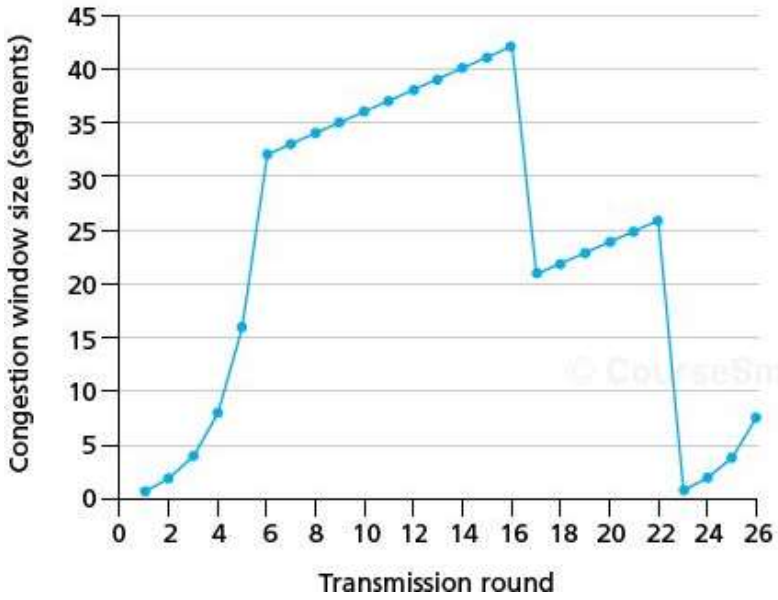
Cpr E 489 Spring 2020
Homework #6 Solution

1. (50 points) Assume TCP Reno is the protocol experiencing the behavior shown in the following "Transmission round vs. Congestion window size" figure. Answer each of the following questions, and provide a short discussion justifying your answer.



Answer:

a) Identify the time intervals when TCP Slow Start is operating: 1 to 6, and 23 to 26.
b) Identify the time intervals when TCP Congestion Avoidance is operating: 6 to 16, and 17 to 22.
c) What is the value of *ssthresh* at the 5th transmission round: 32.
d) What is the value of *ssthresh* at the 15th transmission round: 32.
e) What is the value of *ssthresh* at the 25th transmission round: 13.
f) After the 16th transmission round, is the segment loss detected by a 3rd duplicate ACK or by a timeout? 3rd duplicate ACK.
g) During which transmission round is the 50th data segment sent:
6th round, because:
1+2+4+8+16 = 31 < 50 < 63 = 1+2+4+8+16+32
h) During which transmission round is the 150th date segment sent:
9th round, because:
1+2+4+8+16+32+33+34 = 130 < 150 < 165 = 1+2+4+8+16+32+33+34+35
i) During which transmission round is the 250th data segment sent:
12th round, because:
1+2+4+8+16+32+33+34+35+36+37 = 238 < 250 < 276 = 1+2+4+8+16+32+33+34+35+36+37+38
j) Assuming a segment loss is detected after the 26th round by a timeout, what will be the values of new congestion window size and *ssthresh*? 1 and 4.

2. (50 points) Suppose two TCP stations (a sender and a receiver) have established a connection between them successfully. Suppose that (i) the sender runs the TCP New Reno congestion control scheme and, initially, *cwnd = 1 data segment* and *ssthresh = 4 data segments*; (ii) the receiver has informed the sender that *rwnd = 10 data segments*; (iii) data segments #12 and #16 are lost on the first attempt, while all other transmissions (including re-transmitted data segments and ACK frames) are successful. The sender behavior at time 4*RTT (Round-Trip Time) is shown in the table below. Complete the rest of the table for the sender behavior at 5*RTT, 6*RTT, and 7*RTT.

Answer:

Time	Packet Received	Action Taken	List of unACKs packets	Total # dup ACKs	Estimated # outstanding packets	ssthresh value	cwnd size	cwnd range	# **new** packets to send
4 RTT	A9		9,10,11,12			4	5+1/5	9,10,11,12,13	1: #13
	A10		10,11,12,13			4	5+2/5	10,11,12,13,14	1: #14
	A11		11,12,13,14			4	5+3/4	11,12,13,14,15	1: #15
	A12		12,13,14,15			4	5+4/5	12,13,14,15,16	1: #16
5 RTT	1st dup A12		12,13,14,15,16			4	5+4/5	12,13,14,15,16	0
	2nd dup A12		12,13,14,15,16			4	5+4/5	12,13,14,15,16	0
	3rd dup A12	*Enter Fast Recovery*							
		Retransmit #12	12,13,14,15,16	3	16-12+1 - 3 = 2	2	2	12,13	0
6 RTT	A16	*Partial ACK*							
		Stay in Fast Recovery							
		Retransmit #16	16	0	16-16+1 - 0 = 1	2	2	16,17	1: #17
7 RTT	A17	*Exit Fast Recovery*	17			2	2+1/2	17,18	1: #18
	A18		18			2	3	18,19,20	2: #19, #20