Computer Networks midterm (101/4)

只寫答案而沒有解釋說明，扣一半分數
共 **107** 分，以扣分計

1. How does the traceroute program run with ICMP? (6%)

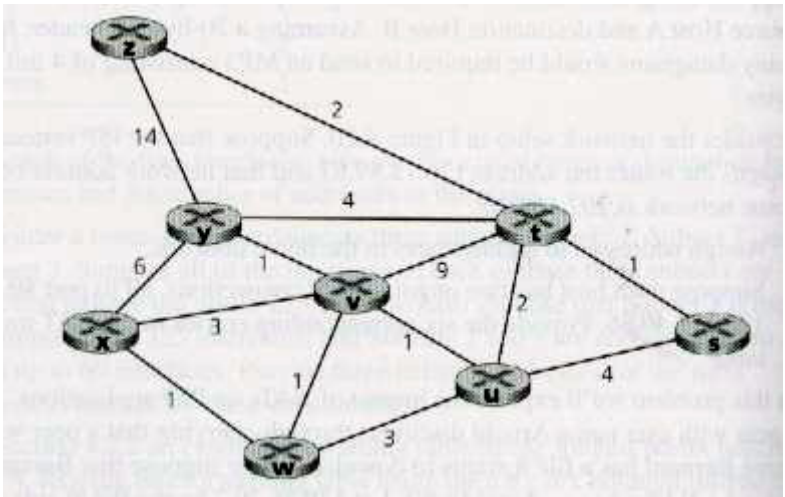
2. How to implement NAT at the router? (6%)

3. (a) What is the purpose of the DHCP protocol? (2%) (b) Draw a figure to show the four messages exchanged between the DHCP client and server. (8%, 10% total) (要畫圖，也要寫訊息名稱)

4. Draw a figure to show (a) the router architecture (4%) (b) three types of switching fabrics (6%) (10% total) (要畫圖，也要寫名稱)

5. Compare and contrast link state and distance vector routing algorithms. (9%)

6. Use Dijkstra's shortest-path algorithm to compute the shortest path from v to all network nodes. (數值相同時，優先選字母順序較前者, 1% each, 7% total) (a) Show how the algorithm works by computing a table. (b) show the forwarding table of v. (一欄是 Next hop，7%) (14% total)



7. 針對 IPv4 Class A 網路（以十進位表示，要寫完整過程） (10%)
將第一個 Class A 網路分成 7 subnets，subnet mask 的值為何？(2%)
請列出第 7 個 subnet 的網路表示法 (2%) 可用 IP 範圍？(4%) 共有幾個 IP 可用？(2%)

8. What are the two key network-layer functions in a datagram network? (名稱 2%, 說明 2%, 8% total) What is the additional network-layer function in a virtual-circuit network? (2%)

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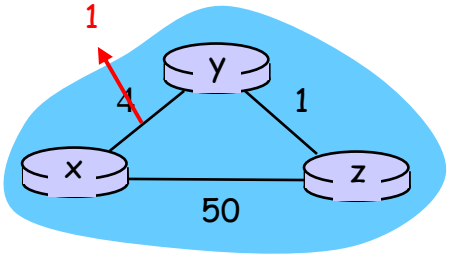
9. Consider sending a 1480-byte datagram into a link that has an MTU of 500 bytes, including 20-byte IP header. Suppose the original datagram is stamped with the identification number 1. List these segments in a table with their data lengths, IDs, flags and offsets. (表格中 data length, offset 每列一分，flag 、ID 全部一分。沒有解釋或不清楚，視狀況扣分，10%)

fragment	data lengths	ID	offset	flag
1				
…..				

10. Describe how TCP does its congestion control. (8%)

11. List changing processes of three tables of node X, Y and Z with the distance vector algorithm, from the time <u>before the X-Y link cost is changed from 4 to 1</u> to the time <u>three tables are stabilized</u>. (4 行 table 一行 3%,共 12%， 2 行箭頭各 1%,共 2% => total 14%)



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只寫答案而沒有解釋說明，扣一半分數

1. How does the traceroute program run with ICMP? (6%)

Ans:

- Source sends series of UDP segments to dest (2%)
  First has TTL =1
  Second has TTL=2, etc.
- When nth datagram arrives to nth router:
  Router discards datagram (1%)
  And sends to source an ICMP message (type 11, code 0) (1%)
- When ICMP message arrives, source calculates RTT (1%)
- Stopping criterion
  UDP segment eventually arrives at destination host. Destination returns ICMP "host unreachable" packet (type 3, code 3) (1%)

2. How to implement NAT at the router? (6%)

Ans:

NAT router must: (6%)

- *outgoing datagrams: replace* (source IP address, port #) of every outgoing datagram to (NAT IP address, new port #)
- *remember (in NAT translation table)* every (source IP address, port #) to (NAT IP address, new port #) translation pair
- *incoming datagrams: replace* (NAT IP address, new port #) in dest fields of every incoming datagram with corresponding (source IP address, port #) stored in NAT table

3. DHCP: (10%)

Goal: allow host to *dynamically* obtain its IP address from network server when it joins network (2%)

Flow: (8%)

- host broadcasts "DHCP discover" msg
- DHCP server responds with "DHCP offer" msg
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg

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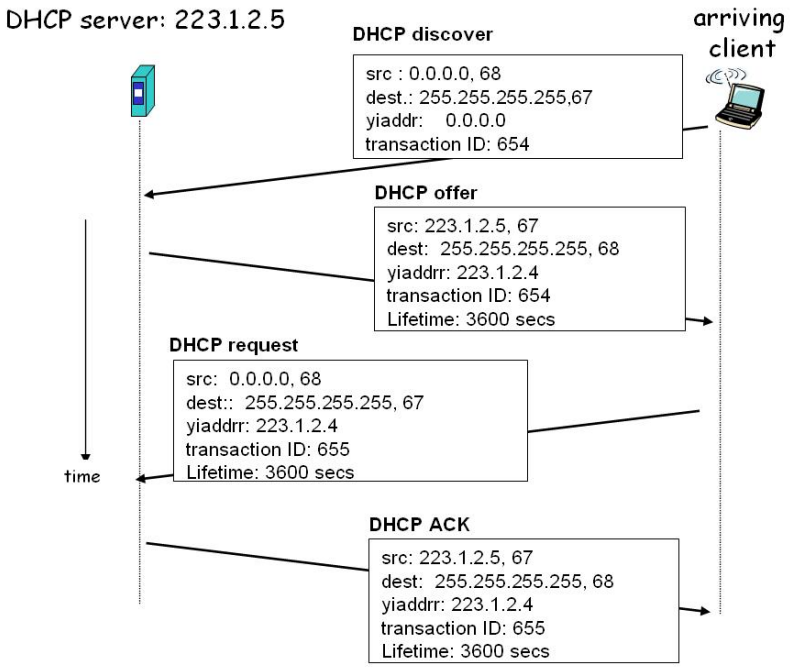
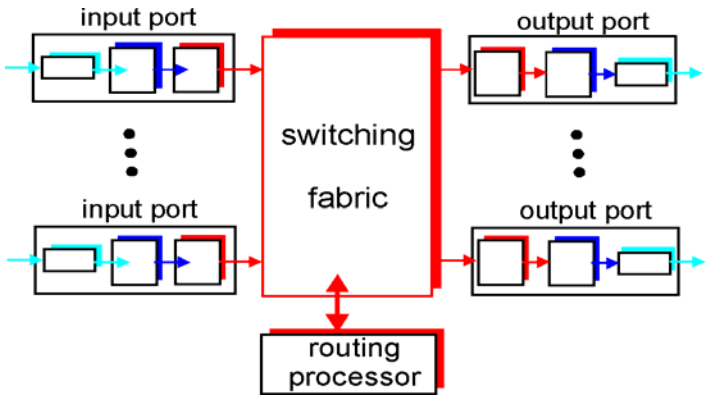


4. (10%)

(a) (4%)



(b) (6%)

List the three types of switching fabrics. (2% each, 6% total)

switching via memory; (2%)

switching via a bus; (2%)

switching via an interconnection network (2%)

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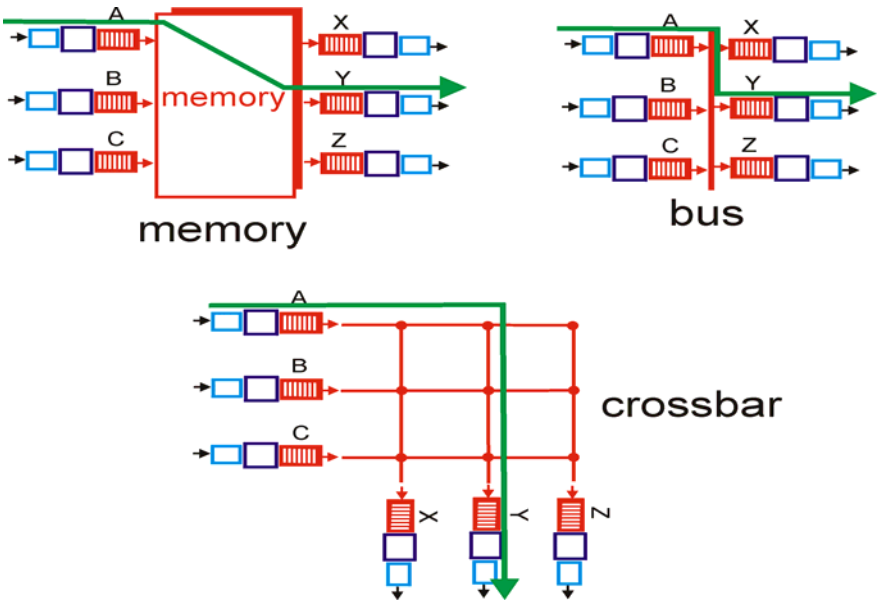

5. Compare and contrast link state and distance vector routing algorithms. (9%)
   - Link state algorithms: Computes the least-cost path between source and destination (1%) using complete, global knowledge about the network. (2%)
   - Distance-vector routing: The calculation of the least-cost path is carried out in an iterative, distributed manner. (2%) A node only knows the neighbor to which it should forward a packet in order to reach given destination along the least-cost path (2%), and the cost of that path from itself to the destination (2%)

6. Use Dijkstra's shortest-path algorithm to compute the shortest path from v to all network nodes. (數值相同時，優先選字母順序較前者, 1% each, 7% total) (a) Show how the algorithm works by computing a table. (b) show the forwarding table of v. (7%)

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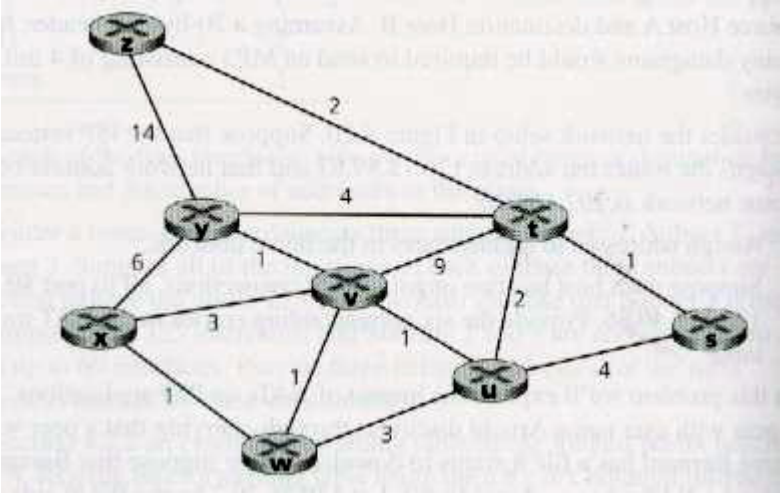

Ans: (1% each, 7% total)

N'	D(s),p(s)	D(t),p(t)	D(u),p(u)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
v	∞	9,v	1,v	1,v	3,v	1,v	∞
vu	a.) 5,u	c.) 3,u		1,v	3,v	1,v	∞
vuw	5,u	3,u			d.) 2,w	1,v	∞
vuwy	5,u	3,u			2,w		e.) 15,y
vuwyx	5,u	3,u					15,y
vuwyxt	b.) 4,t						f.) 5,t
vuwyxts							5,t

a). $D(s) = \min\{D(s), D(u) + C(u, s)\} = \min\{\infty, 1 + 4\} = 5$
b). $D(s) = \min\{D(s), D(t) + C(t, s)\} = \min\{5, 3 + 1\} = 4$
c). $D(t) = \min\{D(t), D(u) + C(u, t)\} = \min\{9, 1 + 2\} = 3$
d). $D(x) = \min\{D(x), D(w) + C(w, x)\} = \min\{3, 1 + 1\} = 2$
e). $D(z) = \min\{D(z), D(y) + C(y, z)\} = \min\{\infty, 1+14\} = 15$
f). $D(z) = \min\{D(z), D(t) + C(t, z)\} = \min\{15, 3 + 2\} = 5$

Forwarding table of v: (1% each, 7% total)

Destination	Next hop (output link)
s	u
t	u
u	u
w	w
x	w
y	y
z	u

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7. 針對 IPv4 Class A 網路（以十進位表示，要寫完整過程） (10%)
將第一個 Class A 網路分成 7 subnets，subnet mask 的值為何？(2%)
請列出第 7 個 subnet 的網路表示法 (2%) 可用 IP 範圍？(4%) 共有幾個 IP 可用？(2%)

Ans:

將第一個 Class A 網路分成 7 個 subnet，加上全為 0 與全為 1 的兩個不能用的 subnet ID，最少需要 7+2=9 < 2^4, subnet mask 的值 => 需要 Host ID 的前 4 個 bits 當作 subnet ID。所以新的 subnet mask 是由原本 Class A 的 default subnet mask 255.0.0.0 來改，改成 11111111. 11110000. 00000000.00000000 => 255.240.0.0 (2%)

subnet 的 ID 要從第一個 Class A Network ID 00000001. 00000000. 00000000.00000000 來改，需要 Host ID 的前 4 個 bits 當作 subnet ID，不可全為 0 或 1。因此第 7 個 subnet ID 為 00000001. 01110000. 00000000.00000000 => 1.112.0.0 (2%)
因此第一個可用 Host ID 為 00000001. 01110000. 00000000. 00000001 = 1.112.0.1 (2%)
最後一個可用 Host ID 為 00000001. 01111111. 11111111. 11111110 = 1.127.255.254 (2%)
->共有 2^{20}-2 個可用 Host ID (2%)

8. What are the two key network-layer functions in a datagram network? (8%) What is the additional network-layer function in a virtual-circuit network? (2%)

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)
Additional function of VC-based network layer: call setup. (2%)

9. Consider sending a 1480-byte datagram into a link that has an MTU of 500 bytes, 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, flag 每列一分，ID 全部一分。沒有解釋或不清楚，視狀況扣分，10%)

fragment	data lengths	ID	offset	flag
1				

…..				

Ans:

IP data=500–20=480Bytes. 500 Bytes 內 IP data=480Bytes, 1480 byte-20 byte datagram IP data=1480–20=1460Bytes,分為 480, 480, 480, 20 共 4 個 fragments, 加上 20bytes IP header 後，data length 為 500, 500, 500, 40.

fragment	data lengths	ID	offset	flag
1st	500	1	0	1
2nd	500	1	480/8=60	1
3rd	500	1	60*2=120	1
4th	40	1	60*3=180	0

(data length, offset,每列一分，flag、ID 全部一分。沒有解釋或不清楚，視狀況扣分，10%)

10.(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%)**.

11.(a) initial table X-Y cost from 4 -> 1

(4 行 table 一行 3% (x, y, z 各看自己那列 1%),共 12%， 2 行箭頭各 1%,共 2% => total 14%)

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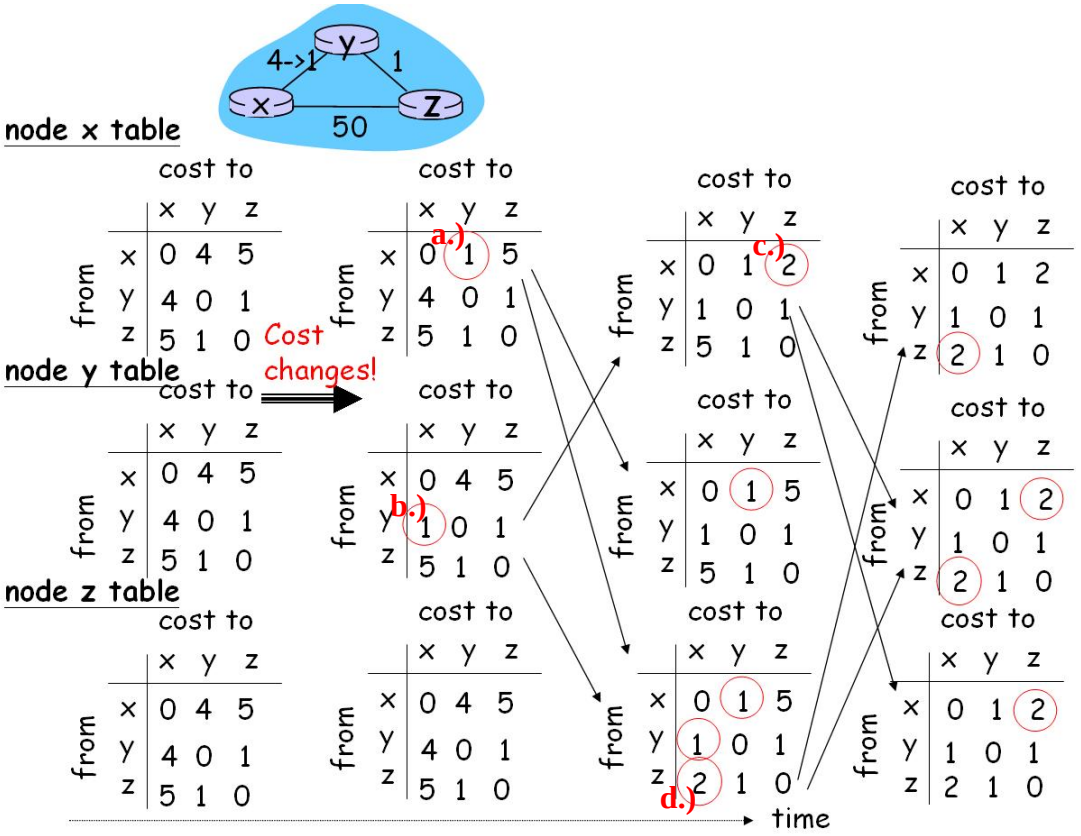

a). $D_x(y) = \min\{C(x,y) + D_y(y), C(x,z) + D_z(y)\} = \min\{1+0, 50+1\} = 1$

b). $D_y(x) = \min\{C(y,x) + D_x(x), C(y,z) + D_z(x)\} = \min\{1+0, 1+50\} = 1$

c). $D_x(z) = \min\{C(x,z) + D_z(z), C(x,y) + D_y(z)\} = \min\{50+0, 1+1\} = 2$

d). $D_z(x) = \min\{C(z,x) + D_x(x), C(z,y) + D_y(z)\} = \min\{50+0, 1+1\} = 2$