Week 9: Application Layer

Internet Technologies COMP90007

Lecturer: Muhammad Usman

Semester 2, 2020

World Wide Web (WWW)

- World Wide Web key components are?
  - Client and Server software – **Firefox** is the client software for web access where **Apache** is on the server side
  - Web mark-up languages - **HTML** – how webpages are coded
  - Web scripting languages – More dynamicity to webpages - **Javascript**
  - **HTTP** – about how to transfer

Web Access

- A web page consists of objects
- An object can be HTML file but also JPEG image, Java applet, audio file, …
- A web page consists of a base HTML file which includes several referenced objects
- Each object is addressable by a URL (uniform resource locator)
- Example URL:

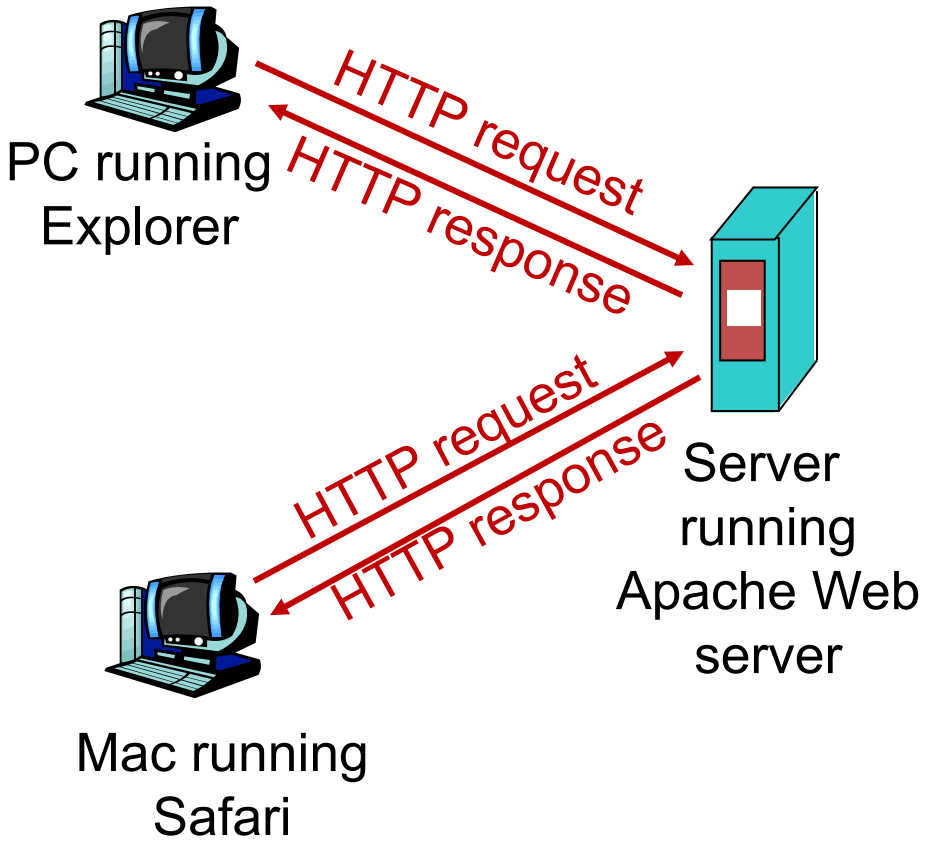
`www.someschool.edu/someDept/pic.gif`

host name | path name

HTTP: hypertext transfer protocol

HyperText "text … cross-referencing between sections of text and associated graphic material"

- HTTP is at the application layer
- client/server model
  - ***client:*** browser that requests, receives and displays Web objects
  - ***server:*** Web server sends objects in response to requests



HTTP Connections

- Non-persistent HTTP
  - at most one object sent over a TCP connection
- Persistent HTTP
  - multiple objects can be sent over a single TCP connection between client and server

Non-persistent HTTP (I)

suppose user enters URL:
`www.someSchool.edu/someDepartment/home.index`

contains text and references to 10 images

1a. HTTP client initiates TCP connection to HTTP server (process) at `www.someSchool.edu` on port 80

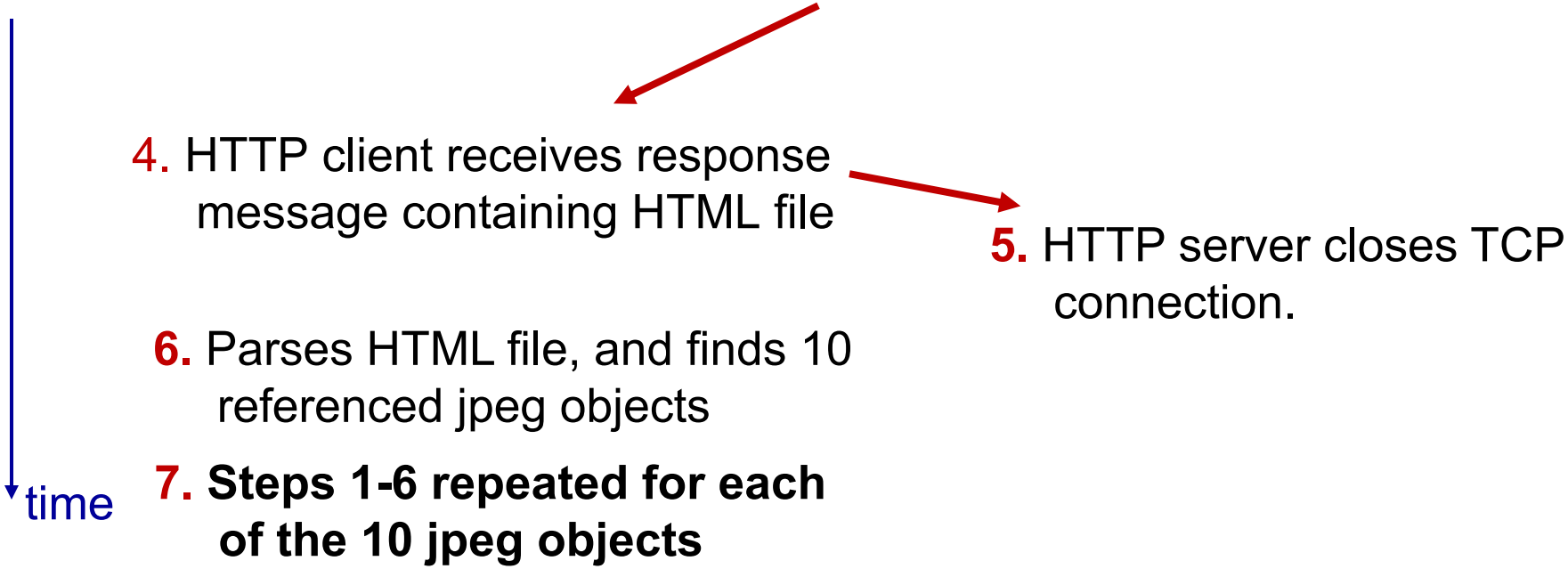
1b. HTTP server at host **`www.someSchool.edu`** waiting for TCP connection at port 80. Accepts connection, notifying client

2. HTTP client sends a HTTP ***request message*** (containing URL) into TCP connection socket. Message indicates that client wants object **`someDepartment/home.index`**

3. HTTP server receives request message, forms ***response message*** containing requested object, and sends message into its socket

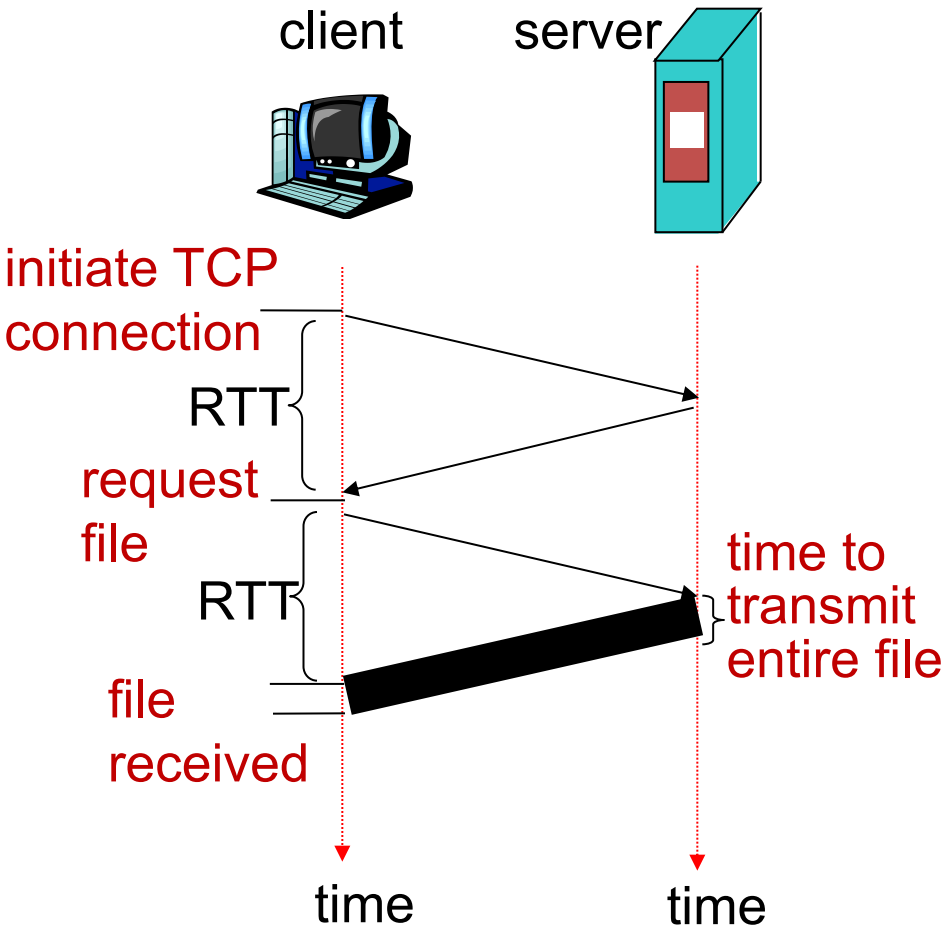
time

Non-persistent HTTP (II)



Non-Persistent HTTP:Response Time

- Round Trip Time (RTT) – time for a small packet to travel from client to server and back
- Response time
  - one RTT to initiate TCP connection
  - one RTT for HTTP request and first few bytes of HTTP response to return
  - file transmission time
- Total response time = 2 RTT+ file transmission time



Non-Persistent HTTP – Issues

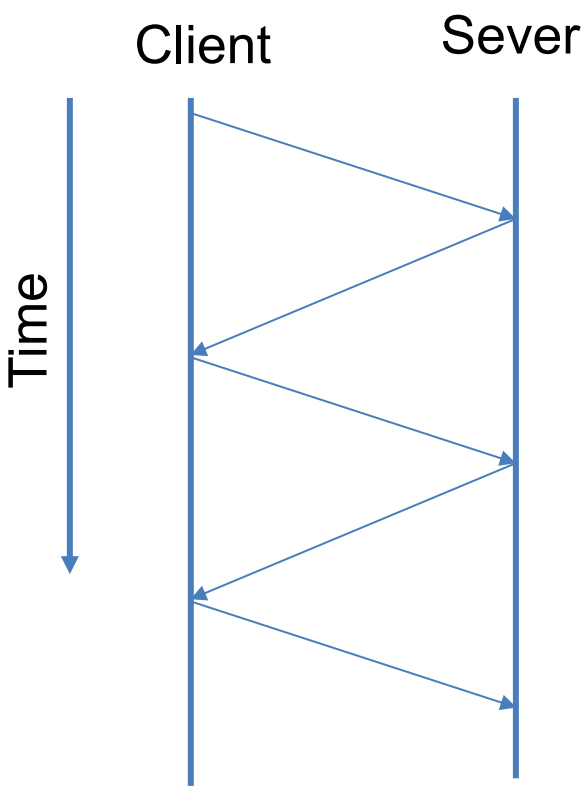
- Requires new connection per requested object
- OS overhead for *each* TCP connection
- Delivery delay of 2 RTTs per requested object

Persistent HTTP

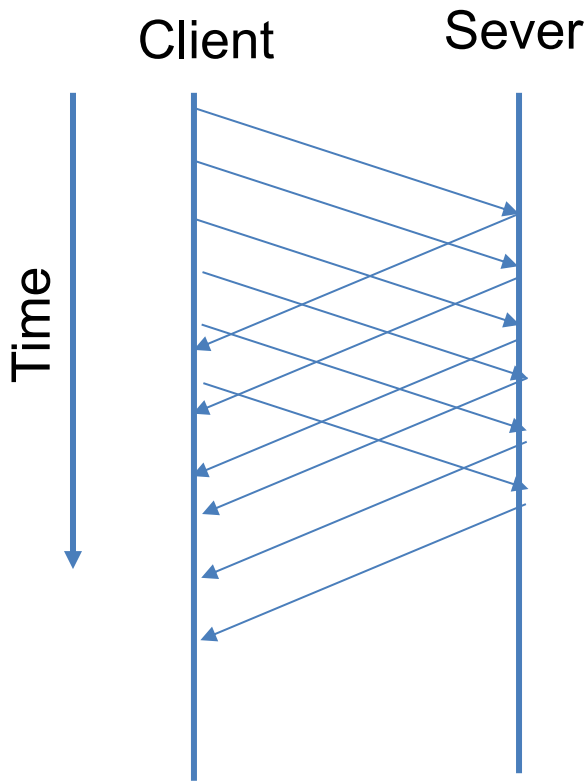
- Server leaves connection open after sending response
- Subsequent HTTP messages between same client/server sent over open connection
- *Pipelining* – client sends request as soon as it encounters a referenced object
  - ➔as little as one RTT for all the referenced objects
- Server closes a connection if it hasn't been used for some time

Sequential vs Pipeline

Sequential



Pipeline



HTTP Request Message: Example

request line (GET, POST, HEAD commands)

header lines

indicates end of header lines

```
GET /index.html HTTP/1.1\r\n
Host: www-net.cs.umass.edu\r\n
User-Agent: Firefox/3.6.10\r\n
Accept: text/html,application/xhtml+xml\r\n
Accept-Language: en-us,en;q=0.5\r\n
Accept-Encoding: gzip,deflate\r\n
Accept-Charset: ISO-8859-1,utf-8;q=0.7\r\n
Keep-Alive: 115\r\n
Connection: keep-alive\r\n
\r\n
```

Persistent HTTP

HTTP Response Message: Example

200 OK – request succeeded, requested object later in this msg
….
404 Not Found – requested document not found on this server

status line:

header lines

```
HTTP/1.1 200 OK\r\n
Date: Sun, 26 Sep 2010 20:09:20 GMT\r\n
Server: Apache/2.0.52 (CentOS)\r\n
Last-Modified: Tue, 30 Oct 2007 17:00:02 GMT\r\n
Content-Length: 2652\r\n
Keep-Alive: timeout=10, max=100\r\n
Connection: Keep-Alive\r\n
Content-Type: text/html; charset=ISO-8859-1\r\n
\r\n
data data data data data ...
```

data, e.g., requested HTML file

HTTP Request Methods

Method	Description
GET	Request to read a Web page
HEAD	Request to read a Web page's header
PUT	Request to store a Web page **(write a new page / resource)**
POST	Append to a named resource (e.g., a Web page)
DELETE	Remove the Web page
TRACE	Echo the incoming request
CONNECT	Reserved for future use
OPTIONS	Query certain options

HTTP Error Codes

Code	Meaning	Examples
1xx	Information	100 = server agrees to handle client's request
2xx	Success	200 = request succeeded; 204 = no content present
3xx	Redirection	301 = page moved; 304 = cached page still valid
4xx	Client error	403 = forbidden page; 404 = page not found
5xx	Server error	500 = internal server error; 503 = try again later

Cookies

- **The http servers are stateless**
- Cookies to place small amount (<4Kb) of info on users computer and re-use deterministically (RFC 2109)
- Questionable mechanism for tracking users (invisibly perhaps)

User-server Interaction:Cookie Example 1

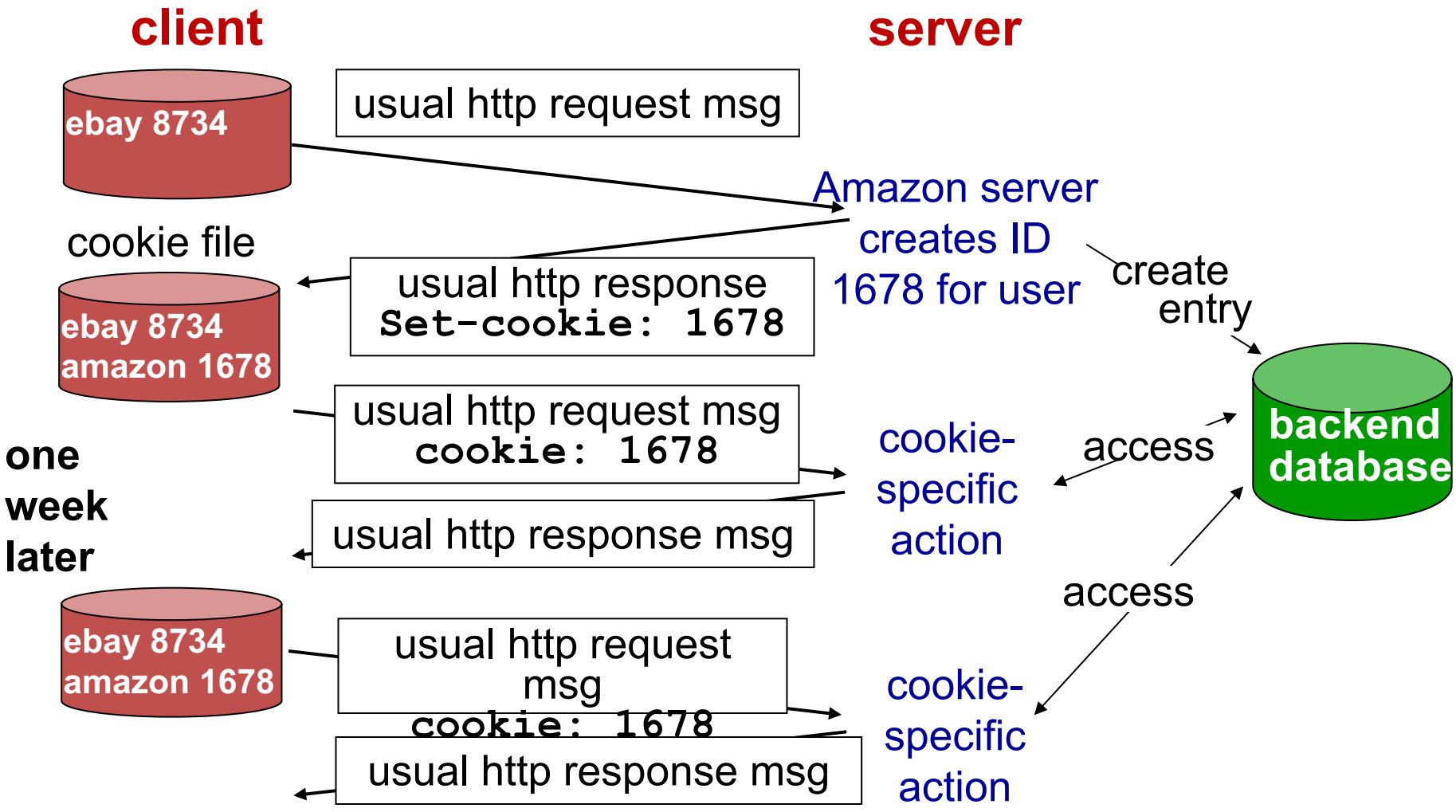
Susan always accesses the Internet from her (*cookie-enabled*) home PC. She visits a specific (*cookie-enabled*) e-commerce site for the first time

- When the initial HTTP requests arrives at the site, the site creates:
  - unique ID
  - entry in backend database for ID
- The e-commerce site then responds to Susan's browser, including in the HTTP response
  - Set-cookie: 1234 — ID

User-server Interaction: Cookie Example (Contd)

- Susan's browser appends a line to a cookie file that it manages
  - www.e-commerce-site.com 1234
- Next time Susan request a page from that site, a cookie header line will be added to her request
  - Cookie: 1234
- The server will then perform a cookie-specific action

Keeping state with Cookies: Example 2



Beyond User Tracking: Advantages of Cookies

- Authorization
- Shopping carts
- Recommendations
- User session state

Cookies vs Sessions

- **Both introduce "memory" or state into HTTP and are about multiple TCP connections**

Sessions

- Sessions information regarding visitor's interaction stored at the server side: up to some hours
- When user closes the website, the session ends
- Sessions information size can be large

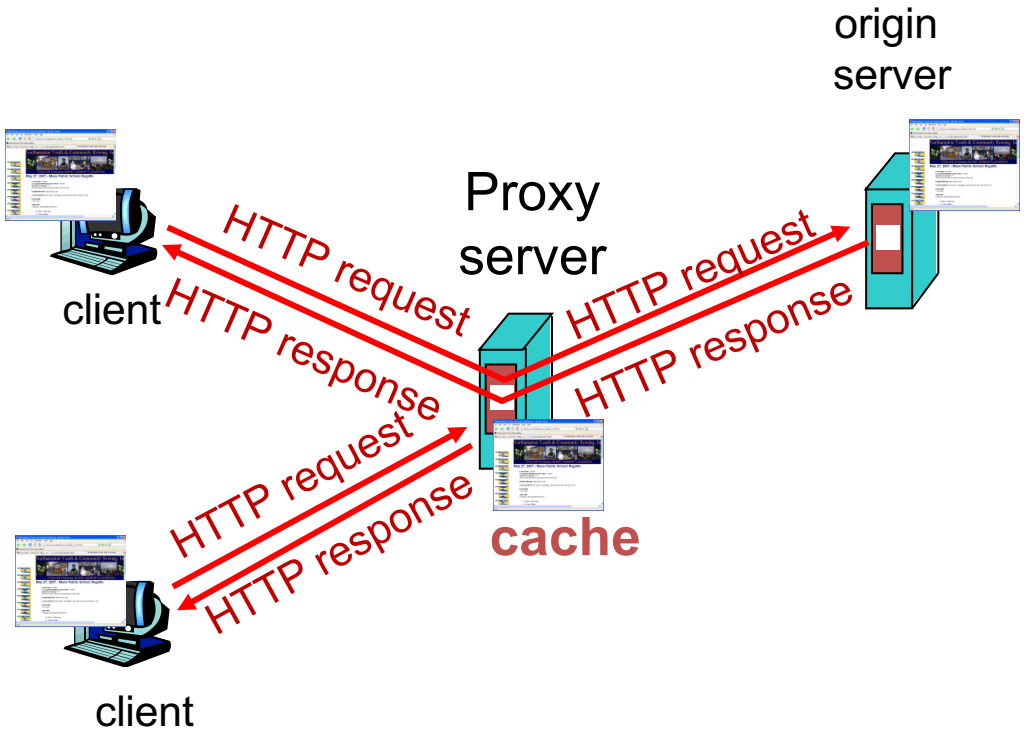
Cookies

- Cookies are transferred between server and client
- Cookie information stored at both client and server
- Maintain client information until deleted
- Cookies information size limited

Web Caches (Proxy Server)

Goal: satisfy client request without involving origin server

- User sets browser to access Web via cache
  - ➔browser sends all HTTP requests to cache
    - **if object in cache,** cache returns object
    - **else** cache requests object from origin server, then returns object to client



More about Web Caching

- Cache acts as both client and server
- Typically cache is installed by ISP (university, company, residential ISP)
- Causes problems for frequently changing data though

Why Web caching?

- Reduce response time for client request
- Reduce traffic on an institution's access link