COMP9121 Assignment 1 2024 S2

Due: 08 Sep 2024 at 23:59

In this assignment, some questions are student number dependent; you will get zero in that question if you use another student's number.

You need to show your progress. Giving a final answer only is not acceptable.

You can write your answers on paper and scan, or you can type your answers in your computer. Please merge all you answers in a single pdf file and upload in Canvas.

There are 10 question in total. Each question is equally weighted.

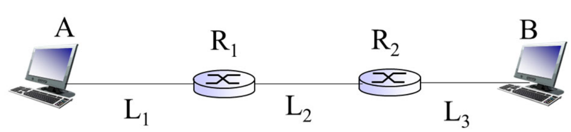
1. **CRC.**

(1) What is your student number? Convert your student number to binary and hexadecimal numbers.

(2) Let D be the binary number your derived above. The generator G starts with 1 and ends with 1, with all intermediate bits being zero, so G = 10…01. The CRC should be 1 byte in length. Calculate the CRC derived by D and G.

2. **Delay.**

Consider two hosts, A and B, are connected by three links and two routers as shown the figure below. Suppose node A sends two packets consecutively to B. Each packet is with the size of 100 bytes. Each router applies store and forward. There is no bit error or packet loss.



We have: Bandwidth of L_1 = 0.8 Mbps. Bandwidth of L_2 = 0.4 Mbps. Bandwidth of L_3 = 0.8 Mbps. Length of L_1 = 100 km. Length of L_2 = 200 km. Length of L_3 = 200 km. Propagation speed of links = 2×10^8 (m/s).

(1) What is the overall delay to deliver the two packets? (From the start of sending first packet at A till the second packet is completely received by B)

(2) At $\frac{k}{10}$ ms, where is the first bit of the **second** packet? k is the last **two** digits of your student number. (0ms is defined as the instant when A starts sending the first bit of the first packet).

3. **Parity**.

Using the last 6 bits of your student number in binary form (which you should have already calculated it in Question 1), to form a 6-bit information stream. Generate the parity bit and you can derive a 7-bit coded stream.

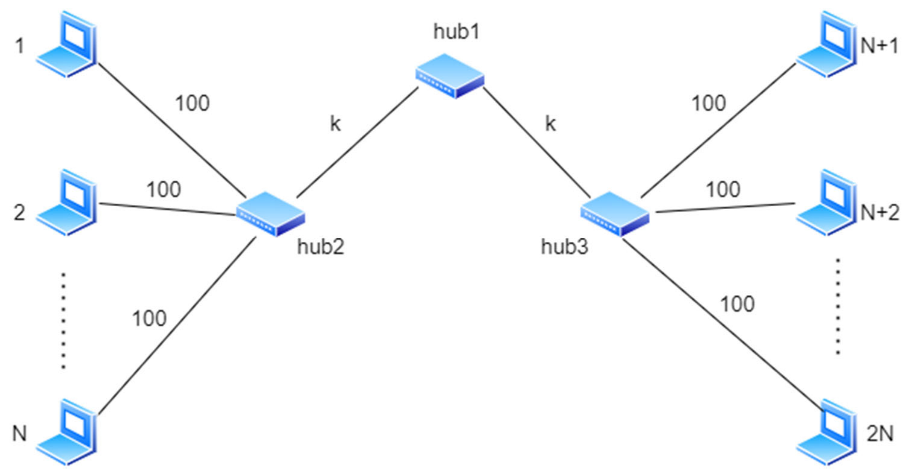
1) Send the coded stream through a random flipping channel with bit-flip probability p=0.05. Each bit is flipped independently. Assume that only the information bits may flip, and the parity bit will **not** flip.

Please calculate the probability that some of the bits are flipped, but this is **not** detected by the parity check.

2) Send the coded stream into a random lossy channel with bit-lost probability p=0.05. Each bit is lost independently. Assume that only the information bits may be lost, and the parity bit will **not** be lost. Please calculate the probability that some of the bits are lost, but this is **not** detected by the parity check.

4. CSMA-CD Performance.

2N computers have been connected in a network as illustrated. The length of each link is written in meters. Let k be the last **three** digits of your student number. Each computer generates 1000 packets per second with each packet being 500 bytes. The maximum rate of all links is 1 Gbps. The propagation speed in the medium is 2.0×10^8 meters/second.



(1) What is the maximum number of nodes supported in the network if CSMA-CD is used on the shared medium?

(2) Assume that hub1 is replaced with a switch. Find the maximum number of nodes supported in the network if CSMA-CD is used on the shared medium. Assume that 3/4 of the traffic is kept in its own side and 1/4 of the traffic goes to the other side.

5. Address allocation.

A company has been granted a block of IP addresses starting with 150.12.32.0/20. The address space should be allocated to four subnets A, B, C and D. Let k be the last digit of your student number. Subnet A needs (k+18) addresses, subnet B needs (k+40) addresses, subnet C needs (k+80) addresses, and subnet D needs (k+253) addresses.

(1) The IP addresses have been assigned in the following order A, B, C, and D (subnet A has the smallest IP addresses and subnet D has the largest IP addresses). What is the starting IP address of subnets A, B, C, and D?

(2) The IP addresses have been assigned in the following order D, C, B, and A. Redo the question (1).

6. **NAT.** In the figure below, assume the address 134.31.44.2 is the public IP and 192.168.2.224 with subnet mask 255.255.255.248 are local IPs for the private network. Assume a web application is running

on port 5500 on all hosts A, B, C, D, and E. Each web application in each host generates a packet to Server 1 (223.21.77.40, 80). We assume there is no other traffic.

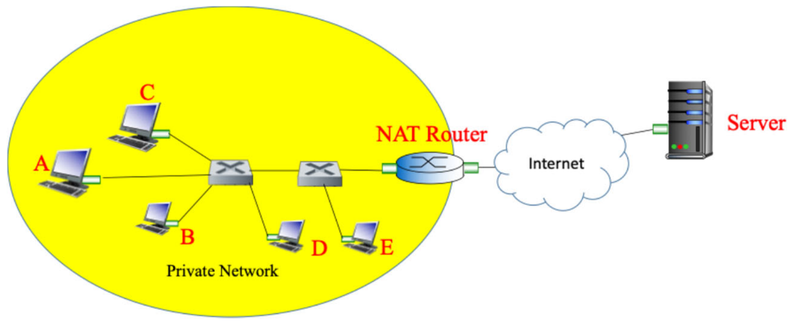
(1) Assign local IP addresses to the A—E

(2) Following (1), generate the NAT translation table for all traffic in the network by considering that port numbers in the range of [63001, 63005] are available to be assigned in the NAT.

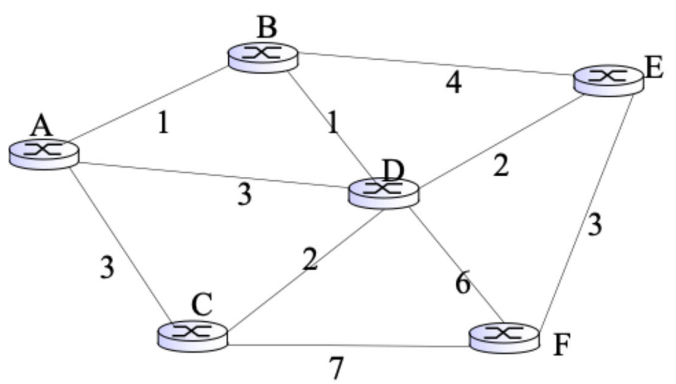
(3) Following (2), when the Server sends a reply packet to node C, what are the (IP address, port) fields in the packet header for both the source and destination?

(4) Following (3), when the packet arrives at the NAT Router, how does the NAT Router process the packet?

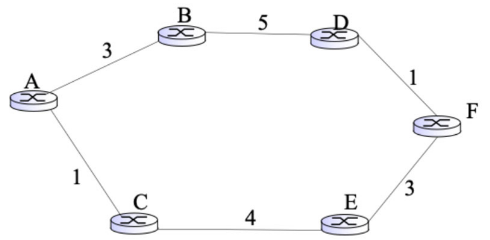
The correct answer may not be unique.



7. Dijkstra. In the following network, using Dijkstra's algorithm to find the shortest distances from F to all other nodes in the network. The link costs are labelled.



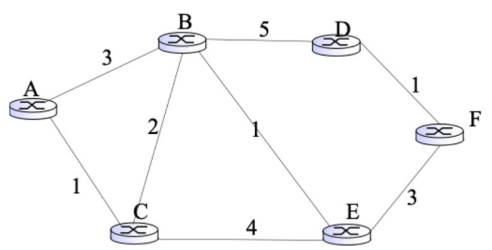
8. Distance Vector. Consider the network topology presented in the figure below. The link costs are labelled.



(1) Use the distance vector algorithm to find the shortest distances from all routers to router F by filling in the table below (assume that exchanges of routing information and routing table updates are synchronous). The table allows up to 8 iterations, but you can stop whenever the algorithm converges.

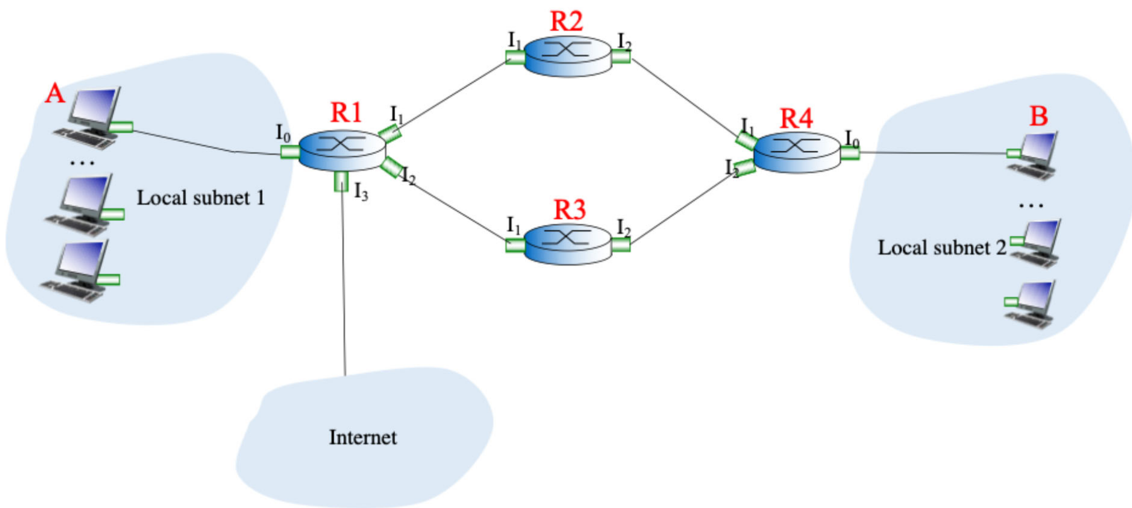
	A	B	C	D	E
Initial	−1,∞	−1,∞	−1,∞	−1,∞	−1,∞
1					
2					
3					
4					
5					
6					
7					
8					

(2) After the convergence of (1), assume that the links B − E and B − C are connected with costs shown below. Do NOT use split horizon or reverse poisoning. Fill in the table below using the distance vector algorithm to find the shortest distance from each router to router F. The table allows up to 8 iterations, but you can stop whenever the algorithm converges.



	A	B	C	D	E
Initial					
1					
2					
3					
4					
5					
6					
7					
8					

9. Routing. The figure below shows the network. The IP address and MAC address of each interface are listed below and the forwarding tables of routers are also listed.



Interface		IP address	MAC address
A		192.168.64.35	AA-AA-AA-AA-AA-AA
B		192.168.79.42	BB-BB-BB-BB-BB-BB
R1	I_0	192.168.64.1	AA-00-00-00-00-AA
	I_1	192.168.65.1	AA-11-11-11-11-AA
	I_2	192.168.66.1	AA-22-22-22-22-AA
	I_3	192.168.67.1	AA-33-33-33-33-AA
R2	I_1	192.168.65.2	BB-11-11-11-11-BB
	I_2	192.168.68.1	BB-22-22-22-22-BB
R3	I_1	192.168.66.2	CC-11-11-11-11-CC
	I_2	192.168.69.1	CC-22-22-22-22-CC
R4	I_0	192.168.72.1	DD-00-00-00-00-DD
	I_1	192.168.68.2	DD-11-11-11-11-DD
	I_2	192.168.69.2	DD-22-22-22-22-DD

R1 forwarding table

192.168.64.0/21	I_0
192.168.72.0/21	I_1
192.168.78.0/23	I_2
Default	I_3

R2 forwarding table

192.168.64.0/21	I_1
192.168.72.0/21	I_2
Default	I_1

R3 forwarding table

192.168.64.0/21	I_1
192.168.78.0/23	I_2
Default	I_1

R4 forwarding table

192.168.64.0/21	I_1
192.168.72.0/21	I_0
Default	I_2

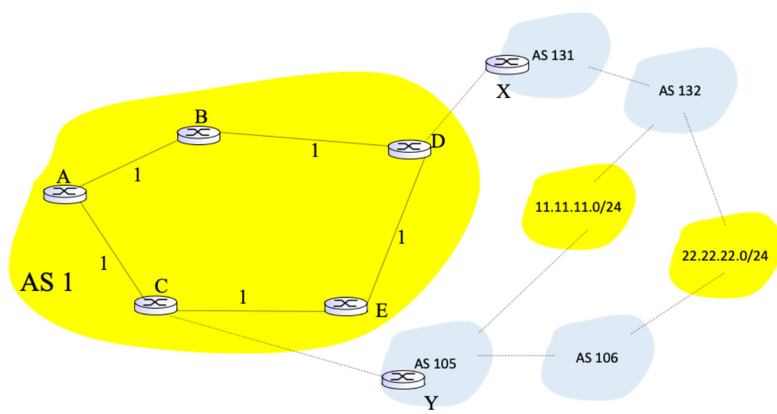
“A” sends a packet to “B”, with source IP address 192.168.64.35 and destination IP address 192.168.79.42. It is successfully delivered.

(1) Does the system route the packet via A-R1-R2-R4-B or A-R1-R3-R4-B? Why?

(2) When this packet is being delivered on the R4-B hop, specify the source IP address, destination IP address, source MAC address, destination MAC address of the packet.

(3) If your answer to (1) is A-R1-R2-R4-B, when the packet is being delivered at R2-R4 hop, specify the source IP address, destination IP address, source MAC address, and destination MAC address of the packet. If your answer to (1) is A-R1-R3-R4-B, when the packet is being delivered at R3-R4 hop, specify the source IP address, destination IP address, source MAC address, and destination MAC address of the packet.

10. **Inter-AS**. Consider the network topology as follows. There are multiple ASes in the network. A–E indicate routers within AS1. X and Y are gateway routers of AS131 and AS105. Link costs in AS1 are labelled in the figure. AS1 is a customer network of AS105 and AS131. 11.11.11.0/24 is a customer network of AS132 and AS105. 22.22.22.0/24 is a customer network of AS132 and AS106.



(1) Are the following AS-PATHs allowed? Why or why not?

AS1-AS131-AS132-11.11.11.0/24

AS1-AS131-AS132-22.22.22.0/24

AS1-AS105-11.11.11.0/24

AS1-AS105-AS106-22.22.22.0/24

(2) Figure out entries in forwarding tables at different routers. Fill in the table below. (In “Next Hop”, choose one of the follows: A, B, C, D, E, X, Y.) Provide your reason for each entry.

Router	Pre-fix	Next Hop
A	11.11.11.0/24	
A	22.22.22.0/24	

B	11.11.11.0/24	
B	22.22.22.0/24	
C	11.11.11.0/24	
C	22.22.22.0/24	
D	11.11.11.0/24	
D	22.22.22.0/24	
E	11.11.11.0/24	
E	22.22.22.0/24	

10 marks

1. ~~CRC.~~

(1) What is your student number? Convert your student number to binary and hexadecimal numbers.

(2) Let D be the binary number your derived above. The generator G starts with 1 and ends with 1, with all intermediate bits being zero, so G = 10…01. The CRC should be 1 byte in length. Calculate the CRC derived by D and G.

(1) 490051481

Binary Number:

2	490051481	1
2	245025740	0
2	122512870	0
2	61256435	1
2	30628217	1
2	15314108	0
2	7657054	0
2	3828527	1
2	1914263	1
2	957131	1
2	478565	1
2	239282	0
2	119641	1
2	59820	0
2	29910	0
2	14955	1
2	7477	1
2	3738	0
2	1869	1
2	934	0
2	467	1
2	233	1

$$
\begin{array}{r|l}
2 & 116 \quad 0 \\
2 & 58 \quad 0 \\
2 & 29 \quad 1 \\
2 & 14 \quad 0 \\
2 & 7 \quad 1 \\
2 & 3 \quad 1 \\
2 & 1 \quad 1 \\
 & 0
\end{array}
$$

$\boxed{1\ 1101\ 0011\ 0101\ 1001\ 0111\ 1001\ 1001}$

Hexadecimal Number:

$$
\begin{array}{r|l}
16 & 490051481 \quad 9 \\
16 & 30628217 \quad 9 \\
16 & 1914263 \quad 7 \\
16 & 119641 \quad 9 \\
16 & 7477 \quad 5 \\
16 & 467 \quad 3 \\
16 & 29 \quad 13 \\
16 & 1 \quad 1 \\
 & 0
\end{array}
$$

10 11 12 13 14 15
a b c d e f

$\boxed{1d359799}$

1. ~~CRC.~~

(1) What is your student number? Convert your student number to binary and hexadecimal numbers.

(2) Let D be the binary number your derived above. The generator G starts with 1 and ends with 1, with all intermediate bits being zero, so G = 10…01. The CRC should be 1 byte in length. Calculate the CRC derived by D and G.

(2) D = 1 1101 0011 0101 1001 0111 1001 1001

CRC G = 1 …. 0…. 1 = 1000,0000,1

since CRC code is 8 bits, so CRC Generator is 9 digits

```
              1110 1001 0100 0101 1111 1001 00110
G √ 1110 1001 1010 1100 1011 1100 1100 1000 00000

1000 0000 1
 110 1001 00
 100 0000 01
 010 1001 011
  10 0000 00 1
  00 1001 0100 1
     1000 0000 1
     0001 0100 0100
        1 0000 0001
        0 0100 0101 10
          100 0000 01
          000 0101 1111 11
              100 0000 01
```

```
001 1111 1000
  1 0000 0001
-------------
  0 1111 1001 1
    1000 0000 1
-------------
     111 1001 01
     100 0000 01
-------------
     011 1001 000
      10 0000 001
-------------
       1 1001 0010
       1 0000 0001
-------------
         1001 0011 1
         1000 0000 1
-------------
            1 0011 0000
            1 0000 0001
-------------
            0 0011 0001 000
                10 0000 001
-------------
                01 0001 0010
                 1 0000 0001
-------------
                 0 0001 0011 0
```

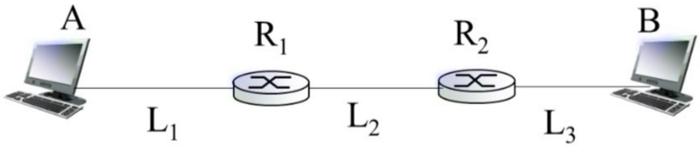
Hence the redundancy is 001 0011 0

append it to the data, we have:

1 1101 0011 0101 1001 0111 1001 100 $\boxed{001\ 0011\ 0}$

2. **Delay.** 6 hard

Consider two hosts, A and B, are connected by three links and two routers as shown the figure below. Suppose node A sends two packets consecutively to B. Each packet is with the size of 100 bytes. Each router applies store and forward. There is no bit error or packet loss.

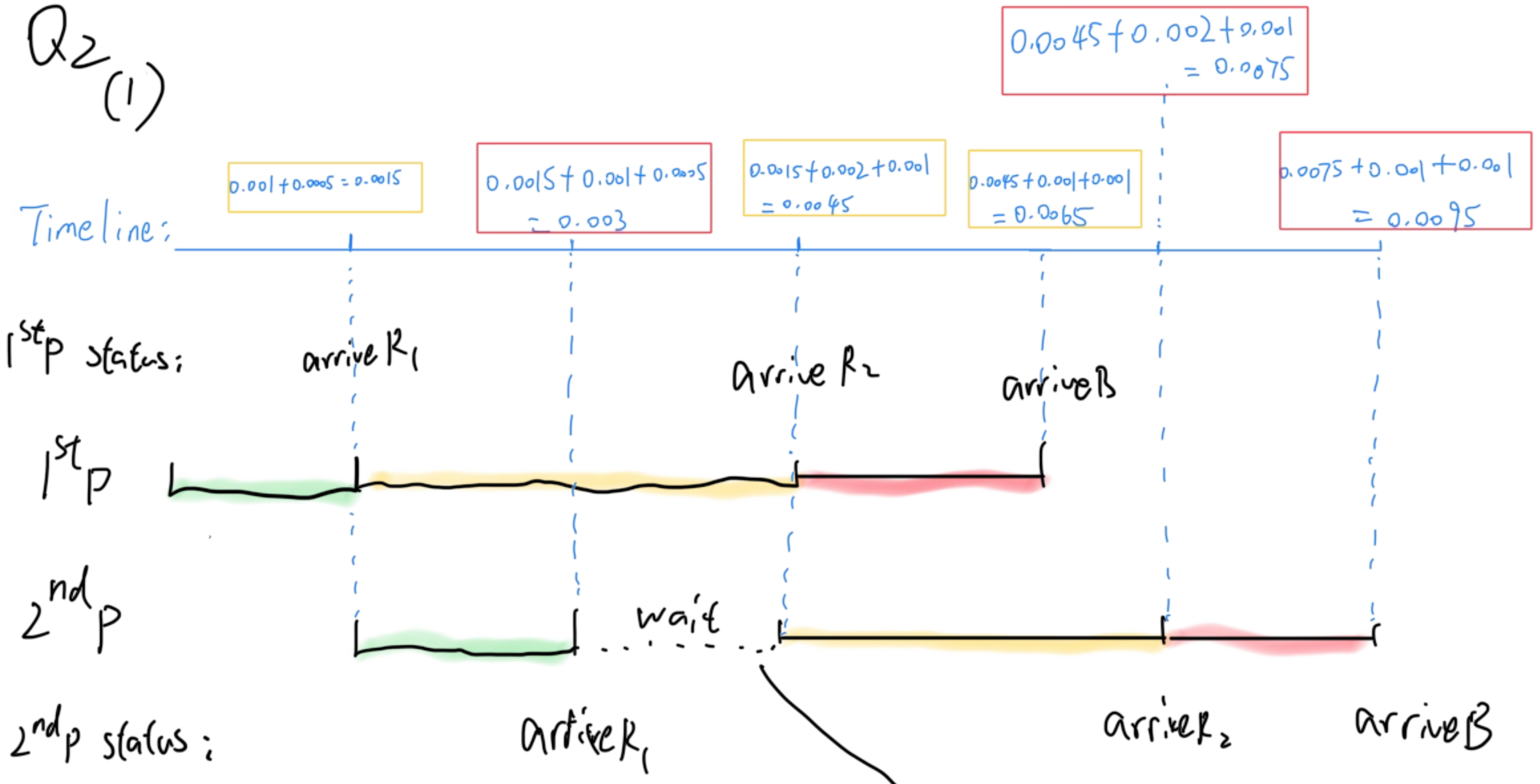


We have: Bandwidth of L_1 = 0.8 Mbps. Bandwidth of L_2 = 0.4 Mbps. Bandwidth of L_3 = 0.8 Mbps. Length of L_1 = 100 km. Length of L_2 = 200 km. Length of L_3 = 200 km. Propagation speed of links = 2×10^8 (m/s).

(1) What is the overall delay to deliver the two packets? (From the start of sending first packet at A till the second packet is completely received by B)

(2) At $\frac{k}{10}$ ms, where is the first bit of the **second** packet? k is the last **two** digits of your student number. (0ms is defined as the instant when A starts sending the first bit of the first packet).

Q2 (1)



Happens because L_2 channel rate is lower than L_1

● : L_1 is occupied

● : L_2 is occupied

● : L_3 is occupied

▭ : Time for packet 1

▭ : Time for packet 2

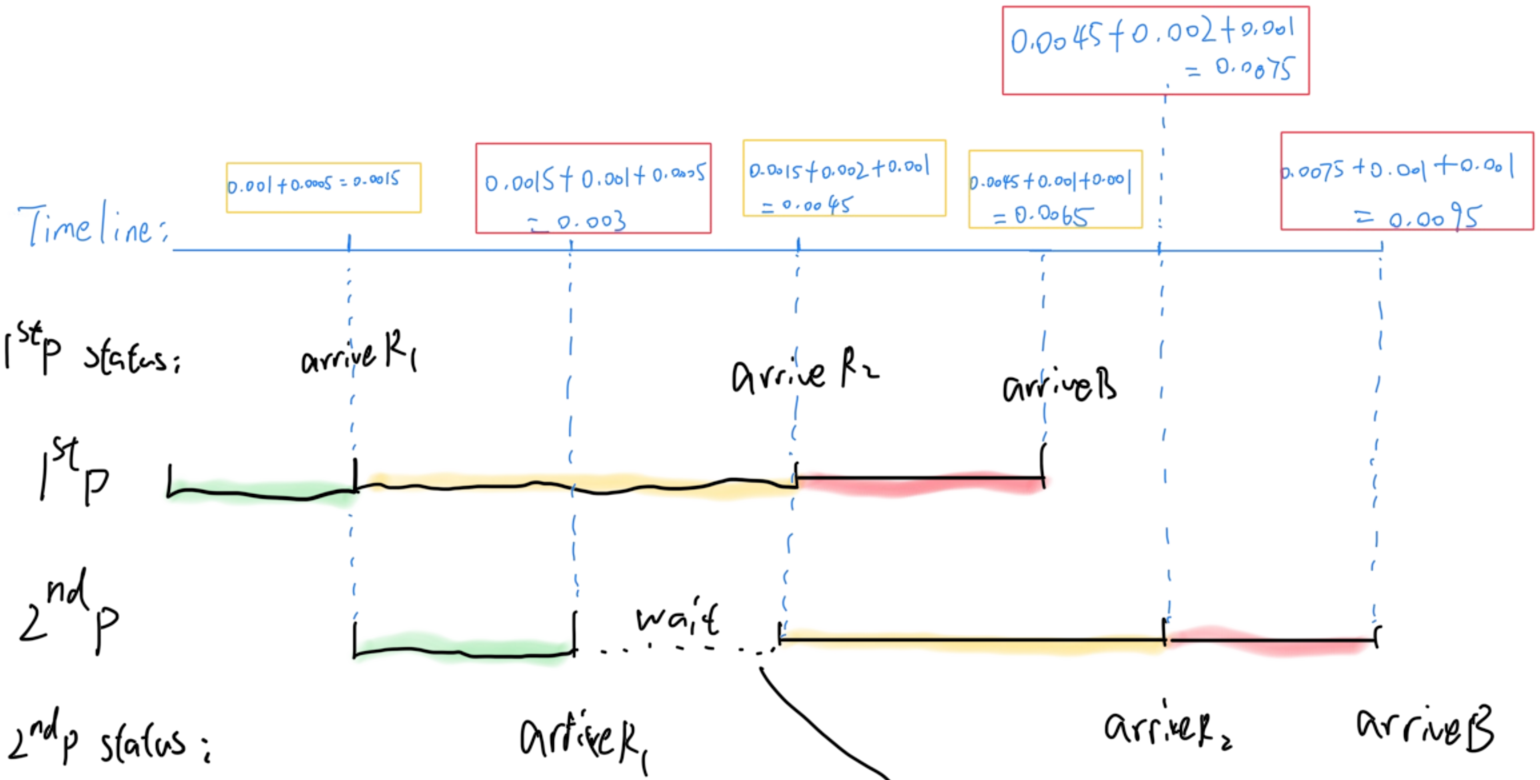
- $\underset{A \to R_1}{t_{prop}} = \dfrac{100 \times 1000}{2 \times 10^8} = 0.0005$; $\underset{R_1 \to R_2}{t_{prop}} = \dfrac{200 \times 1000}{2 \times 10^8} = 0.001 = \underset{R_2 \to B}{t_{prop}}$

- $\underset{A \to R_1}{t_{trans}} = \dfrac{100 \times 8}{0.8 \times 10^6} = 0.001$; $\underset{R_1 \to R_2}{t_{trans}} = \dfrac{100 \times 8}{0.4 \times 10^6} = 0.002$; $\underset{R_2 \to B}{t_{trans}} \dfrac{100 \times 8}{0.8 \times 10^6} = 0.001$

- Using above info, I draw the diagram, and it also include a timeline

· Hence the overall delay is 0.0095 second.

(2)· $k = 81$, $\frac{81}{10} = 8.1\ ms = 0.0081\ s$



: L_1 is occupied

: L_2 is occupied

: L_3 is occupied

because L_2 channel rate is lower than L_1

: Time for packet 1

: Time for packet 2

As you can see, at 0.0081 s, the 1st bit of 2nd packet locate between R_2 and B.

3. **Parity**. Normal 4

Using the last 6 bits of your student number in binary form (which you should have already calculated it in Question 1), to form a 6-bit information stream. Generate the parity bit and you can derive a 7-bit coded stream.

1

1) Send the coded stream through a random flipping channel with bit-flip probability p=0.05. Each bit is flipped independently. Assume that only the information bits may flip, and the parity bit will **not** flip. Please calculate the probability that some of the bits are flipped, but this is **not** detected by the parity check.

2) Send the coded stream into a random lossy channel with bit-lost probability p=0.05. Each bit is lost independently. Assume that only the information bits may be lost, and the parity bit will **not** be lost. Please calculate the probability that some of the bits are lost, but this is **not** detected by the parity check.

Binary form = 01 100| 1 # we should have even number of 1's after received the data

(1) · $P = 0.05$

· Parity bit will not flip, so $n = 6$

· Want to know the Prob when bits flipped but not detected. (i.e. even number bits flipped)

① 2 flipped

$$P\binom{6}{2} \times (1-p)^4 p^2 = 15 \times (0.95)^4 \times 0.05^2 = 2.036 \times 10^{-3}$$

点乘

② 4 flipped

$$P\binom{6}{4} \times (1-p)^2 p^4 = 15 \times 0.95^2 \, 0.05^4 = 8.461 \times 10^{-5}$$

③ 6 flipped

$$P\binom{6}{6} \times p^6 = 1 \times 0.005^6 = 1.5625 \times 10^{-14}$$

P(even number bits flipped) = ① + ② + ③ = $\boxed{2.121 \times 10^{-3}}$

(2) 0 1 1 0 0 1 1

a b c d e f

> The only case to lose even number of 1's is to lose two 1's and 0's

① lose 1 digits:

will not cause "not detected" senario, because it is not possible to lose even number of 1's (not include 0 1's)

② lose 2 digits: $\binom{3}{2}$

. there are only 3 possibility will lead to "not detected" senario $\begin{cases} bc \\ bf \\ cf \end{cases}$

. $P = 3 \cdot p^2(1-p)^4 = 3 \times 0.05^2 \times 0.95^4$

$= 6.109 \times 10^{-3}$

~~③ lose 3 digits~~

~~. There are 9 possibility to lead to "not detected"~~

~~senario (i.e. lose even number of 1's)~~

. bc a, d, e   bf a, d, e   cf a, d, e

. $P = 9 \times p^3 \times (1-p)^3 = 9 \times 0.05^3 \times 0.95^3 = 9.645 \times 10^{-4}$

④ lose 4 digits

- There are 18 posabilities to lead to "not detected" senario

- bc a d
      e
    d a
      e
    e d
      a

  bf a d
      e
    d a
      e
    e d
      a

  cf a d
      e
    d a
      e
    e d
      a

∴ $P = 18 \times p^4 \times (1-p)^2 = 1.015 \times 10^{-4}$

⑤ lose 5 digits

- There are only 3 possibilities

  bc ade   bf ade   cf ade

- $P = 3 \times p^5 (1-p) = 8.906 \times 10^{-7}$

⑥ lose 6 digits

It is impossible, since we must lose odd number of 1's in this case

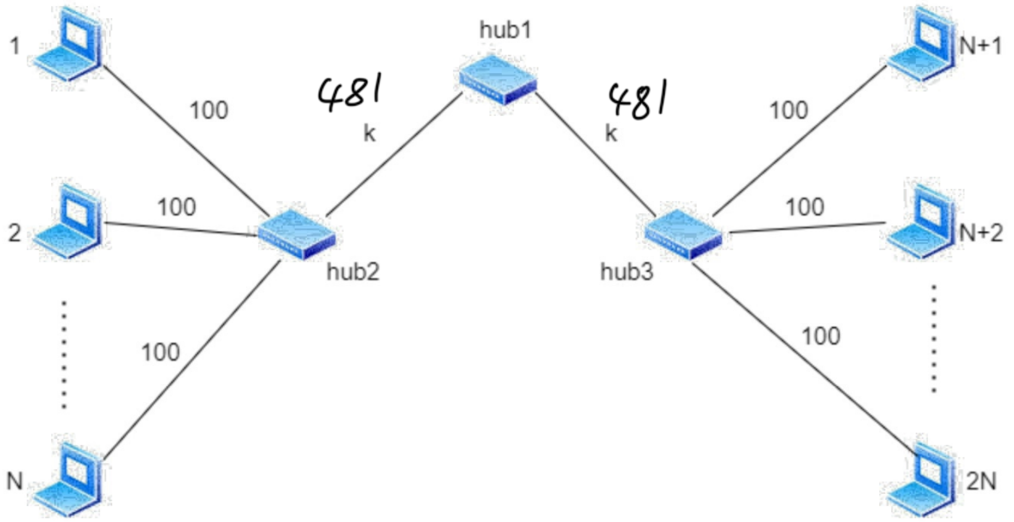
Combine ② ③ ④ ⑤, we get

$$p = 6.109 \times 10^{-3} + 9.645 \times 10^{-4} + 1.015 \times 10^{-4} + 8.906 \times 10^{-7}$$

$$= \boxed{7.176 \times 10^{-3}}$$

4. **CSMA-CD Performance.**

2N computers have been connected in a network as illustrated. The length of each link is written in meters. Let k be the last **three** digits of your student number. Each computer generates 1000 packets per second with each packet being 500 bytes. The maximum rate of all links is 1 Gbps. The propagation speed in the medium is 2.0×10^8 meters/second.



(1) What is the maximum number of nodes supported in the network if CSMA-CD is used on the shared medium?

(2) Assume that hub1 is replaced with a switch. Find the maximum number of nodes supported in the network if CSMA-CD is used on the shared medium. Assume that 3/4 of the traffic is kept in its own side and 1/4 of the traffic goes to the other side.

- 1 packet = 500 bytes
- K = 481
- channel rate = 1 Gbps
- propagation delay = 2.8×10^8 m/s

- max distance = 100 + 481 + 481 + 100 = 1162 m

$$(1)\ t_{trans} = \frac{1 \text{ packet size}}{\text{Channel rate}} = \frac{500 \times 8 \text{ bits}}{10^9 \text{ bps}} = 4 \times 10^{-6}$$

$$t_{prop} = \frac{\text{max cable length}}{\text{propagation speed}} = \frac{1162 \text{ m}}{\cancel{2.8} \times 10^8 \text{ m/s}} = 4.15 \times 10^{-6}$$

$$efficiency = \frac{1}{1+5\frac{4.15\times10^{-6}}{4\times10^{-6}}} = 0.1616$$

$$2N = \frac{0.1616 \times 10^9}{1000\times500\times8}$$

$$= 40.4 \simeq \boxed{40}$$

(2)

$$t_{trans} = \frac{1 \text{ packet size}}{\text{Channel rate}} = \frac{500\times8 \text{ bits}}{10^9 \text{ bps}} = 4\times10^{-6}$$

$$t_{prop} = \frac{\cancel{200}}{2\times10^8} = 10^{-6}$$

100+481

$$efficiency = \frac{1}{1+5\frac{10^{-6}}{4\times10^{-6}}} = 0.444$$

$\frac{7}{4}N$

$$N+\cancel{\frac{3}{4}N} = \frac{0.444\times10^9}{1000\times500\times8} = 111$$

$N = 63.4$ (I know N cannot be float number)

$\Downarrow$

$2N = 126.857 \simeq \boxed{126}$

5. **Address allocation.** 10 Normal

A company has been granted a block of IP addresses starting with 150.12.32.0/20. The address space should be allocated to four subnets A, B, C and D. Let k be the last digit of your student number. Subnet A needs (k+18) addresses, subnet B needs (k+40) addresses, subnet C needs (k+80) addresses, and subnet D needs (k+253) addresses.

(1) The IP addresses have been assigned in the following order A, B, C, and D (subnet A has the smallest IP addresses and subnet D has the largest IP addresses). What is the starting IP address of subnets A, B, C, and D?

(2) The IP addresses have been assigned in the following order D, C, B, and A. Redo the question (1).

(1) · $k=1$

A: $19 \le 2^n - 2 \Rightarrow n = 5$ bits

B $41 \le 2^n - 2 \Rightarrow n = 6$ bits

C $81 \le 2^n - 2 \Rightarrow n = 7$ bits

D $254 \le 2^n - 2 \Rightarrow n = 8$ bits

· 150.12.32.0/20

$\Downarrow$

150.12. 0010 $\underbrace{0000 . 0000\ 0000}_{\text{can be assigned}}$

150.12.0010

A : 5 bits

0000 0000 0000 starting

0000 0001 1111 Ending

B : 6 bits

0000 0010 0000 X

0000 0100 0000 starting

0000 0111 1111 Ending

C : 7 bits

0000 1000 0000 starting

0000 1111 1111 Ending

D : 8 bits

0001 0000 0000 starting

0001 1111 1111 Ending

(2)

150.12.0010

D: 8 bits

0000 0000 0000 starting

0000 1111 1111 Ending

C 7 bits

0001 0000 0000 starting

0001 0111 1111 Ending

B: 6 bits

0001 1000 0000 Starting

0001 1011 1111 Ending

A: 5 bits

0001 1100 0000 Starting

0001 1101 1111 Ending

9

Normal

6. **NAT.** In the figure below, assume the address 134.31.44.2 is the public IP and 192.168.2.224 with subnet mask 255.255.255.248 are local IPs for the private network. Assume a web application is running on port 5500 on all hosts A, B, C, D, and E. Each web application in each host generates a packet to Server 1 (223.21.77.40, 80). We assume there is no other traffic.

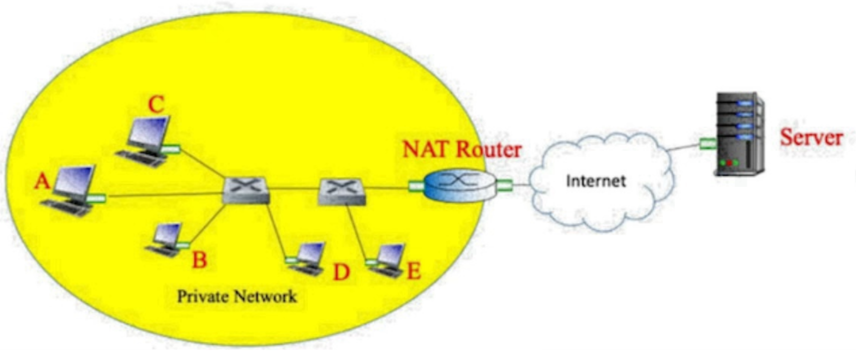
(1) Assign local IP addresses to the A—E

(2) Following (1), generate the NAT translation table for all traffic in the network by considering that port numbers in the range of [63001, 63005] are available to be assigned in the NAT.

(3) Following (2), when the Server sends a reply packet to node C, what are the (IP address, port) fields in the packet header for both the source and destination?

(4) Following (3), when the packet arrives at the NAT Router, how does the NAT Router process the packet?

The correct answer may not be unique.



1 Public IP Address: 134.31.44.2

2 Local IP Address: 192.168.2.224/29

255.255.255.248 ⇒

2 | 248 0
2 | 124 0
2 | 62 0
2 | 31 1
2 | 15 1
2 | 7 1
2 | 3 1
2 | 1 1
0

only have 3 can be assigned

$4 \times 8 - 3 = 29$

广播地址

是 host 部份全为1

(1) 192.168.2.1110 0000 used for Network address

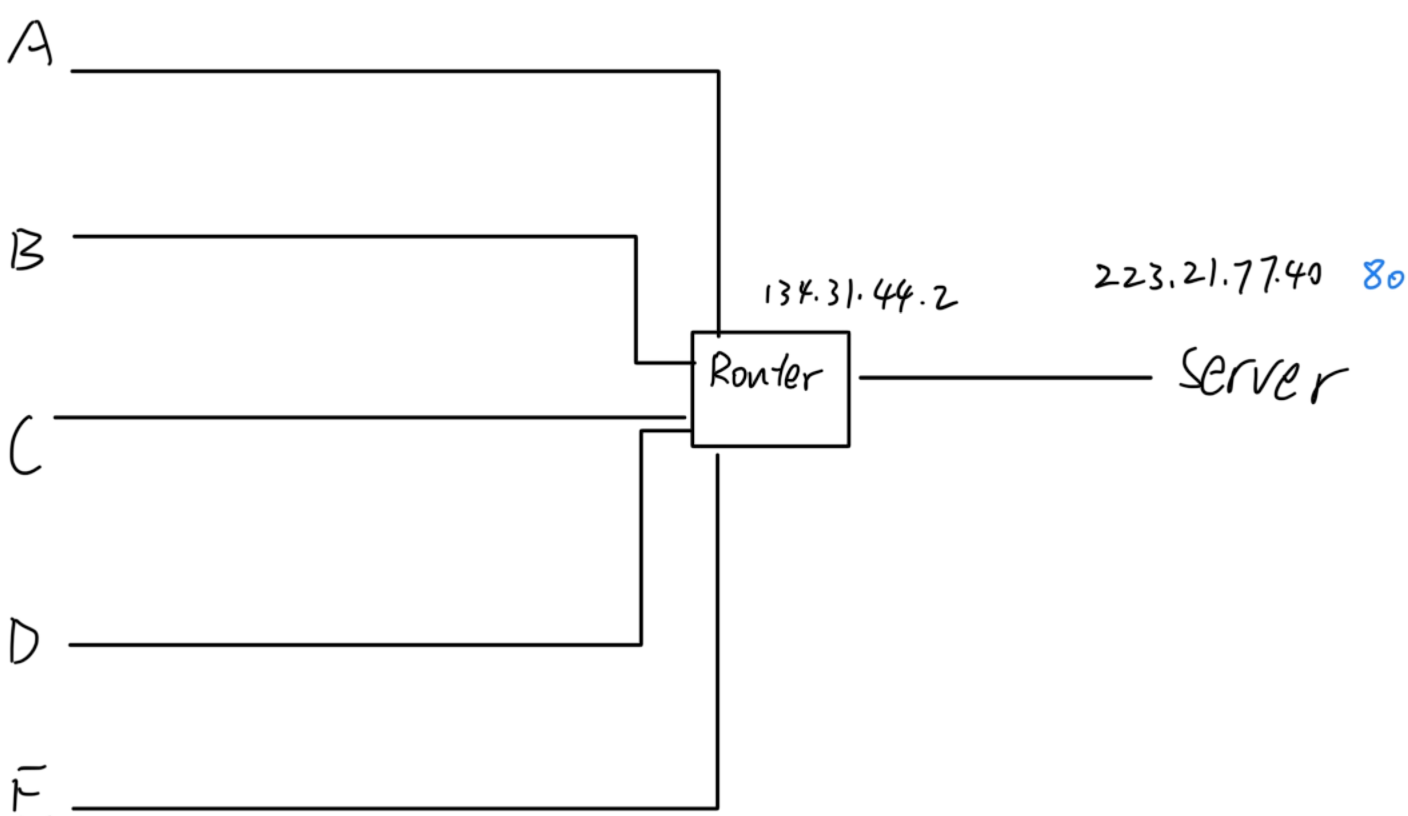
$\underbrace{192.168.2}_{24 \text{ bits}}.\underbrace{11100}_{5 \text{ bits}}000$

192.168.2.1110 0111 used for broad address

2 | 224 0
2 | 112 0
2 | 56 0
2 | 28 0
2 | 14 0
2 | 7 1
2 | 3 1
2 | 1 1
0

A	192.168.2.11100 001	225
B	192.168.2.11100 010	226
C	192.168.2.11100 011	227
D	192.168.2.11100 100	228
E	192.168.2.11100 101	229

(2) I will imitate translation table in week 4 Page 48



Host | Black means host → server → | Router | Blue means server → Host ← | Server

A:	
S: 192.168.2.225 5500	S: 134.31.442 63001
D: 223.21.77.40 80	D: 223.21.77.40 80
S: 223.21.77.40 80	S: 223.21.77.40 80
D: 192.168.2.225 5500	D: 134.31.44.2 63001
B:	
S: 192.168.2.226 5500	S: 134.31.44.2 63002
D: 223.21.77.40 80	D: 223.21.77.40 80
S: 223.21.77.40 80	S: 223.21.77.40 80
D: 192.168.2.226 5500	D: 134.31.44.2 63002
C	
S: 192.168.2.227 5500	S: 134.31.442 63003
D: 223.21.77.40 80	D: 223.21.77.40 80
S: 223.21.77.40 80	S: 223.21.77.40 80
D: 192.168.2.227 5500	D: 134.31.44.2 63003

D:

S: 192.168.2.228 5500

D: 223.21.77.40 80

S: 223.21.77.40 80

D: 192.168.2.228 5500

S: 134.31.442 63004

D: 223.21.77.40 80

S: 223.21.77.40 80

D: 134.31.44.2 63004

E:

S: 192.168.2.229 5500

D: 223.21.77.40 80

S: 223.21.77.40 80

D: 192.168.2.229 5500

S: 134.31.442 63005

D: 223.21.77.40 80

S: 223.21.77.40 80

D: 134.31.44.2 63005

(3)

	IP address	port
Source	223.21.77.40	80
Destination	134.31.44.2	63003

(4) I think I clearly explain this in part (2). But I will still use plain English to describe it.

- Since IPv4 is limited, we have to use NAT to solve this problem

- NAT has global IP address, and all hosts in its subnet will use this global IP address to communicate with other hosts/server which has different global IP Address

- In order to avoid ambiguity, each subnet has local IP Address, and correspond to a different port in router
- In this question, different host in subnet use different local IP address and $\underbrace{\text{same port}}_{\text{"local"}}$ number (5500)

host to server

- Wherever they want to send msg to server, they need go through router, which will change source address to global address, and port (5500) to Router port number
- Notice that, each host correspond to a different port in router, for example, A corresponds to

port 63001.

- Then router will use its global IP Address and corresponding port number to send msg to server

- whenever server want to send msg to host, it also need to go through router
- In order to know the destination of msg, server need to send msg to corresponding port in router
- For example, if server want to send to A, then it need send msg to port 63001 in router
- After msg reach router, router will send this msg to host according to the port number.

10 Normal

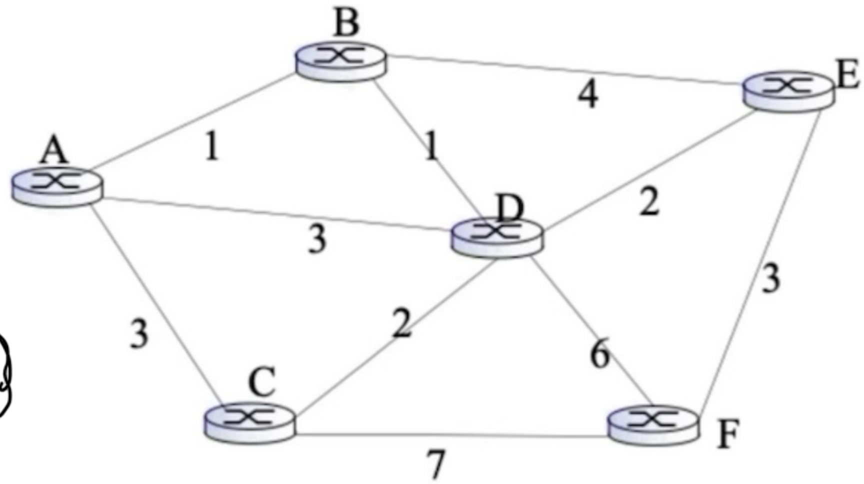
7. Dijkstra. In the following network, using Dijkstra's algorithm to find the shortest distances from F to all other nodes in the network. The link costs are labelled.

$N_A = \{C, B, D\}$ $N_E = \{B, D, F\}$ $N_F = \{C, D, E\}$

$N_B = \{A, D, E\}$

$N_C = \{A, D, F\}$

$N_D = \{A, B, C, E, F\}$



Iteration	Tree	A	B	C	D	E
Initial	F	(-1,∞)	(-1,∞)	(F,7)	(F,6)	(F,3)
1	F, E	(-1,∞)	(E,7)	(F,7)	(E,5)	
2	F,E,D	(D,8)	(D,6)	(F,7)		
3	FEDB	(B,7)		(F,7)		
4	F,E,D,B,C	(B,7)				
5.	ABCDEF	(B,7)	(D,6)	(F,7)	(E,5)	(F,3)

A B C D E

A → B → D → E → F cost is 7

B → D → E → F cost is 6

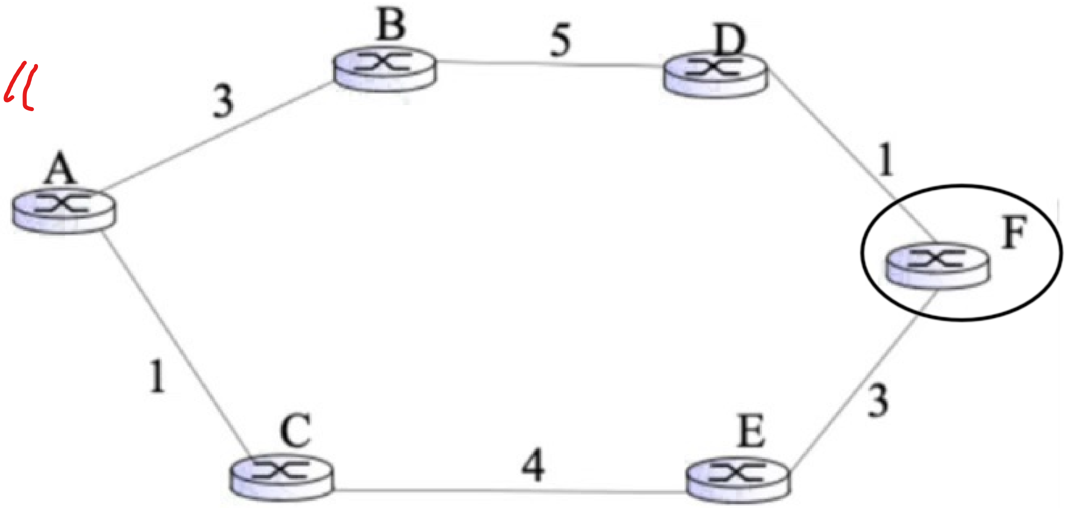
C → F cost is 7

D → E → F cost is 5

E → F cost is 3

Q8. Full

10



(1) Use the distance vector algorithm to find the shortest distances from all routers to router F by filling in the table below (assume that exchanges of routing information and routing table updates are synchronous). The table allows up to 8 iterations, but you can stop whenever the algorithm converges.

	A	B	C	D	E
Initial	−1,∞	−1,∞	−1,∞	−1,∞	−1,∞
1	-1, ∞	-1, ∞	-1, ∞	F, 1	F, 3
2	-1, ∞	D, 6	E, 7	F, 1	F, 3
3	C, 8	D, 6	E, 7	F, 1	F, 3
4	C, 8	D, 6	E, 7	F, 1	F, 3
5					
6					
7					
8					

$A = \min\{3 + D(B),\ 1 + D(C)\}$

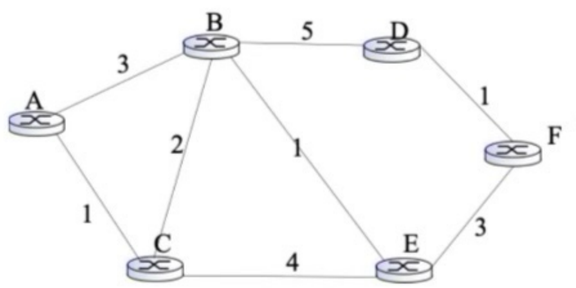
$B = \min\{3 + D(A),\ 5 + D(D)\}$

$C = \min\{1 + D(A),\ 4 + D(E)\}$

$D = \min\{5 + D(B),\ 1\}$

$E = \min\{4 + D(C),\ 3\}$

(2) After the convergence of (1), assume that the links B – E and B – C are connected with costs shown below. Do NOT use split horizon or reverse poisoning. Fill in the table below using the distance vector algorithm to find the shortest distance from each router to router F. The table allows up to 8 iterations, but you can stop whenever the algorithm converges.



	A	B	C	D	E
Initial	C,8	D,6	E,7	F,1	F,3
1	C,8	E,4	E,7	F,1	F,3
2	B,7	~~E,4~~	~~B,6~~	F,1	F,3
3	~~B,7~~	E,4	B,6	F,1	F,3
4					
5					
6					
7					
8					

Q9 1 Ø Normal

(1) Does the system route the packet via A-R1-R2-R4-B or A-R1-R3-R4-B? Why?

(2) When this packet is being delivered on the R4-B hop, specify the source IP address, destination IP address, source MAC address, destination MAC address of the packet.

(3) If your answer to (1) is A-R1-R2-R4-B, when the packet is being delivered at R2-R4 hop, specify the source IP address, destination IP address, source MAC address, and destination MAC address of the packet. If your answer to (1) is A-R1-R3-R4-B, when the packet is being delivered at R3-R4 hop, specify the source IP address, destination IP address, source MAC address, and destination MAC address of the packet.

S: 192.168.64.35

D: 192.168.79.42

100011

2|35 1
2|17 1
2|8 0
2|4 0
2|2 0
2|1 1
0

101010

2|42 0
2|21 1
2|10 0
2|5 1
2|2 0
2|1 1
0

(1) we need to use Longest Prefix Matching to choose interface for R1, we use Forwarding Table for R1

I_1 $\underbrace{192}_{8}.\underbrace{168}_{8}.\underbrace{01001}_{5}000.00000000$ $=21$

I_2 $\underbrace{192}_{8}.\underbrace{168}_{8}.\underbrace{0100111}_{7}0.00000000$

D: 192.168.01001111.00101010

2|72 0
2|36 0
2|18 0
2|9 1
2|4 0
2|2 0
2|1 1
0

2|78 0
2|39 1
2|19 1
2|9 1
2|4 0
2|2 0
2|1 1

Because I_2 has longest address prefix that matches destination address, hence we choose A → R1 → R3 → R4 → B

(2)

	IP	MAC
S:	192.168.64.35 A	DD-00-00-00-00-DD R4
D:	192.168.79.42 B	BB-BB-BB-BB-BB-BB B

2	79	1
2	39	1
2	19	1
2	9	1
2	4	0
2	2	0
2	1	1
	0	

(3) $R_3 \rightarrow R_4$

· That's $R_3 I_2 \rightarrow R_4 I_2$

	IP	MAC
S	192.168.64.35 A	CC-22-22-22-22-CC R3
D	192.168.79.42 B	DD-22-22-22-22-DD R4

Q10.

(1) all AS-PATHs are allowed, but some of them are not optimal AS-PATH.

- They are allowed because

① all AS appear in above graphs and

② they are ordered in AS-PATH/s

③ Include a prefix in the AS-PATH

- AS1 - AS131 - AS132 - 11.11.11.0/24 is not optimal because there is a shorter AS-PATH

(2) For this question, we need to use, shortest AS-PATH Hot potato rules. We do not need to use local preference because network manager did not set it in this problem.

Router	Pre-fix	Next Hop
A	11.11.11.0/24	C

we need go through Y to get shortest AS-PATH, and C is the cloest route in AS1

Router	Pre-fix	Next Hop
A	22.22.22.0/24	C

We get Tie in this case.

. Then we use Hot potato rule which indicate that C is the cloest route in AS1. and A→C is the shortest path to C

B 11.11.11.0/24 A

we need go through Y to get shortest AS-PATH, and B→A→C is shortest in AS1

B 22.22.22.0/24 D

We get Tie in this case.
. Then we use Hot potato rule which indicate that B→D is the shortest path to gate in AS1

C 11.11.11.0/24 Y

we need go through Y to get shortest AS-PATH, and C is the cloest route in AS1
to Y

C 22.22.22.0/24 Y

We get Tie in this case.
. Then we use Hot potato rule which indicate that C is the cloest route in AS1

D 11.11.11.0/24 E

we need go through Y to get shortest AS-PATH, and D→E→C is shorter than
D→B→A→C

D 22.22.22.0/24 X

We get Tie in this case.
. Then we use Hot potato rule which indicate that D is the cloest route

E 11.11.11.0/24 C

we need go through Y to get shortest AS-PATH, and C is the cloest route in AS1. And E → C is the shortest path to C

E 22.22.22.0/24 Either D or C

we get Tie in this case.

. Then we use Hot potato rule

And we find E → C and E → D have same distance to AS1 gate. Hence we can choose any of them as next Hop