Computer Networks
Fall 2019/20
Exercise 3

Submission in pairs by Thursday **2-1-2010.** Submission is done by uploading your work to the course Moodle website. >>> No late submissions will be accepted
The name of the submitted file must be: Exercise3_username1_username2.[suffix].
For example: Exercise3_israel.israeli_david.davidi.zip (with dots). The first and last names of both students must appear. Only one student should submit the assignment (not both). Covers Chapter 3 from the textbook.

Problem 1 (10 points). The Alternating Bit Protocol uses two sequence numbers 0 and 1. Assume that we change the protocol and use **13** sequence numbers instead of just two. The window size is still 1. Also, assume that messages can be duplicated or lost but messages are not corrupted and the medium does not reorder messages. What is the maximum number of different messages that can be in transit from the sender to the receiver at the same time? (Different messages are messages that have different data content.) Briefly justify your answer.

Problem 2 (15 points). The maximum amount of data that can be grabbed and placed in a segment is called the maximum segment size (MSS). The MSS does not include the headers. What is the maximum size of a single file that can be sent from A to B over TCP assuming an MSS of 1480 bytes? Assume that if a packet *p* is sent before a packet *q* then the sequence number of *p* **must be** smaller than the sequence number of *q*. Briefly justify your answer.

Problem 3 (20 points). Hosts A and Host B are communicating over a TCP connection, the first segment sent from A to B has sequence number 1, and (A has sent and) B has already received from A all (data) bytes up through byte 1024. Suppose A then sends three new segments to B back to back. The first, the second and the third segments contain 50, 100, and 200 bytes of data, respectively.
a. What is the sequence number in the first new segment from Host A to Host B?
b. What is the sequence number in the second new segment from Host A to Host B?
c. What is the sequence number in the third new segment from Host A to Host B?
d. If the first new segment arrives to B before the second and third, what is the acknowledgement number, in the acknowledgement of the first arriving segment?
e. If the first new segment arrives to B after the second and after the third, what is the acknowledgement number, in the acknowledgement of the first arriving segment? Assume that the second and third arrive in order.
f. If the second new segment arrives to B before the first and after the third, what is the acknowledgement number, in the acknowledgement of the first arriving segment?
g. If the second new segment arrives to B after the first and after the third, what is the acknowledgement number, in the acknowledgement of the first arriving segment? Assume that the first and third arrive in order.
h. If the third new segment arrives to B after the first and before the second, what is the acknowledgement number, in the acknowledgement of the first arriving segment?

For each of the questions above, give an answer assuming (1) buffering is not used on the receiver side, and (2) buffering is used on the receiver side.
Briefly justify your answers.

Answer:

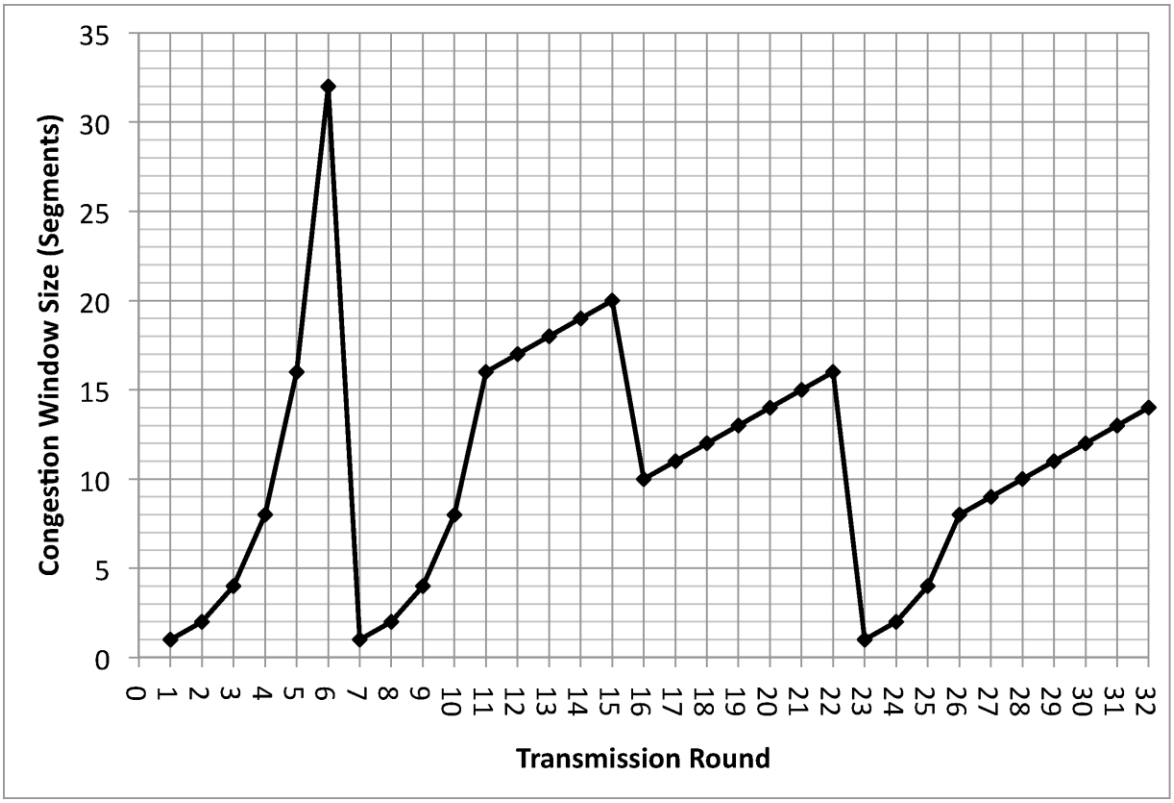
#	**Without buffering**	**With buffering**
a.		
b.		
c.		
d.		
e.		
f.		
g.		
h.		

Problem 4 (30 points). **Ten** packets are sent over TCP, where there is a **2**ms difference in the submission time. The first packet is sent at time 0. The receiver sends ACK immediately when receiving a packet. The RTT is **4**ms. The time of sending the packets and ACK is negligible. Assume that the size of the TCP window is always big enough so there is no need to wait for sending new packets. Also assume that all the packets that were sent before time 0 were already acknowledged. There is no used of "delayed Ack" (that is, ACK is sent as soon as a packet arrives). Also, in the case of a timeout or a triple ACK (when using fast retransmit) a packet is sent immediately.

a. Assume that the ACK for the fourth, fifth and sixth packets (that was sent at times 6,8 10) were lost. Also, assume that fast retransmit is not used, and no more packets are lost. When will an ACK arrive to the sender from which the sender will know that the fourth packet has arrived, assuming timeout time is **9**ms?
b. Assume that the fifth and sixth packets (that were sent at times 8 and 10) were lost. Also, assume that fast retransmit is used, and no more packets are lost. When will the fifth packet arrive (to the receiver), assuming timeout time is **11**ms?
c. Same as **(b)**, but assuming that timeout time is **7**ms?
d. Assume that the seventh packet (that was sent at time 12) was lost. Also, assume that fast retransmit is not used, and no more packets are lost. When the seventh packet will arrive (to the receiver), assuming timeout time is **10**ms?
e. Assume that the fourth and fifth packets (that were sent at time 6 and 8, resp.) were lost. Also, assume that fast retransmit is not used, and no more packets are lost. When the fifth packet (not the fourth) will arrive (to the receiver), assuming timeout time is **15**ms? Justify your answers.

Section	Answer
a	
b	
c	
d	
e	

Problem 5 (25 points). Consider the following plot of TCP window size as a function of time, that is, as a function of the number of rounds. (In each round the sender transmits all the segments in its congestion window and either receives acknowledgements for them or there is a loss event.)



a. What is the version of the protocol experiencing the behavior shown above? TCP Tahoe or TCP Reno?
b. Identify all the intervals of time when TCP slow start is operating, and identify the intervals of time when TCP congestion avoidance is operating.

c. What are all the transmission rounds in which segment loss is detected by a triple duplicate ACK?

d. What are all the transmission rounds in which segment loss is detected by a timeout?

e. What is known about the initial value of the Threshold?

f. What are the values of Threshold during the 12, 21,25 transmission rounds?

g. During what transmission round is the 29^{th} segment sent?

h. Assuming a packet loss is detected after the 32nd round by the receipt of a triple duplicate ACK, what will be the new values of the congestion-window size and of the Threshold?