CS3640 Written Assignment-3

Due: Apr 22, 2022 midnight
Submit as a single PDF on ICON

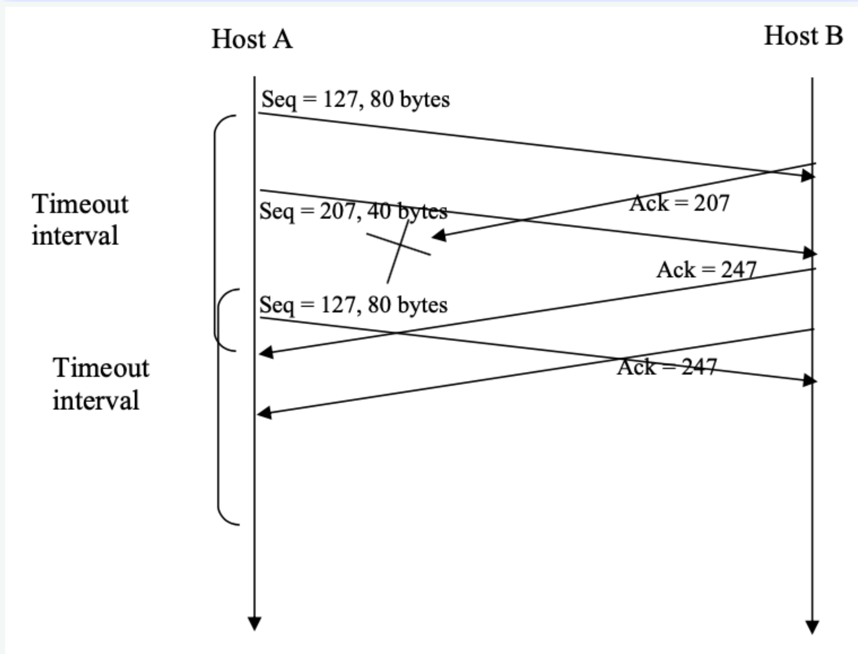
This assignment covers chapters 3, 4, and 5 (i.e., *Transport Layer* and *Network Layer*). The goal is to familiarize students with networking related problem solving.

Q1. TCP reliable data transfer **20 points**

Two hosts, A and B, are communicating over a TCP connection. So far, B has received from A all bytes up through byte 126. Suppose A then sends two segments to B back-to-back. The first and second segments contain 80 and 40 bytes of data, respectively. In the first segment, the sequence number is 127, the source port number is 302, and the destination port number is 80. B sends an acknowledgment whenever it receives a segment from A.

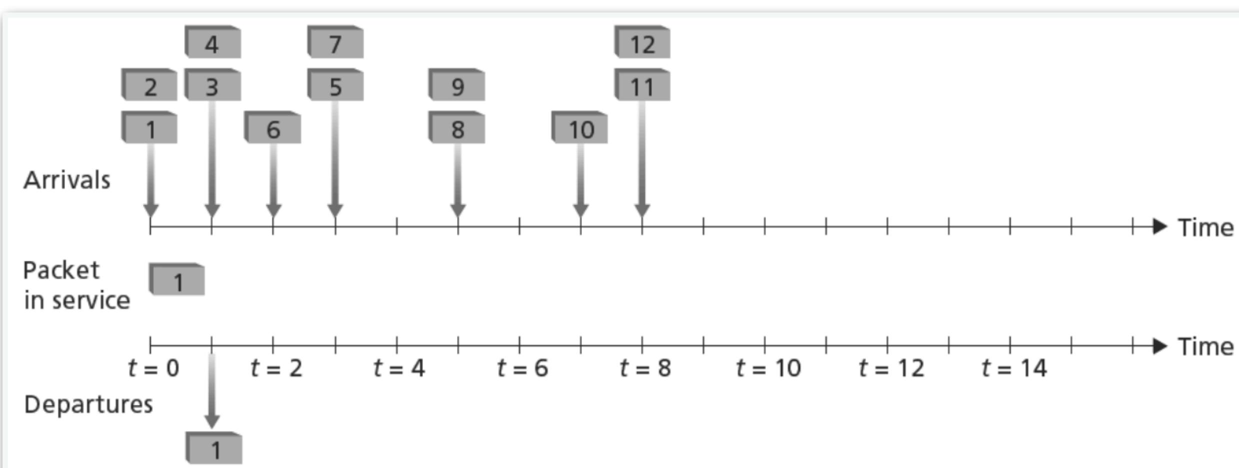
(i) In the second segment sent from A to B, what are the sequence number, source port number, and destination port number?
(ii) If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number?
(iii) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?
(iv) Suppose the two segments sent by A arrive in order at B. The first acknowledgment is lost and the second acknowledgment arrives after the first timeout interval. Draw a timing diagram, showing these segments and all other segments and acknowledgments sent. (Assume there is no additional packet loss.) For each segment in your figure, provide the sequence number and the number of bytes of data; for each acknowledgment, provide the acknowledgment number.

(i) sequence number is 207, source port number is 302, and destination port number is 80
(ii) acknowledgement number is 207, source port is 80, and destination port is 302
(iii) acknowledgement number is 127, indicating that it is still waiting for bytes 127 onwards
(iv) Shown below is the timing diagram:



Q2. Packet scheduling policies **20 points**

Consider the arrival of packets at a router buffer as shown below. Then, for each of the policy choices listed below, indicate the time at which packets 2 through 12 each leave the queue. For each packet, what is the delay between its arrival and its departure? What is the average of this delay across all packets?



(i) if using **FIFO policy**
(ii) if using **priority scheduling**, where odd-numbered packets are considered high priority, and even-numbered packets are treated as low priority.
(iii) if using **WFQ policy**, where odd-numbered packets belong to class 1, and even-numbered packets belong to class 2. Class 1 has a weight of 2, while class 2 has a weight of 1.
(iv) Compare the average packet delay observed across FIFO, priority, and WFQ policies.

(i) FIFO

packet	departure	delay
2	2	2
3	3	2
4	4	3
5	6	3
6	5	3
7	7	4
8	8	3
9	9	4
10	10	3
11	11	3
12	12	4

(ii) Priority

packet	departure	delay
2	3	3
3	2	1
4	7	6
5	4	1
6	8	6
7	5	2
8	10	5
9	6	1
10	11	4
11	9	1
12	12	4

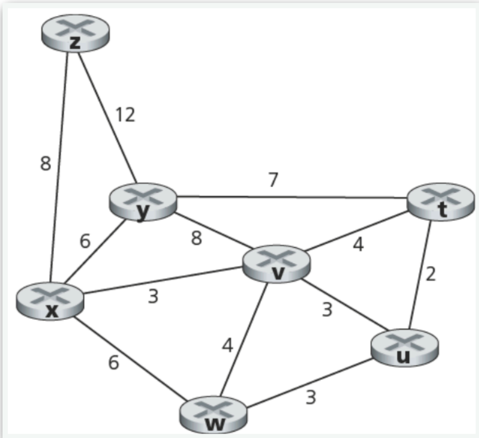
(iii) WFQ

packet	departure	delay
2	3	3
3	2	1
4	6	5
5	4	1
6	8	6
7	5	2
8	10	5
9	7	2
10	11	4
11	9	1
12	12	4

(iv) All three policies have an average packet delay of **3.091**

Q3. Dijkstra's algorithm **20 points**

Here is a network with seven routers. Use Dijkstra's algorithm to compute the shortest path (i) from **z** to all other network routers, (ii) from **v** to all other network routers. Show your method of construction by populating a table like Table-5.1 (page 385) or as shown in slide-18 of lecture-19. Finally, show how the resulting forwarding tables would be at routers **z** and **v**.



(i) For **z**

Step	N'	D(x), P(x)	D(u), P(u)	D(v), P(v)	D(w), P(w)	D(y), P(y)	D(t), P(t)
0	z	8,z	∞	∞	∞	12,z	∞
1	zx		∞	11,x	14,x	12,z	∞
2	zxv		14,v		14,x	12,z	15,v
3	zxvy		14,v		14,x		15,v
4	zxvyu				14,x		15,v
5	zxvyuw						15,v
6	zxvyuwt						

(ii) For **v**

Step	N'	D(x), P(x)	D(u), P(u)	D(t), P(t)	D(w), P(w)	D(y), P(y)	D(z), P(z)
0	v	3,v	3,v	4,v	4,v	8,v	∞
1	vx		3,v	4,v	4,v	8,v	11,x
2	vxu			4,v	4,v	8,v	11,x
3	vxut				4,v	8,v	11,x
4	vxutw					8,v	11,x
5	vxutwy						11,x
6	vxutwyz						

Forwarding table at z

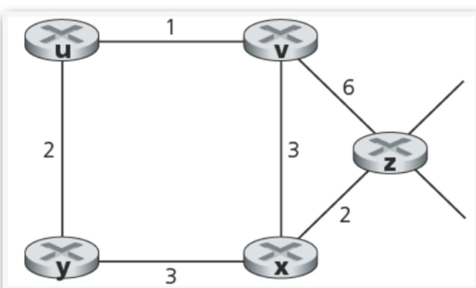
Destination	Out link
t	x
u	x
v	x
w	x
x	x
y	y

Forwarding table at v

Destination	Out link
t	t
u	u
w	w
x	x
y	y
z	x

Q4. Bellman-Ford algorithm **20 points**

This is a network with five routers configured to run Bellman-Ford algorithm. Shown next to it is the distance table of **z** at time t = 0 (i.e., DV exchanges have not started yet). As you can see, **z** knows the distance to its neighbors but does not know the DVs of its neighbors. Compute **z**'s distance table entries after iterations t = 1, 2, and 3.



from\to	u	v	x	y	z
v	∞	∞	∞	∞	∞
x	∞	∞	∞	∞	∞
z	∞	6	2	∞	0

t = 1

	u	v	x	y	z
v	1	0	3	∞	6
x	∞	3	0	3	2
z	7	5	2	5	0

t = 2

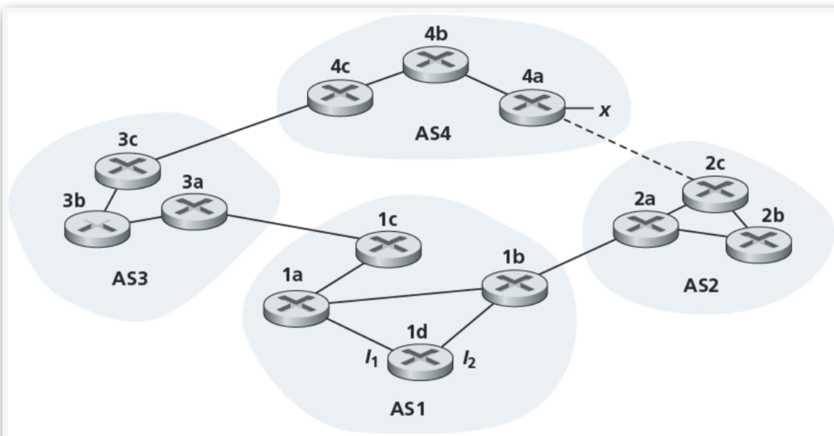
	u	v	x	y	z
v	1	0	3	3	5
x	4	3	0	3	2
z	6	5	2	5	0

t = 3

	u	v	x	y	z
v	1	0	3	3	5
x	4	3	0	3	2
z	6	5	2	5	0

Q5. Routing protocols **20 points**

Here is a four AS topology. All four AS'es run OSPF as their intra-domain routing protocol, and BGP as their inter-domain routing protocol. OSPF is configured to treat all links to be of equal weight. (i) Suppose that the dotted link between **4a** and **2c** does not exist. From which protocol (i.e., OSPF, iBGP, or eBGP) does **3c** learn about prefix **x**? How do routers **3a**, **1c**, and **1d** learn about **x**? You just need to name the protocol. (ii) Suppose the dotted link between **4a** and **2c** is active. Now, router **1d** learns that **x** is reachable via AS2 as well as AS3. Will **1d** be using link l_1 or l_2 to send datagrams destined for **x**? Explain your answer.



(i) **3c** learns via eBGP; **3a** learns via iBGP; **1c** learns via eBGP; **1d** learns via iBGP.

(ii) **1d** will choose l_2 (since **1b** is closer than **1c** i.e, hot potato routing).