Assignment 4

Maximum Marks: 100

DUE: 10 March 2020 (Tuesday)

Note: Please show your working for full credit
Note for references: Adding references does not allow you to copy text word to word

Q1. (10 Marks)
Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time *t*, the next in-order packet that the receiver is expecting has a sequence number of *k*. Assume that the medium does not reorder messages. Answer the following questions:

a. What are the possible sets of sequence numbers inside the sender's window at time *t*? Justify your answer.
b. What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time *t*? Justify your answer.

Q2. (10 Marks)
Look at the figures below and mention what sliding window protocol is being used? Justify your reasoning. (3 marks)

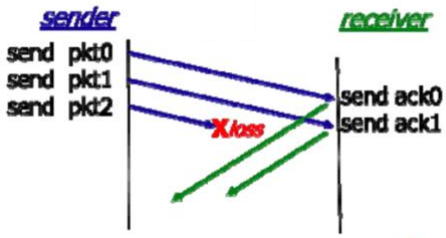


Figure 2A

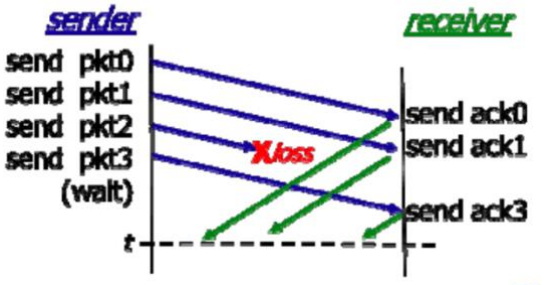


Figure 2B

Think about Figure 2B again.

a. Assume that the windows size of sender and receiver are 4, and also assume sequence number goes from 0 to 20. Where are the positions of sender and receiver windows over this sequence number space at time t? (3 marks)
b. After time t, the sender in Figure 2B will receive ACKs from the receiver. List all the possible future events at sender. (4 marks)

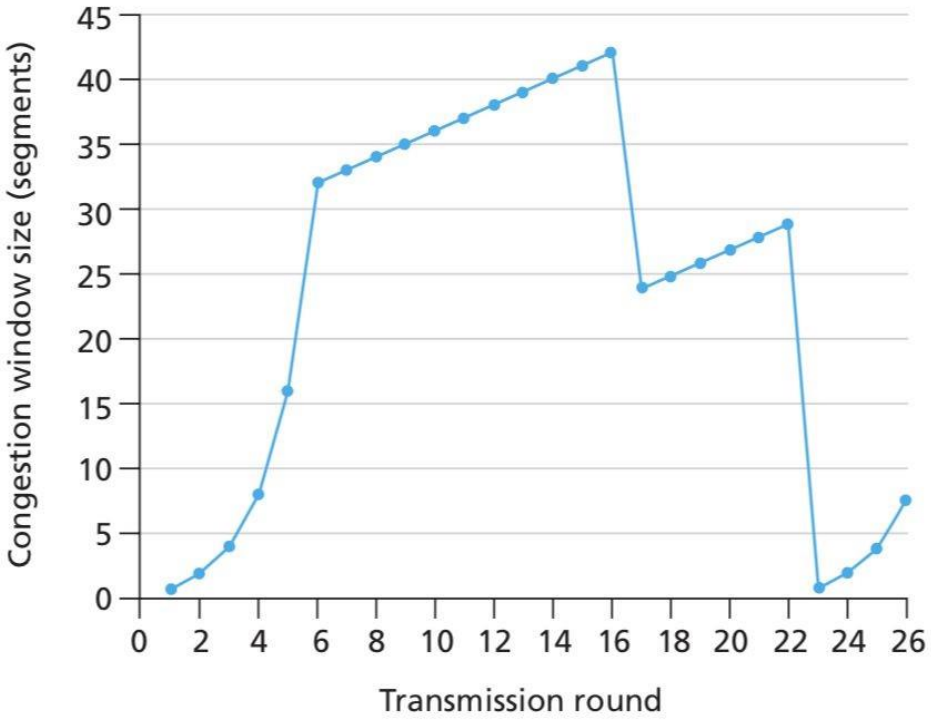
Q3. (10 Marks)
Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110.

a. How much data is in the first segment?
b. Suppose that the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number?

Q4. (12 Marks)
Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 126. Suppose Host A then sends two segments to Host 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. Host B sends an acknowledgment whenever it receives a segment from Host A.

a. In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?
b. 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?
c. If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?
d. 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 time- out 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 that you add, provide the acknowledgment number.

Q5. (22 Marks)



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

a. Identify the intervals of time when TCP slow start is operating.
b. Identify the intervals of time when TCP congestion avoidance is operating.
c. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
d. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
e. What is the initial value of ssthresh at the first transmission round?
f. What is the value of ssthresh at the 18th transmission round?
g. What is the value of ssthresh at the 24th transmission round?
h. During what transmission round is the 70th segment sent?
i. Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh?
j. Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round?

k. Again, suppose TCP Tahoe is used, and there is a timeout event at 22nd round. How many packets have been sent out from 17th round till 22nd round, inclusive?

Q6. (10 Marks) Consider transferring an enormous file of *L* bytes from Host A to Host B. Assume an MSS of 536 bytes.

a. What is the maximum value of *L* such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes.
b. For the *L* you obtain in (a), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.

Q7. (6 Marks) Give timeline diagram of different TCP states between client and server.

Q8. (5 Marks) Consider host A sending a TCP segment to host B containing a sequence number 81920, an acknowledgement number of 65530 and 10240 bytes of data. What will be the sequence number and acknowledgement number in the segment sent back next from B to A.

Q9. (5 Marks) In a connection, the value of cwnd is 3000 and the values of rwnd is 5000. The host has sent 2,000 bytes, which have not been acknowledged. How many more bytes can be sent

Q10. (10 Marks) For a particular, the TCP/IP Reno congestion control algorithm is employed with an initial congestion window of 4Kb and an initial threshold of 12Kb. The maximum segment size (MSS) in use on the connection is 4Kb. Assume that the receive window remains a constant 32 Kb. A timeout occurs after transmission #7, and a triple duplicate acknowledgment problem is noticed after transmission #15. How much data does the sender attempt to send on the 24th transmission? Also fill out below form. (All the calculation formulas you used in this question should follow on professor's slides)

Transmission#	Congestion Window	Threshold	Receive Window
1	4Kb	12Kb	32Kb
2	8Kb	12Kb	32Kb
3	16 Kb	12Kb	32Kb
4	20 Kb	12Kb	32Kb
5			32Kb
6			32Kb
7			32Kb
8			32Kb
9			32Kb
10			32Kb
11			32Kb
12			32Kb
13			32Kb
14			32Kb
15			32Kb
16			32Kb
17			32Kb
18			32Kb
19			32Kb
20			32Kb
21			32Kb
22			32Kb
23			32Kb
24			32Kb