Homework Assignment 4: 100 points

Due date: Nov. 25, 2022 (Friday)

Question 1: (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 are the fundamental functions of the network layer? (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) The two fundamental functions of the network layer is routing and forwarding

Question 2: (20 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.

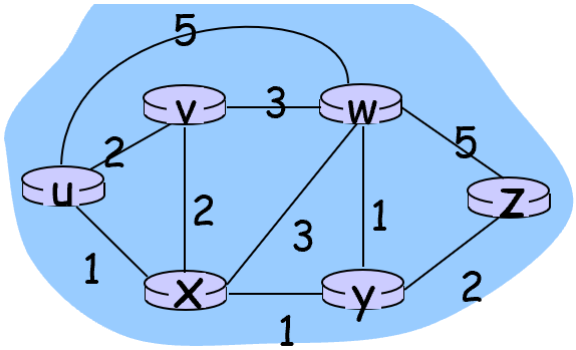

Figure 1:

(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. (10 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. (10 points)

Solution: there are two feasible solutions.

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 3: (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)

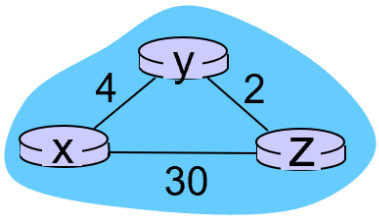

Figure 2

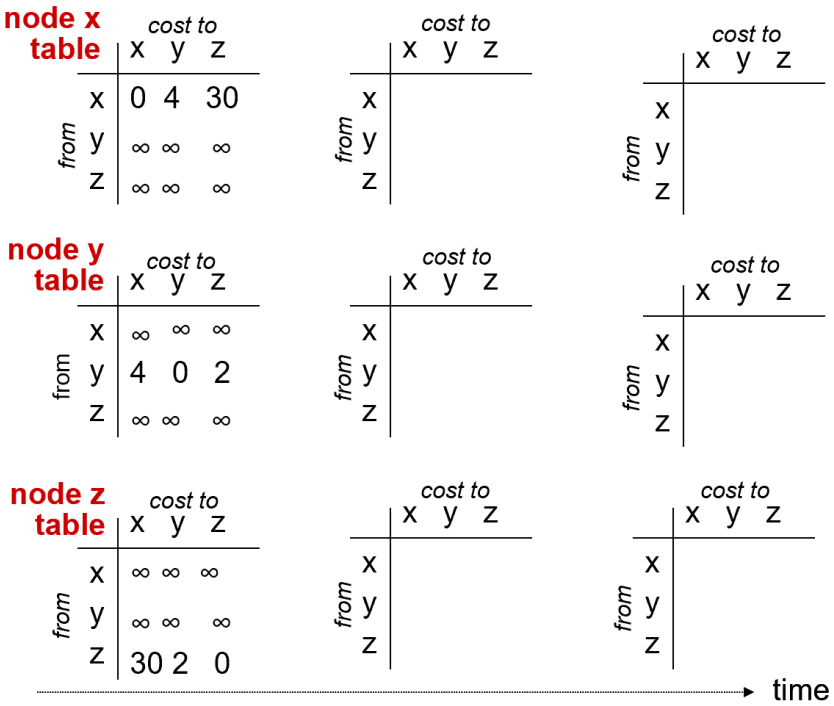

Figure 3

(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)

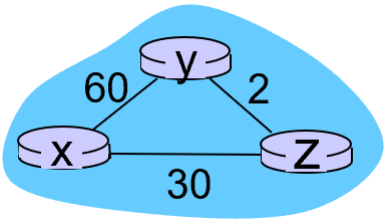

Figure 4

Solution:

(a)

node x table

from \ cost to	x	y	z
x	0	4	30
y	∞	∞	∞
z	∞	∞	∞

from \ cost to	x	y	z
x	0	4	6
y	4	0	2
z	30	2	0

from \ cost to	x	y	z
x	0	4	6
y	4	0	2
z	6	2	0

node y table

from \ cost to	x	y	z
x	∞	∞	∞
y	4	0	2
z	∞	∞	∞

from \ cost to	x	y	z
x	0	4	30
y	4	0	2
z	30	2	0

from \ cost to	x	y	z
x	0	4	6
y	4	0	2
z	6	2	0

node z table

from \ cost to	x	y	z
x	∞	∞	∞
y	∞	∞	∞
z	30	2	0

from \ cost to	x	y	z
x	0	4	30
y	4	0	2
z	6	2	0

from \ cost to	x	y	z
x	0	4	6
y	4	0	2
z	6	2	0

time

(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).

Question 4: (20 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)

(a) Consider the following figure with three autonomous systems (ASs) as shown in Figure 5. Does router "3b" perform both the Inter-AS routing algorithm and Intra-AS routing algorithm simultaneously? Please explain your reasons. (10 points)

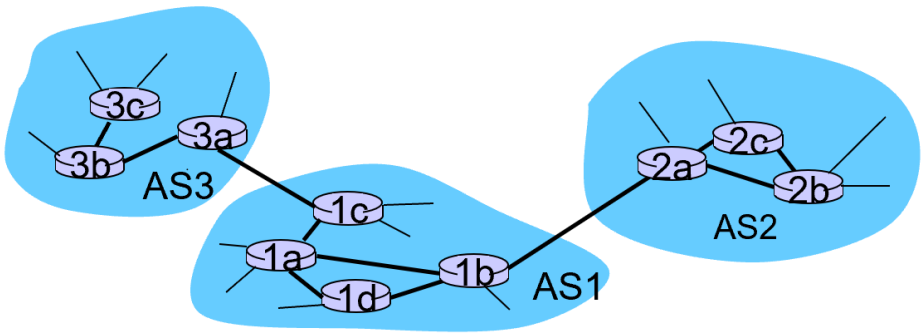

Figure 5

(b) Please specify an example of Intra-AS routing algorithm and an example of Inter-AS routing algorithm. (10 points)

(c) Please specify the differences between the eBGP connectivity and iBGP connectivity. (10 points)

Solution

(a) Router "3b" performs both inter-AS routing algorithm and intra-AS routing algorithm, since router "3b" has to send datagrams to all the three ASs. When the datagram is delivered to AS2, then the inter-AS routing algorithm is required.

(b) Intra-AS routing algorithm: OSPF, and inter-AS routing algorithm: BGP

(c) eBGP is to obtain the subnet reachability information from the neighboring ASs, and iBGP is to propagate reachability information to all AS-internal routers.