CS118 Discussion 1A, Week 2

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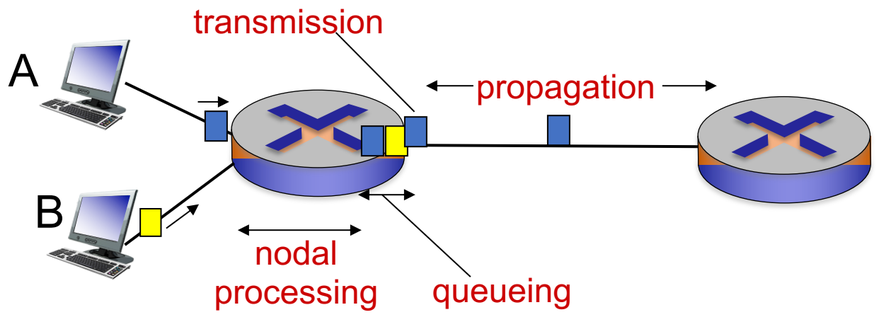
Friday / 10 -11:50am

Outline

- Lecture Review
  - Packet delay, loss, throughput
    - Questions for review
  - Applications
    - HTTP: three factors
    - SMTP, DNS, P2P

Packet delay review



$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$

d_{proc}: nodal processing
- check bit errors
- determine output link

d_{queue}: queueing delay
- time waiting at output link for transmission
- depends on congestion level of router

d_{trans}: transmission delay:
- L: packet length (bits)
- R: link *bandwidth (bps)*
- $d_{trans} = L/R$

d_{prop}: propagation delay:
- d: length of physical link
- s: propagation speed (~2×10^8 m/sec)
- $d_{prop} = d/s$

Question 1

- Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R_1=500kbps, R_2=2Mbps, and R_3=1Mbps.

  a. Assuming no other traffic in the network, what is the throughput for the file transfer?

  b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

  c. Repeat (a) and (b), but now with R_2 reduce to 100kpbs.

Solution

a. Assuming no other traffic in the network, what is the throughput for the file transfer? **Ans: 500 kbps**

b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?
Ans: (4*10^6)*8/(500*10^3)= 64 seconds

c. Repeat (a) and (b), but now with R2 reduce to 100kpbs. **Ans: 320 seconds**

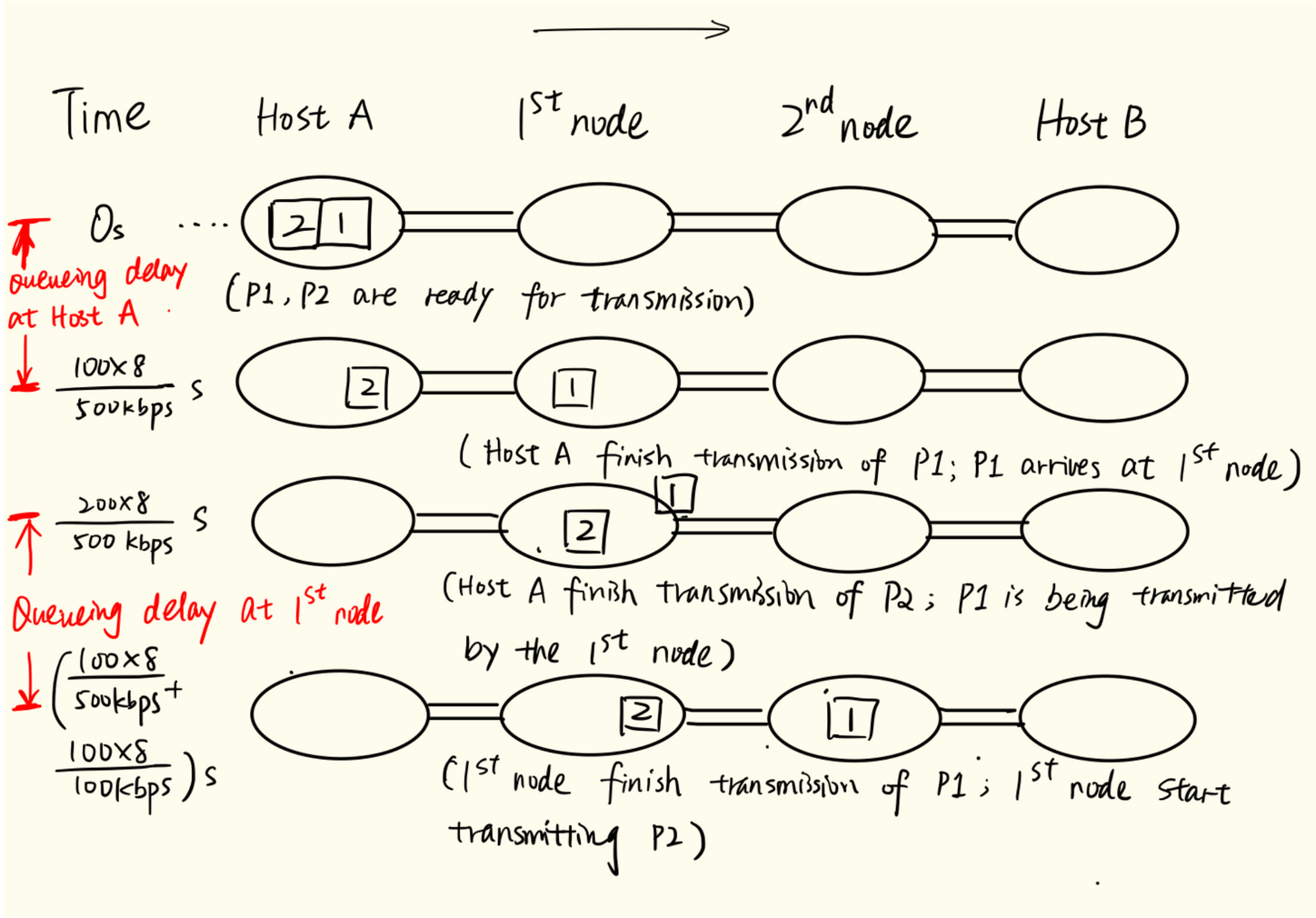
Question 1 cont'd

- Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R_1=500kbps, R_2=100kbps, and R_3=1Mbps.

  d. Suppose the file is 200 bytes and it is segmented into two 100 bytes packets. What is the queuing delay for the second packet at host A, the first node, the second node?

Solution

- Queueing delay at host A = 100bytes * 8 / 500kbps - 0 = 1.6 ms
- Queueing delay at 1st node = 100bytes*8/500kbps + 100bytes*8/500kbps – 200bytes*8/500kbps = 6.4ms
- No queueing delay at 2nd node



Question 2

a. How long does it take a packet of length 1000 bytes to propagate over a link of distance 2500km, propagation speed 2.5x10^8 m/s, and transmission rate 2 Mbps?
b. More generally, how long does it take a packet of length L to propagate over a link of distance d, propagation speed s, and transmission rate R bps?
c. Dose this delay depend on packet length?
d. Does this delay depend on transmission rate?

Solution

a. How long does it take a packet of length 1000 bytes to propagate over a link of distance 2500km, propagation speed 2.5x10^8 m/s, and transmission rate 2 Mbps?

   - **Ans: (2500*10^3)/(2.5*10^8)=0.01s = 10ms**

b. More generally, how long does it take a packet of length L to propagate over a link of distance d, propagation speed s, and transmission rate R bps? **Ans: d/s**

c. Dose this delay depend on packet length? Ans: No

d. Does this delay depend on transmission rate? Ans: No

Question 3

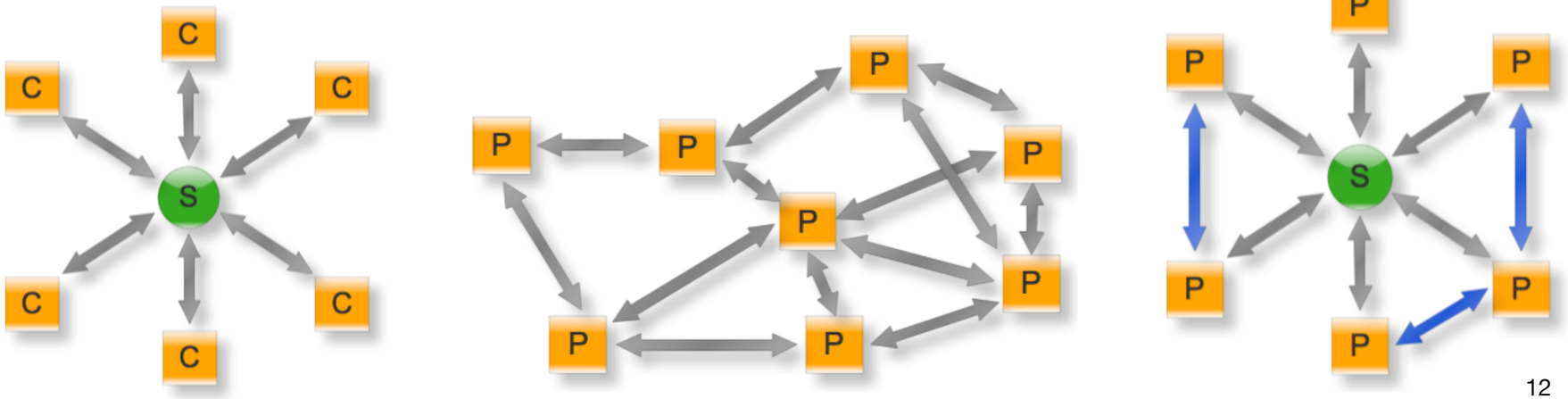
- Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application layer protocols besides HTTP are needed in this scenario?

Solution

- Application layer protocols: DNS and HTTP
- Transport layer protocols: UDP for DNS; TCP for HTTP

Application Layer: Models

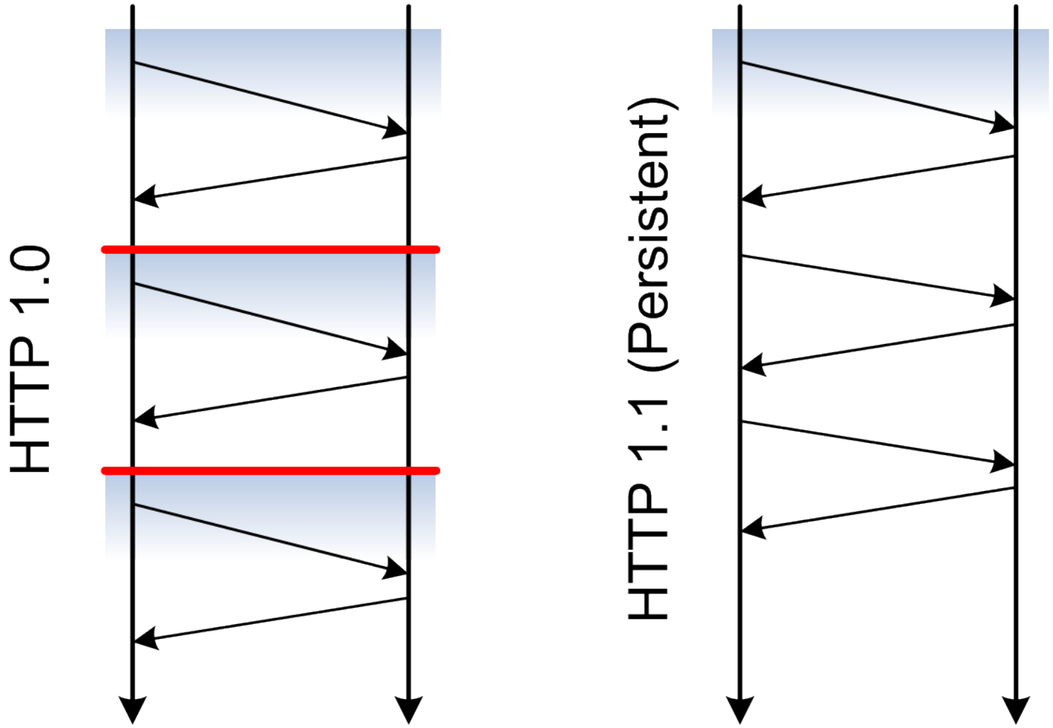
- Application Architectures
  - Client-server model: Web (TCP), FTP (TCP), E-mail (TCP), DNS (UDP/TCP)
  - Peer-to-Peer (P2P): BitTorrent (TCP)
  - Hybrid model: Skype (TCP&UDP)



Application Layer: Protocols

- HTTP (**H**yper**t**ext **T**ransfer **P**rotocol)
  - Client-server model
    - Client – browsers: send request, receive response and display web objects
    - Server – web servers: send objects in response to requests
  - On top of TCP
    - Client initiates TCP connection to server; server accepts the connection; HTTP messages exchange; TCP connection closed
    - Question: To send HTTP message to web server, what does the server's address consist of?
  - A stateless protocol on top of TCP
    - What if we want stateful service (e.g. shopping cart)?

Non-persistent v.s. Persistent



Question

- How many TCP connections do we need to get one HTML file with 5 embedded images? How many RTTs shall we need?
  - For Non-persistent HTTP ?
  - For persistent HTTP?

Solution

- For non-persistent HTTP:
  - TCP connections: 6
  - RTT: 6 * 2 = 12, for 2 RTT per TCP connection
- For persistent HTTP:
  - TCP connection: 1
  - RTT: 1 + 6 = 7
    - 1 RTT for TCP connection set-up
    - 6 RTT for requesting and sending 6 objects

HTTP Header: request

- Request message elements:
  - Method
    - Method Types: GET, HEAD, POST, PUT, DELETE, Conditional GET
  - URL
  - HTTP Version
  - Header lines
    - CRLF (carriage return and line feed) at start of line indicates end of header lines

HTTP Header: response

- Response message elements:
  - HTTP Version
  - Status line
  - Header lines
    - CRLF at start of line indicates end of header lines
  - Data requested

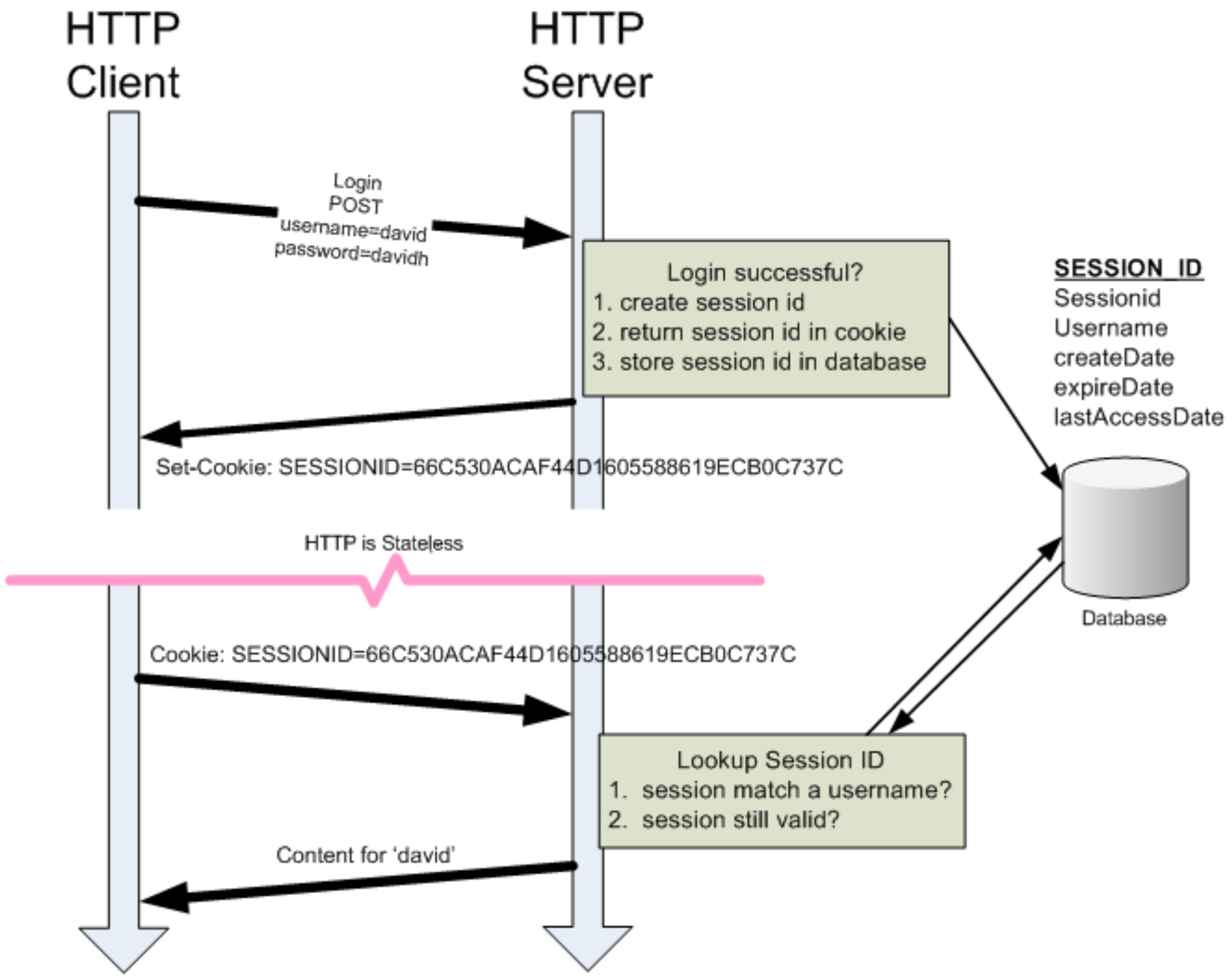
Try HTTP GET yourself

- telnet google.com 80
  - Get / HTTP/1.1
  - Host: google.com
  - <Enter>
  - <Enter>

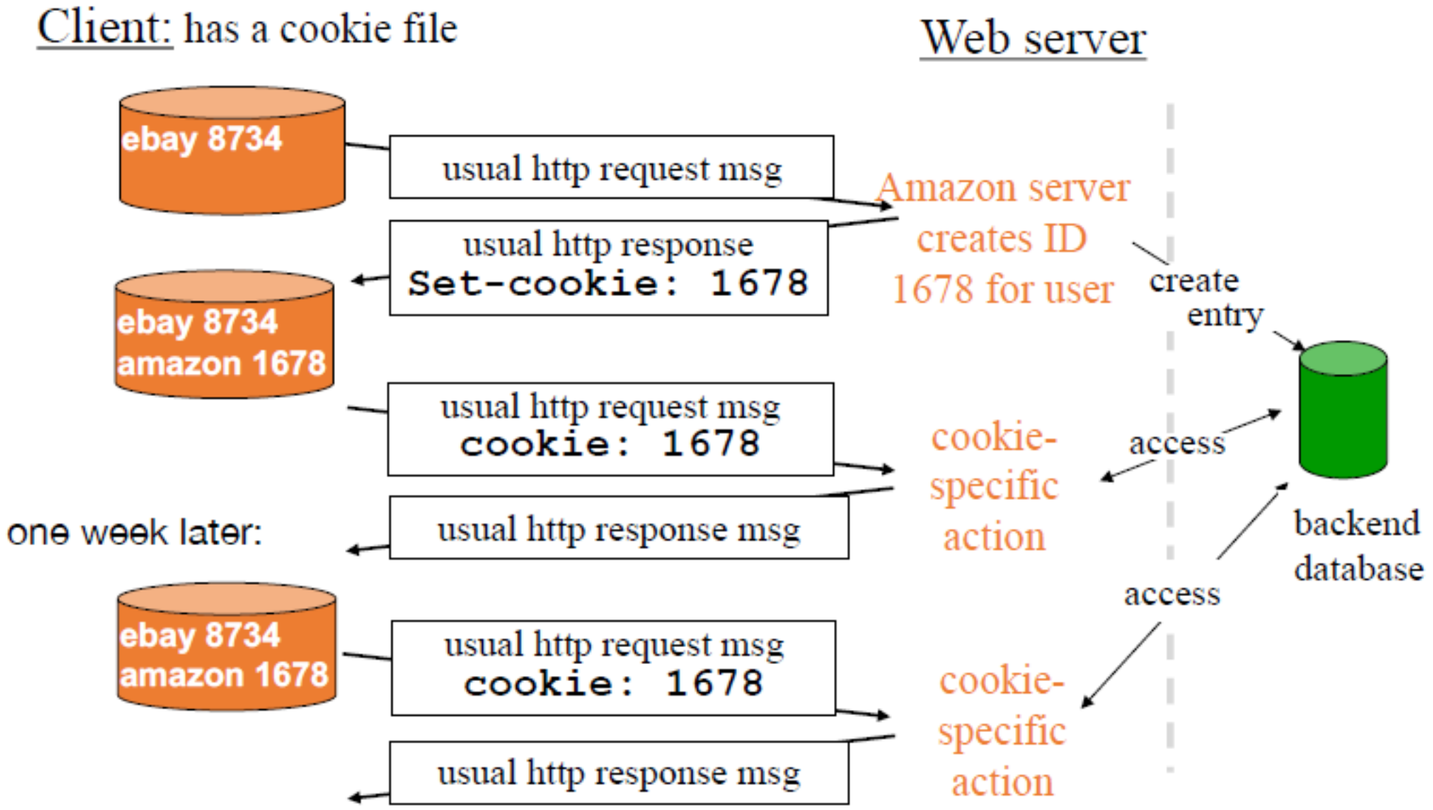
Cookie

- Bring statefulness into HTTP
- Components
  - Cookie header line of HTTP response message
  - Cookie header line of HTTP request message
  - Cookie file on the browser
  - Back-end database at web-site

Cookie: make HTTP stateful



Cookie: operations



Web caching: Proxy

- Proxy acts both as client and server
  - Browser sends HTTP requests to the cache
    - Cache returns the object, if it is in cache
    - Cache requests the object from the original server, otherwise
- What if original object gets updated?
  - HTTP conditional GET
    - Cache specifies date of cached copy in HTTP request
    - Server sends no object if cached copy is up-to-date

HTTP conditional GET

Request:

GET /sample.html HTTP/1.1

Host: example.com

Response:

HTTP/1.x 200 OK

Via: The-proxy-name

Content-Length: 32859

Expires: Tue, 27 Dec 2005 11:25:11 GMT

Date: Tue, 27 Dec 2005 05:25:11 GMT

Content-Type: text/html; charset=iso-8859-1

Server: Apache/1.3.33 (Unix) PHP/4.3.10

Cache-Control: max-age=21600

Last-Modified: Wed, 01 Sep 2004 13:24:52 GMT

Etag: “4135cda4”

Cache-Control: It tells the client the maximum time in seconds to cache the document.

Last-Modified: The document’s last modified date

Etag: A unique hash for the document.

HTTP conditional GET

Request:

GET /sample.html HTTP/1.1

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Response:

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Cache-Control: max-age=21600

Last-Modified: Wed, 01 Sep 2004 13:24:52 GMT

Etag: “4135cda4”

Request:

GET /sample.html HTTP/1.1

Host: example.com

If-Modified-Since: Wed, 01 Sep 2004 13:24:52 GMT

If-None-Match: “4135cda4”

Response:

HTTP/1.x 304 Not Modified

Via: The-proxy-server

Expires: Tue, 27 Dec 2005 11:25:19 GMT

Date: Tue, 27 Dec 2005 05:25:19 GMT

Server: Apache/1.3.33 (Unix) PHP/4.3.10

Keep-Alive: timeout=2, max=99

Etag: “4135cda4”

Cache-Control: max-age=21600

Question

Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message.

a. What is the URL of the document requested by the browser? cs118/index.html

b. What version of HTTP is the browser running? HTTP/1.1

c. Does the browser request a non-persistent or a persistent connection? The browser requests a persistent connection. This is shown by the line "Connection:keep-alive."

GET /cs118/index.html HTTP/1.1<cr><lf>

Host: gaia.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (Windows;U;Windows NT 5.1; en-US; rv:1.7.2) Gecko/20040804 Netscape/7.2 (ax) <cr><lf>

Accept:ext/xml, application/xml, application/xhtml+xml, text/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5<cr><lf>

Accept-Language: en-us,en;q=0.5<cr><lf>

AcceptEncoding: zip,deflate<cr><lf>

Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7<cr><lf>

Keep-Alive: 300<cr><lf>

Connection:keep-alive<cr><lf><cr><lf>

Question

Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message.

d. What is the IP address of the host on which the browser is running?
gaia.cs.umass.edu

e. What type of browser initiates this message? Why is the browser type needed in an HTTP request message?
The type of browser that initiates this message is Mozilla 5.0 on Windows. The browser type is needed in an HTTP request message because different browsers may handle the same webpage differently, due to having different capabilities.

GET /cs118/index.html HTTP/1.1<cr><lf>

Host: gaia.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (Windows;U;Windows NT 5.1; en-US; rv:1.7.2) Gecko/20040804 Netscape/7.2 (ax) <cr><lf>

Accept:ext/xml, application/xml, application/xhtml+xml, text/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5<cr><lf>

Accept-Language: en-us,en;q=0.5<cr><lf>

AcceptEncoding: zip,deflate<cr><lf>

Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7<cr><lf>

Keep-Alive: 300<cr><lf>

Connection:keep-alive<cr><lf><cr><lf>

Question

The text below shows the reply sent from the server in response to the HTTP GET message in the question above.

a. Was the server able to successfully find the document or not? What time was the reply provided?

The status code of 200 and the phrase OK indicate that the server was able to locate the document successfully. The reply was provided on Tuesday, 07 Mar 2008 12:39:45 Greenwich Mean Time.

b. When was the document last modified?

Saturday 10 Dec 2005 18:27:46 GMT

c. How many bytes are there in the document being returned? 3874 bytes

a. What are the first 5 bytes of the document being returned? Did the server agree to a persistent connection? <!doc

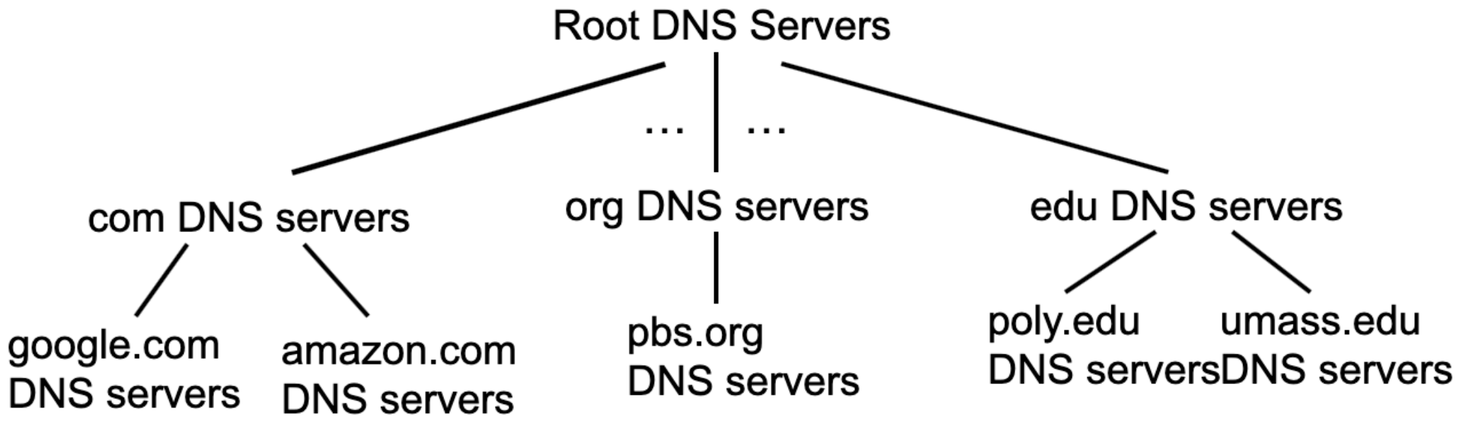
HTTP/1.1 200 OK<cr><lf>
Date: Tue, 07 Mar 2008 12:39:45GMT<cr><lf>
Server: Apache/2.0.52 (Fedora) <cr><lf>
Last-Modified: Sat, 10 Dec2005 18:27:46 GMT<cr><lf>
ETag: "526c3-f22-a88a4c80"<cr><lf>
Accept- Ranges: bytes<cr><lf>
Content-Length: 3874<cr><lf>
Keep-Alive: timeout=max=100<cr><lf>
Connection: Keep-Alive<cr><lf>
Content-Type: text/html; charset =ISO-8859-1<cr><lf><cr><lf>
<!doctype html public "- //w3c//dtd html 4.0 transitional//en"><lf><html><lf> <head><lf> <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1"><lf><meta name="GENERATOR" content="Mozilla/4.79 [en] (Windows NT 5.0; U) Netscape]"><lf> <title>CMPSCI 453 / 591 / NTU-ST550A Spring 2005 homepage</title><lf></head><lf>
<much more document text following here (not shown)>

Application Layer: Protocols

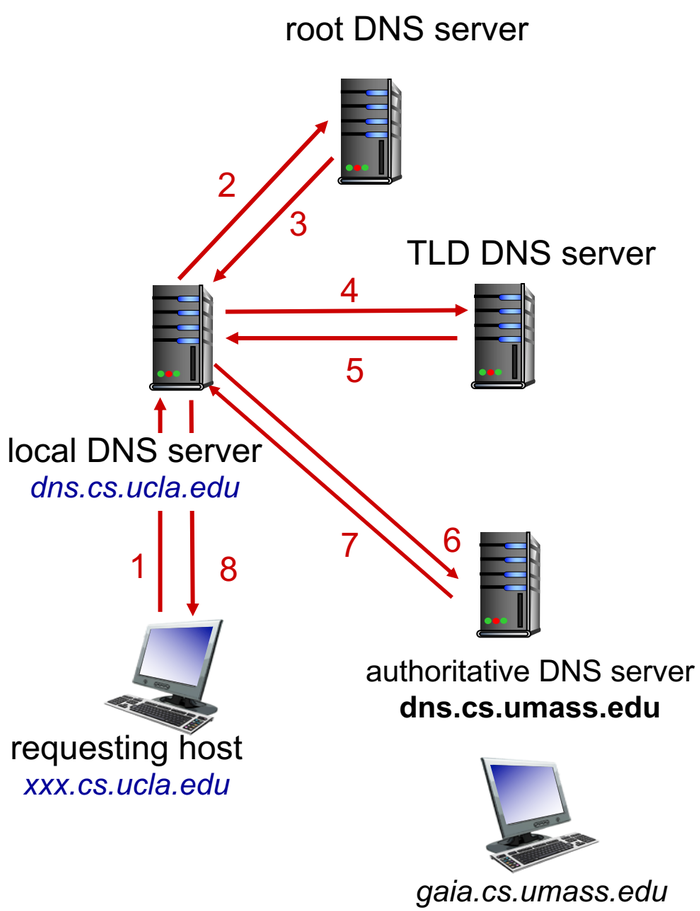
- SMTP: protocol for email exchange between mail servers
  - Protocol between user agent and mail server: POP, IMAP, HTTP-based
- P2P: no always-on server, peers are intermittently connected
  - BitTorrent: tracker and torrent. Files are divided into multiple chunks.

Application Layer: Protocols

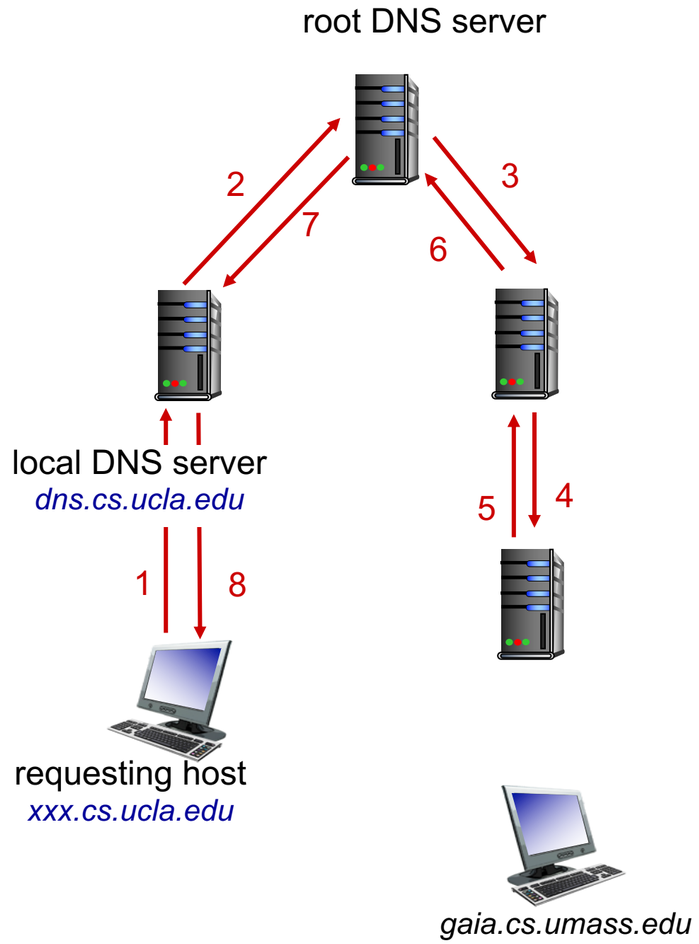
- DNS: convert hostname to IP address (and more)
- Transport-layer protocol: mainly over UDP
- A distributed and hierarchical database: achieve scalability
  - Root DNS servers
  - Top-level domain (TLD) servers
  - Authoritative DNS servers
  - local DNS server (aka, DNS resolver)



Iterative query - Recursive query



Iterative



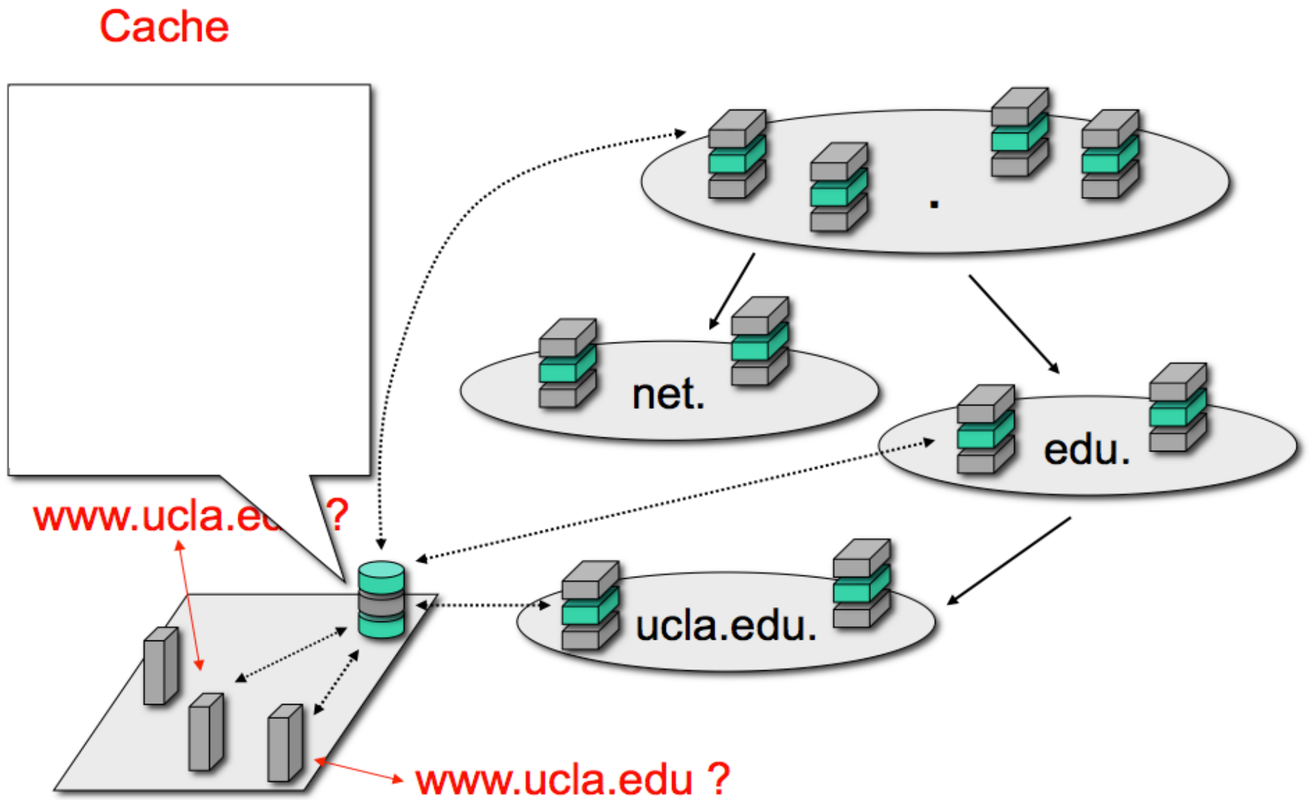
Recursive: heavy load on upper levels

DNS protocol: exercise

- Assume the cache is empty initially
- Host A queries www.ucla.edu, how many queries should the resolver issue?
- After A's DNS query, host B queries www.mit.edu, how many queries should the resolver issue?

DNS protocol: exercise

- Assume the cache is empty initially
- Host A queries www.ucla.edu, how many queries should the resolver issue?



DNS protocol: exercise

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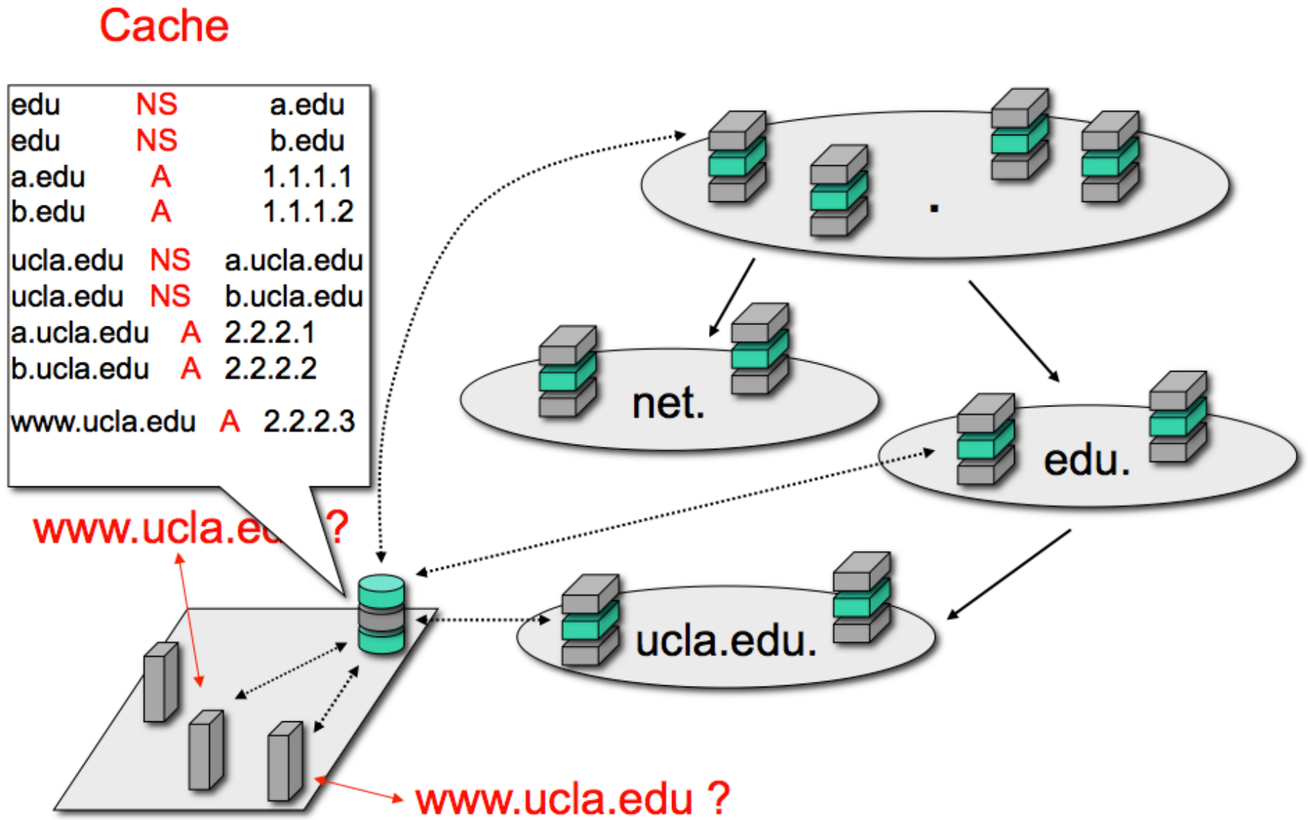

DNS protocol: exercise

- Assume the cache is empty initially
- Host A queries www.ucla.edu, how many queries should the resolver issue?
  - 3 queries. To root DNS server, edu DNS server and ucla.edu DNS server
- After A's DNS query, host B queries www.mit.edu, how many queries should the resolver issue?
  - 2 queries. To edu DNS server and ucla.edu DNS server, given the IP address of edu DNS server is cached.