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CSCI 4273/5273 Network Systems

Problem Set #2

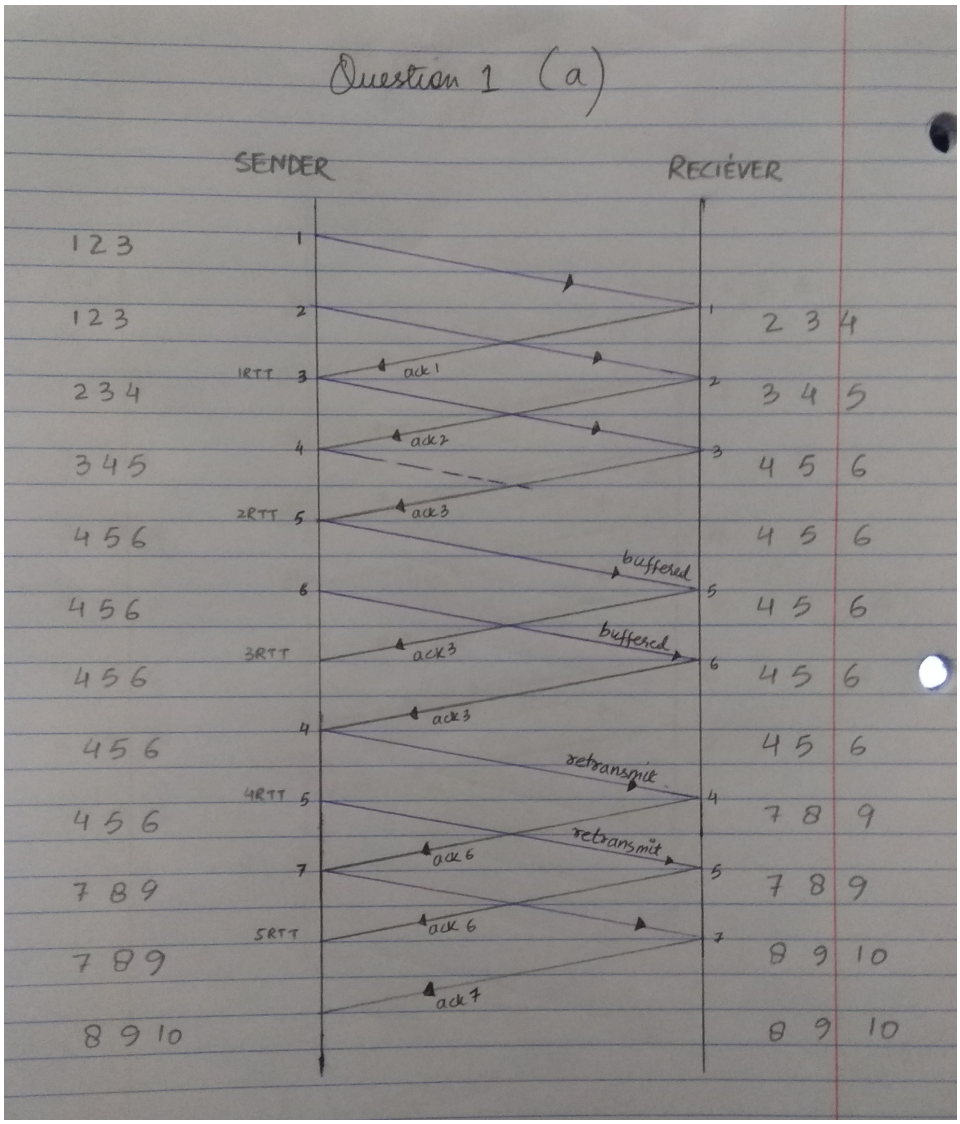
Fall 2018 Oct 15th

Problem 1(8pts)

Draw a time line diagram for the sliding window algorithm with SWS = RWS = 3 frames, for the following two situations. Use a timeout interval of about 2 × RTT. And assume 2 frames must be send ½ RTT apart which means if everything is normal Sender will receive ACK and then immediately send the next frame.

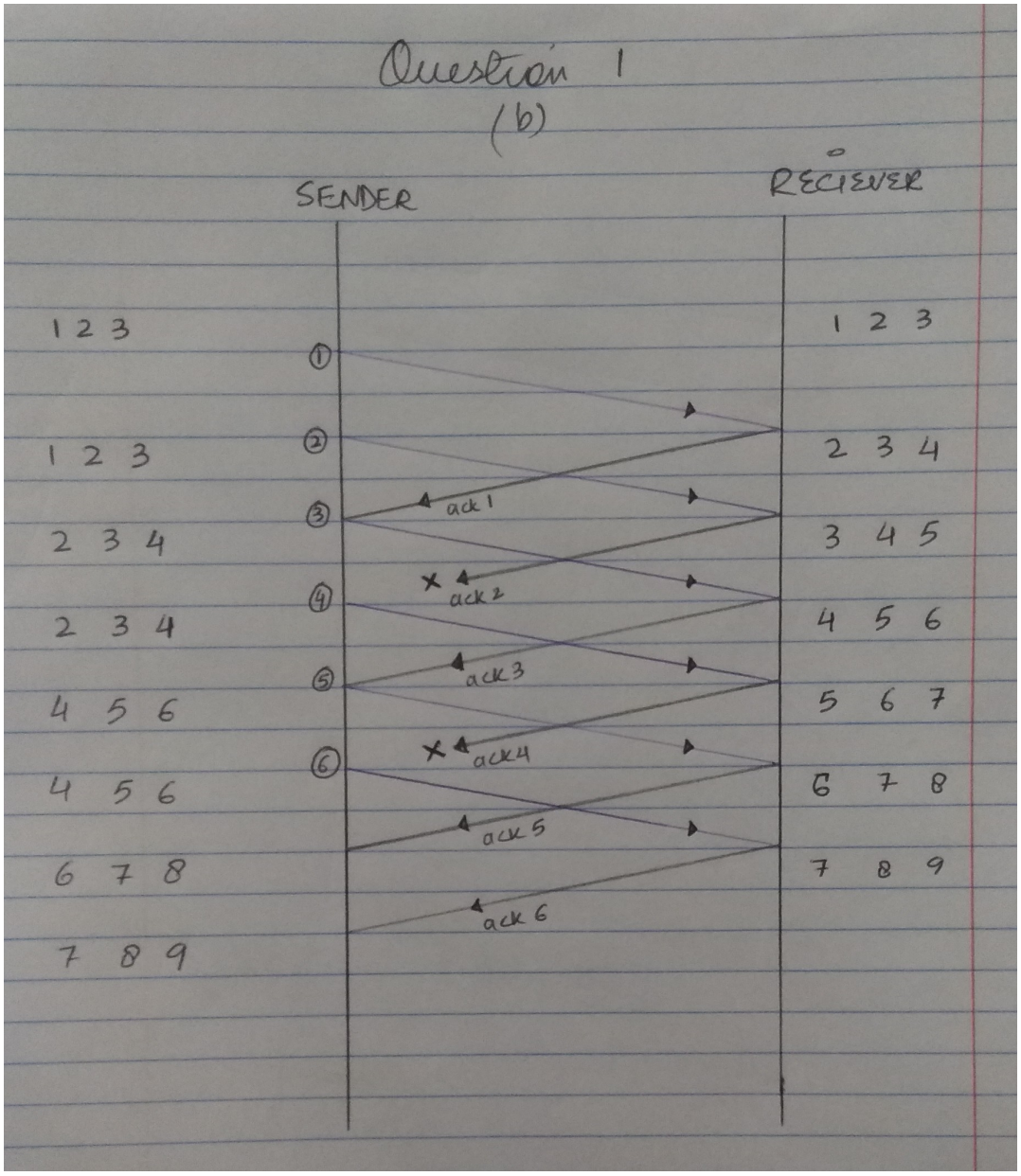
(a) Frame4 is lost. Draw the algorithm with time line diagram till Frame7 is send. (4pts)

answer(a):



(b) ACK 2 and 4 are lost. Draw the algorithm with time line diagram till Frame 6 is send. (4pts)

answer(b):

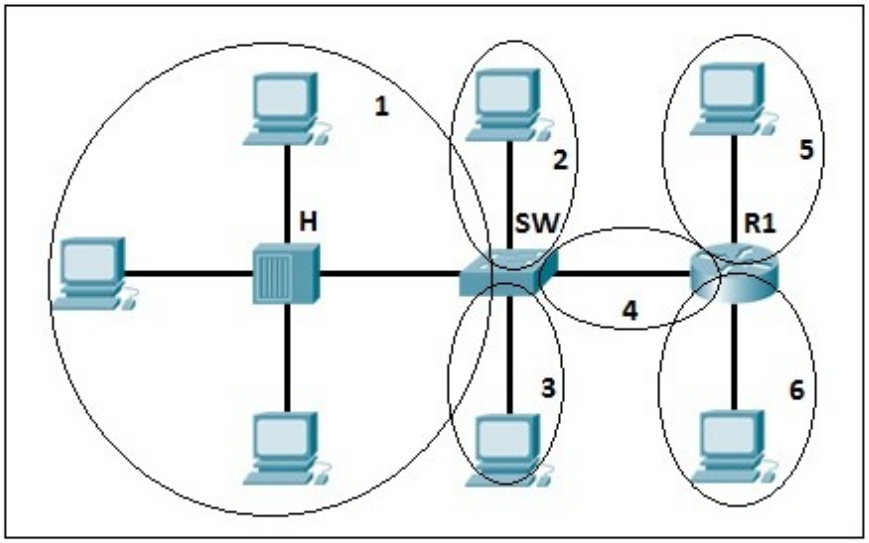


Problem 2 (6pts)

Explain collision domain and broadcast domain with respect to a hub, switch, and a router.

[1][2]Collision domain is a group of Ethernet devices that are connected on a network onto which all the devices compete for a shared network. A collision domain is a part of the network where the packet collision probability is higher in a network. Only one device can transmit in the network at a time while other devices listen to avoid any collision. Collision domain is also called as Ethernet Domain. A collision occurs when multiple devices transmit packets simultaneously on a shared network, thus reducing network efficiency. Collisions are often in hub environment. Each port on a bridge,switch or a router is in an isolated collision domain whereas hub is in same collision domain.

Figure below showing different collision domains for switch, hub and router



When two devices are connected with separate cables to a switch, we have two collision domains as per figure 1

if a switch is connected to a router then we have three collision domains as per figure 1

If 2 devices are connected to a Hub then its one collision domain as per figure 2.

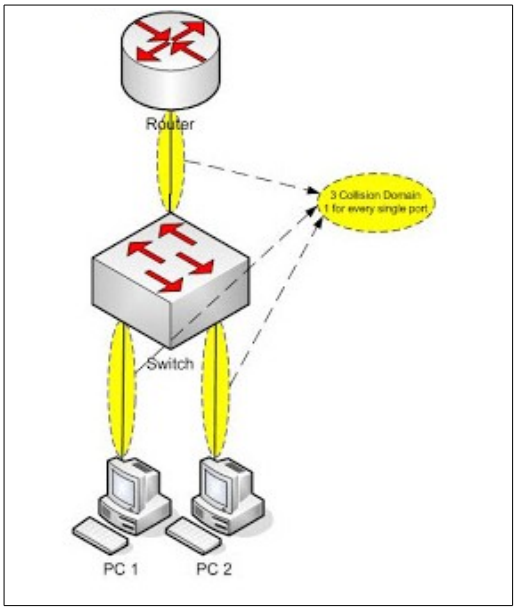


Figure 1

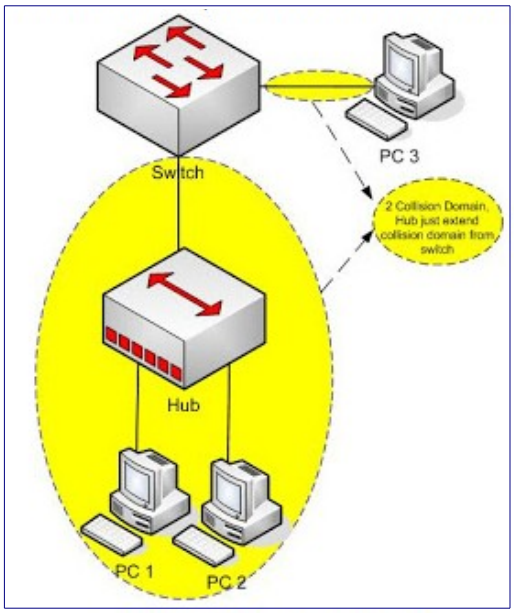
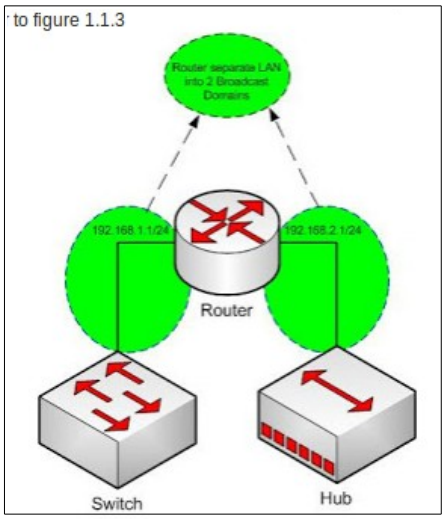


Figure 2

Broadcasting Domain is the domain in which broadcast is forwarded. In a broadcast, a single device talks while as others listen. All ports on a hub or switch belong to a same broadcasting domain, where as all ports on a router are in different broadcasting domains.



If devices connected together are connected using a repeater, hub switch or bridge, all the devices are in ONE broadcasting domain. Router is used to separate Broadcasting domains, so a presence of a router will create another broadcasting domain

References:

[1]:http://ccna-guidance.blogspot.com/2010/08/11-what-is-collision-domain-broadcast.html

[2] https://study-ccna.com/collision-broadcast-domain/

Problem 3 (7pts)

Consider the following networked computers connected by Bridge X and Y. Bridge X has interface 1,2 and3. Bridge Y has interface 1 and 2. Assume at the beginning the address tables of Bridge X and Y are all empty. Write down the address tables of Bridge X and Y after the following communication finished.

1. A send a packet to C
2. B send a packet to D
3. C send a packet to E
4. E send a packet to A
5. D send a packet to A

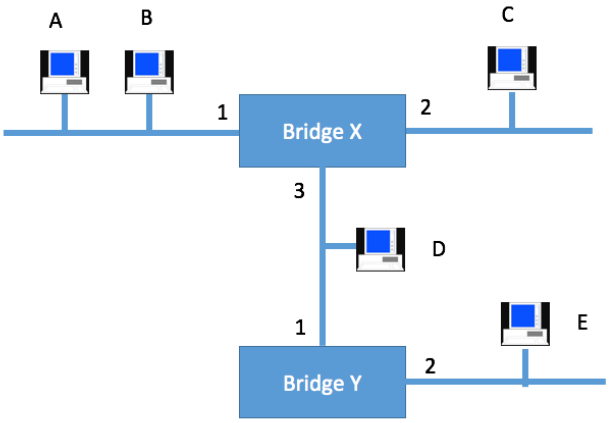


Figure 1

Bridge X

Address	Interface
A	1
B	1
C	2
E	3
D	3

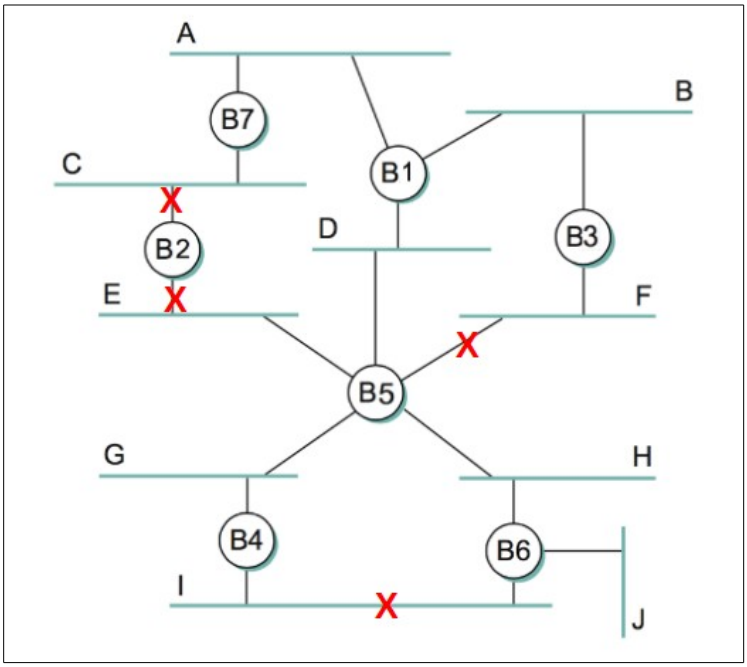
Bridge Y

Address	Interface
A	1
B	1
C	1
E	2
D	1

Problem 4 (5pts)

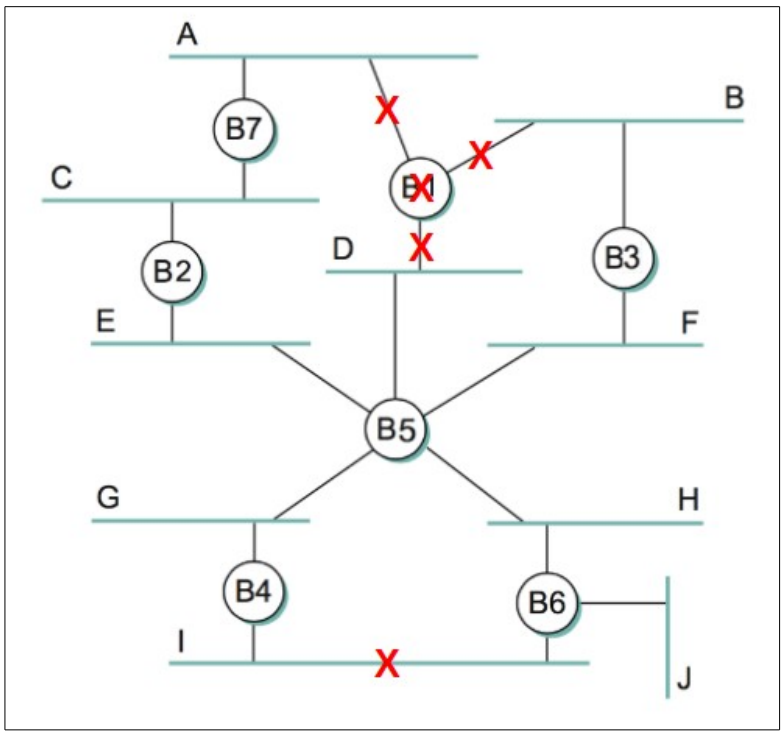
Given the extended LAN shown in Figure 2, indicate which ports are not selected by the spanning tree algorithm. Note that the bridge with the smallest ID becomes a root.

Figure 2



Problem 5 (5pts)

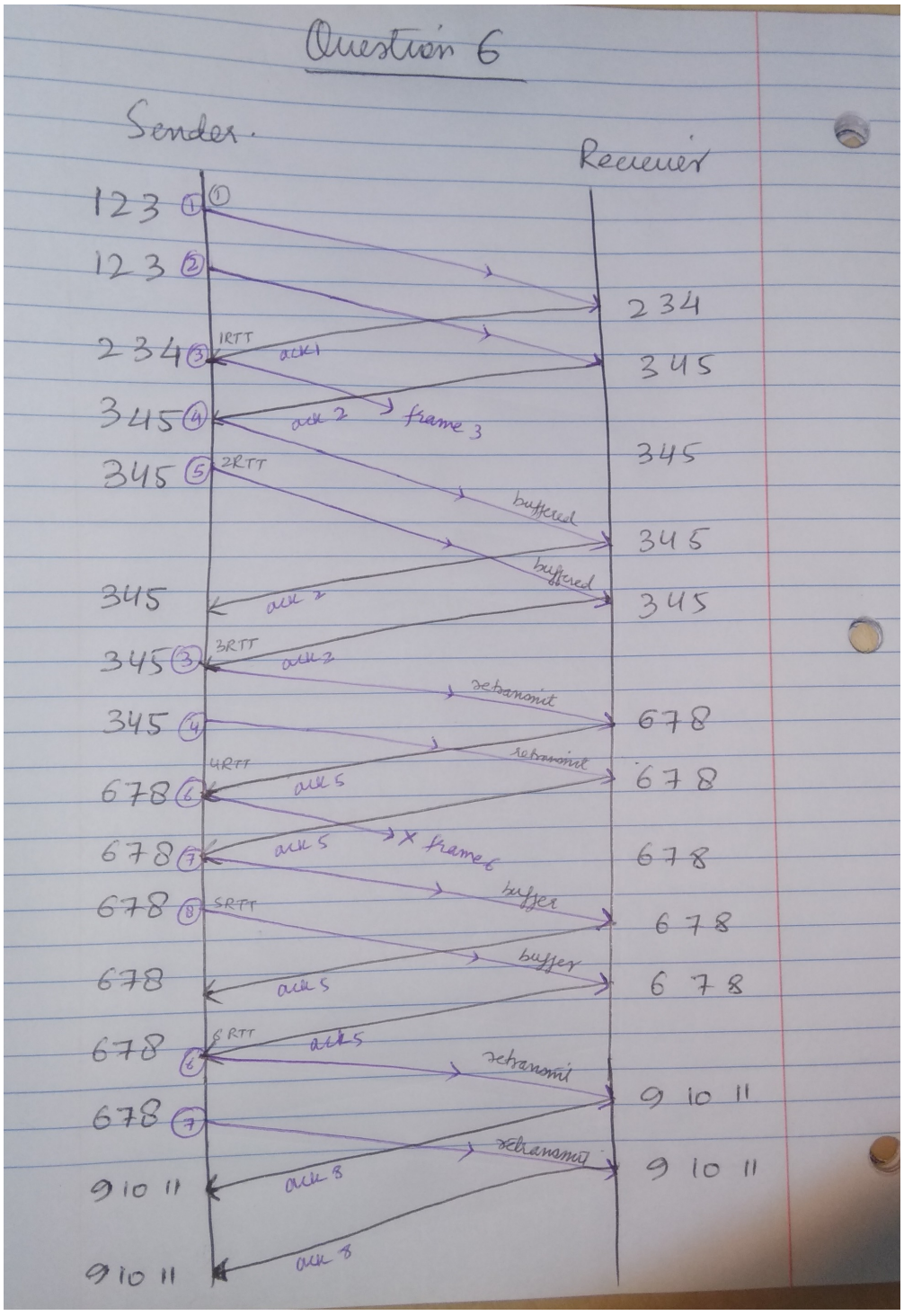
Still considering Figure 2. If Bridge B1 suffers catastrophic failure. Again indicate which ports are not selected by the spanning tree algorithm.



Problem 6 (6pts)

Draw a time line diagram for the sliding window algorithm with SWS = RWS = 3 frames, for the following situations. Use a timeout interval of about 2 × RTT. And assume 2 frames must be send ½ RTT apart which means if everything is normal Sender will receive ACK and then immediately send the next frame.

Frames 3 and 6 are lost on their first transmissions. Draw the algorithm with time line diagram till Frame 6 is sent. (6pts)



Problem 7 (6pts)

Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time t, the next in-order packet that the receiver is expecting has a sequence number of k. Assume that the medium does not reorder messages. Answer the following questions:

(a) What are the possible sets of sequence numbers inside the sender's window

at time t? Justify your answer. (2 pts)

(b) What are all possible values of the ACK field in all possible messages currently

propagating back to the sender at time t? Justify your answer. (2 pts)

(c) With the Go-Back-N protocol, is it possible for the sender to receive an ACK for a packet that falls outside of its current window? Justify your answer with an example. (2 pts)

answer(a):

window size is 4.Suppose sender has sent k packets and all those k packets have been received and their ack has been received by the sender. So the sender window will be updated to [k,k+4-1] or [k,k-3]

if a previous ack is not received , then the sender's window will be updated to [k-4,k-1]

if all the acks to k are missing, then the sender's window is [k-4,k-1]

Thus the range will be [k-4,k]

answer(b):

possible values of the ACK field are in the range [k-4,k-1]

answer(c):

Yes it is possible for the sender to receive an ACK for packet that falls outside its current window. Suppose a sender sends out packets in a time slot and receives the ack in another time slot at which the sender has timed out. So the sender will again send the packets to the receiver and will receive the corresponding acks from the receiver.

Problem 8 (6 points)

(a) Is 10.72.0.255/255.255.254.0 a valid IP address for a host? **[2pts]**
(b) Divide the 10.72.0.0/16 subnets into five large networks of 8192 IPs each, 8 medium-sized networks of 2048 IPs each, and 10 small sized networks of 128 IPs each. **[2pts]**
(c) Is 192.168.2/23 and 192.168.3/23 representing the same subnet? Please justify your answer. **[2pts]**

answer(8a):

10.72.0.255/255.255.254.0 is a valid IP address for a host

answer(8b):

```
Five 8192:

    10.72.0.0/19          10.72.31.255/19
    10.72.32.0/19         10.72.63.255/19
    10.72.64.0/19         10.72.95.255/19
    10.72.96.0/19         10.72.127.255/19
    10.72.128.0/19        10.72.159.255/19


Eight 2048:

    10.72.160.0/21        10.72.167.255/21
    10.72.168.0/21        10.72.175.255/21
```

```
10.72.176.0/21      10.72.183.255/21
10.72.184.0/21      10.72.191.255/21
10.72.192.0/21      10.72.199.255/21
10.72.200.0/21      10.72.207.255/21
10.72.208.0/21      10.72.215.255/21
10.72.216.0/21      10.72.223.255/21
```

Ten 128:

```
10.72.224.0/25      10.72.224.127/25
10.72.224.128/25    10.72.224.255/25
10.72.225.0/25      10.72.225.127/25
10.72.225.128/25    10.72.225.255/25
10.72.226.0/25      10.72.226.127/25
10.72.226.128/25    10.72.226.255/25
10.72.227.0/25      10.72.227.127/25
10.72.227.128/25    10.72.227.255/25
10.72.228.0/25      10.72.228.127/25
10.72.228.128/25    10.72.228.255/25
```

answer(c):

192.168.2/23 and 192.168.3/23 represent the same subnet
In this IP addressing, the masking is provided to be 23 hence the number of addresses available is 2^9 i.e 512 hence the addressing from 192.168.0/23 till 192.169.255/23 will belong to same subnet hence 192.168.2/23 and 192.168.3/23 represent the same subnet

Problem 9 (6 points)

An organization has been assigned the prefix 192.168.1.0/23 and wants to form subnets for 4 departments which have the following number of hosts:

Department A: 130 hosts

Department B: 120 hosts

Department C: 60 hosts

Department D: 31 hosts

(a) Give a possible arrangement of subnet masks to make this possible. **[4pts]**

An organization has been assigned the prefix 192.168.1.0/23 and wants to form subnets for 4 departments which have the following number of hosts:

Department A: 130 hosts
Department B: 120 hosts
Department C: 60 hosts
Department D: 31 hosts

There are a total of 512 IP subnets

Department A: 256 IP subnets
Range: 192.168.1.1 – 192.168.1.254
Network ID: 192.168.1.0
Broadcasting ID: 192.168.1.255

Department B: 128 IP subnets
Range: 192.168.2.1 - 192.168.2.126
Network ID: 192.168.2.0
Broadcasting ID: 192.168.2.127

Department C: 64 IP subnets
Range: 192.168.2.129 – 192.168.2.190
Network ID: 192.168.2.128
Broadcasting ID: 192.168.2.191

Department D: 64 IP subnets
Range: 192.168.2.193 – 192.168.2.254
Network ID: 192.168.2.192
Broadcasting ID: 192.168.2.255

(b) Suggest what the organization might do if department C grows to 65 hosts. **[2pts]**

Department C has been alloted a total of 64 subnets and if C grows to 65, providing more subnets will not be possible as allotting more than 64 subnets that is 128 subnets to C to accommodate the requirement of 65 will leave Department D with zero subnets hence it is not possible to allocate more than 64 subnets to C

Problem 10 (9 points)

For the network given below in Figure 3, give global distance-vector tables for each node when**:**

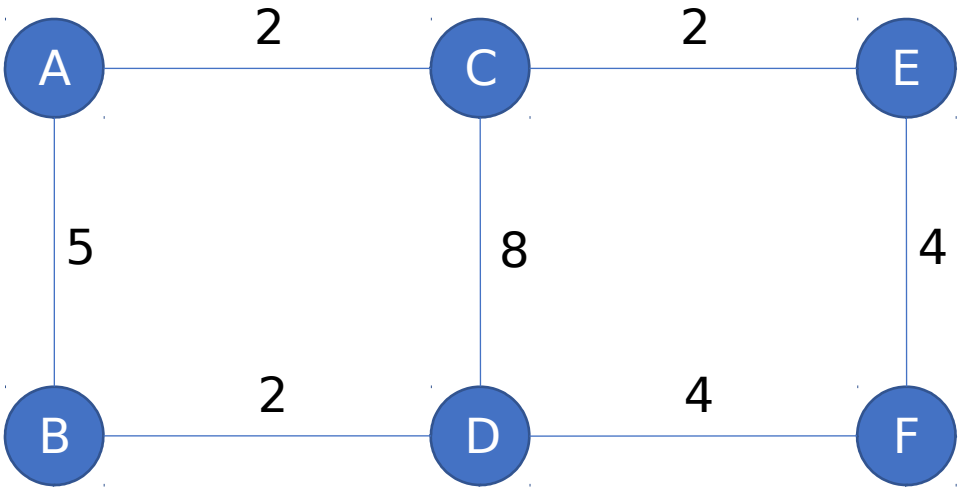


Figure 3

(a) Each node knows only the distance of its immediate neighbors. **[3pts]**
(b) Each node has reported the information it had in the preceding step to its immediate neighbors. **[3pts]**
(c) Repeat step (b) one more time. **[3pts]**

answer(a):

	A	B	C	D	E	F
A	0	5	2	INFINITY	INFINITY	INFINITY
B	5	0	INFINITY	2	INFINITY	INFINITY
C	2	INFINITY	0	8	2	INFINITY
D	INFINITY	2	8	0	INFINITY	4
E	INFINITY	INFINITY	2	INFINITY	0	4
F	INFINITY	INFINITY	INFINITY	4	4	0

answer(b):

	A	B	C	D	E	F
A	0	5	2	7	4	INFINITY
B	5	0	7	2	INFINITY	6
C	2	7	0	8	2	6
D	7	2	8	0	8	4
E	4	INFINITY	2	8	0	4
F	INFINITY	6	6	4	4	0

answer(c):

	A	B	C	D	E	F
A	0	5	2	7	4	8
B	5	0	7	2	9	6
C	2	7	0	8	2	6
D	7	2	8	0	8	4
E	4	9	2	8	0	4
F	8	6	6	4	4	0

Problem 11 (5 points)

Again for the network graph in Figure. 3. Show how the link-state algorithm builds the routing table for node D.

(a) Show the detailed steps with the link-state algorithm. **[3pts]**

D ={A,B,C,D,E,F}

Link state algorithm for node D as :

Node D initially uses Dijikstra's Algorithm to construct its routing table

D is starting node N' as N'={D}

B,C and F as neighbors

d{A,B,C,D,E,F} = {INF,2,8,0,INF,4}

Iteration 1: Adding immediate neighbor B to node N' since d(B) has the smalled value in comparison to d(C) and d(F) so N'={B,D}

So d{A,B,C,D,E,F} = {7,2,8,0,INF,4}

Iteration 2: Adding immediate neighbor F to node N' since d(F) has the smaller value in comparison to d(C) so N'={B,D,F}

So d{A,B,C,D,E,F} = {7,2,8,0,8,4}

Iteration 3: Adding neighbor A to node N' since d(A) has the smaller value in comparison to d(C) and d(E) so N'={A,B,D,F}

So d{A,B,C,D,E,F} = {7,2,8,0,8,4}

Iteration 4: Adding neighbor C to node N' since d(C) has the same value in comparison to d(E) so N'={A,B,C,D,F}

So d{A,B,C,D,E,F} = {7,2,8,0,8,4}

Iteration 5: Adding neighbor E to node N'

so N'={A,B,C,D,E,F} So d{A,B,C,D,E,F} = {7,2,8,0,8,4}

Since Node N' contains all the nodes so the algorithm is complete

(b) Show the final routing table of node D. **[2pts]**

Destination	Next Hob	Distance
A	B	7
B	B	2
C	C	8
E	F	8
F	F	4

Problem 12 (6 points)

(a) What is the difference between CSMA/CD and CSMA/CA

(b) Why is collision detection more complex in wireless networks such as 802.11 compare to wired networks such as Ethernet.

(c) How can hidden and exposed terminals be detected in 802.11 networks? Explain how it works.

answer(a):

CSMA stands for Carrier Sense Multiple Access. It is a MAC (Media Access Control) protocol that allows multiple access on a shared transmissions medium. Each node in CSMA first checks for traffic before transmitting data on the shared transmissions medium.

CSMA is used for collision avoidance, collision detection or collision resolution.

CSMA/CD stands for CSMA with Collision Detection. It is a CSMA variant that improves the CSMA performance by keeping a track of any collision and as soon any collision is detected, the transmissions is terminated.

CSMA/CA stands for CSMA with Collision Avoidance. It is a CSMA variant that improves the CSMA efficiency by avoiding collision by detecting if the shared bus or medium is busy and thus deferring the transmissions for a random interval of time. The delay provided reduces the incidence of collision in transmission.

answer(b):

Collision detection is more complex in wireless networks such as 802.11 compare to wired networks such as Ethernet because of its duplexity. A wireless network as given in question as 802.11 are generally half duplex whereas wired network like Ethernet is generally full duplex. Because of its half duplexity, a wireless network has a different sensitivity towards transmission and reception power and thus is not able to receive a signal

immediately after transmitting a signal thereby unable to detect any collision. Moreover a wireless transceiver sends and receives data or signal on different channels rather than on a single channel so collision detection is not possible. A wireless network also contains nodes that may be hidden and not apparent to other nodes and thus unable to receive signal from those nodes increases difficulty to detect collision in a wireless network.

answer(c) :

Hidden and exposed terminals be detected in 802.11 networks as per following:

- Increasing TX power: Increasing transmission power in a wireless network can detect hidden nodes by allowing the cell to increase its radius and size and there by allowing non hidden nodes to detecting hidden nodes in their scope. As nodes in a CSMA/CA protocol need to wait before communicating with an access point, so all the hidden nodes are recognized in the network.

- Omni directional Antennas: Using bidirectional Antennas for widespread networks hidden nodes can be detected as directional antennas do not recognize the nodes that are not in their path.

- Removing Obstacle in the path of an TX/RX and a hidden node: By removing obstacles like a wall several times an unreachable node can be reached by TX/RX as unreachable nodes also tend to remain hidden if the power of TX/RX is not strong enough to discover the node because of obstacles

Problem 13 (6 points)

The network graph is shown in Figure. 4.

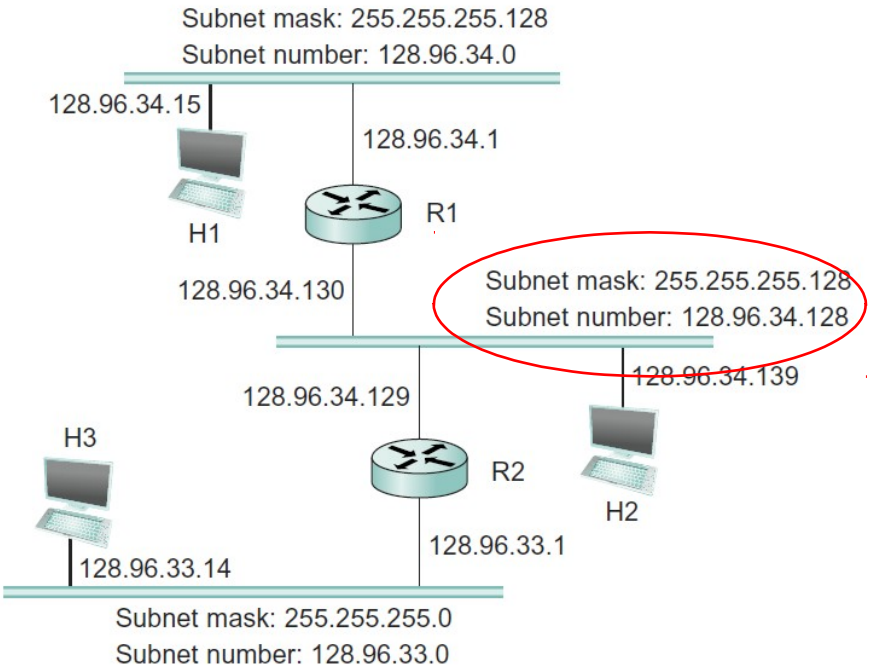


Figure 4

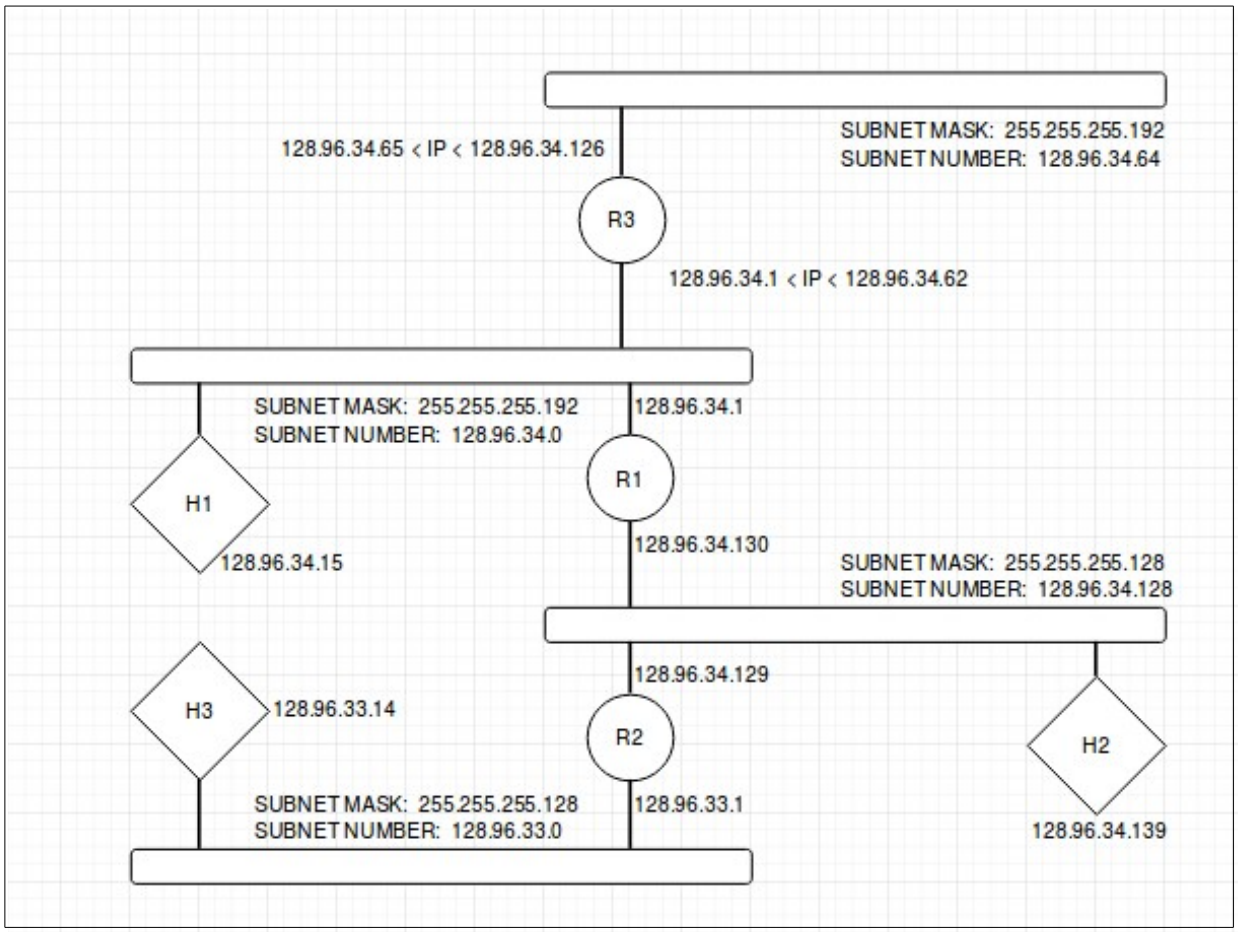
(a) Host H1 sends a packet to the destination 128.96.34.126. Explain how this packet traverses in the network described below. You need to describe who received the packet and what are their reactions. **[2pts]**

Host H1 sends a packet to the destination as 128.96.34.126.The LAN with subnet 128.96.34.0 has a capacity of 128 hosts starting from 128.96.34.0 till 128.96.34.127 including Network ID and Broadcasting ID, usually Network ID is the first and Broadcasting ID is the last as in this case 128.96.34.0 is the Network ID and 128.96.34.255 is the Broadcasting ID .The router R1 connected to this LAN at 128.96.34.1 recognizes the destination address belonging to this LAN only and floods it out to that LAN only and will not forward it to the other networks.

(b) Host H3 sends a packet to the destination 128.96.34.250. Explain how this packet traverses in the network. **[2pts]**

Host H3 sends a packet to the destination 128.96.34.250
In this case the Host H3 will send a packet with destination ID as 128.96.34.250.Host H3 has a IP address of 128.96.33.0.The destination address received by R2 recognizes the destination address belonging to llnd Network and will therefore forward the packet to the network with addresses starting from 128.96.34.128 and ending with 128.96.34.255.R1 will also hear the packet but R1 will not forward it further anymore

(c) The subnet of H1 has now two different teams and would like to split it into two subnets. Please add one more subnet and add R3 and change the network configurations as you need. Note that you are allowed to modify the network as least disruptive as possible. **[2pts]**



The subnet mask of H1 changes from 255.255.255.128 to 225.225.225.192 to accommodate 64 hosts while as the new network will also have the same subnet mask accommodating the rest of the 64 hosts. The Ip for the R3 router will be in a range of 128.96.34.65 - 128.96.34.126 for the new network and IP for the same router will be 128.96.34.1 till 128.96.34.62. The IP addresses as 128.96.34.0 and 128.96.34.64 will be set for Network ID and the ip address 128.96.34.127 and 128.96.34.63 will be set for Broadcasting ID

Problem 14 (8 points)

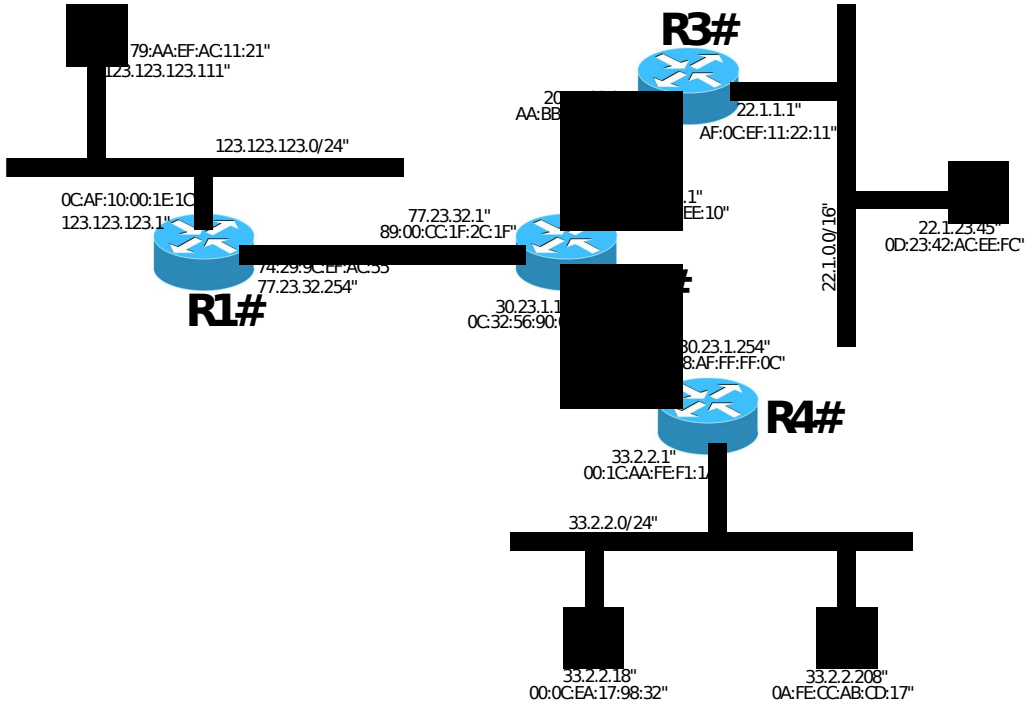


Figure. 5

Above in Figure 5 is the network graph with 4 routers (R1, R2, R3, R4) and 4 hosts (A, B, C, D). Each router interfaces and hosts are labeled with both IP and MAC address, Routing is enabled so that any two hosts can communicate with each other and also the default gateway of each host is set to its gateway router.

(a) Suppose that B send an IP packet to C through R3, R2, R4. Write down the IP packet's content (src MAC, dst MAC, src IP, dst IP) along the path in the Table given below: **[4pts]**

	Src MAC	Dst MAC	Src IP	Dst IP
B → R3	**0D:23:42:AC:EE:FC**	**AF:0C:EF:11 :22: 11**	**22.1.23.45**	**33.2.2.18**
R3 → R2	**AA:BB:CC:AF:2F:11**	**AF: CC :1F :11 :EE :10**	**22.1.23.45**	**33.2.2.18**
R2 → R4	**OC:32:56:90:09:EF**	**89:98:AF:FF:FF:0C**	**22.1.23.45**	**33.2.2.18**
R4 → C	**00:1C:AA:FE:F1:1A**	**00:0C:EA:17:98:32**	**22.1.23.45**	**33.2.2.18**

(b) When A sends out an ARP query for its default gateway, what is the reply to that query? **[2pts]**

SRC IP	DST IP	SRC MAC	DST MAC
123.123.123.111	123.123.123.1	79:AA:EF:AC:11:21	00:00:00:00:00:00

SRC IP	DST IP	SRC MAC	DST MAC
123.123.123.111	123.123.123.1	79:AA:EF:AC:11:21	0C:AF:10:00:1E:1C

(c) Suppose the routers use link-state routing protocol, what will be R3's routing table entries? **[2pts]**

Destination	Next Hop	Cost	Inteface Ports
20.11.33.0	Connected	0	20.11.33.254
20.1.0.0/16	Connected	0	20.1.1.254
30.23.1.0/24	20.11.33.1	1	20.11.33.254

77.23.32.0/24	20.11.33.1	1	20.11.33.254
123.123.123.0/24	20.11.33.1	2	20.11.33.254
33.2.2.0/24	20.11.33.1	2	20.11.33.254

Problem 15 (2 points)

Suppose a computer just boot up, connected to wireless network and successfully obtained IP, gateway and DNS address. Now it wants to access www.yahoo.com from its browser. Describe the sequence of packets exchanged to and from this computer until the webpage starts to load. (include what kind of protocol is used and what is the content of the packets)

The protocol is followed as :

1. DHCP
2. ARP
3. DNS
4. HTTP Request
5. HTTP Response

The protocol follows sequentially from 1 to 5 as

DHCP → ARP → DNS →HTTP Request → HTTP Response

DHCP: DHCP stands for Dynamic Host Configuration Protocol. DHCP is required to obtain the following parameters as IP Address, Subnet , Default Gateway and DNS Server Address

ARP: ARP stands for Address Resolution Protocol. ARP is followed after DHCP and is used to gather information related to the MAC Address of the gateway. ARP is used to get the MAC address so that the packets can be forwarded to the next network.

DNS: DNS stands for Domain Name System. DNS Is used to gather the IP address of the website (www.yahoo.com) and for that the DNS sends a query to the DNS server. DNS gets the IP address for the requested website from the DNS server.

HTTP request is then sent to the www.yahoo.com (destination IP) along with a port number.

HTTP response.In return to the HTTP request, the destination sends a HTTP response that contains data about the webpage and thus dispalys the content on the browser

Problem 16 (9 points)

Consider the simple network in Figure 5 below, X, Y and Z are switches and link cost as specified. Assume Distance Vector algorithm is used and have converged. Now Y's and Z's Routing table will look like Table. 3.

(a) Now Let assume the cost of link X-Y suddenly changed to 100. Please write down the Y's and Z's routing table regarding distance to X, after Y updates this information to Z and then Z updates its information back. **[3pt2]**

answer(a):

Figure. 5 Node Y/Distance	Via X	Via Z
X	4	6
Node Z/Distance	Via X	Via Y
X	50	5

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	6
Node Z/Distance	Via X	Via Y
X	50	7

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	8
Node Z/Distance	Via X	Via Y
X	50	7

(b) Please write down the Y's and Z's routing table regarding X after Y updates this information to Z again and then Z updates back again. **[3pt2]**

answer(b):

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	8
Node Z/Distance	Via X	Via Y
X	50	7

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	8
Node Z/Distance	Via X	Via Y
X	50	9

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	10
Node Z/Distance	Via X	Via Y
X	50	9

(c) How many updates did Y get until its distance to X have converged with Distance Vector algorithm? **[3pts]**

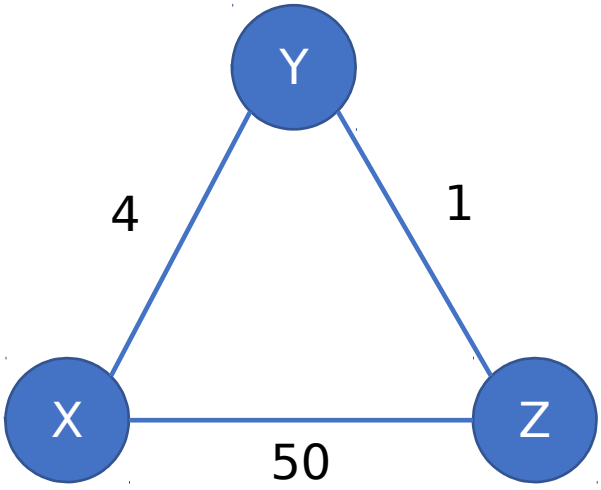


Figure. 5

Node Y/Distance	Via X	Via Z
X	4	6
Node Z/Distance	Via X	Via Y
X	50	5

Table. 2

answer(c):

After X via Y and X via Z are updated the values at X via Y is 7 and and X via Z is 8

In second step, after X via Y and X via Z are updated the values at X via Y is 9 and and X via Z is 10

After 22nd update, the X via Y and X via Z are updated and the values at X via Y is 49 and and X via Z is 50

In the 23rd step we have as follows

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	50
Node Z/Distance	Via X	Via Y
X	50	49

Figure. 5 Node Y/Distance	Via X	Via Z
X	100	51
Node Z/Distance	Via X	Via Y
X	50	51

In the 23rd updates for Y, the distance to X converges with distances with Distance Vector Algorithm