Homework Assignment 3: 100 points

Due date: Nov. 17, 2023 (Friday)

Question 1: (15 points)

(a) Please specify three examples of MAC which are based on the rationale of "random access". (5 points)

(b) Can CSMA completely avoid collisions? Please explain your solution. (5 points)

(c) What are the differences between CSMA/CD and CSMA/CA? (5 points)

Solution:

(a) Slotted ALOHA, ALOHA, CSMA, CSMA/CD, and CSMA/CA

(b) CSMA cannot completely avoid collision, since the signal propagation requires some delay.

(c) CSMA/CD means collision detection, which is usually used in wired networks, CSMA/CA means collision avoidance, which is usually used in wireless networks.

Question 2: (10 points)

(a) As shown in Figure 1, suppose that host A sends a datagram to host B. Will the source/destination IP addresses be changed when the datagram traverses through the router R? (5 points)

(b) As shown in Figure 1, suppose that host A sends a datagram to host B. Will the source/destination MAC addresses be changed when the frame traverses through the router R? (5 points)

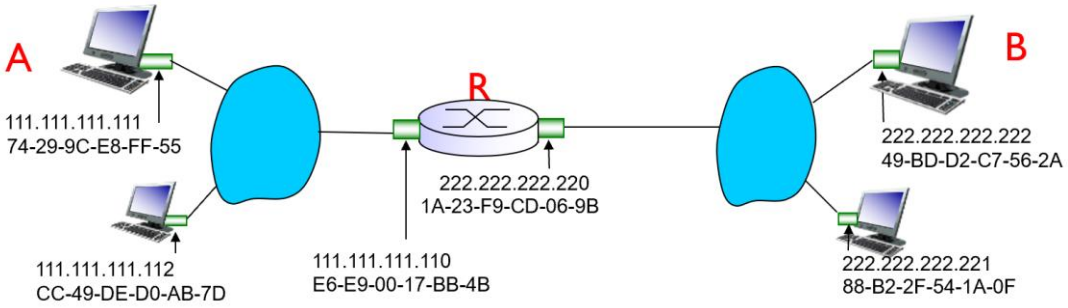


Figure 1

Solution:

(a) No, the source/destination IP addresses will not be changed

(b) Yes, the source/destination MAC addresses be changed

From A to R: Source MAC: 74-29-9C-E8-FF-55 and Destination MAC: E6-E9-00-17-BB-4B

From R to B: Source MAC: 1A-23-F9-CD-06-9B and Destination MAC: 49-B-D2-C7-56-2A

Question 3: (10 points)

(a) What are the differences between the function of the network layer and the function of the data link layer? (5 points)

(b) What the difference between the MAC address and IP address? (5 points)

Solution:

(a) Network layer is for end-to-end (or host-to-host) datagram delivery, in which the datagram may go through several routers. The data link layer is for hop-by-hop frame delivery, in which the frame is delivered between two neighboring network devices.

(b) MAC address is a layer-2 address, which is used in the data-link layer for forwarding the data-link layer frame. Normally, each network interface has a unique MAC address which cannot be changed at all. IP address is a layer-3 address which is used in the network layer for forwarding the

IP datagram. Normally, each network interface is assigned a unique IP address within one subnet and this IP address could be changed when the network device moves to another subnet.

Question 4: (15 points)

Please explain the difference between the Link-State based routing algorithm and the Distance-Vector based algorithm.

Solution:

Link-State based routing algorithm is a centralized routing algorithm. It requires each router to collect the global network information (including how the routers are connected and the detailed link cost for each connection between two routers). After collecting this global network information, each router can individually perform the distance-based routing algorithm to obtain the forwarding table. Distance-Vector based routing algorithm is a decentralized routing algorithm. Each router calculates its distance to the other routers and represent these distances as a vector (i.e., the so-called distance vector). Then, each router sends its updated distance vector (if the vector is different from its previous version) to its neighboring routers. Those neighboring routers then use this updated distance vector to re-calculate their respectively own distances. Such operations are performed iteratively, until no single router's distance vector is changed.

Question 5: (30 points)

Consider the network topology as shown in Figure 1. Suppose that all routers use Link-State based routing algorithm for finding the optimal routing.

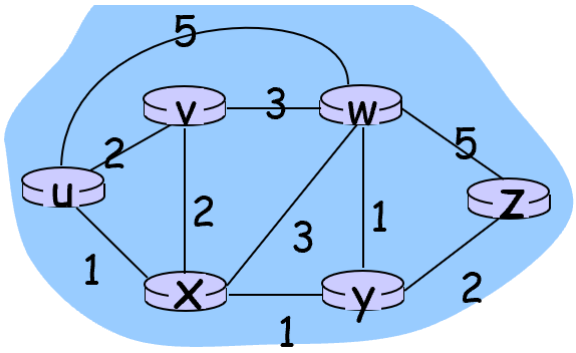


Figure 1:

(a) Consider that router "u" is performing the Link-State routing algorithm. Please specify the detailed procedures for performing the Dijkstra algorithm by filling the following table. (15 points)

Solution:

Step	N'	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(z), p(z)
0	u	2 u	5 u	1 u	∞	∞
1	ux	2 u	4 x		2 x	∞
2	uxy	2 u	3 y			4 y
3	uxyv		3 y			4 y
4	uxyvw					4y
5	uxyvwz					

(b) Consider that router "z" is performing the Link-State routing algorithm. Please specify the detailed procedures for performing the Dijkstra algorithm by filling the following table. (15 points)

Solution: there are two feasible solutions as shown in the following tables, respectively.

Step	N'	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(u), p(u)
0	z	∞	5 z	∞	2 z	∞
1	zy		3 y	3 y		∞
2	zyx	5 x	3 y			4 x
3	zyxw	5 x				4 x
4	zyxwu	5 x				
5	zyxwuv					

Step	N'	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(u), p(u)
0	z	∞	5 z	∞	2 z	∞
1	zy	∞	3 y	3 y		∞
2	zyw	∞		3 y		8 w
3	zywx	5 x				4 x
4	zywxu	5 x				
5	zywxuv					

Question 6: (20 points)

(a) Consider the network topology shown in Figure 2. Suppose that the distance vector based algorithm is used for routing. Please specify convergence process as shown in the following Figure 3. (10 points)

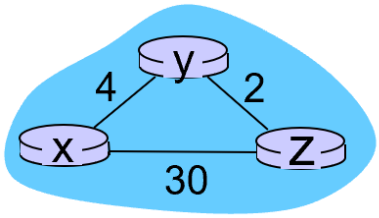


Figure 2

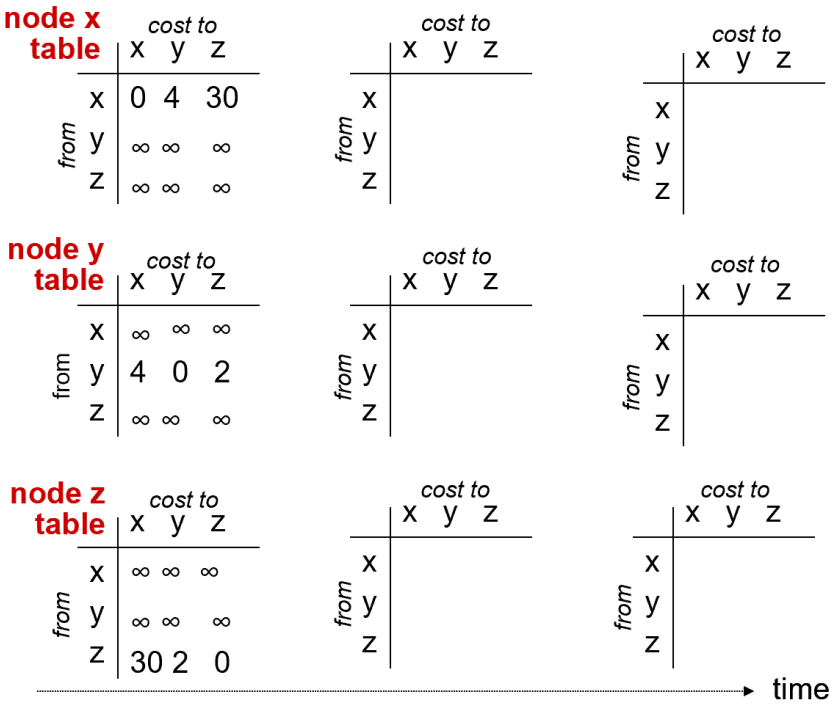
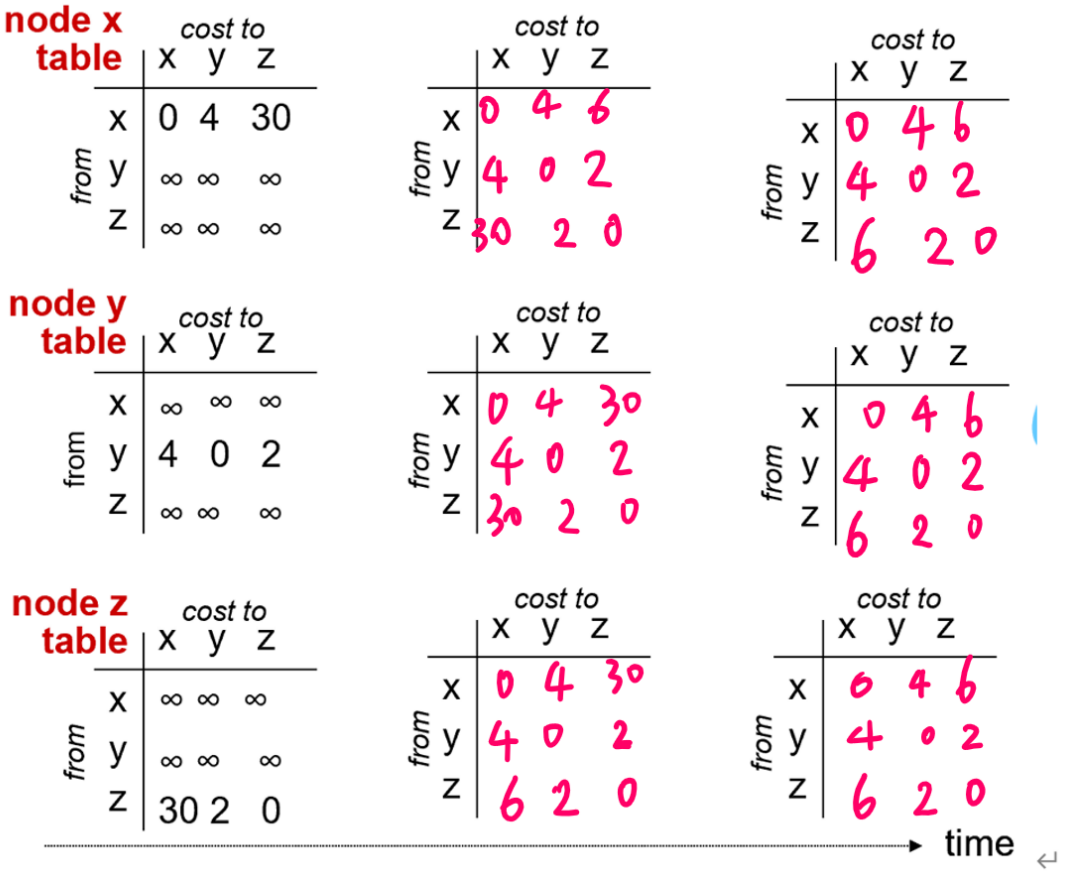


Figure 3

Solution:

(a)



(b) After convergence of the distance vector based algorithm in the above Question 3(a), if the link cost between router x and router y is increased to 60 as shown in Figure 4 below, will the distance vector based algorithm converge quickly after this increased link cost? Please explain your reasons. (10 points)

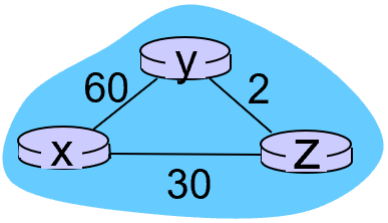


Figure 4

(b) No, the distance vector based algorithm will converge very slowly. Specifically, based on the router Y's local distance vector from router Z, router Y may be misled (by router Z's distance vector) that router X can still be reached via router Z with the distance of 6. As a result, the router Y slowly increase its distance to router X by the incremental size of 2 (i.e., the distance between router Y and router Z).