CS305: Computer Networking
2022 Fall Semester Written Assignment # 1

Due: Oct. 17th, 2022, please submit through Sakai

Please answer questions in English. Using any other language will lead to a zero point.

Q 1. Consider a datagram network using 8-bit host addresses. Suppose a router has four links, numbered 0 through 3, and uses longest prefix matching. It has the following forwarding table:

Prefix Match	Interface
111	0
111000	1
111111	2
otherwise	3

(a) For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

(b) Describe how your forwarding table determines the appropriate link interface for

- 11001000
- 11100001
- 11110000

Solution:

(a) See the table below:

Prefix	Range of destination host addresses	Number of addresses in the range
111	11100000 through 11111111	$2^5 = 32$
111000	11100000 through 11100011	$2^2 = 4$
111111	11111100 through 11111111	$2^2 = 4$
otherwise	00000000 through 11011111	$(2^3 - 1)2^5 = 2^8 - 2^5 = 224$

(b)
- 11001000: interface 3
- 11100001: interface 1
- 11110000: interface 0

Q 2. Suppose an ISP owns the block of addresses of the form 128.119.40.0/23. Suppose it wants to create four subnets from this block and assign them to four organizations, respectively.

- Organization 1: at least 200 IP addresses
- Organization 2: at least 96 IP addresses
- Organization 3: at least 62 IP addresses
- Organization 4: at least 60 IP addresses

What are the prefixes (of form a.b.c.d/x) for the four subnets?

Solution: This block of IP addresses can be written as

$$\underline{10000000\ 01110111\ 0010100}0\ 00000000 \tag{1}$$

Divide this block into four blocks to satisfy the requirements of the organizations:

- Organization 1: since $2^8 = 256 > 200$, we can assign the following block

$$\underline{10000000\ 01110111\ 00101000}\ 00000000, \tag{2}$$

  which can be represented as 128.119.40.0/24.

- Organization 2: since $2^7 = 128 > 96$, we can assign the following block

$$\underline{10000000\ 01110111\ 00101001\ 0}0000000, \tag{3}$$

  which can be represented as 128.119.41.0/25.

- Organization 3: since $2^6 = 64 > 62$, we can assign the following block

$$\underline{10000000\ 01110111\ 00101001\ 10}000000, \tag{4}$$

  which can be represented as 128.119.41.128/26.

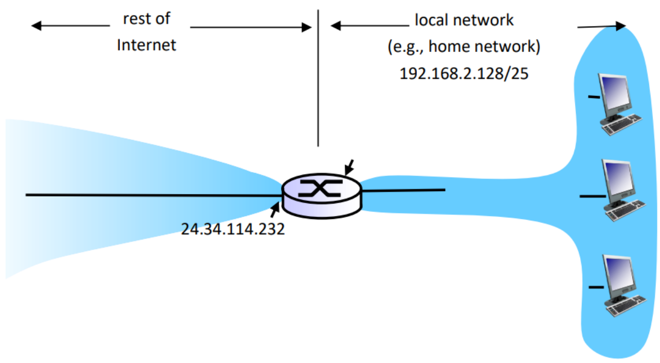
- Organization 4: since $2^6 = 64 > 60$, we can assign the following block

$$\underline{10000000\ 01110111\ 00101001\ 11}000000, \tag{5}$$

  which can be represented as 128.119.41.192/26.

Note: There are multiple possible solutions. The above shows one of them. As long as (1) the block assigned to each organization can satisfies the requirement of that organization and (2) there is no overlap between blocks, students can get the points.

Q 3. Consider the network setup in the figure below. Suppose that the ISP instead assigns the router the address 24.34.114.232 and the network address of the home network is 192.168.2.128/25.



(a) Assign addresses to the interfaces of the three hosts in the home network.

(b) Consider two hosts with IP addresses 192.168.2.200 and 192.168.2.201. Each host has two ongoing TCP connections, associated with port numbers 3000 and 3001, respectively. All these TCP connections are connected to port 80 at server host 128.121.40.87. Provide the four corresponding entries in the NAT translation table. For the information we do not provide, you can choose any values as long as they are feasible.

Solution:

(a) There are multiple answers. Any three distinctive IP addresses belonging to 192.168.2.128/25 would work. Note that 192.168.2.128/25 can be represented as

$$\underline{11000000\ 10101000\ 00000010\ 1}0000000, \tag{6}$$

WAN side	LAN side
24.34.114.232, 5001	192.168.2.200, 3000
24.34.114.232, 5002	192.168.2.200, 3001
24.34.114.232, 5003	192.168.2.201, 3000
24.34.114.232, 5004	192.168.2.201, 3001

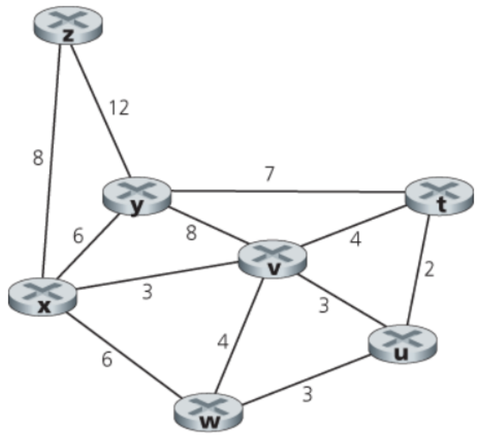
– A correct answer could be from top to bottom 192.168.2.128, 192.168.2.129, 192.168.2.130.

– An INCORRECT answer: 192.168.2.0, 192.168.2.1, 192.168.2.2.

(b) The NAT translation table:

The port numbers 5001, 5002, 5003, and 5004 can be changed to any values between 1024 to 65535. The four port numbers on the WAN side must be different.

Q 4. Consider the following network. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Table 5.1.

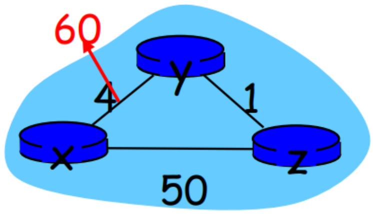


Solution:

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

Q 5. Consider a network as shown in the figure below. The distance vector algorithm is used to calculate the forwarding table. Assume that the distance vectors have already been calculated correctly, then both x and y detect that the link cost $c(x, y)$ changed from 4 to 60, if the poisoned reverse is used (z tells y that $D_z(x)$ is infinite if packets from z to x go through y, similar for x). Note: although the values of $c(x, y)$ and $c(y, x)$ are the same in the recent setting, $c(x, y)$ and $c(y, x)$ are not interchangeable when using the Bellman-Ford equation.

- Write down how the distance vectors of these routers change resulting from the link cost change until the algorithm converges. Draw tables similar as those in Figure 5.6 in our textbook.
- Provide the messages (i.e., the distance vector) transmitted during the procedure.



Solution:
S0: In the beginning,

Node x				
		cost to		
		x	y	z
from	x	0	4	5
	y	4	0	1
	z	5	1	0

Node y				
		cost to		
		x	y	z
from	x	0	4	∞
	y	4	0	1
	z	∞	1	0

Node z				
		cost to		
		x	y	z
from	x	0	4	5
	y	4	0	1
	z	5	1	0

S1: After x and y detect the cost change, x and y update their distance vector (the updated values are marked in bold text):

Node x				
		cost to		
		x	y	z
from	x	0	**51**	**50**
	y	4	0	1
	z	5	1	0

Node y				
		cost to		
		x	y	z
from	x	0	4	∞
	y	**60**	0	1
	z	∞	1	0

Node z				
		cost to		
		x	y	z
from	x	0	4	5
	y	4	0	1
	z	5	1	0

Then, since x and y has updated their distance vector,

- x sends $[0, 51, 50]$ to y, and it sends $[0, \infty, 50]$ to z;
- y sends $[60, 0, 1]$ to both x and z.

S2: After x and y send their distance vector to neighbors, z will update its distance vector as follows:

Node x				
		cost to		
		x	y	z
from	x	0	51	50
	y	60	0	1
	z	5	1	0

Node y				
		cost to		
		x	y	z
from	x	0	51	50
	y	60	0	1
	z	∞	1	0

Node z				
		cost to		
		x	y	z
from	x	0	∞	50
	y	60	0	1
	z	**50**	1	0

Then, z sends $[50, 1, 0]$ to x and y.

S3: After z broadcasts its updated distance vector, y will update its distance vector:

Node x				
		cost to		
		x	y	z
from	x	0	51	50
	y	60	0	1
	z	50	1	0

Node y				
		cost to		
		x	y	z
from	x	0	51	50
	y	**51**	0	1
	z	50	1	0

Node z				
		cost to		
		x	y	z
from	x	0	∞	50
	y	60	0	1
	z	50	1	0

Then, y sends $[51, 0, 1]$ to x, and it sends $[\infty, 0, 1]$ to z;

S4: After y has sent its distance vector to neighbors, no one will further update its distance vector:

Node x				
		cost to		
		x	y	z
from	x	0	51	50
	y	60	0	1
	z	50	1	0

Node y				
		cost to		
		x	y	z
from	x	0	51	50
	y	51	0	1
	z	50	1	0

Node z				
		cost to		
		x	y	z
from	x	0	∞	50
	y	∞	0	1
	z	50	1	0

That is, convergence has reached.