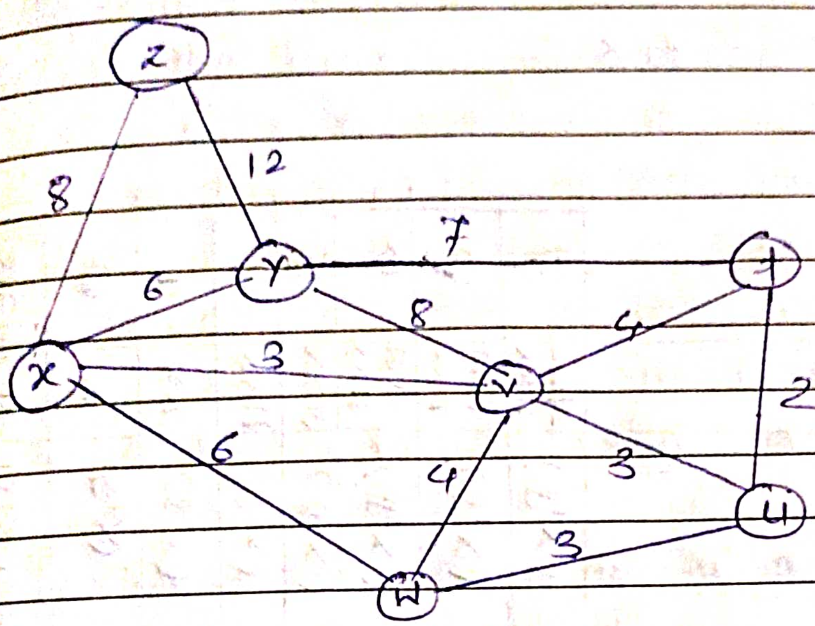
Homework - 6

① Given network:



While computing the cost from x to all the nodes from x, ~~to~~ by using Dijkstra's algorithm and referring to the table 5.1, we define the below terms first.

N' ⇒ Subset of all nodes to which 'v' nodes will belong whenever cost from x (source) to 'v' is known.

D(v) and P(v) ⇒ These are the least costs and the previous nodes having the least cost.

Now by using the algorithm we compute the table as follows:

Table using Dijkstra's algorithm

Step	N'	D(z),P(z)	D(y),P(y)	D(v),P(v)	D(w),P(w)	D(u),P(u)	D(t),P(t)
0	x	(8,x)	(6,x)	(3,x)	(6,x)	∞	∞
1	xv	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)
2	xvu	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)
3	xvuw	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)
4	xvuwy	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)
5	xvuwyt	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)
6	xvuwytz	(8,x)	(6,x)	(3,x)	(6,x)	(6,v)	(7,v)

The table is computed using the steps of Dijkstra's algorithm as follows:

① In the first step, we start by giving the cost to w, y, v nodes as 6, 6, 3 resp. These are directly connected to x.

② We follow the below step iteratively till we connect all the nodes in the network:

a> Find the node with minimum value in the previous distance list and which not presen in N' set.

b> Add this node to N' and then update the list of distance.

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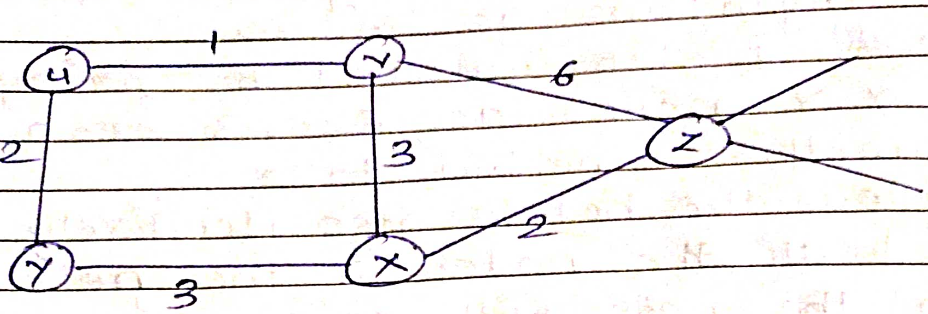
② Given Network :



Distance vector routing alogorithm shares the routing table of a node with the other nodes and maintains the information to select the shortest path from source to destination.
It uses Bellmann Ford algorithm :

$$d_x(y) = \min_v \{ c(x,v) + d_v(y) \}$$

using this computation we compute tables :

From		cost to				
~~Ø~~		u	v	x	y	z
~~v~~	⇒	∞	∞	∞	∞	∞
~~x~~	⇒	∞	∞	∞	∞	∞
z	⇒	∞	6	2	∞	0

From		cost to				
		u	v	x	y	z
v	⇒	1	0	3	∞	6
x	⇒	∞	3	0	3	2
z	⇒	~~7~~	5	2	5	0

From		cost to				
		u	v	x	y	z
v	⇒	1	0	3	3	5
x	⇒	4	3	0	3	2
z	⇒	6	5	2	5	0

From		cost to				
		u	v	x	y	z
v	⇒	1	0	3	3	5
x	⇒	4	3	0	3	2
z	⇒	6	5	2	5	0

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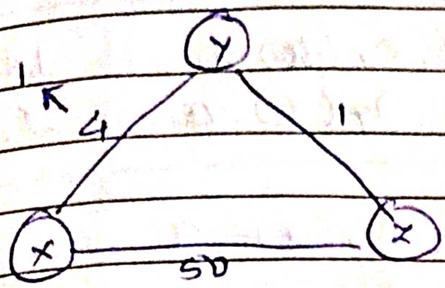
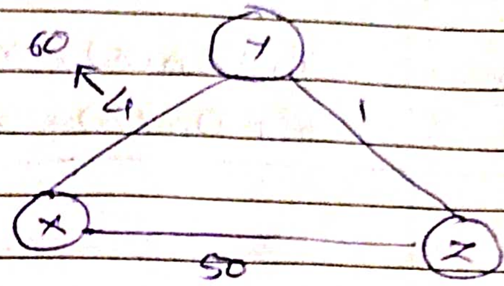
③ Here, it is asked to assume the synchronous version of distance-vector algorithm. In this, it is also assumed that the exchange of distance vectors happens among the node and neighbors. The computation of the tables of each node follows this stratergy. For example, between node x & node Y are neighbors then Y will tell it's all neighbors about optimal path within 1 or 2 hops range.

If we consider the diameter of the network as 'd' i.e. the longest path without loops, then after 'd-1' iterations, every network node will be aware of shortest path cost of 'd' and the no. of hops will be 'd'. Thus, for the convergence, this algorithm will need 'd-1' iteration since all the paths having more than 'd' hops will be closed paths i.e. they will have loops in it.

④ Given networks are:





a) When the router w is added, costs from present nodes to 'W' are as follows:

$c(Y,W) = 1, \quad c(Z,W) = 1$ e

After stabalizing router will tell distance value to x as follows:

① W ⇒ Y $\qquad D_W(x) = \infty$

② W ⇒ Z $\qquad D_W(x) = 5$

① Y ⇒ W $\qquad D_Y(x) = 4$

② Y ⇒ Z $\qquad D_Y(x) = 4$

① Z ⇒ W $\qquad D_Z(x) = \infty$

② Z ⇒ Y $\qquad D_Z(x) = 6$

b) When c(X,Y) is increased to 60 & poisoned reveree is used, count-to-infinity problem will be present. The convergence process will take place when the nodes will start exchanging their distance vector. This will be represented as follows:

Time	W (informs to)	Y (informs to)	Z (informs to)
t_0	Y, $D_w(x) = \infty$ Z, $D_w(x) = 5$	W, $D_y(x)=4$ Z, $D_y(x)=4$	W, $D_z(x)=$ [illegible] Y, $D_z(x)=$ [illegible]
t_1	—	W, $D_y(x)= 9$ Z, $D_y(x)=\infty$	—
t_2	Y, $D_w(x) = \infty$ Z, $D_w(x) = 10$	—	unchanged
t_3	—	unchanged	W, $D_z(x)=\infty$ Y, $D_z(x)=1$
t_4	unchanged	W, $D_y(x)=14$ Z, $D_y(x)=\infty$	—

From the above table, it can be seen clearly, that routers W, Y, Z all have ∞ entry while sharing vectors with x router. Hence, the count-to-infinity issue will arise.

c) If $c(y,x)$ changes to 60 then we need to eliminate the link of ~~x~~ y and z to avoid count to infinity problem.

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(5) Given :
1> AS3 and AS2 working on OSPF
2> AS1 and AS4 using RIP
3> There is no initial link between AS2 & AS4

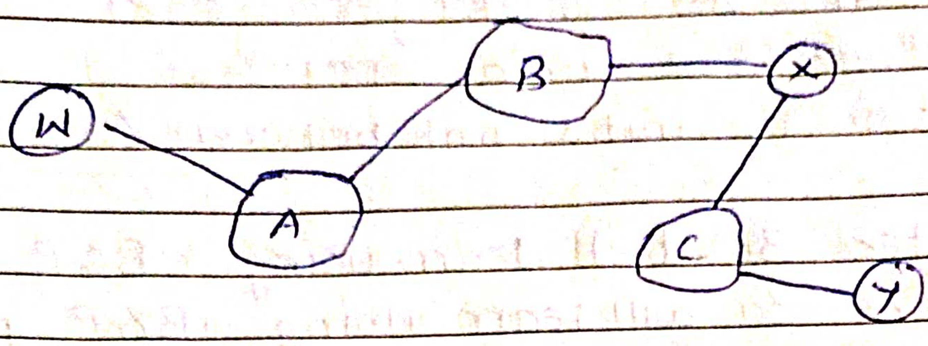
∴ a> routes 3c will learn using eBGP protocol.
b> routes 3a will learn using iBGP protocol.
c> routes 1c will learn using eBGP protocol.
d> routes 1d will learn using iBGP protocol.

(6) a> Here, since the 1d router will put an entry (x, 1) in forwarding table, the interface will initiate the lowest cost from 1d router to 1c router. i.e. gateway router. This will lead the value of I equal to I_1 and not I_2.

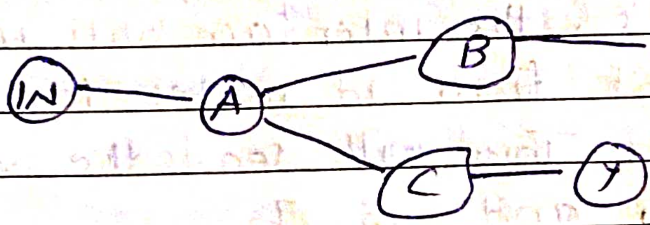
b> Here, I_1 and I_2 has same path distance but the next immidiate hop of I_2 is closest. Hence value of I will be set to I_2.

c> I will be set to I_1 because I_1 is responsible for initiating the shortest AS path.

7. Topology view of X ⇒



Topology view of W ⇒



In the above views, W and Y both contain the AC links i.e. AS A & AS C links respectively. on the paths. X is completely unware of AC links since W & Y donot share their routing tables containg AC link with X.

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8 a) Given data:
protocol used ⇒ slotted ALOHA.
data of node A > data of nod B
P_A(retransmission) > P_B(retransmission)

∴ a) Avg. throughput of A ⇒ $P(A) \times (1 - P(B))$
Total efficiency ⇒ $P(A) \cdot (1 - P(B)) +$
$P(B) \cdot (1 - P(A))$

b) given $P(A) = 2P(B)$.
∴ Throughput of A $= 2P(B)\,(1 - P(B))$
$= 2P(B) - 2(P(B))^2$ ... (1)

Throughput of B $= P(B) \cdot (1 - P(A))$
$= P(B) \cdot (1 - 2P(B))$
$= P(B) - 2(P(B))^2$ ... (2)

From 1 & 2, avg. throughput of A is not twice as large as throughput of B.
We have to choose $P(A) = 2 - \left(\frac{P(A)}{P(B)}\right)$ for

avg. throughput of A = 2 × avg. throughput of B.

c) From the given eq'n & eq'n 1 & 2,
avg. throughput of A = $2P(1-P)(N-1)$
and throughput of any node in network ⇒
$P(1-P)(N-2)(1-2P)$

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(9) a> Router R_1 won't be asked to forward the datagram by E. The main reason is E & F are on same LAN thus E checks the subnet prefix of F to learn this. Router R1 won't receive any packet. IP datagram containing frame will have below details:

- source IP ⇒ IP address of E
- destination IP ⇒ IP address of F
- Source MAC address ⇒ E's MAC address
- destination MAC ⇒ MAC address of F.

b> For performing ARP query operation, E can verify the B's IP address. It will definitely won't perform ARP query since E and B are on the different LAB. Ethernet frame between E & B will have:

⇒ source & destination IPs as that of E's IP and B's IP respectively.

⇒ Source & destination MAC addresses as that of E's MAC address and the MAC address of the interface R1 connected to subnet 3 respectively.

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c) 1) Here, the received ARP frame have the destination address as a broadcast message address. Hence it will know that subnet 1 and S1 are connected using the common interface of S1 leading to learn that A is present in the subnet 1. Thus, ~~subnet S1~~ switch S1 uses both of it's interfaces to broadcast the ethernet frame. Once broadcasting is done, S1 will also do update entry of A in it's forwarding table.

2) Router R1 will get the ARP request message. But it won't be able to forward it to subnet 3.

3) A's query message will already hold the A's MAC address. Thus ~~B~~ there is no need for B to send query message to A for it's MAC address.

4) Here, A & B are on the same LAN. Hence, Swith S1 will drop the frame which is received. It will also enter an entry of B in the forwarding table once B gives response to S1.

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(10) Here, routes between S2 and S3 is replaced by a switch say Snew.

a) No, here Snew won't get any packet from E. To learn that the F is on the same LAN, E will easily check the F's IP address prefix. Corresponding ethernet frame will have:
⇒ Source & destination IP ⇒ E's IP and F's IP respectively.
⇒ Source & destination MAC ⇒ E's MAC and F's MAC respectively.

b) E will perform ARP querying to find the host B & broadcast the ethernet frame. E to S2 ethernet frame will follow below details:
⇒ Source IP = IP address of E
⇒ destination IP = IP address of B
⇒ Source MAC = MAC address of E
⇒ Destination MAC = broadcast MAC address.

c) i) Switch will use both interfaces to broadcast the ethernet frames. becaus the destination address of ARP is broadcast address. S1 will learn the subnet 1 contains host A & subnet & S1 are connected via interface. Thus, S1 update an entry in forwarding table for A.

2> The switch Snew will certainly broadcast the query packet it received in the ARP request message to all the interfaces.

3> There won't be any change as A's query message already contains the A's MAC address and hence B won't send query message for MAC address of A.

4> S1 will discard the frame that it got because A and B share the same interface. Before doing this it will update the forwarding table for B after receiving response message from B.

(11) broadcast channel for A & B is 10 Mbps.
propagation delay 245 bit times.
KA = 0, KB = 1
A & B begins the transmission at t = 0
1st collision = 245 bit times.

∴ 1> At t = 0 :
A & B starts the transmission.

2> At t = 245 :
First collision is between A & B.

3> At t = 293 :
A & B both ends the transmission of the jam signal.

4> At t = 293 + 245 = 538 :
[redacted] Last bit of B arrives at A and it finds an idle channel.

5> At t = 96 + 538 = 634
[redacted] A starts the transmission

6> At t = 293 + 512 = 805
B will perform from second step again.
Before the retransmission, B senses idle channel for 96 times.

7> At t = 634 + 245 = 879
B receives the transmission of A.

From above calculations, it is clear that, B won't retransmit but A will retransmit. Retransmission of A reaches to B before 901 bit times which is scheduled time of B. Hence, there won't be any collision. A will ~~start~~ start retrasmission at 634.

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(12) Right after powering on PC, computer will initiate special IP datagram. This step is the DHCP server discovery step. Datagram is wrapped in ethernet frame. This is broadcasted to the ethernet. In this step, PC will obtain the IP address. This special datagram ~~destined~~ have dest. IP as 255.255.255.255. DHCP server provides the list of IP address of 1st hop routers. & Local DNS address.
It is given that ARP cache is empty, hence computer will use MAC address fetched by providing ARP request message of the DNS server & 1st hop router.
Then, the PC will receive the downloadable web page IP address. First PC will check if local DNS will have requested web page. If it is not present pc will use DNS protocol to get web page IP address.
PC will make use of HTTP request after getting an IP of web page. This request message is wrapped & segmented in a TCP packet and later in IP packet. Lastly, ethernet frames are used to encapsulate this HTTP message.
Every ethernet frame once reaches router, it will transfer to IP layer to check routing table. IP packet is then sent through internet to reach the web server.

Lastly, once the requested webpage found on the webserver, it will be sent back to PC using HTTP response message. The process gets exactly reversed where first the ~~package~~ web page is encapsulated in the TCP, IP packet & then into ethernet frames. Once router gets these frames, IP packets follow the routes to reach first-hop counter & router will forward IP packets to computer by using frames of ethernet.