Computer Networks Final (103/1)

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%) (26% total)
   (b) How TCP does its flow control? (6%)
   (c) What values are used by TCP and UDP to identify their sockets? (6%)
   (d) Describe four operations to provide reliable data transfer over channels with errors and loss? (8%)

2. (a) List TCP seven characteristics (7%)
   (b) Consider TCP protocols. Suppose the sequence number space is of size *k*. What is the largest allowable sender window *w*? (5%)

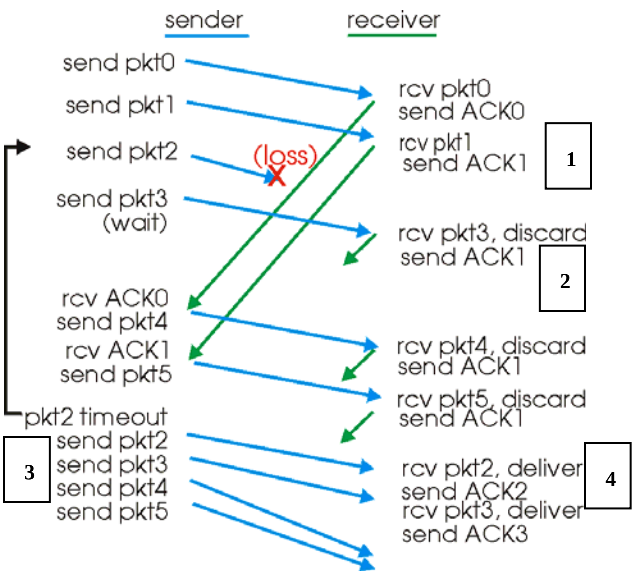
3. (a)Which tool allows the host running the tool to query any specified DNS server for a DNS record? (2%)
   (b) How to run the tool in (a) to execute "Please send me the host names of the authoritative DNS for ncue.edu.tw" operation? (4%)
   (c) How to run the tool in (a) to execute "Please send me the host names of `www.ncue.edu.tw, but` we want to the query sent to the DNS server *dns.hinet.net* rather than to the default DNS server" operation? (4%)
   (d) Which tool can be used to show your current TCP/IP information? (2%)
   (e) How to empty the DNS cache in your host? (2%) (14% total)

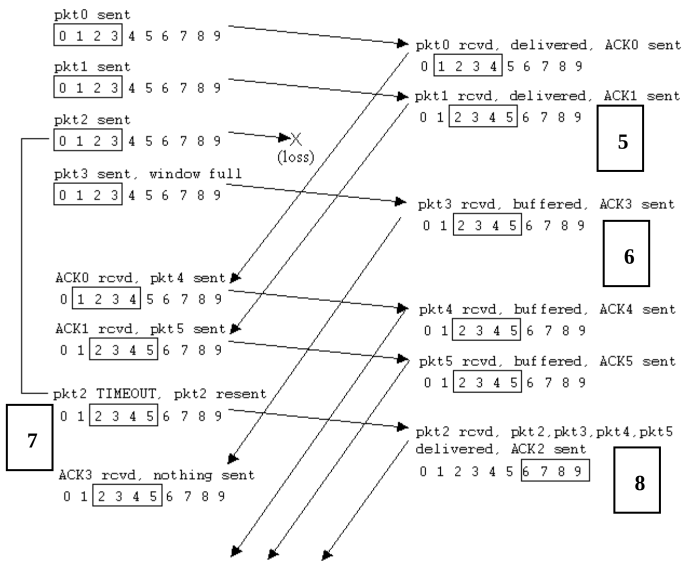
4. Draw the flow of the TCP three way handshake to explain its operations. Suppose the <u>initial sequence numbers of the client and the server are 300 and 2</u>, respectively. 必須在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (10%)

5. UDP and TCP uses 1's complement for their checksums. Suppose you have the following three 8-bit byptes: 00100011, 01001110, 01010100. What is the 1's complement for the sum of these 8-bit bytes? Show all work. （要寫出過程 6%） With the 1's complement scheme, how does the receiver detect errors? Is it possible that 1-bit error will go undetected? (2%) How about a 2-bit error? (2%) (10% total)

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

Computer Networks Final (103/1)



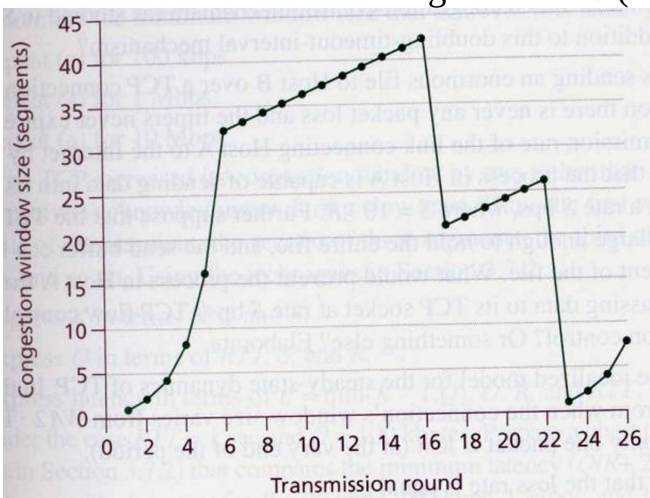


7. (a) Describe how TCP Reno does its congestion control. (8%) (12% total)

(b) Answer and justify the following questions. (4%)

a. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (2%)

b. During what transmission round is the 70th segment sent? (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? (2%)

(b) If n=3, α=0.2 and $EsitmatedRTT^{1} = 0$, what are <u>coefficients of $SampleRTT^1$ and $SampleRTT^2$</u> when calculating EstimatedRTT? (4%)

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   (b) How TCP does its flow control? (6%)
   (c) What values are used by TCP and UDP to identify their sockets? (6%)
   (d) Describe four operations to provide reliable data transfer over channels with errors and loss? (8%)

Ans:

(a) Explain how TCP Fast Retransmit works. (6%)

If sender receives <u>3 ACKs for the same data</u>, (2%) it supposes that <u>segment after ACKed data was lost</u> (2%): <u>resend segment before timer expires</u> (2%) (6% total)

(b) How TCP does its flow control? (6%)

<u>Rcvr advertises spare room by including value of **RcvWindow** in segments</u> (2%)
<u>Sender limits unACKed data to **RcvWindow**</u> (2%) for <u>guaranteeing receive buffer doesn't overflow</u> (2%)

(c) UDP socket identified by two-tuple: (dest IP address, dest port number) (2%)

TCP socket identified by 4-tuple: (4%)
- source IP address
- source port number
- dest IP address
- dest port number

(d) sender adds <u>*sequence number* to each pkt</u> to detect duplicate pkts (2%)

receiver uses <u>checksum</u> to detect bit errors (2%)
receiver sends <u>ACK with seq # of last pkt received OK</u> (2%)
sender <u>waits "reasonable" amount of time for ACK</u>, retransmits if no ACK received in this time (2%)

2. (a) List TCP seven characteristics (7%)
   (b) Consider TCP protocols. Suppose the sequence number space is of size *k*. What is the largest allowable sender window *w*? (5%)

Ans:

(a) (7%)
- point-to-point: one sender, one receiver
- reliable, in-order byte steam:
- pipelined: TCP congestion and flow control set window size
- send & receive buffers
- full duplex data: bi-directional data flow in same connection
- connection-oriented: handshaking (exchange of control msgs) init's sender, receiver state before data exchange
- flow controlled: sender will not overwhelm receiver

(b) The sequence number space must be at least twice as large as the window size, $k \geq 2w$. (5%)

3. (a)Which tool allows the host running the tool to query any specified DNS server for a DNS record? (2%)
   (b) How to run the tool in (a) to execute "Please send me the host names of the authoritative DNS for ncue.edu.tw" operation? (4%)
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   (d) Which tool can be used to show your current TCP/IP information? (2%)
   (e) How to empty the DNS cache in your host? (2%)
   (14% total)

Ans:

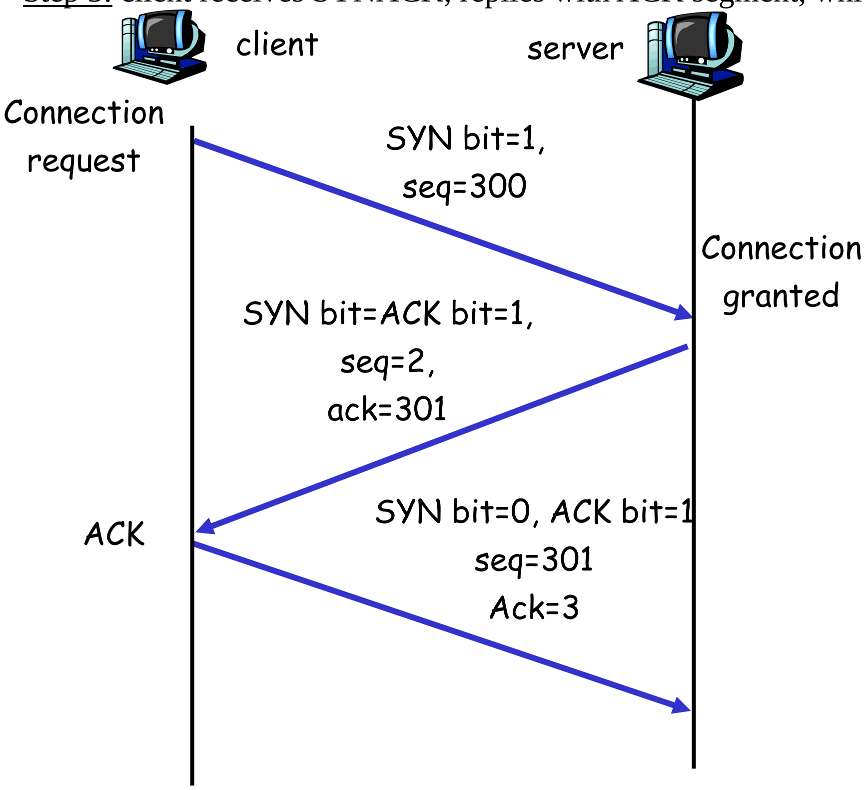
(a) *nslookup* (2%)

(b) nslookup –type=NS ncue.edu.tw (4%)
(c) nslookup www.ncue.edu.tw dns.hinet.net (4%)
(d) ipconfig (2%)
(e) ipconfig /flushdns (2%)

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 300 and 2, 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%)



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. UDP and TCP uses 1's complement for their checksums. Suppose you have the following three 8-bit byptes: 00100011, 01001110, 01010100. What is the 1's complement for the sum of these 8-bit bytes? Show all work. （要寫出過程 6%） With the 1's complement scheme, how does the receiver detect errors? Is it possible that 1-bit error will go undetected? (2%) How about a 2-bit error? (2%) (10% total)

Ans:

```
     00100011
+    01001110
----------------------------
     01110001   (2%)

     01110001
+    01010100
----------------------------
     11000101   (2%)
```

Computer Networks Final (103/1)

One's complement = <u>00111010</u> (2%)

To detect errors, the receiver <u>adds the four words (the three original words and the checksum)</u>. <u>If the sum contains a zero, the receiver knows there has been an error</u>. OR <u>check if computed checksum equals checksum field value. If NO, error is detected</u>. (2%)

<u>All one-bit errors will be detected</u> (2%), but <u>two-bit errors can be undetected</u> (2%) (e.g., if the last digit of the first word is converted to a 0 and the last digit of the second word is converted to a 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 (<u>window = 4</u>) (1%)

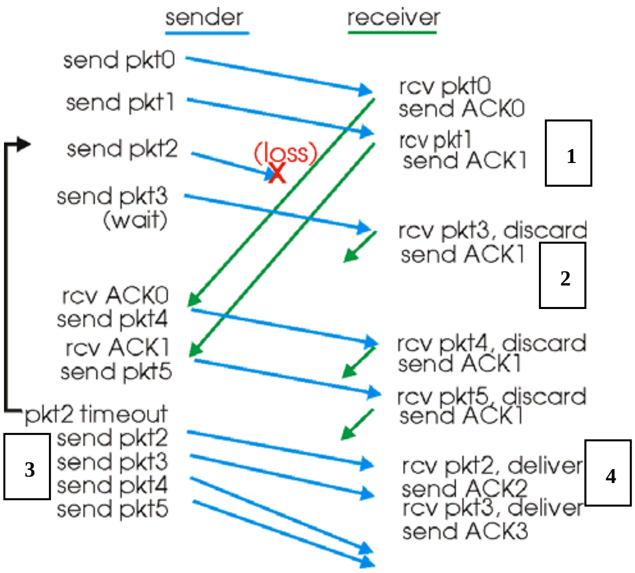
(1) ACK-only: always send ACK for correctly-received pkt with highest *in-order* seq # (1%)

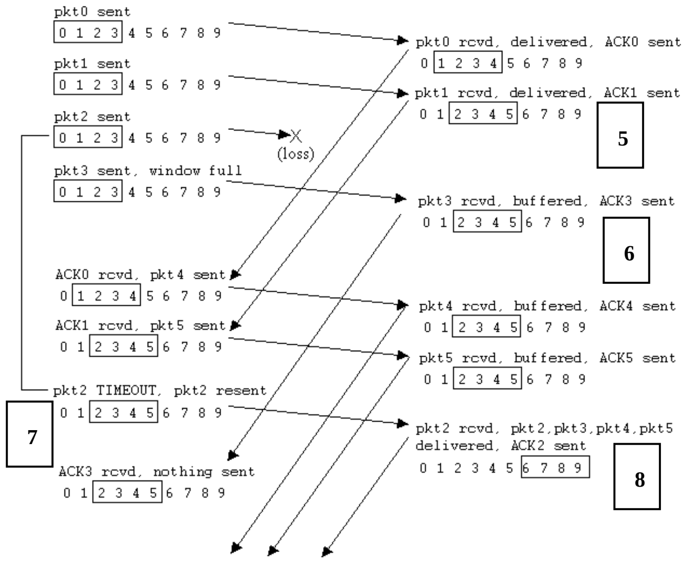
(2) out-of-order pkt:

- 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%)





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%)

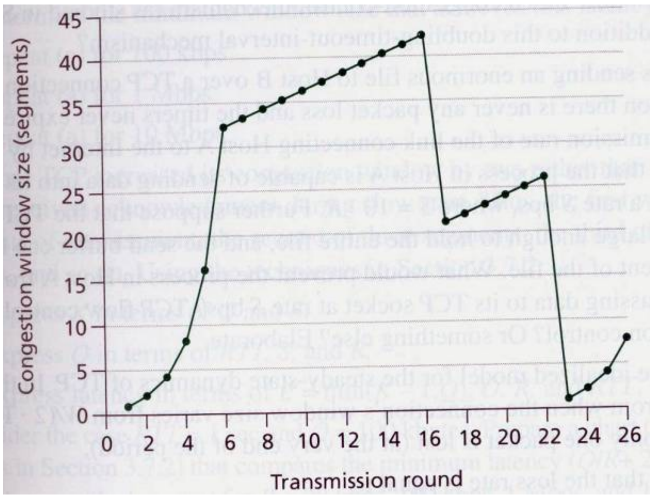
7. (a) Describe how TCP Reno does its congestion control. (8%) (12% total)

(b) Answer and justify the following questions. (4%)

c. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout? (2%)

d. During what transmission round is the 70th segment sent? (2%)

Computer Networks Final (103/1)



Ans: (8%)

When **CongWin** is below **Threshold** (1%), sender in slow-start phase, window grows exponentially (1%).

When **CongWin** is above **Threshold** (1%), sender is in congestion-avoidance phase, window grows linearly (1%).

When a triple duplicate ACK occurs (1%), **Threshold** set to **CongWin/2** and **CongWin** set to **Threshold** (1%).

When timeout occurs (1%), **Threshold** set to **CongWin/2** and **CongWin** is set to 1 MSS (1%).

(b) (8%)

a. After the 16^{th} transmission round, packet loss is recognized by a triple duplicate ACK event. (2%)

b. During the 1^{st} transmission round, packet 1 is sent; packet 2-3 are sent in the 2^{nd} transmission round; packets 4-7 are sent in the 3^{rd} transmission round; packets 8-15 are sent in the 4^{th} transmission round; packets 16-31 are sent in the 5^{th} transmission round; packets 32-63 are sent in the 6^{th} transmission round; packets 64 – 96 are sent in the 7^{th} transmission round. Thus packet 70 is sent in the 7^{th} transmission round. (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? (2%)

(b) If n=3, α=0.2 and $EsitmatedRTT^{1} = 0$, what are coefficients of $SampleRTT^1$ and $SampleRTT^2$ when calculating EstimatedRTT? (4%)

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 (2%)

(b) As n=3, α=0.2 and $EsitmatedRTT^{1} = 0$, (4%)

$$EstimatedRTT^{3} = \alpha \times SampleRTT^{3-1} + \alpha(1-\alpha) \times SampleRTT^{3-2} + (1-\alpha)^2 \times EsitmatedRTT^{3-2}$$
$$= \alpha \times SampleRTT^{2} + \alpha(1-\alpha) \times SampleRTT^{1} + (1-\alpha)^2 \times EsitmatedRTT^{1}$$
$$= 0.2 \times SampleRTT^{2} + 0.2 \times (1-0.2) \times SampleRTT^{1}$$
$$= 0.2 \times SampleRTT^{2} + 0.2 \times 0.8 \times SampleRTT^{1}$$