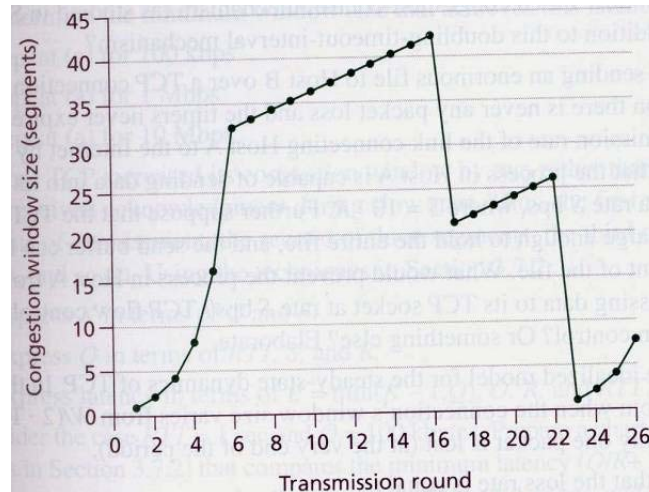


1. Answer and justify the following questions using TCP Reno. (16% total)
  - a. After the 16<sup>th</sup> and 22<sup>th</sup> transmission rounds, is segment loss detected by a triple duplicate ACK or by a timeout? Why? (要說明原因，原因跟答案都正確 2% each, 任一不正確則 0 分, 4% total)
  - b. During what transmission round is the 50<sup>th</sup> segment sent? (要說明, 4%)
  - c. Identify the TCP slow start intervals. (2% each, 4% total) 在哪兩個 intervals  $[x,y]$  之間? 有兩個答案
  - d. Identify the TCP congestion avoidance intervals. (2% each, 4% total) 在哪兩個 intervals  $[x,y]$  之間? 有兩個答案



Ans: (16%)

- a. After the 16<sup>th</sup> transmission round, packet loss is recognized by a triple duplicate ACK. 因為下一個 transmission round, CWND 下降為原本一半(2%)  
After the 22<sup>th</sup> transmission round, packet loss is recognized by a timeout. 因為下一個 transmission round, CWND 下降為 1 (2%)
  - b. During the 1<sup>st</sup> transmission round, packet 1 is sent; packet 2-3 are sent in the 2<sup>nd</sup> transmission round; packets 4-7 are sent in the 3<sup>rd</sup> transmission round; packets 8-15 are sent in the 4<sup>th</sup> transmission round; packets 16-31 are sent in the 5<sup>th</sup> transmission round; packets 32-63 are sent in the 6<sup>th</sup> transmission round; packets 64 – 96 are sent in the 7<sup>th</sup> transmission round. Thus packet 50 is sent in the 6<sup>th</sup> transmission round. (說明 2%, 答案 2%, 共 4%)
  - c. TCP slowstart is operating in the intervals [1,6] and [23,26] (2% each, 4% total)
  - d. TCP congestion avoidance is operating in the intervals [6,16] and [17,22] (2% each, 4% total)
2. (a) 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. (4%)
  - (b) Why is it said that FTP sends control information “out-of-band”? (4%) (12% total)

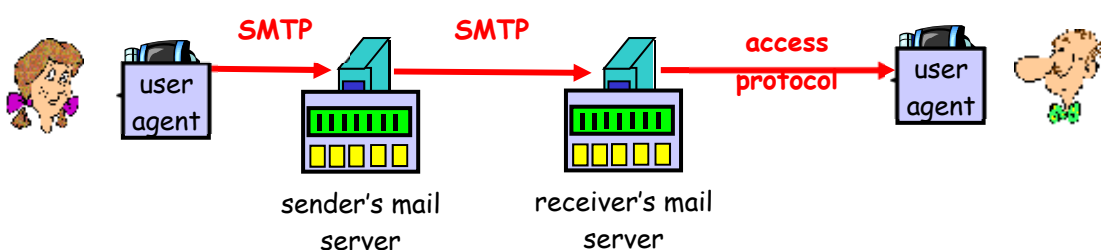
Ans:

(a)

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, 4% total)

(b) FTP uses two parallel TCP connections, one connection for sending control information (2%) (such as a request to transfer a file) and another connection for actually transferring the file. (2%) Because the control information is not sent over the same connection that the file is sent over, FTP sends control information out of band. (4% total)

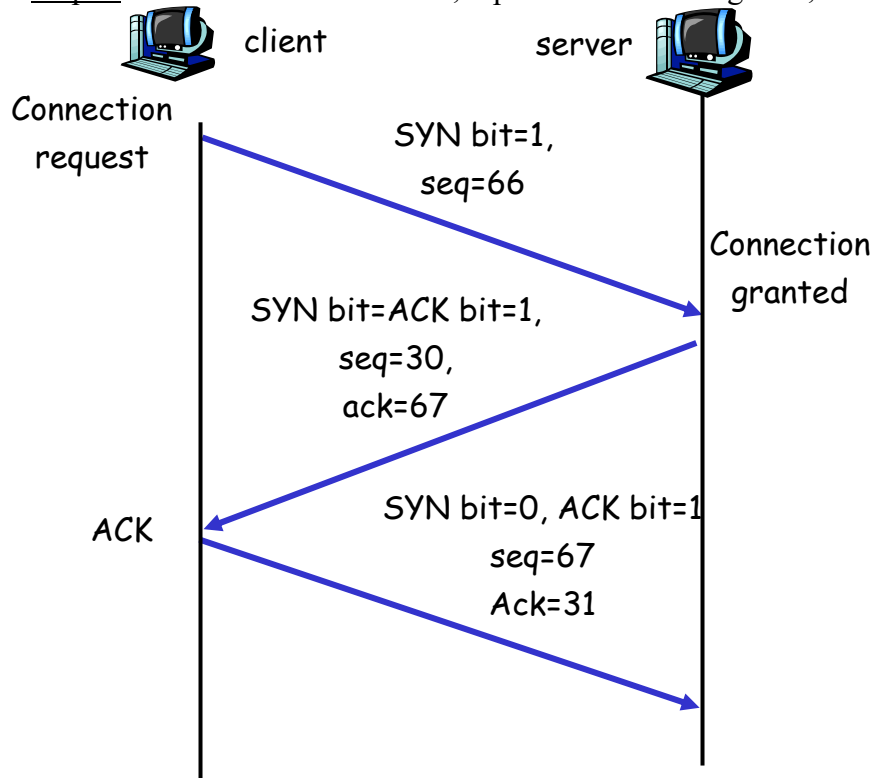
3. Draw and write the flow of the TCP three way handshake to explain its operations. Suppose the initial sequence numbers of the client and the server are 66 and 30, respectively. 必須寫出三步驟的過程，在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (10%)

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

4. (a) How to run the tool to query specified DNS server to execute "Please send me the host names of the authoritative DNS for *ncue.edu.tw*" operation? (2%)
- (b) How to run the tool to query DNS server to execute "Please send me the host names of *www.ncue.edu.tw*, but we want the query sent to the DNS server *dns.aiit.or.kr*" operation? (2%)
- (c) What three services are provided by the domain name system? (6%)
- (d) Explain iterated query and recursive query (4%)
- (e) Authoritative DNS servers (2%) (16% total)

Ans:

(a) `nslookup -type=NS ncue.edu.tw` (2%)

(b) `nslookup www.ncue.edu.tw dns.aiit.or.kr` (2%)

(c) DNS services (6%)

- hostname to IP address translation (2%)
- host aliasing (Canonical, alias names)
- mail server aliasing

(d) 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

(e) authoritative DNS server (2%)

- organization's DNS servers, providing authoritative hostname to IP mappings for organization's

servers

5. Consider sending a 1580-byte datagram into a link that has an MTU of 620bytes, including 20-byte IP header. Suppose the original datagram is stamped with the identification number 1. List these segments in a table with their data lengths, IDs, flags and offsets. (表格中 data length, offset 每列 1 分。沒有解釋或不清楚，視狀況扣分，12%)

fragment	data lengths	ID	offset	flag
1		1		
....				

Ans:

620 Bytes 內 IP data=620-20=600Bytes. 1580 byte-20 byte (datagram IP data)=1560Bytes, 分為 600, 600, 360, 共 3 個 fragments, 加上 20bytes IP header 後, data length 為 620, 620, 380.

fragment	data lengths	ID	offset	flag
1st	620 (1%)	1 (1%)	0 (1%)	1 (1%)
2nd	620 (1%)	1 (1%)	600/8=75 (1%)	1 (1%)
3rd	380 (1%)	1 (1%)	75*2=150 (1%)	0 (1%)

(data length, ID, offset, flag 每列 1 分。沒有解釋或不清楚，視狀況扣分，12%)

6. (a) Explain two network-layer functions (功能 1%, 說明 1%, 2% each, 4% total) (19% total)  
(b) What is the longest prefix matching? (2%)  
(c) Explain four scheduling mechanisms used in router. (名稱 1%, 說明 1%, 2% each, 8% total)  
(d) How many addresses do IPv4 have? (2%)  
(e) What is HOL blocking? (3%)

Ans:

- (a) forwarding: move packets from router's input to appropriate router output (1%, 1%)  
routing: determine route taken by packets from source to destination  
(b) when looking for forwarding table entry for given destination address, use longest address prefix that matches destination address. (2%)  
(c) FIFO (first in first out) scheduling: send in order of arrival to queue (1%, 1%)  
Priority scheduling: send highest priority queued packet  
Round Robin (RR) scheduling: cyclically scan class queues, sending one complete packet from each class (if available)  
Weighted Fair Queuing (WFQ): each class gets weighted amount of service in each cycle (2%)  
(d)  $2^{32}$  IPv4 addresses; (2%)  
(e) queued packet in an input queue must wait (1%) for transfer through the fabric because it is blocked by another packet at the head of the line. (2%)

7. Compare GBN, SR. Assume that the timeout values for all three protocols are sufficiently long such that 4 consecutive data segments and their corresponding ACKs can be received (if not lost in the channel) by the receiving host (Host B) and the sending host (Host A) respectively. Suppose Host A sends 4 data Segments to Host B, and the 2th segment (sent from A) is lost. In the end, all 4 data segments have been correctly received by Host B. How many segments has Host A sent in total (1% for GBN, SR) and how many ACKs has Host B sent in total (1% for GBN, SR)? What are their sequence numbers and ack numbers (0.5% each)? Answer this question for all two protocols 畫出傳送與重傳過程說明，標示出每個訊息是 pkt or ack，並附加上 sequence number 1%. (15% total)

Ans:

a. **GoBackN:**

A sends 7 segments in total. (1%)

They are initially sent **segments 1, 2, 3, 4** and later **resent segments 2, 3, 4**. (0.5%, 3.5%)

B sends 6 ACKs. (1%)

They are 3 ACKS with **sequence number 1, 1, 1**, and 3 ACKS with **sequence numbers 2, 3, 4**. (0.5%, 3%)

### Selective Repeat:

**A** sends 5 segments in total. (1%)

They are initially sent **segments 1, 2, 3, 4** and later **resent segments 2**. (0.5%, 2.5%)

**B** sends 4 ACKs. (1%)

They are 3 **ACKs** with **sequence number 1, 3, 4**. And there is 1 ACK with **sequence number 2**. (0.5%, 2%)

