Computer Networks Final (102/1)

只寫答案而沒有解釋說明，扣一半分數

1. (a) Explain how TCP Fast Retransmit works. (6%)
   (b) How TCP does its flow control? (6%)

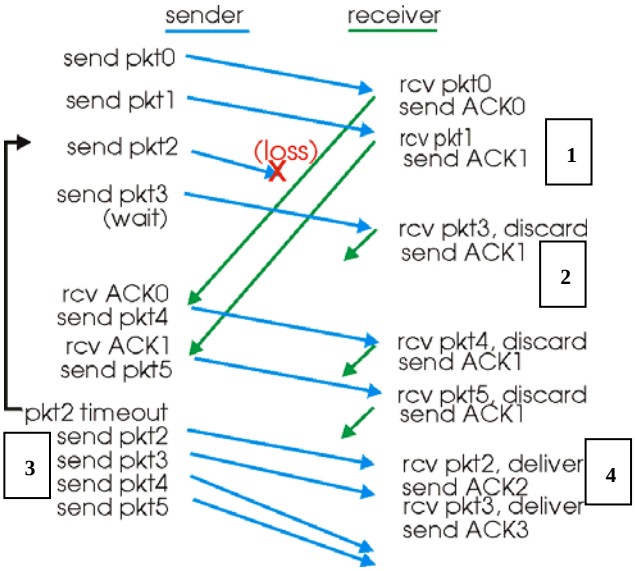
2. (a) What three services are provided by the domain name system? (3%)
   (b) Explain iterated query and recursive query (4%)
   (c) Authoritative DNS servers (2%)

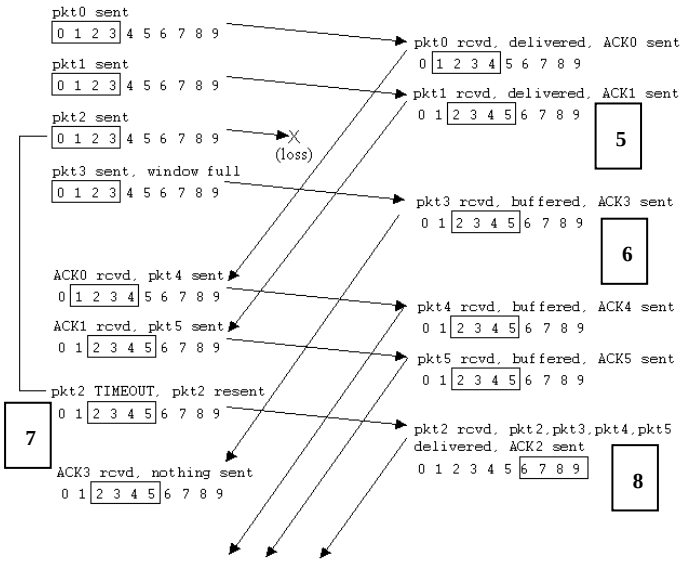
3. What are the major differences between SMTP and POP3? (4%) Draw a figure to show the mail-sending flow and all necessary modules among two end users. (7%) (11% total)

4. Draw the flow of the TCP three way handshake to explain its operations. Suppose the initial sequence numbers of the client and the server are 1 and 299, respectively. 必須在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (10%)

5. How sender and receiver detect “errors” in transmitted TCP/UDP segment? (10%)

6. List and compare two pipelined transport protocols with these two figures. (寫出 Window=? 與各標號處的動作 10%)





7. (a) Describe how TCP Reno does its congestion control. (8%)
   (b) Answer and justify the following questions. (8%)
   a. Identify the TCP slow start intervals. (2%)
   b. Identify the TCP congestion avoidance intervals. (2%)
   c. After the 22th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (2%)
   d. Assume a packet loss is detected after the 26th round by the receipt of a timeout event, what are the congestion-window size and Threshold value? (2%)

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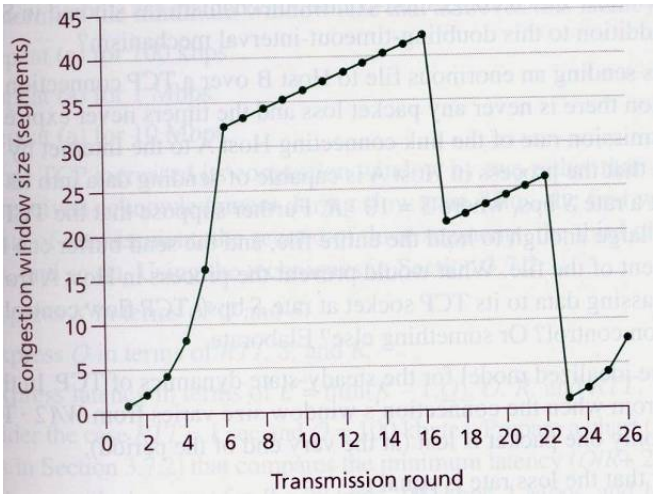

8. Consider the TCP procedure for estimating RTT ($EstimatedRTT^{n} = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$).

(a)Why TCP uses this function? (3%)

(b)Let $SampleRTT^{n}$ be the most recent sample RTT, let $SampleRTT^{n-1}$ be the next most recent sample RTT, and so on. Express EstimatedRTT in terms of n SampleRTTs if $EsitmatedRTT^{1} = 0$. (8%)

(c) If n=4 and α=0.1, what are <u>coefficients of $SampleRTT^{1}$, $SampleRTT^{2}$ and $SampleRTT^{3}$</u> when calculating EstimatedRTT? (3%)

9. What are the two key network-layer functions in a datagram network? (8%)

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只寫答案而沒有解釋說明，扣一半分數

1. (a) Explain how TCP Fast Retransmit works. (6%)
   (b) How TCP does its flow control? (6%)

Ans:

(a) Explain how TCP Fast Retransmit works. (6%)
If sender receives 3 ACKs for the same data, (3%) it supposes that segment after ACKed data was lost: resend segment before timer expires (3%) (6% total)
(b) How TCP does its flow control? (6%)
Rcvr advertises spare room by including value of **RcvWindow** in segments (3%)
Sender limits unACKed data to **RcvWindow** for guaranteeing receive buffer doesn't overflow (3%)

2. (a) What three services are provided by the domain name system? (3%)
   (b) Explain iterated query and recursive query (4%)
   (c) Authoritative DNS servers (2%)

Ans:

(a) DNS services (3%)
- hostname to IP address translation
- host aliasing (Canonical, alias names)
- mail server aliasing

(b) iterated query: (2%)
- contacted server replies with name of server to contact

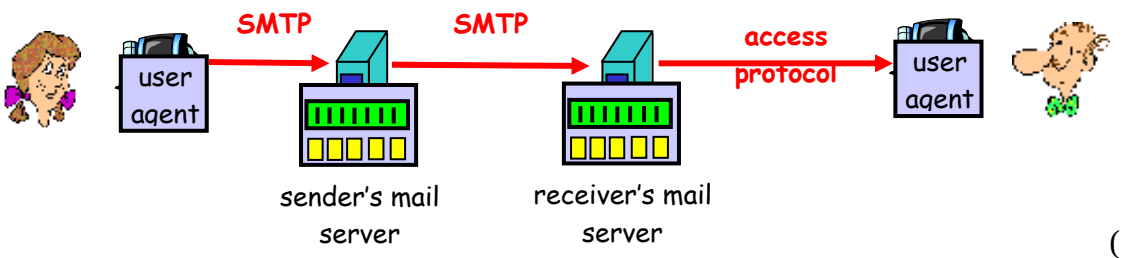
recursive query: (2%)
- contacted server forwards the DNS query to next server and waits for the reply

(c) authoritative DNS server (2%)
- organization's DNS servers, providing authoritative hostname to IP mappings for organization's servers

3. 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)

4. Draw the flow of the TCP three way handshake to explain its operations. Suppose the initial sequence numbers of the client and the server are 1 and 299, respectively. 必須在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (10%)

Ans: Three way handshake:

Step 1: client host sends TCP SYN segment to server (搭配圖要正確 2%)
Step 2: server host receives SYN, replies with SYNACK segment (4%)
Step 3: client receives SYNACK, replies with ACK segment, which may contain data (4%)

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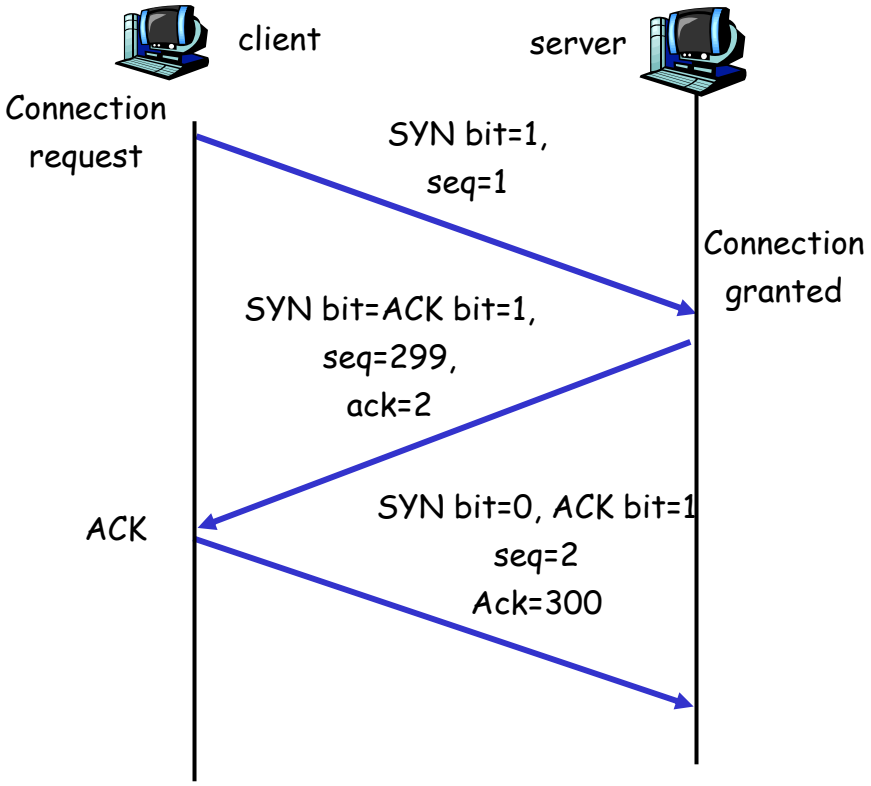

上圖每個符號含內容 1 分，標示不全者，視狀況扣分，共 10 分

5. How sender and receiver detect “errors” in transmitted TCP/UDP segment? (10%)

Ans: Sender:

treat segment contents as sequence of 16-bit integers

checksum: addition (1’s complement sum) of segment contents (2%)

sender puts checksum value into UDP checksum field (2%)

Receiver:

compute checksum of received segment (2%)

check if computed checksum equals checksum field value: (2%)

NO - error detected (1%) YES - no error detected. (1%)

6. List and compare two pipelined transport protocols with these two figures. (寫出 Window=? 與各標號處的動作 10%)

Ans:

Go-back-N (5%)

- “window” of up to N, consecutive unack’ed pkts allowed (window = 4) (1%)

(1) ACK-only: always send ACK for correctly-received pkt with highest *in-order* seq # (1%)

(2) out-of-order pkt:

- discard (don’t buffer) -> no receiver buffering! (1%)
- Re-ACK pkt with highest in-order seq # (1%)

(3) timeout(n): retransmit pkt n and all higher seq # pkts in window (1%)

(4) deliver in-order segments to upper layer. (1%)

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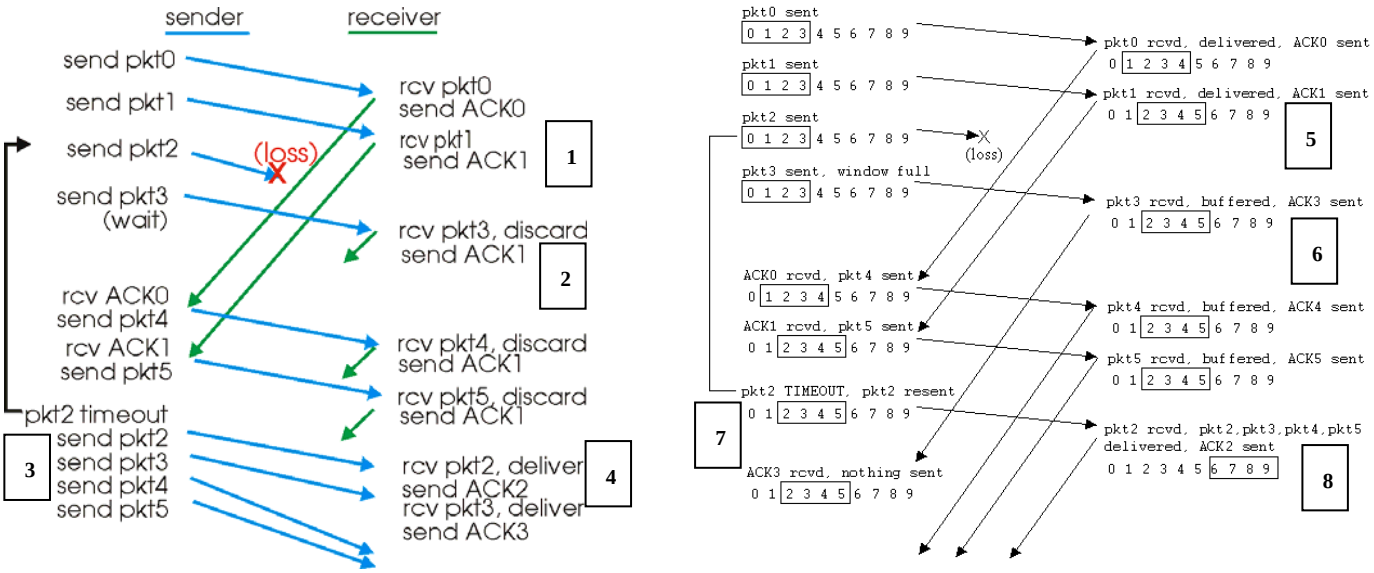

Selective Repeat (4%)
(5) receiver *individually* acknowledges all correctly received pkts (1%)
(6) buffers out-of order pkts (1%)
(7) sender only resends pkts for which ACK not received when timeout (1%)
(8) deliver total in-order pkts to upper layer (1%)

7. (a) Describe how TCP Reno does its congestion control. (8%)
(b) Answer and justify the following questions. (8%)
   a. Identify the TCP slow start intervals. (2%)
   b. Identify the TCP congestion avoidance intervals. (2%)
   c. After the 22th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (2%)
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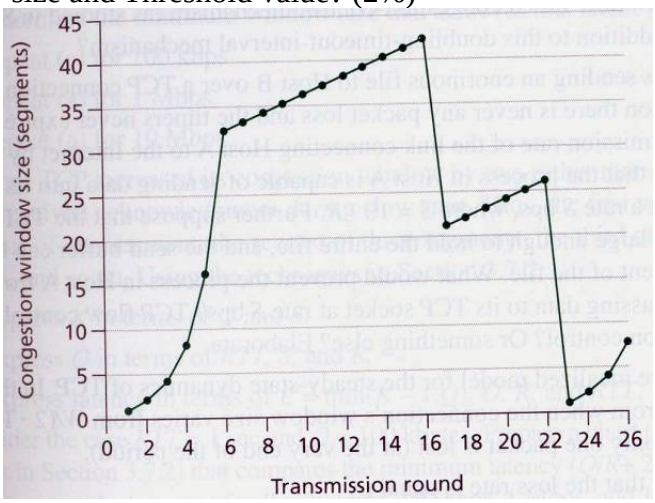

Ans: (8%)
When **CongWin** is below **Threshold**, sender in slow-start phase, window grows exponentially.
When **CongWin** is above **Threshold**, sender is in congestion-avoidance phase, window grows linearly.
When a triple duplicate ACK occurs, **Threshold** set to **CongWin/2** and **CongWin** set to **Threshold**.
When timeout occurs, **Threshold** set to **CongWin/2** and **CongWin** is set to 1 MSS.
(b) (8%)
a. TCP slowstart is operating in the intervals [1,6] and [23,26] (1% each, 2% total)

b. TCP congestion avoidance is operating in the intervals [6,16] and [17,22] (1% each, 2% total)
c. After the 22th transmission round, packet loss is recognized by a timeout event. (2%)
d. The congestion window and threshold will be set to half the current value of the congestion window (8) when the loss occurred. Thus the new values of the threshold will be 4 but and window will be 1. (說明 1%, 答案 1%，共 2%)

8. Consider the TCP procedure for estimating RTT ($EstimatedRTT^{n} = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$).
(a)Why TCP uses this function? (3%)
(b)Let $SampleRTT^{n}$ be the most recent sample RTT, let $SampleRTT^{n-1}$ be the next most recent sample RTT, and so on. Express EstimatedRTT in terms of n SampleRTTs if $EsitmatedRTT^{1} = 0$. (8%)
(c) If n=4 and α=0.1, what are coefficients of $SampleRTT^{1}$, $SampleRTT^{2}$ and $SampleRTT^{3}$ when calculating EstimatedRTT? (3%)

Ans: (a) Exponential weighted moving average => influence of past sample decreases exponentially fast. 據測量出來的 SampleRTT，估計下一次的 EstimatedRTT，用來設定下一次的 Timeout 時間 (3%)

(b) Denote $EstimatedRTT^{(n)}$ for the estimate after the *n*th sample.
(8%)

$$EstimatedRTT^{n} = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$$
$$= \alpha \times SampleRTT^{n-1} + (1-\alpha) \times [\alpha \times SampleRTT^{n-2} + (1-\alpha) \times EsitmatedRTT^{n-2}]$$
$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + (1-\alpha)^{2} \times EsitmatedRTT^{n-2}$$
$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + (1-\alpha)^{2} \times$$
$$[\alpha \times SampleRTT^{n-3} + (1-\alpha) \times EsitmatedRTT^{n-3}]$$
$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} + \alpha(1-\alpha)^{2} \times$$
$$SampleRTT^{n-3} + (1-\alpha)^{4} \times EsitmatedRTT^{n-3}$$
$$= .....$$
$$= \alpha \times SampleRTT^{n-1} + \alpha(1-\alpha) \times SampleRTT^{n-2} +$$
$$\alpha(1-\alpha)^{2} \times SampleRTT^{n-3} + ... + \alpha(1-\alpha)^{n-2} \times SampleRTT^{n-(n-1)}$$
$$+(1-\alpha)^{n-1} \times EsitmatedRTT^{n-(n-1)}$$
$$== \alpha \sum_{j=1}^{n-1} (1-\alpha)^{j-1} SampleRTT^{n-j} + (1-\alpha)^{n-1} EsitmatedRTT^{1}$$
$$= \alpha \sum_{j=1}^{n-1} (1-\alpha)^{j-1} SampleRTT^{n-j} \ (\because EsitmatedRTT^{1} = 0)$$

(c) As n=4 and α=0.1, (3%)

$$EstimatedRTT^{4} = \alpha \times SampleRTT^{4-1} + \alpha(1-\alpha) \times SampleRTT^{4-2} + (1-\alpha)^{2} \times$$
$$[\alpha \times SampleRTT^{4-3} + (1-\alpha) \times EsitmatedRTT^{4-3}]$$
$$= \alpha \times SampleRTT^{3} + \alpha(1-\alpha) \times SampleRTT^{2} + (1-\alpha)^{2} \times \alpha \times SampleRTT^{1}$$
$$= 0.1 \times SampleRTT^{3} + 0.1 \times (1-0.1) \times SampleRTT^{2} + (1-0.1)^{2} \times 0.1 \times SampleRTT^{1}$$
$$= 0.1 \times SampleRTT^{3} + 0.1 \times 0.9 \times SampleRTT^{2} + (0.9)^{2} \times 0.1 \times SampleRTT^{1}$$

9. What are the two key network-layer functions in a datagram network? (8%)
Ans: forwarding: move packets from router's input to appropriate router output
routing: determine route taken by packets from source to dest. (名稱 2%, 說明 2%, 8% total)