Computer Network Midterm 106-1

1. Consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 128 kbps bit stream on the fly. Host A then groups the bits into 256-byte packets. There are two links between Hosts A and B; the first link has its transmission rate 2 Mbps and its propagation delay 10 msec. The second link has its transmission rate 10 Mbps and its propagation delay 5 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)? (12%)

Ans:

Consider the first bit in a packet. Before this bit can be transmitted, all of the bits in the packet must be generated. This requires

$\frac{256*8}{128*10^3}\text{sec} = 16\ \text{msec}$ (3%)

The time required to transmit the packet in the first link is

$d_{trans1} = \frac{256*8}{2*10^6}\text{sec} = 1.024\ \text{msec}$ (3%)

$d_{prop1} = 10\ \text{msec}$

The time required to transmit the packet in the second link is

$d_{trans2} = \frac{256*8}{10*10^6}\text{sec} = 0.2048\ \text{msec}$ (3%)

$d_{prop2} = 5\ \text{msec}$

The delay until decoding is

$\underline{16\ \text{msec} + 1.024\ \text{msec} + 10\ \text{msec} + 0.2048\ \text{msec} + 5\ \text{msec} = \mathbf{32.2288\ msec}}$ (3%)

2. Suppose 2*N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for (a) the first N packets, (b) the last N packets (N+1~2*N) and (c) the total 2*N packets? (4% each, 12% total)

Ans:

(a) The queuing delay is 0 for the first transmitted packet, L/R for the second transmitted packet, and generally, $(n-1)L/R$ for the n^{th} transmitted packet. Thus, the average delay for the first N packets is:

$\underline{(L/R + 2L/R + \ldots\ldots + (N-1)L/R)/N}$ *(2%)*

$= L/(RN) * (1 + 2 + \ldots\ldots + (N-1))$

$= L/(RN) * N(N-1)/2$

$= LN(N-1)/(2RN)$

$\underline{= \mathbf{(N-1)L/(2R)}}$ ***(2%)***

(b) The queuing delay is nL/R for the $(n+1)^{th}$ transmitted packet, $(n+1)L/R$ for the $(n+2)^{th}$ transmitted packet, and generally, $(2*n-1)L/R$ for the $(2*n)^{th}$ transmitted packet. Thus, the average delay for the last N packets is:

$$(NL/R + (N+1)L/R + \ldots\ldots + (2*N-1)L/R)/N$$
$$= L/(RN) * (N + (N+1) + \ldots\ldots + (2*N-1))$$
$$= L/(RN) * N(3N-1)/2$$
$$= LN(3N-1)/(2RN)$$
$$= \underline{\mathbf{(3N-1)L/(2R)}}$$

(c) The average delay for the total 2*N packets is:

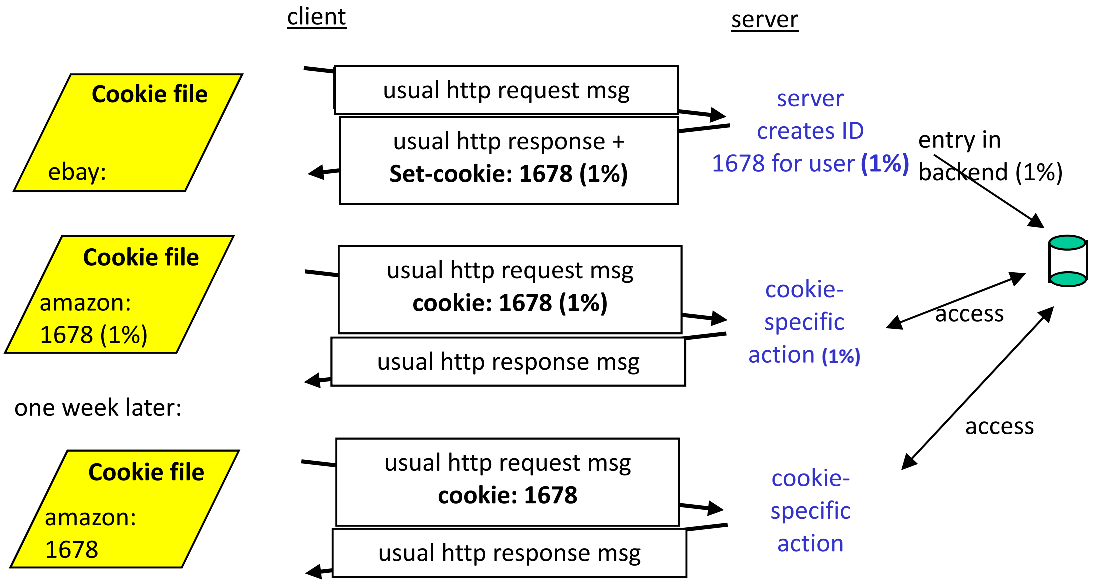
$$\frac{\frac{L}{R}+\frac{2L}{R}+\ldots\ldots+\frac{(N-1)L}{R}+\frac{NL}{R}+\frac{(N+1)L}{R}+\ldots\ldots+\frac{(2*N-1)L}{R}}{2N}$$
$$= L/(2RN) * (1 + 2 + \ldots\ldots + (2*N-1))$$
$$= L/(2RN) * 2N(2N-1)/2$$
$$= LN(2N-1)/(2RN)$$
$$= \mathbf{(2N-1)L/2R}$$

3. (a) Describe detailed operations of HTTP cookie, web caching and conditional GET. (6*3=18%)（說明其用處，並畫圖加解釋每步驟）(b) Describe how Web caching can reduce the delay in receiving a requested object. (2%) (18% total)

Ans:

❑ cookie:

when a user visits a specific web site for first time and initial HTTP requests arrives at site, site creates a unique ID and creates an entry in backend database for recording user states of this ID.
=> keep client's states (cookie-specific action)!



❑ web caching:

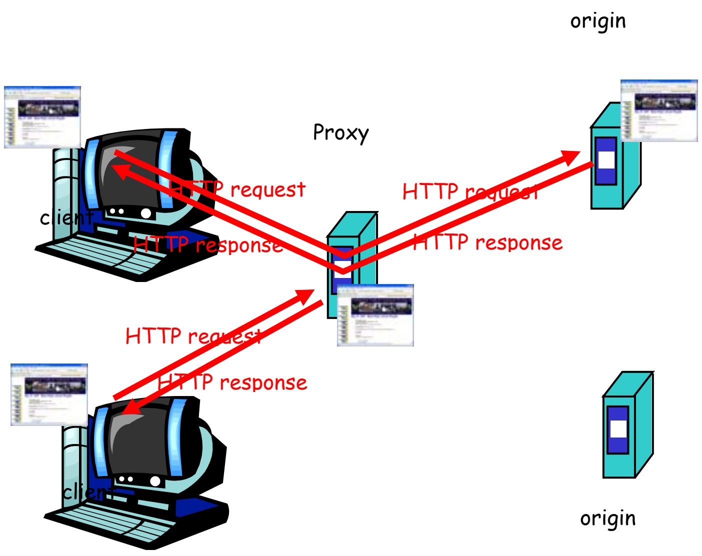
- user sets browser: Web accesses via cache
- browser sends all HTTP requests to cache (2%)

if object in cache

cache returns object (2%)

else

cache requests object from origin server, then returns object to client (2%)



conditional GET (6%)

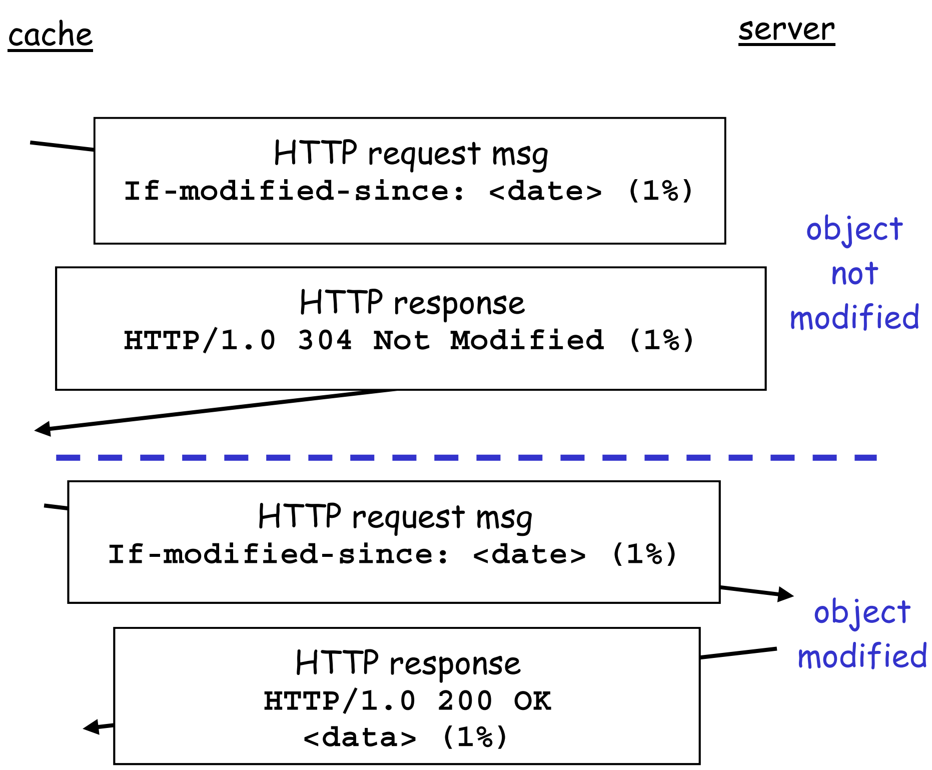
- Conditional GET: don’t send object if cache has up-to-date cached version (1%) => reduce traffic loads (delays) on network links! (1%)

  cache: specify date of cached copy in HTTP request (1%)

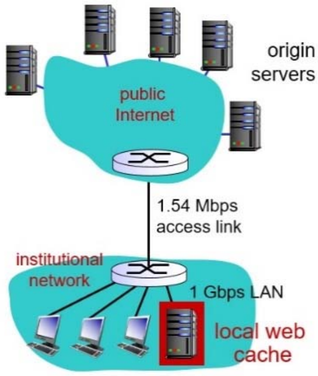
  If-modified-since: <date> (1%)

  server: response contains no object if cached copy is up-to-date: (1%)

  HTTP/1.0 304 Not Modified (1%)



4. Assume the rate of the institutional network is R_l and that of the access link is R_b. Suppose there are N clients requesting a file of size L from the file server on the Internet with HTTP at the same time. For what values of R_l would the file transfer takes less time when a proxy is installed at the institutional network? (Assume the RTT between a client and any other host in the institutional network is negligible.) (10%)



Ans:

Without a proxy, all clients need to reach the origin server on the Internet and share the bandwidth of the access link. As a consequence, the total transfer time is $\mathrm{N} \times \mathrm{L}/R_b$ (3%)

If a proxy is installed, the client share the bandwidth on the local link with the proxy. Thus, total transfer time is $\mathrm{L}/R_b + N \times L/R_l$ (3%)

The file transfer is faster with the proxy when

$$\mathrm{N} \times \mathrm{L}/R_b > \mathrm{L}/R_b + N \times L/R_l$$

$$(\mathrm{N}-1) \times \mathrm{L}/R_b > N \times \mathrm{L}/R_l$$

$$\frac{\mathrm{N}-1}{R_b} > \frac{N}{R_l}$$

$$R_l > \frac{N}{N-1} \times R_b \quad (4\%)$$

5. Assume you request a webpage consisting of one document and five images. The document size is 1kbyte, all images have the same size of 50 kbytes, the download rate is 1Mbps, and the RTT is 100ms. How long does it take to obtain the whole webpage under the following conditions? <u>Why?</u> （要說明(a)(b)的動作與計算過程每個部分在算什麼值）(Assume no DNS name query is needed and the impact of the request line and the headers in the HTTP messages is negligible). (13% total)

a. Nonpersistent HTTP with serial connections. (7%)

b. Persistent HTTP with one connection. (6%)

Ans:

The total download time is:

a. <u>At most one object is sent over a TCP connection</u>. *(2%)*

$$2 \cdot 100 \ \mathrm{ms}\left(\mathrm{TCP\ \ handshaking} + \mathrm{HTTP}\frac{\mathrm{request}}{\mathrm{response}}\mathrm{for\ \ web\ \ page}\right) + 8 * \frac{10^3 bits}{\frac{10^6 bits}{s}}\ (document\ \ transmission\ \ delay) + 5 \cdot \{2 \cdot 100ms\left(\mathrm{TCP\ \ handshaking} + \mathrm{HTTP}\frac{\mathrm{request}}{\mathrm{response}}\mathrm{for\ \ 1\ \ object}\right) + 8 \cdot \frac{50*10^3 bits}{\frac{10^6 bits}{s}}(image\ \ transmission\ \ delay)\} = 3.208s$$

(1% each, 5% total)

b. <u>Multiple objects can be sent over single TCP connection between client and server. The browser first waits to receive a HTTP response from the server before issuing a new HTTP request</u>. *(2%)*

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$2 \cdot 100 \text{ ms}\left(\text{TCP handshaking} + \text{HTTP}\frac{\text{request}}{\text{response}}\text{for web page}\right) + 8 * \frac{10^3 bits}{\frac{10^6 bits}{s}}\ (document\ transmission\ delay) + 5 \cdot \{100ms(\text{HTTP}\frac{\text{request}}{\text{response}}\text{for 1 object}) + 8 \cdot \frac{50*10^3 bits}{\frac{10^6 bits}{s}}(image\ transmission\ delay)\} = 2.708s.$ (1% each, 4% total)

6. (a) Explain Internet protocol stack (1% each layer's name, 1% each layer's functions, 10% total) (b) Besides, you have to write the name of data unit of upper four layer. (寫出最上面四層資料單位的專有名稱，如 xx 層：yy) (4%) (14% total)

Ans:

(a)

application: supporting network applications

transport: host-host data transfer

network: routing of datagrams from source to destination

link: data transfer between neighboring network elements

physical: bits "on the wire" (1% each layer's name, 1% each layer's functions, 10% total)

application
transport
network
link
physical

(b)

application layer: message

transport layer: segment

network layer: datagram

link layer: frame

各 1%，共 4%

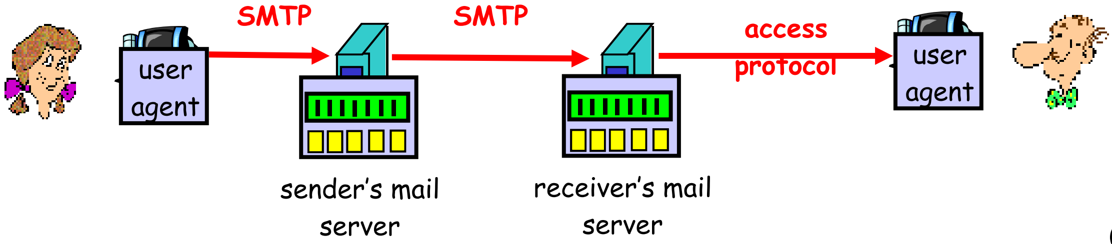
7. What are the major differences between SMTP and POP3? (4%) Draw a figure to show the mail-sending flow and all necessary modules among two end users. (7%) (11% total)

Ans:

POP: Mail access protocol: retrieval from server (說明 2%)

SMTP:

- direct transfer between mail servers to send email messages (說明 2%)



(1% each, 7% total)

8. (a) Compare the circuit switching and packet switching on resource usage, performance, and call setup. (6%) (b) Draw two figures to explain two circuit switching techniques. (4%) (10% total)

Ans:

(a) Circuit-switching: (1% each, total 6%)

  i. end-end resources reserved for "call", like link bandwidth, switch capacity. dedicated resources: no sharing
  ii. circuit-like (guaranteed) performance
  iii. call setup required

 Packet-switching:

  i. each end-end data stream divided into *packets*. User A, B packets *share* network resources *as needed*
  ii. resource contention may degrade performance.
  iii. no call setup required

(b) FDM and TDM (2% each: time/frequency, user)