WWW Servers (2)

- Every Web site has a server process listening to TCP port 80 for incoming connections from clients – normally browsers
- After a connection has been established, the client sends one request and the server sends one response
- Then the connection is released
- The protocol that defines the legal request and response is HTTP
- The operation is Stateless

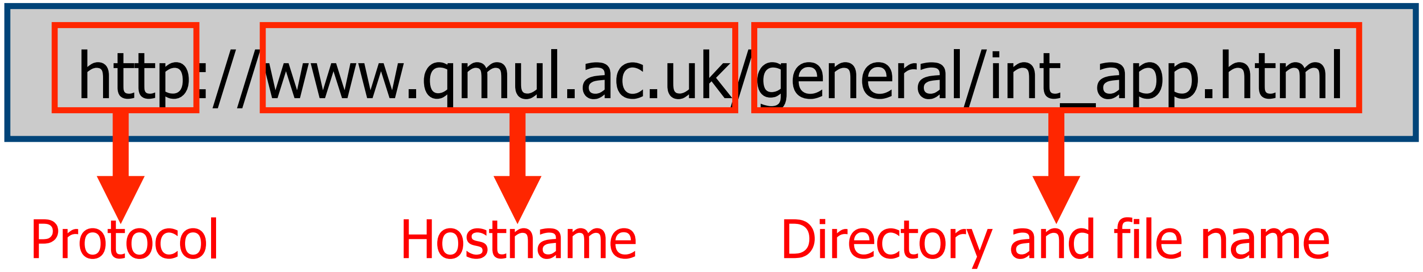
URLs (Uniform Resource Locators)

- The global address of a Web page is described by its URL
- URLs identify
  - the protocol you want to talk
  - the site (domain name or IP Address) you want to go to
  - possible the item you want to see
- They have the form:
  - **protocol://hostname [:port]/directory/item-you-want**

Resources can be dynamically generated on server upon query (Dynamic documents)

Structure Of URLs

- A URL consists of three parts:
  - The protocol – for example **http** or **ftp**
  - The DNS name of the host
  - The directory and file name



http://www.qmul.ac.uk/general/int_app.html

Protocol

Hostname

Directory and file name

- Protocol: http by default
- Port: 80 by default
- Index.html, index.htm, default.htm, default.asp etc. are assumed if no file-name given

Some URLs Examples

Protocol	Use	Example
http	Web pages	http://www.elec.qmul.ac.uk
ftp	File transfer	ftp://elec.qmul.ac.uk/pub/info.doc
file	Local files	file://D:/src/multim/filter.txt
mailto	E-mail	mailto:cip@elec.qmul.ac.uk
telnet	Remote login	telnet://www.elec.qmul.ac.uk

WWW Standards

WWW Standards

- URL
  - RFC 1630, RFC 1738
  - Many RFCs define the URL used for telnet, gopher, mailto, POP, IMAP, etc.
- HTML
  - RFC 2854
- HTTP
  - RFC 2616: defines HTTP/1.1
  - RFC 2617: defines HTTP Authentication (Basic and Digest Access Authentication)

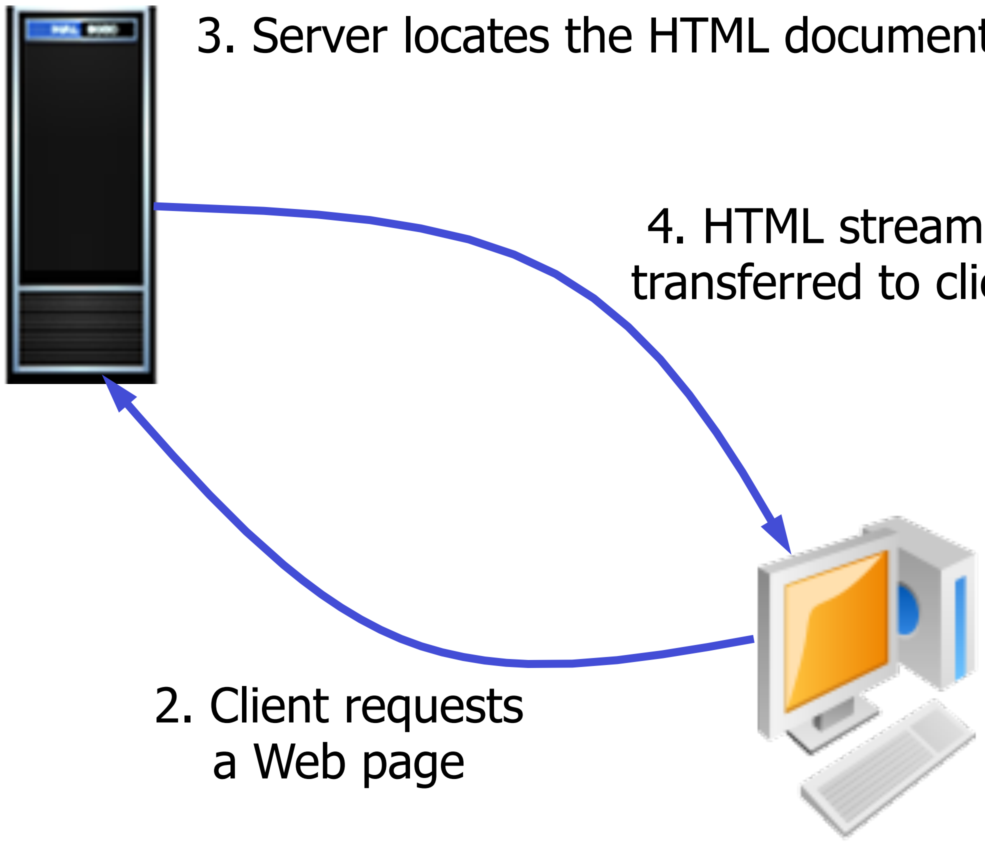
HTML – HTML standars

- HTML is the agreed upon markup language for the Web
- Currently several versions are available
  - HTML 1.0 - most basic tags
  - HTML 2.0 - forms support
  - HTML 3.0 - vendor specific tags crept in
  - HTML 3.2 - current standard, scaled-back 3.0
  - HTML 4.01 - current recommended
  - HTML 5.0 – newest standard
  - XHTML (eXtensible HyperText Markup Language) 1.0/1.1/2.0 – XML based, more extensible, more flexible
- Depending on the browser you use and what version you use, pages can look different because different browsers support different HTML versions
- Differences between HTML and XHTML
  - http://www.w3.org/MarkUp/2004/xhtml-faq

Static vs. Dynamic

- At the beginning, WWW was made up of static documents
  - Each URL corresponded to a single file stored on some hard disk
  - Edit in HTML format
  - .html, .htm
- Today - many of WWW documents are built at request time
  - The URL doesn't correspond to a single file
  - Examples: website access counter, WWW based date-time server, BBS, …
  - Generated dynamically by ASP, JSP, VB Script, PHP, CGI or other programs
  - .asp, .shtm, .php, .cgi etc.
- Why dynamic documents?
  - automation of web site maintenance
  - customized advertising
  - database access
  - shopping carts
  - date and time service
  - jobs for ElecEng students

Procedure Of Static Pages



Web Server

3. Server locates the HTML document

1. Edits the HTML documents

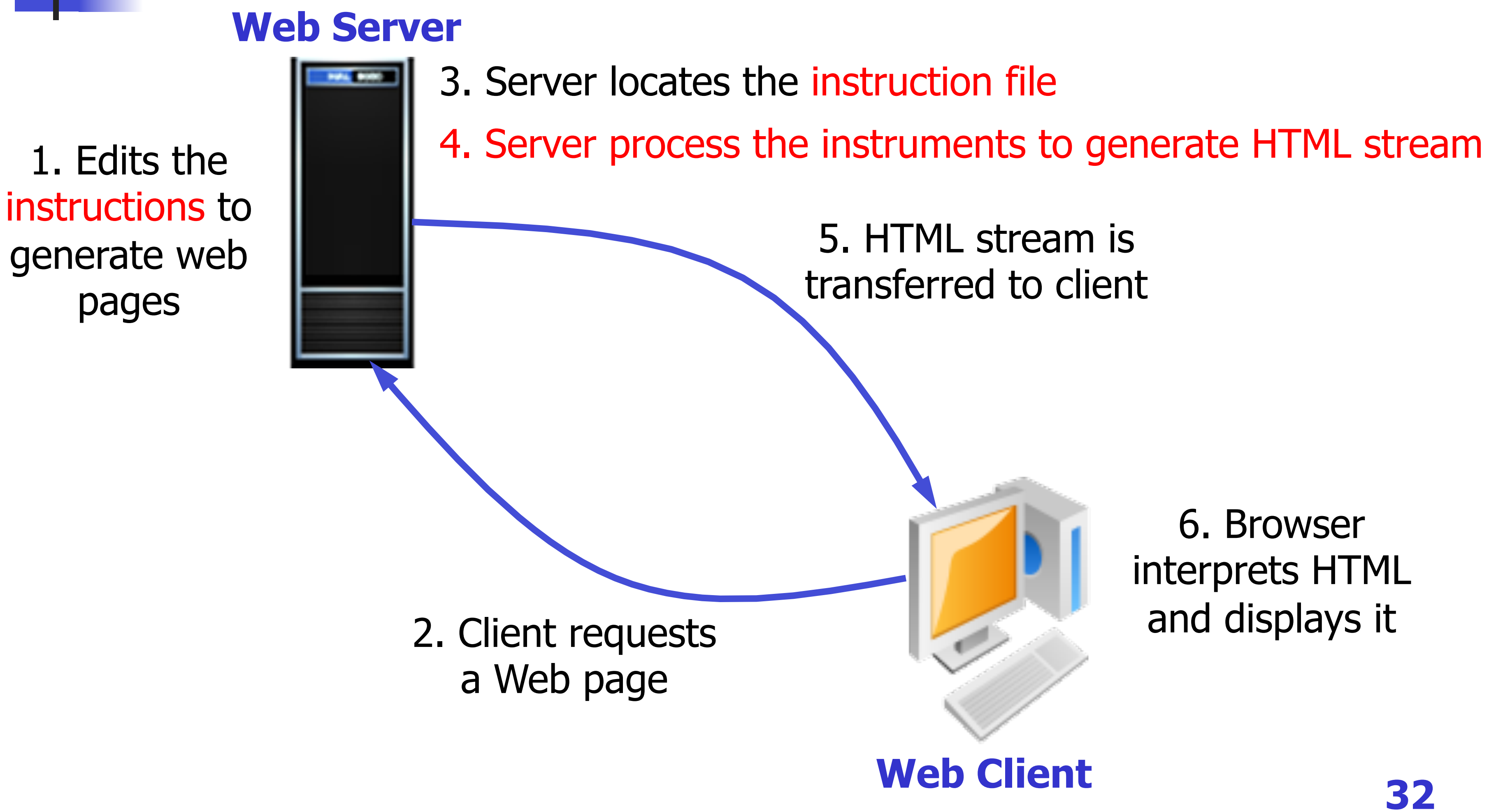
4. HTML stream is transferred to client

5. Browser interprets HTML and displays it

2. Client requests a Web page

Web Client

Procedure Of Server-based Dynamic Pages



Web Server

1. Edits the instructions to generate web pages

2. Client requests a Web page

3. Server locates the instruction file

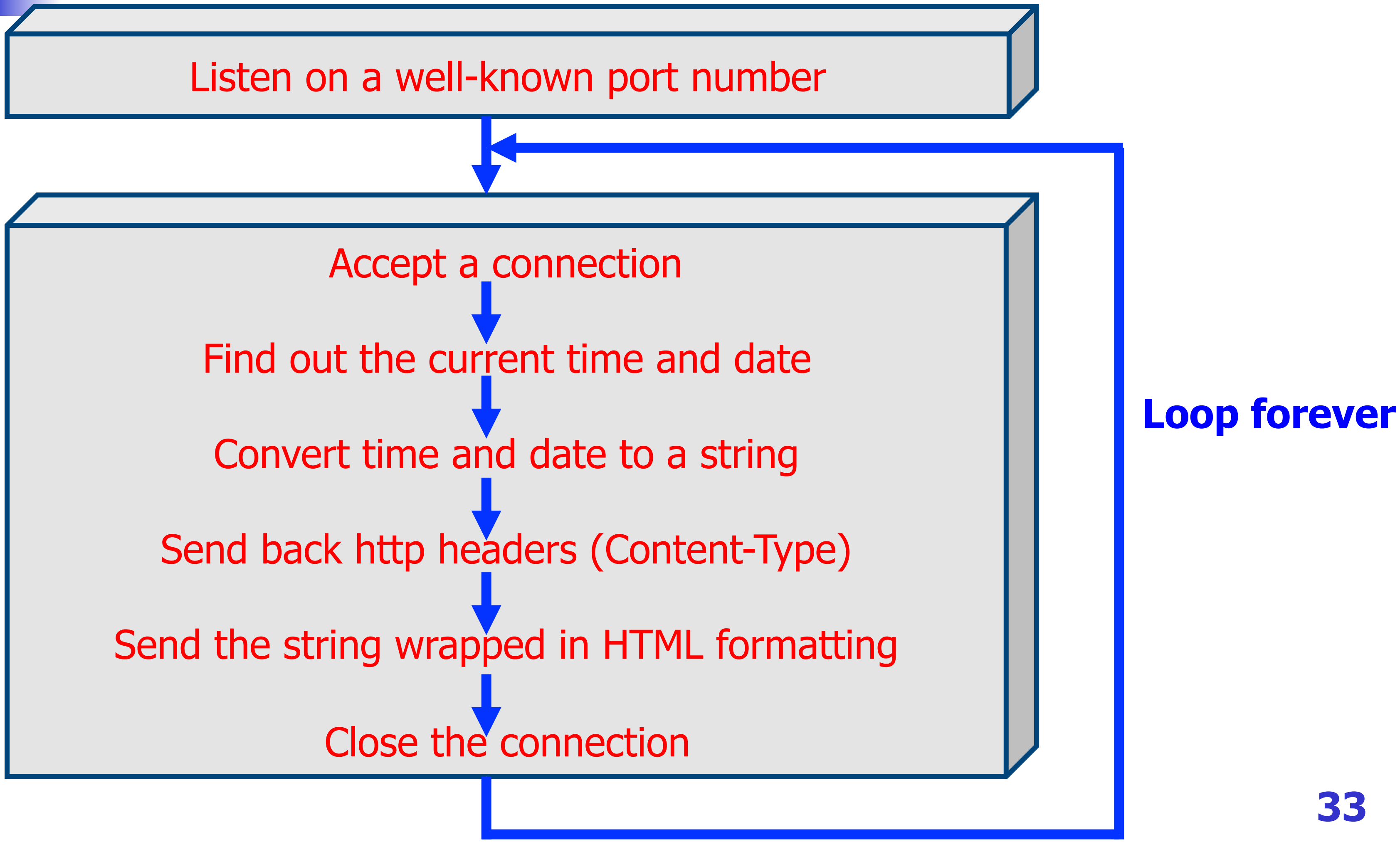
4. Server process the instruments to generate HTML stream

5. HTML stream is transferred to client

6. Browser interprets HTML and displays it

Web Client

Example:
WWW based time and date server



Listen on a well-known port number

Accept a connection

Find out the current time and date

Convert time and date to a string

Send back http headers (Content-Type)

Send the string wrapped in HTML formatting

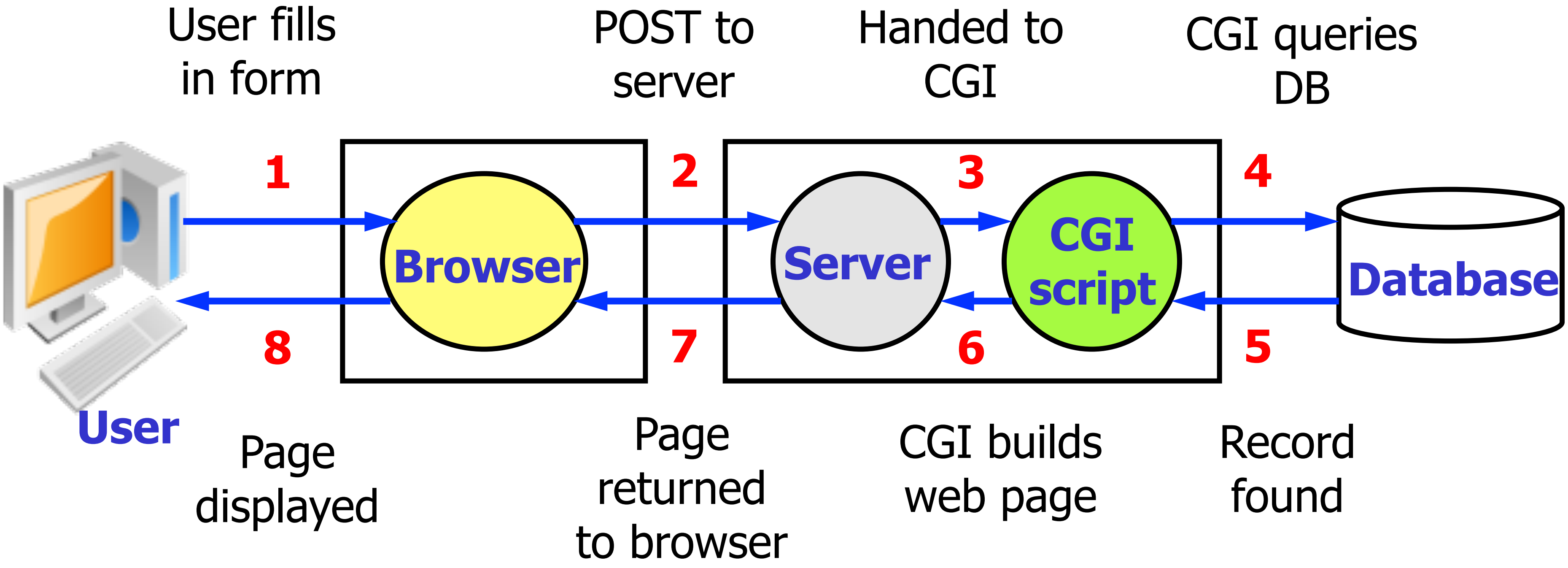
Close the connection

Loop forever

CGI (Common Gateway Interface)

- The Common Gateway Interface (CGI) is a standard for interfacing external applications with information servers, such as HTTP or Web servers.
- A plain HTML document that the Web client retrieves is static, which means it exists in a constant state: a text file that doesn't change. A CGI program, on the other hand, is executed in realtime, so that it can output dynamic information for the server.
- The Web server executes a CGI program to transmit information to the database engine, receive the results and display them to the client. This is an example of a gateway. Currently version is 1.1.
- A CGI program is basically the equivalent of letting the world run a program on your system. For safety, security precautions are taken.

CGI – Procedure



1 User fills in form

2 POST to server

3 Handed to CGI

4 CGI queries DB

5 Record found

6 CGI builds web page

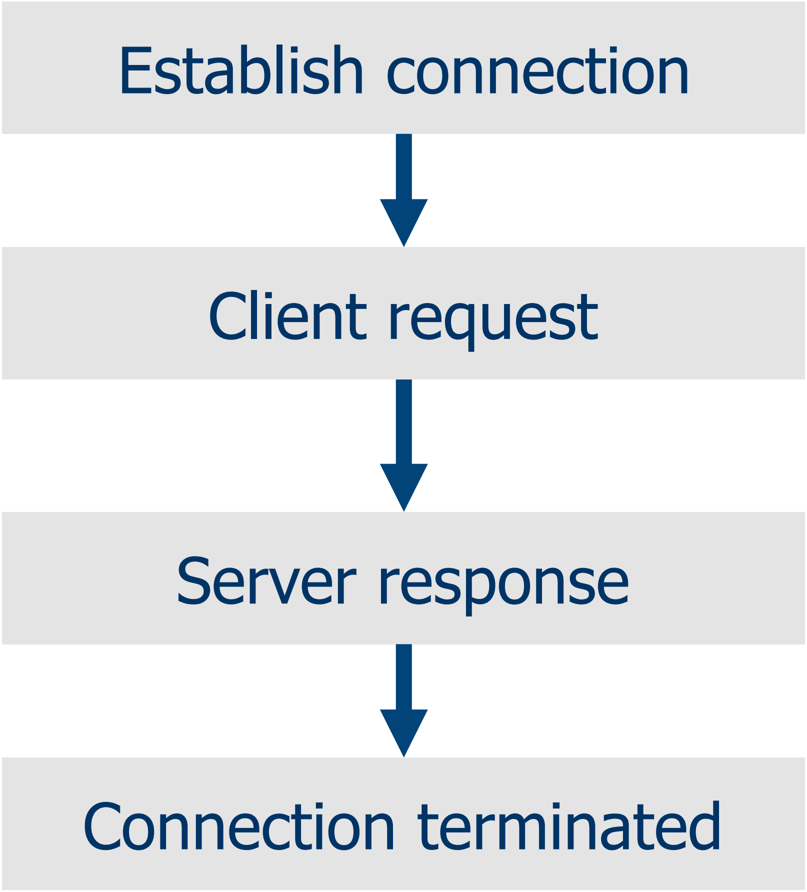
7 Page returned to browser

8 Page displayed

HTTP – Basics

- The heart of the Web
- Features
  - Application layer protocol for client/server communication
  - Request/response based
  - Stateless
  - Bi-directional transfer
  - Capability negotiation
  - Support for cache
  - Support for intermediaries: HTTP proxy

HTTP – HTTP Transaction



Establish connection

- TCP connection set up
- uses a port number as application reference
- usually port 80

Client request

- HTTP message sent with a request line
- request-line = **method URL HTTP version**

Server response

- server sends HTTP message and optionally requested data
- resp-message = HTTP version status code reason-phrase [optional stuff]

Connection terminated

- usually the server
- sometimes the client "stops" it
- anything else, whoever notices terminates

HTTP – Status Codes

- 1xx – for information only
- 2xx – action successful
- 3xx – further action needed (redirect)
- 4xx – client request error
- 5xx – server error

HTTP – Getting Remote Web Pages

- The browser determines the URL
- Browser asks DNS for the IP address of web-page being referred to
- DNS returns the IP address to the browser
- The browser makes a TCP connection to port 80 at the web-page IP address
- The browser sends a get request, eg.
  - GET /dir/FileName.html HTTP/1.0
- The remote server sends the file FileName.html
- The TCP connection is released
- The browser displays all the text in FileName.html
- The browser fetches and displays all the images in FileName.html

HTTP – HTTP Methods

Method	Description
GET	retrieve document specified by URL
PUT	store specified document under given URL
HEAD	identical to GET except that the server MUST NOT return a message-body in the response
OPTIONS	retrieve information about available options
POST	give information (eg. annotation) to the server
DELETE	remove document specified by URL
TRACE	loopback request message
CONNECT	reserved for use with a proxy

HTTP Request and Response Examples

Request Line	**method URL HTTP version**
Headers	**Header name: header value**
Blank Line	
Entity body	**Often not used in request**

```
GET /chn/yxsz/index.htm HTTP/1.1
Host: www.tsinghua.edu.cn
Connection: close
User-Agent: Mozilla/5.0
Accept-Language: cn
[blank line]
```

Response Line	HTTP version status code phrase
Headers	**Header name: header value**
Blank Line	
Entity body	**used in some messages**

```
HTTP/1.1 404 Not Found
```

```
HTTP/1.1 301 Moved Permanently
Location: http://www.xyz.com/index.html
```

```
HTTP/1.1 200 Ok
[blank line]
<data>
```

HTTP – An ASCII/MIME protocol

- Because HTTP is an ASCII / MIME protocol, it is simple for a user at a terminal to communicate directly to a Web server
  - ASCII: defined in RFC 5322
  - MIME: Multipurpose Internet Mail Extension
- Each interaction consists of one ASCII request, followed by one RFC5322 / MIME-like response
  - e.g. Content-type: text/html
  - Data type/subtype
    - text/html
    - text/plain
    - image/gif
    - video/mpeg
    - application/msword
    - etc.

HTTP – An ASCII/MIME protocol

- Content types and subtypes defined by MIME

Type	Subtype	Description
Text	Plain	Unformatted text
	Richtext	Text including simple formatting commands
Image	Gif	Still picture in GIF format
	Jpeg	Still picture in JPEG format
Audio	Basic	Audible sound
Video	Mpeg	Movie in MPEG format
Application	octet-stream	An uninterpreted byte sequence
	Postscript	A printable document in PostScript
Message	RFC5322	A MIME RFC 5322 message
	Partial	Message has been split for transmission
	External-body	Message itself must be fetched over the net
Multipart	Mixed	Independent parts in the specified order
	Alternative	Same message in different formats
	Parallel	Parts must be viewed simultaneously
	Digest	Each part is a complete RFC 2822 message

HTTP/1.1 Performance Enhancements

- HTTP/1.0 is a “stop and wait” protocol
  - Separate TCP connection for each file
    - Connect setup and tear down is incurred for each file
    - Inefficient use of packets
    - Server must maintain many connections

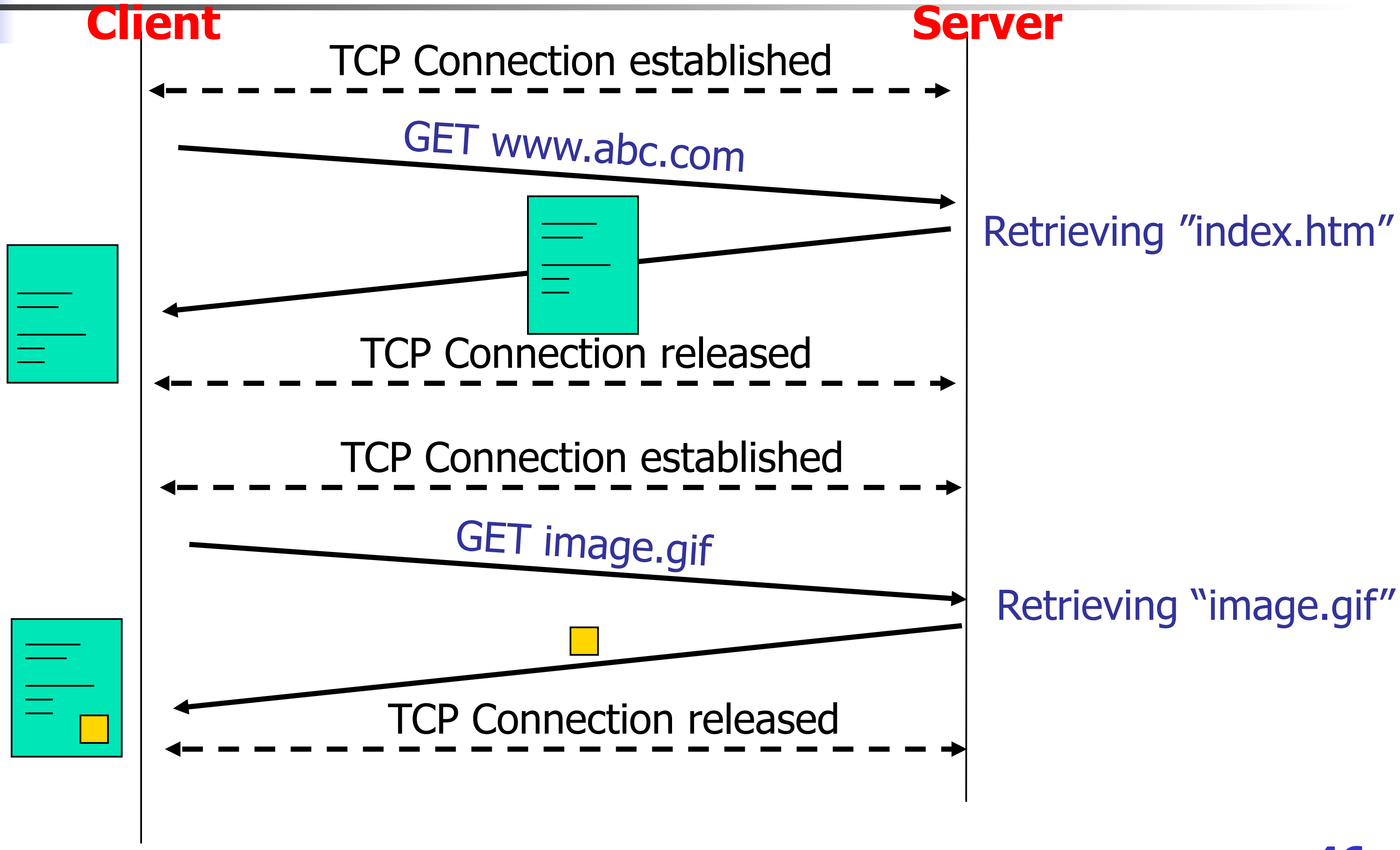
- HTTP/1.1 specification focus on performance enhancements
  - Persistent connections
  - Pipelining
  - Enhanced caching options
  - Support for compression

HTTP/1.1 Persistent Connections and Pipelining

- Persistent connections
  - Use the same TCP connection(s) for transfer of multiple files
  - Reduces packet traffic significantly

- Pipelining
  - Multiple HTTP requests can be written out to a socket together without waiting for the corresponding responses.
  - Pack several HTTP requests into one TCP/IP packet

Example of Non-persistent connections



Client

Server

TCP Connection established

GET www.abc.com

Retrieving ”index.htm”

TCP Connection released

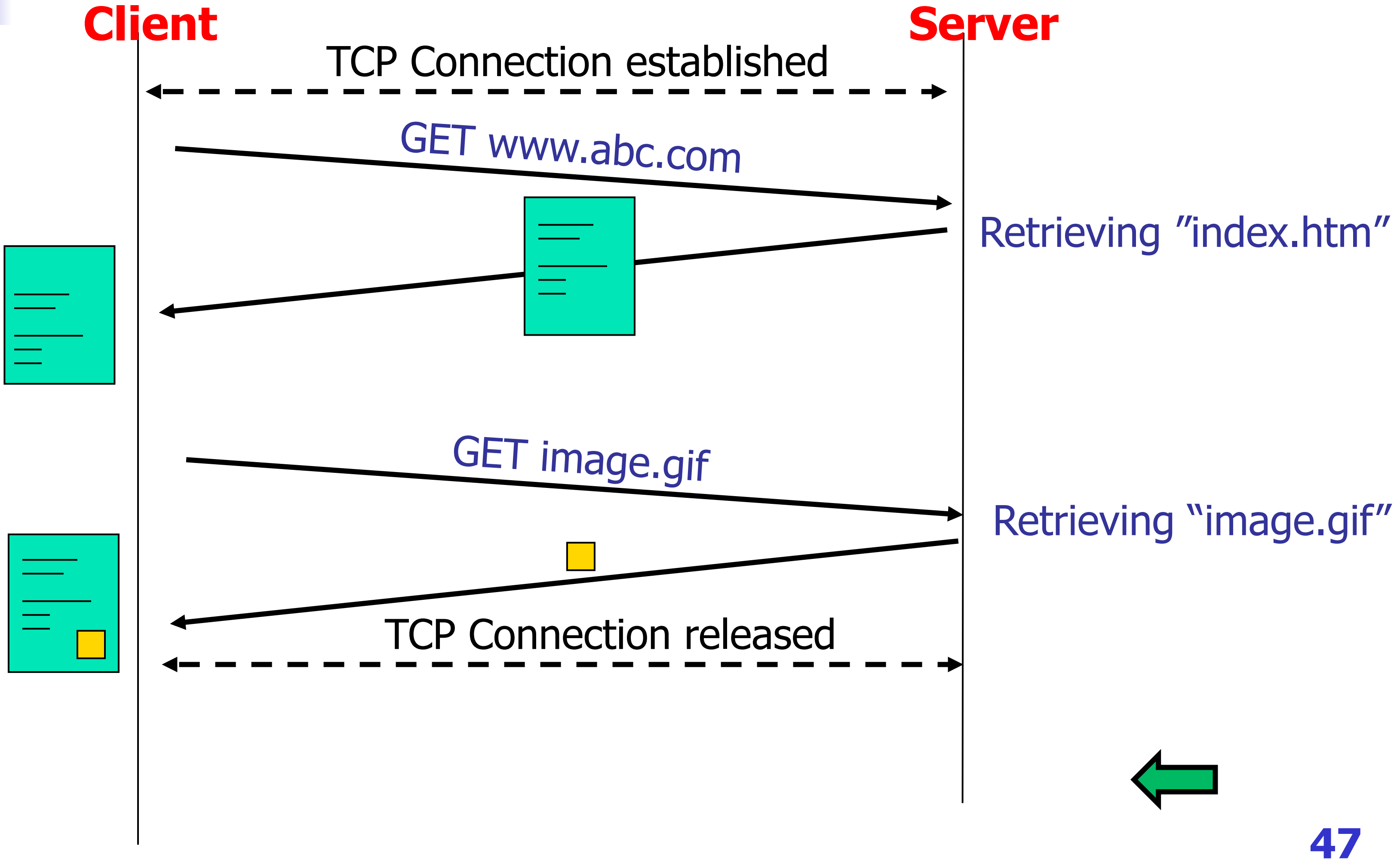
TCP Connection established

GET image.gif

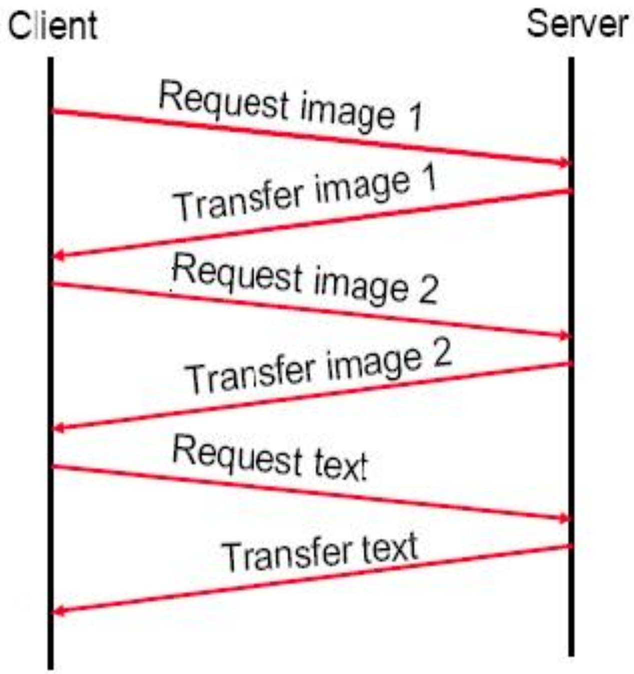
Retrieving “image.gif”

TCP Connection released

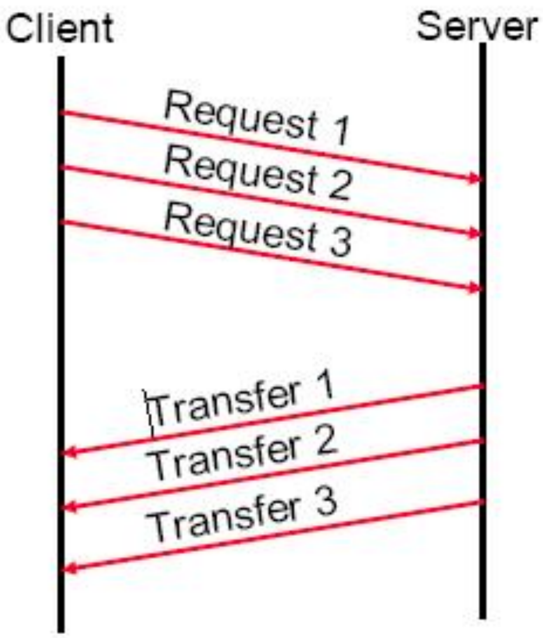
Example of Persistent Connections



Example of Pipelining



Non-pipelining



Pipelining

User-server state: cookies

- Many major Web sites use cookies

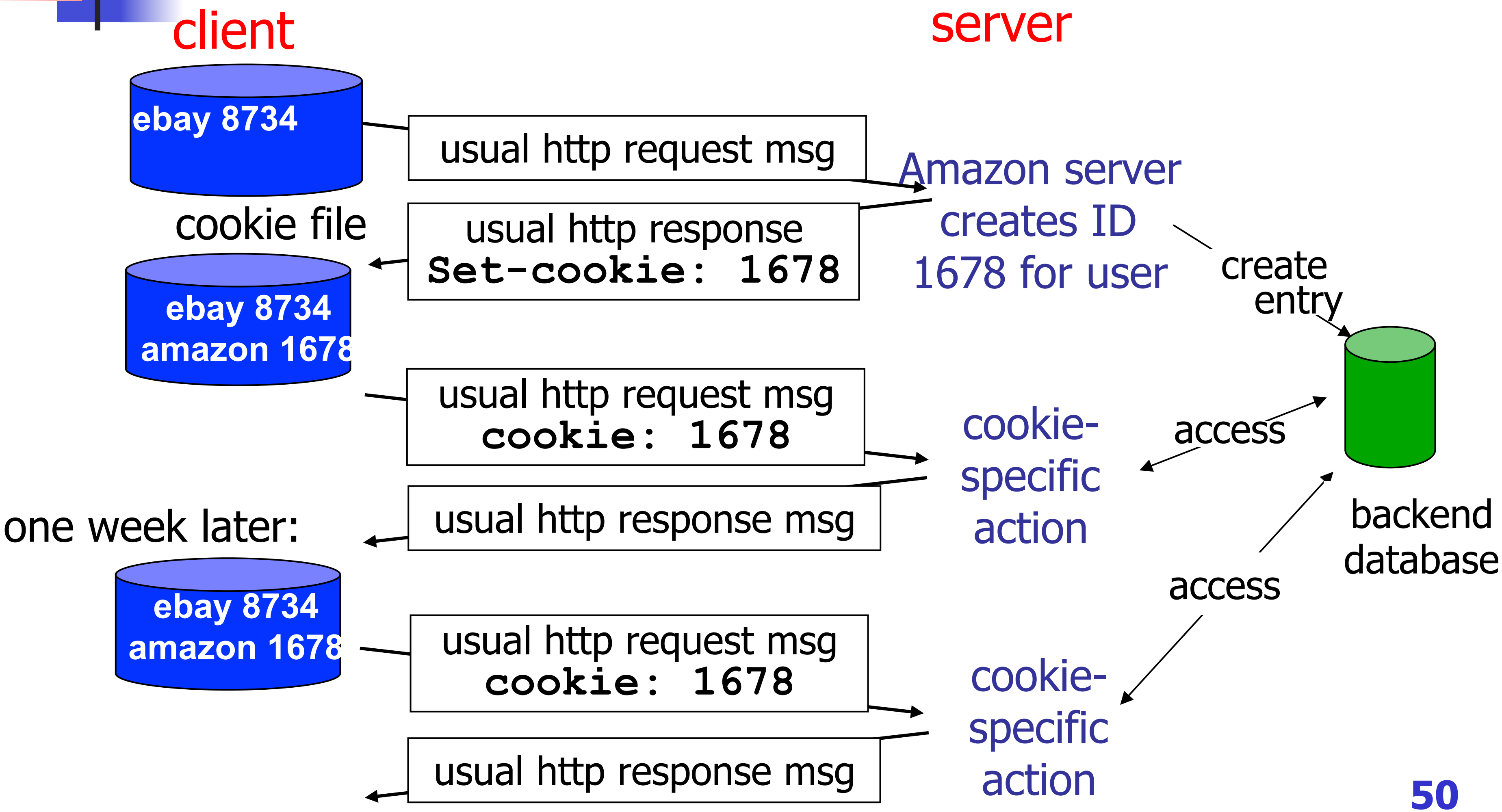
Example:

- Susan always access Internet from PC
- She visits specific e-commerce site for first time
- when initial HTTP request arrives at site, site creates:
  - unique ID
  - entry in backend database for ID

Four components:

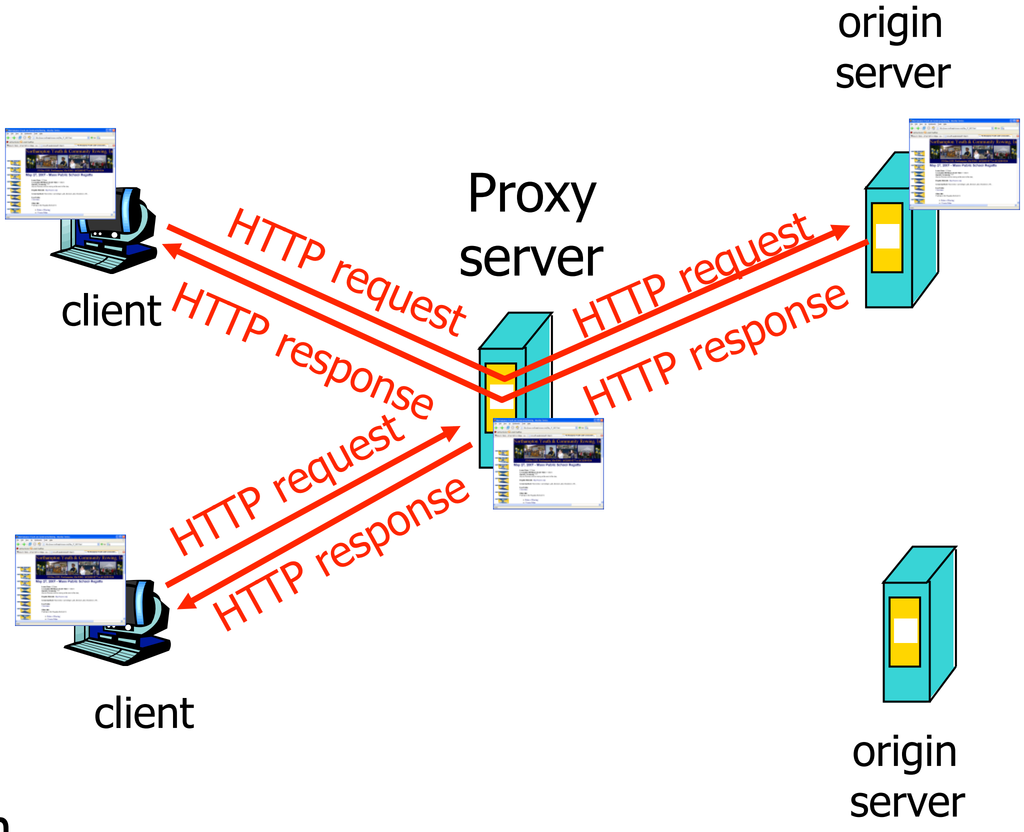
1) cookie header line of HTTP *response* message
2) cookie header line in HTTP *request* message
3) cookie file kept on user’s host, managed by user’s browser
4) back-end database at Web site

Cookies: keeping "state"



Web Caches (Proxy Server)

- Motivation: satisfy client request without involving origin server
- User sets browser: Web accesses via a proxy server
- Browser sends all HTTP requests to proxy server
  - If requested file in cache: proxy server returns file
  - else proxy requests file from origin server, then forwards to client

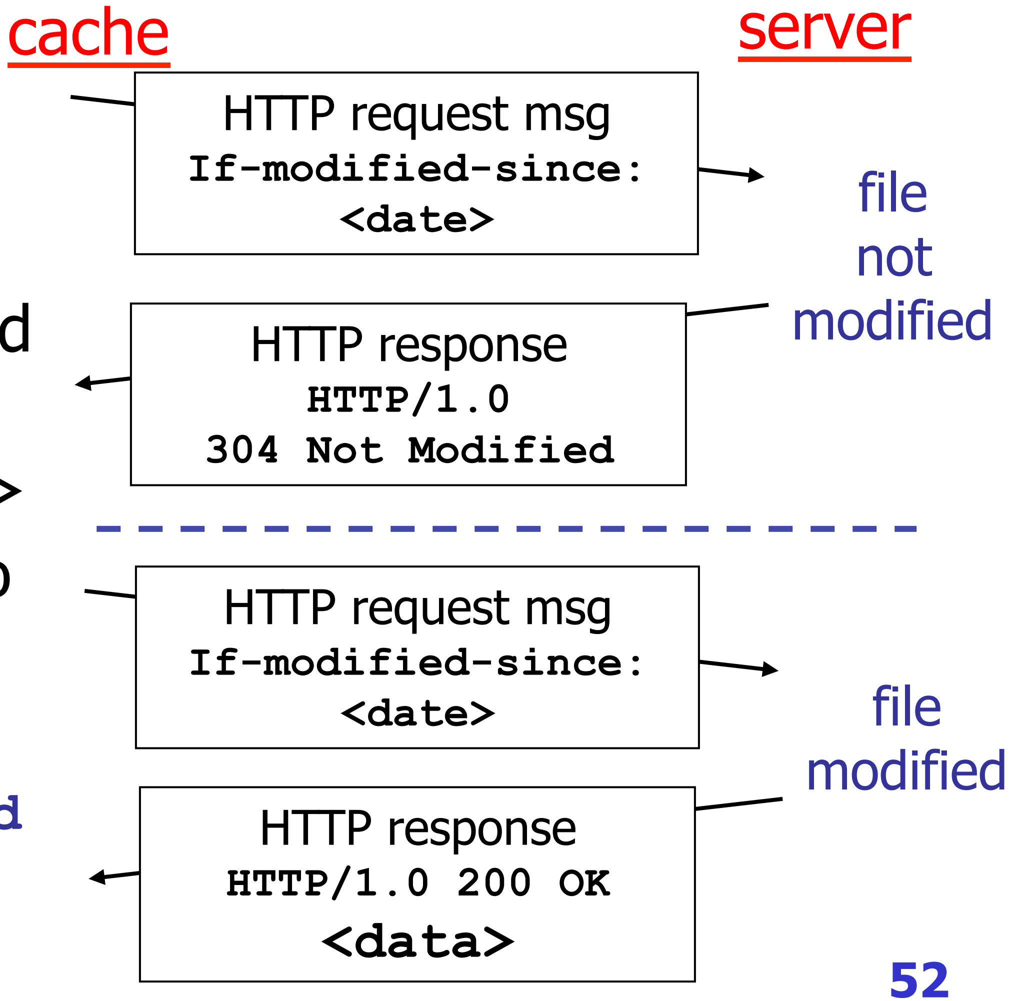


Conditional get

- Server does not send required files if cache has up-to-date cached version
- cache: specify date of cached copy in HTTP request

  If-modified-since: <date>
- server: response contains no object if cached copy is up -to-date:

  HTTP/1.0 304 Not Modified



cache

server

HTTP request msg
If-modified-since: <date>

file not modified

HTTP response
HTTP/1.0 304 Not Modified

HTTP request msg
If-modified-since: <date>

file modified

HTTP response
HTTP/1.0 200 OK
<data>

HTTPS

- Hypertext Transfer Protocol Secure (HTTPS)
- HTTP on top of the SSL(Secure Sockets Layer)/TLS (Transport Layer Security) protocol
- A communication protocol for secure communication over a computer network, with especially wide deployment on the Internet

Summary

Summary

- Terminologies
  - WWW, the Web, W3
  - URL
  - HTML
  - HTTP
- WWW components
  - Client/browser
  - Web server
- URL
  - Structure
  - Used for different services
- HTML
  - Basic web page structure
  - Static vs. dynamic
  - CGI
- HTTP
  - Features
  - Transaction
  - Methods and responses
  - Performance enhancement of HTTP 1.1
  - Idea of cookies
  - HTTP Proxy

Questions

- Does a web address equal to a domain name?
- What are the disadvantages of the stateless feature of HTTP?
- How is the procedure of client-based dynamic pages?
- What is the cookies?
- How does the HTTP proxy work?

Useful URLs

- W3C
  - http://www.w3.org/
- The Web
  - http://www.learnthenet.com/ENGLISH
- HTML
  - http://www.w3.org/MarkUp/Guide/
  - http://www.w3.org/MarkUp/Guide/Advanced.html
  - http://www.w3.org/MarkUp/2004/xhtml-faq
  - http://www.jmarshall.com/easy/html/
  - http://www.dreamdu.com/
- HTTP
  - http://www.jmarshall.com/easy/http/
- A detailed description of Internet history
  - http://www.zakon.org/robert/internet/timeline/

Abbreviations

CGI	Common Gateway Interface
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
MIME	Multi-purpose Internet Mail Extension
URL	Uniform Resource Locator
WWW	World Wide Web