Computer Network Midterm 110-1-A

1. (a) Explain Internet protocol stack (1% each layer's name, 1% each layer's function, 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, function 1%, 10% total)

application
transport
network
link
physical

(b)

application layer: message
transport layer: segment
network layer: datagram
link layer: frame
各 1%，共 4%

2. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has four links, of rates R1=150kbps, R2= 0.2Mbps, R3= $1*10^{-7}$Tbps, and R4=0.0012Gbps. (要有計算式或說明，以及最後答案) (8% total)

a. Assume no other traffic in the network, what is the throughput for the file transfer? (2%)

b. Suppose the file is 15 million bytes. Dividing the file size by the throughput, roughly how long (in second) will it take to transfer the file to Host B? (2%)

c. Repeat (a) and (b), but now with R1 reduced to 50kbps. (2%) (2%)

Ans :

a) min{150kbps, 0.2Mbps, $1*10^{-7}$Tbps, 0.0012Gbps}=$1*10^{-7}$Tbps =100kbps (2%)

b) $15*10^6*8/(100*10^3)$=1200 seconds (2%)

c) min{50kbps, 0.2Mbps, $1*10^{-7}$Tbps, 0.0012Gbps}=50kbps; (2%)

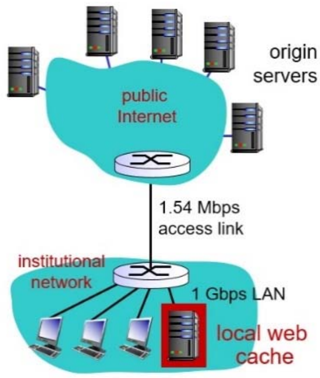
$15*10^6*8/(50*10^3)$=2400 seconds (2%)

3. 答案請畫表格出來 (0.5%, 10%)

Application	Application layer protocol	Transport layer protocol	Data Loss	Elastic Bandwidth	Time Sensitive
File transfer	FTP	TCP	No	Yes	No
e-mail	SMTP	TCP	No	Yes	No

Web	HTTP	TCP	No	Yes	No
Real-time streaming multimedia	HTTP, RTP （都要寫）	TCP, UDP （都要寫）	Yes	No	Yes

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

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

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

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

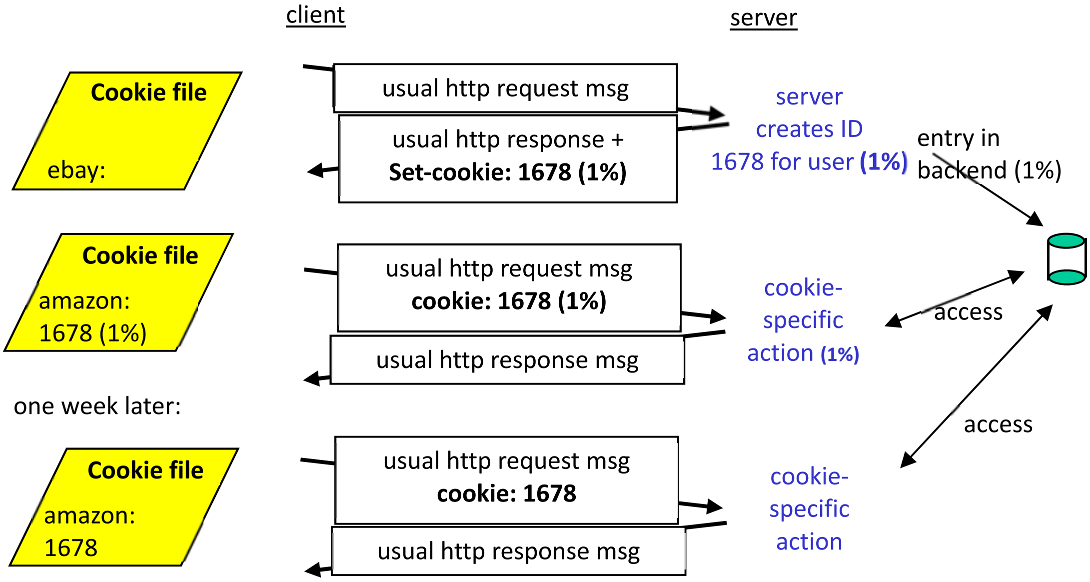
$$R_l > \frac{N}{N-1} \times R_b \quad (4\%)$$

5. 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）

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)!

Computer Network Midterm 110-1-A



❑ web caching:

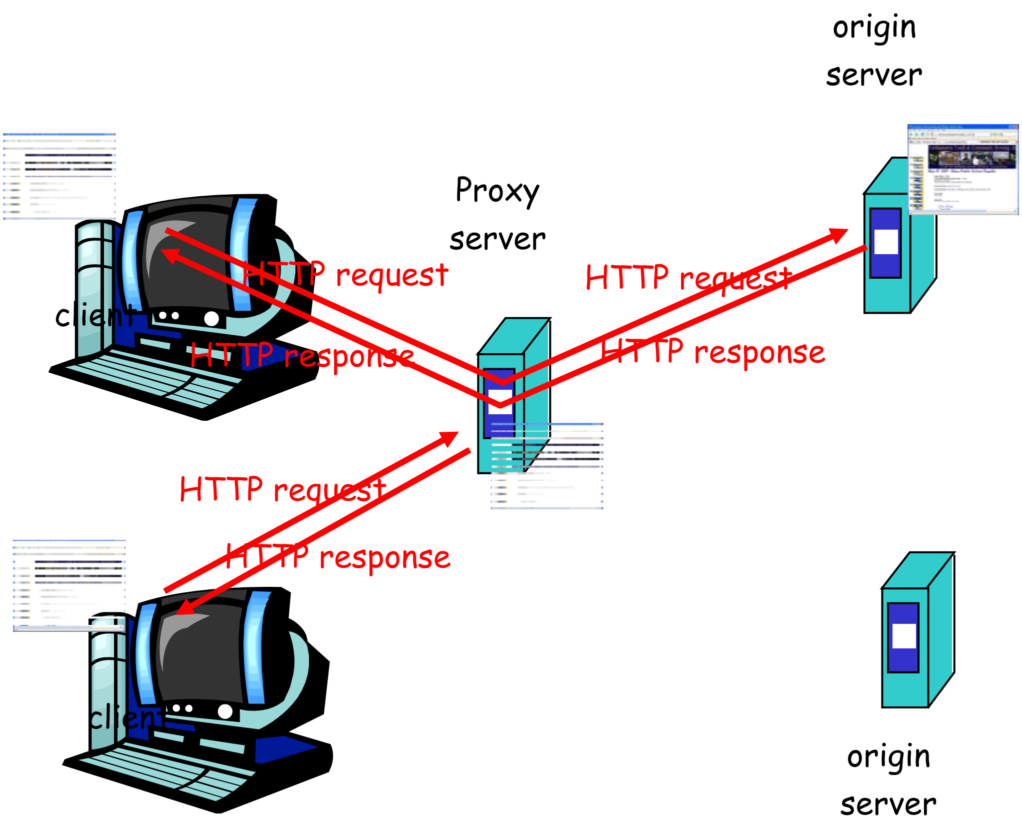
- user sets browser: Web accesses via cache
- browser sends all HTTP requests to cache (2%)

    if object in cache

        cache returns object (2%)

    else

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



conditional GET (6%)

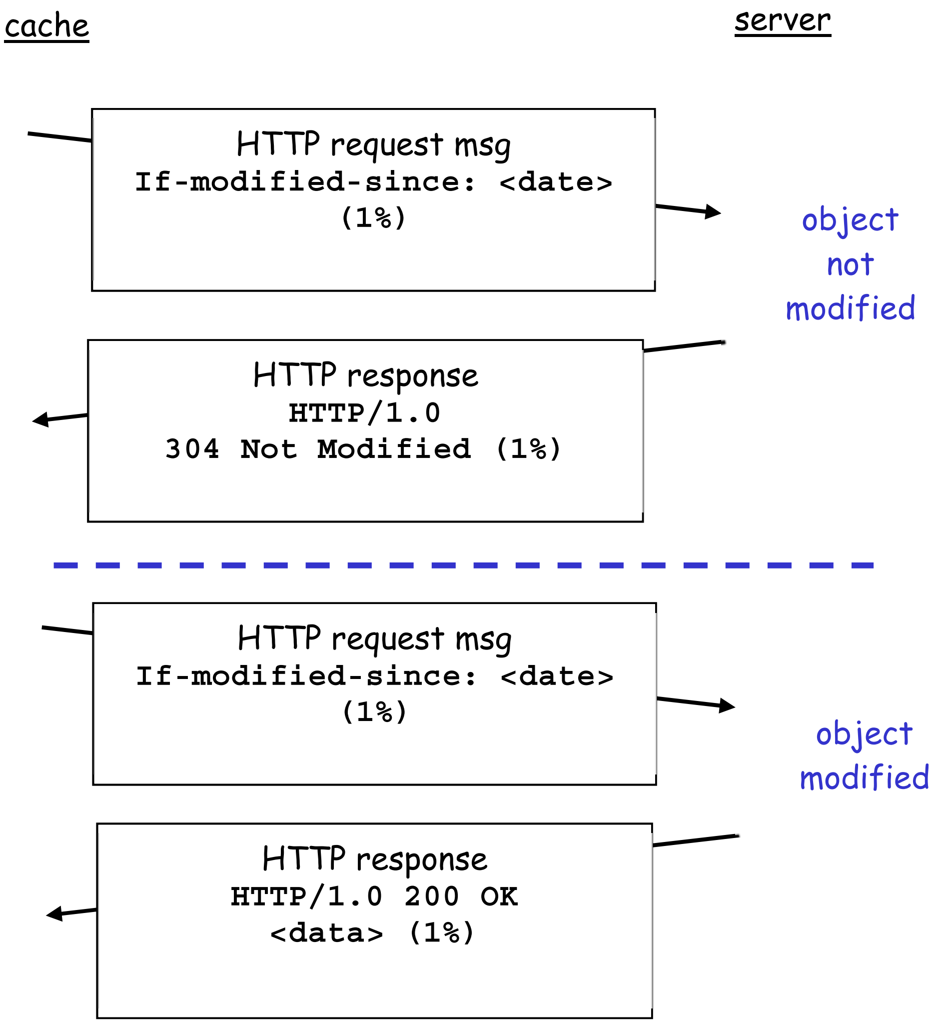
- Conditional GET: don't send object if cache has up-to-date cached version (1%) => reduce traffic loads (delays) on network links! (1%)

  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%)



6. 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 256 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 4 Mbps and its propagation delay 5 msec. The second link has its transmission rate 10 Mbps and its propagation delay 15 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. (a) How much time elapses from the time a bit is created (from the original analog signal at Host A) until all of the bits in the packet are generated? (2%) (b) How much time required to transmit the packet in the first link? (c) How much time required to transmit the packet in the first link? (d) 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)? (4%, 10% total)

Ans:

(a) 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

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

(b) The time required to transmit the packet in the first link is

$d_{trans1} = \frac{256*8}{4*10^6}sec = 0.512\ msec$ (2%)

$d_{prop1} = \mathbf{5}\ msec$

(c) The time required to transmit the packet in the second link is

$d_{trans2} = \frac{256*8}{10*10^6}sec = 0.2048\ msec$ (2%)

$d_{prop2} = \mathbf{15}\ msec$

(d) The delay until decoding is

$\underline{8\ msec + 0.512\ msec + 5\ msec + 0.2048\ msec + 15\ msec = \mathbf{28.7168\ msec}}$ (4%)

7. Suppose you click a hyperlink (http://www.ncue.edu.tw) to obtain a Web page. The IP address for the associated URL is NOT cached in your local host, so a DNS lookup is needed to obtain the IP address. Suppose that *n* DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of $RTT_1, \ldots, RTT_n$. Further suppose the HTML file references four very small objects on the same server. Assuming RTT_0 denotes the round trip time between your host and the server containing the object. Assuming zero transmission time of the object, how much time elapses with (a) nonpersistent HTTP with no parallel TCP connections, (b) persistent HTTP without pipelining, (c) persistent HTTP with pipelining, from when the client clicks on the link until the client receives the Web page and the five objects? (說明每項的動作，畫出過程的時間圖，並解釋如何計算時間，12%)

Ans:

Once the IP address is known by querying DNS servers, RTT_O elapses to set up the TCP connection and another RTT_O elapses to request and receive the Web object.

(a) nonpersistent HTTP without parallel TCP connections:

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

$RTT_1+\ldots+RTT_n$+[1 RTT_0 (TCP handshaking) + 1 RTT_0 (HTTP request/response)]* 5 objects (1 Web page + 4 objects) = $\underline{RTT_1+\ldots+RTT_n+10\ RTT_0}$ (2%)

(b) persistent HTTP without pipelining:

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. *(2%)*

$RTT_1+\ldots+RTT_n$+1 RTT_0 (TCP handshaking) + 1 RTT_0 (HTTP request/response) * 5 objects = $\underline{RTT_1+\ldots+RTT_n+6\ RTT_0}$ (2%)

(c) persistent HTTP with pipelining:

The browser issues requests as soon as it has a need to do so, without waiting for response messages from the server. *(2%)*

$RTT_1+\ldots+RTT_n$+1 RTT_0 (TCP handshaking) + 1 RTT_0 (HTTP request/response for web page) + 1 RTT_0 (HTTP request/response for 4 objects) = $\underline{RTT_1+\ldots+RTT_n+3\ RTT_0}$ (2%)

12% total

8. Describe two application architectures. (8%)

Ans: (a) client-server (2%)

server:

always-on host, permanent IP address (1%)

clients:

communicate with server, do not communicate directly with each other

may be intermittently connected and have dynamic IP addresses (1%)

(b) peer-to-peer: (2%)

no always-on server (1%)

arbitrary end systems directly communicate

peers are intermittently connected and change IP addresses (1%)

9. 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 the first N packets? (10%)

Ans:

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:

$\underline{(L/R + 2L/R + \ldots\ldots + (N-1)L/R)/N}$ *(5%)*

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

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

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

$\underline{= \mathbf{(N-1)L/(2R)}}$ ***(5%)***