

# Week 9: Application Layer

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Internet Technologies COMP90007

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# 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 <https://powcoder.com>
- ❑ Web mark-up languages - **HTML** – how webpages are coded
- ❑ Web scripting languages – More dynamicity to webpages - **Javascript**
- ❑ **HTTP** – about how to transfer

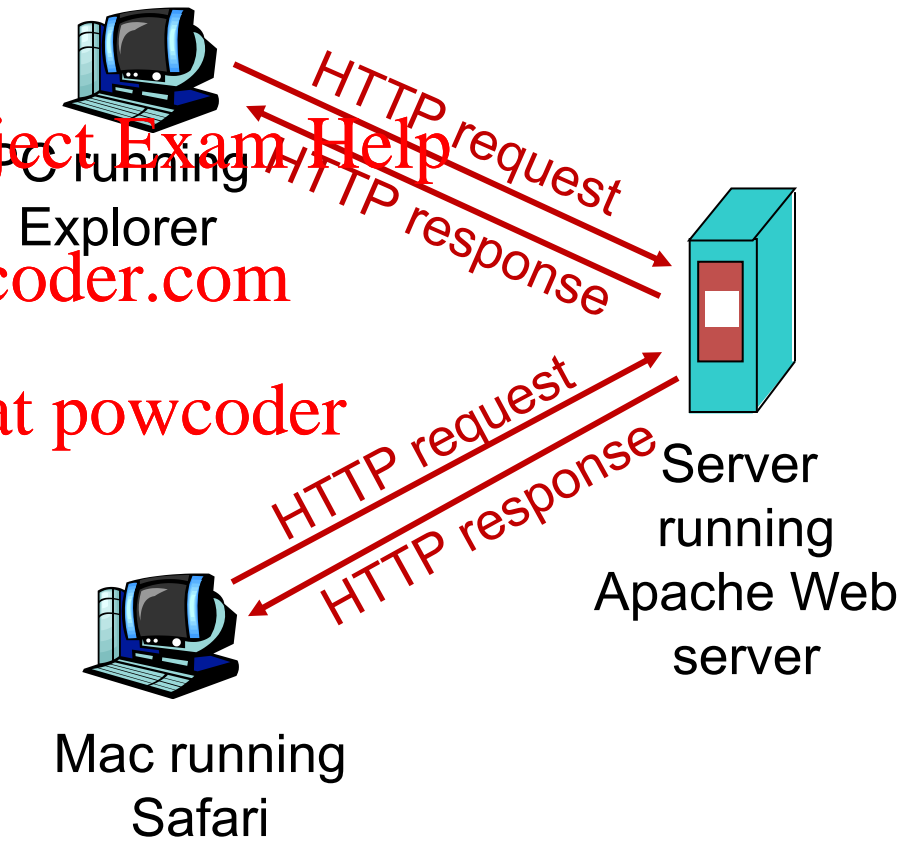
# Web Access

- 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

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- Persistent HTTP <https://powcoder.com>

- multiple objects can be sent over a single TCP connection between client and server

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# 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

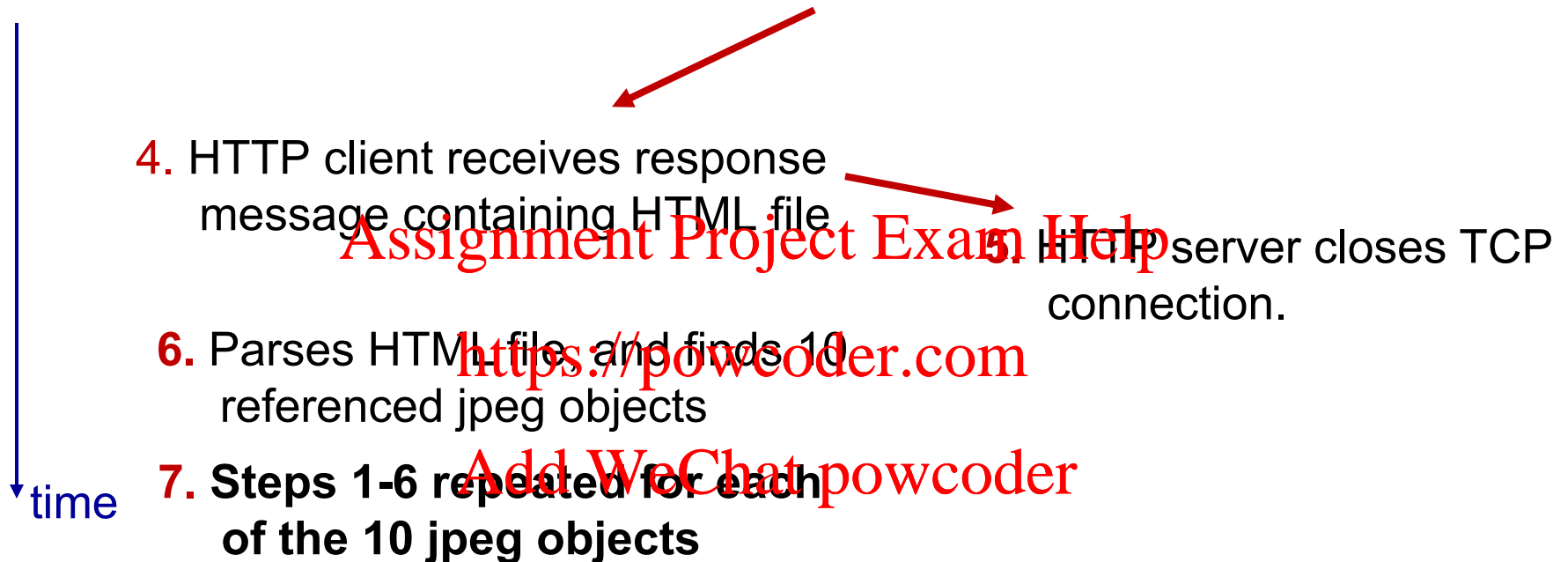
1b. HTTP server at host  
`www.someSchool.edu`  
waiting for TCP connection at  
port 80. Accepts connection,  
notifying client

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)

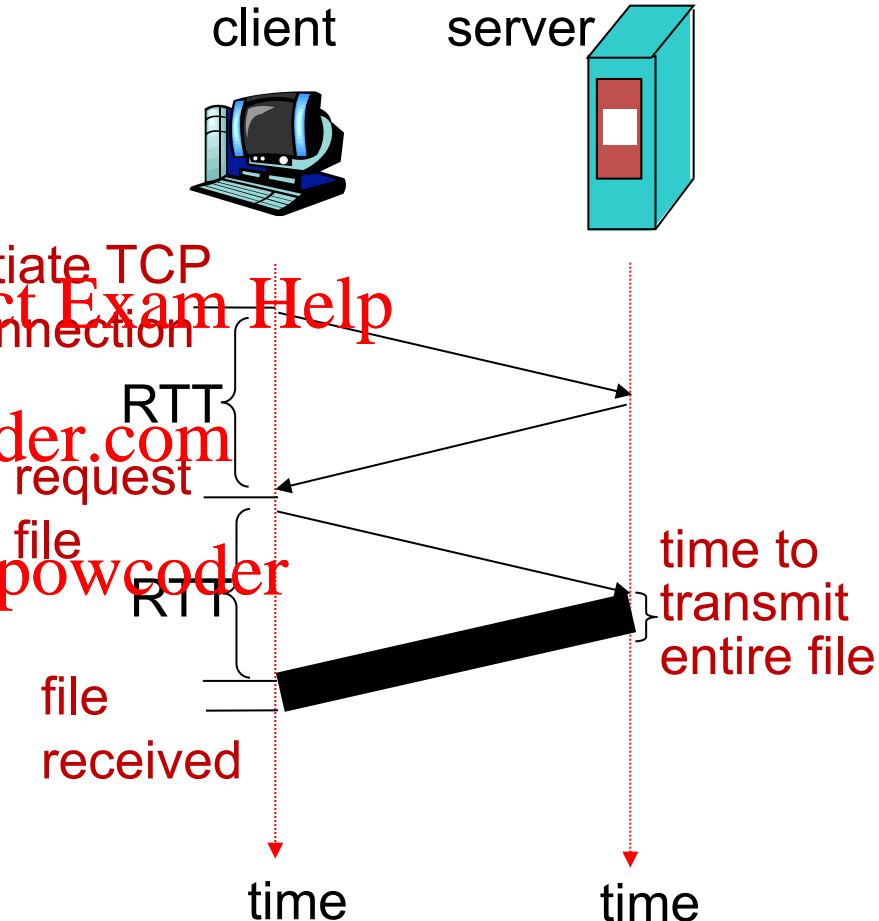


# Non-Persistent HTTP: Response Time

- 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

- Total response time =  
2 RTT +  
file transmission time





# Non-Persistent HTTP – Issues

- Requires new connection per requested object

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- OS overhead for *each* TCP connection

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- Delivery delay of 2 RTTs per requested object

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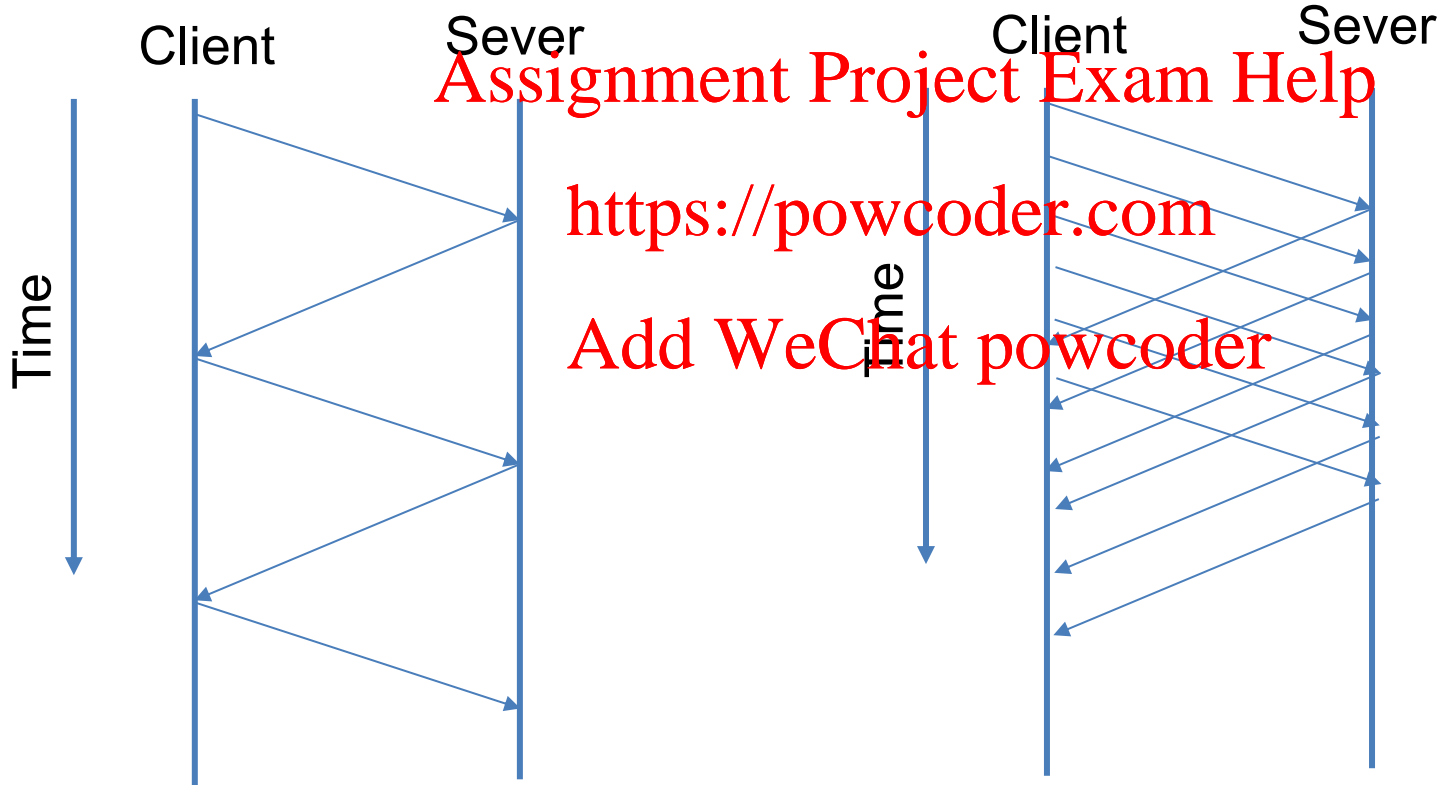
# Persistent HTTP

- 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

```
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
```

indicates  
end of  
header  
lines

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:

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

header  
lines

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# 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

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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 ( $\leq 4\text{Kb}$ ) of info on users computer and re-use deterministically (RFC 2109)  
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- Questionable mechanism for tracking users (invisibly perhaps)  
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# User-server Interaction: Cookie Example 1

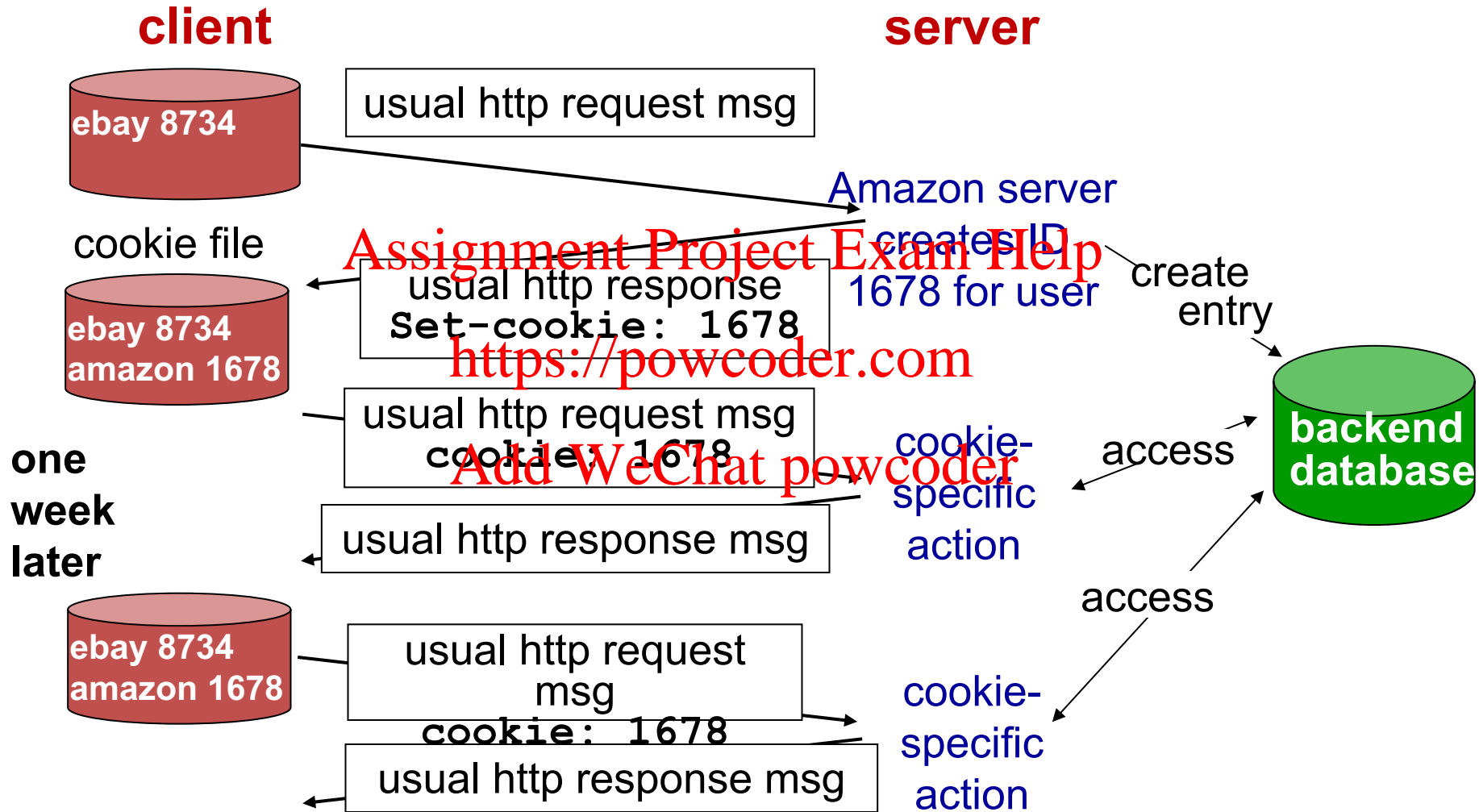
Susan always accesses the Internet from her (*cookie-enabled*) home PC. She visits a specific (*cookie-enabled*) e-commerce site for the first time

- When the initial HTTP request 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
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# 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

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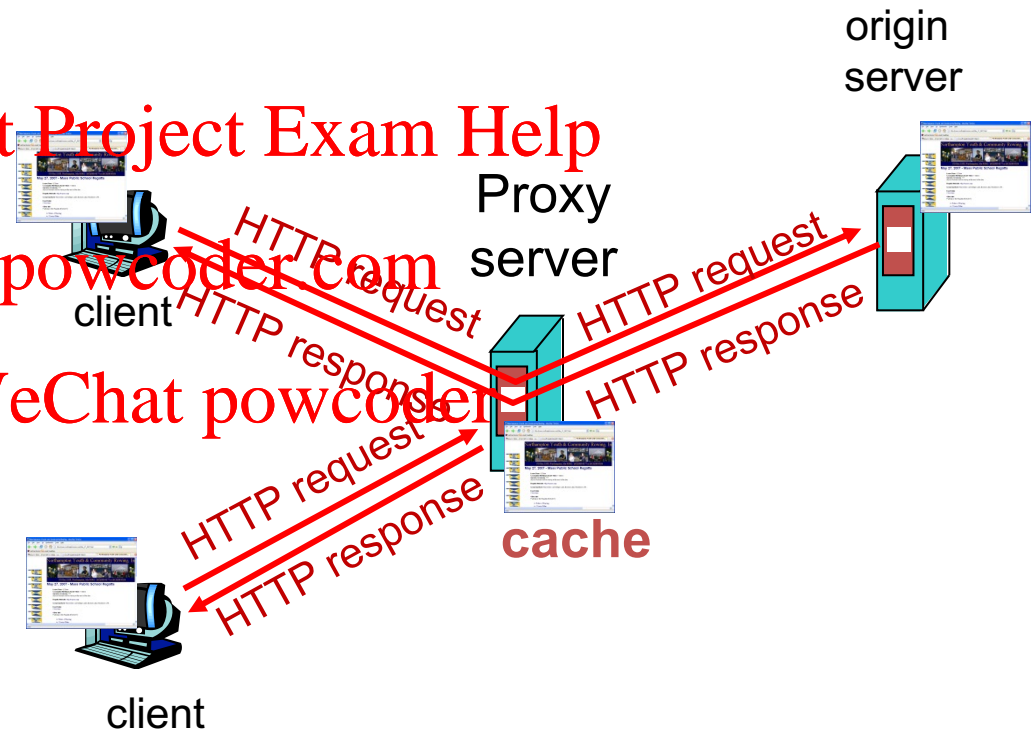
# Web Caches (Proxy Server)

**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

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## Why Web caching?

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