Stephen Sallas
COMP-4320-002
11/18/2021

Homework 3

1. In short, ACK packets do not require sequence numbers because an rdt3.0 receiver can detect a duplicate without a sequence number and an rdt3.0 sender will ignore duplicates without a sequence number. To further explain this, an rdt3.0 receiver receives an ACK and transitions to the next state, so future duplicate ACK packets are easily detected even without sequence numbers. Also, a duplicate ACK will not be the ACK an rdt3.0 sender needs, so it will be ignored even without sequence numbers.

2. EstimatedRTT = alpha * SampleRTT + (1 – alpha) * EstimatedRTT

   EstimatedRTT of SampleRTT(1) = 0.125 * 72 + (1 – 0.125) * 83 = 81.625 ms

   EstimatedRTT of SampleRTT(2) = 0.125 * 128 + (1 – 0.125) * 83 = 88.625 ms

   EstimatedRTT of SampleRTT(3) = 0.125 * 56 + (1 – 0.125) * 83 = 79.625 ms

   EstimatedRTT of SampleRTT(4) = 0.125 * 164 + (1 – 0.125) * 83 = 93.125 ms

   EstimatedRTT of SampleRTT(5) = 0.125 * 45 + (1 – 0.125) * 83 = 78.25 ms

   DevRTT = beta * |SampleRTT - EstimatedRTT of SampleRTT| + (1 – beta) * DevRTT

   DevRTT of SampleRTT(1) = 0.25 * |72 – 81.625| + (1 – 0.25) * 23 = 19.656 ms

   DevRTT of SampleRTT(2) = 0.25 * |128 – 88.625| + (1 – 0.25) * 23 = 27.094 ms

   DevRTT of SampleRTT(3) = 0.25 * |56 – 79.625| + (1 – 0.25) * 23 = 23.156 ms

   DevRTT of SampleRTT(4) = 0.25 * |164 – 93.125| + (1 – 0.25) * 23 = 34.969 ms

   DevRTT of SampleRTT(5) = 0.25 * |45 – 78.25| + (1 – 0.25) * 23 = 25.563 ms

   TimeoutInterval = EstimatedRTT of SampleRTT + 4 * DevRTT of SampleRTT

   TimeoutInterval(1) = 81.625 + 4 * 19.656 = 160.249 ms

   TimeoutInterval(2) = 88.625 + 4 * 27.094 = 197.001 ms

   TimeoutInterval(3) = 79.625 + 4 * 23.156 = 172.249 ms

   TimeoutInterval(4) = 93.125 + 4 * 34.969 = 233.001 ms

   TimeoutInterval(5) = 78.25 + 4 * 25.563 = 180.502 ms

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3. a. sequence number = 106 + 824 = 930

source port number = 5387

destination port number = 7852

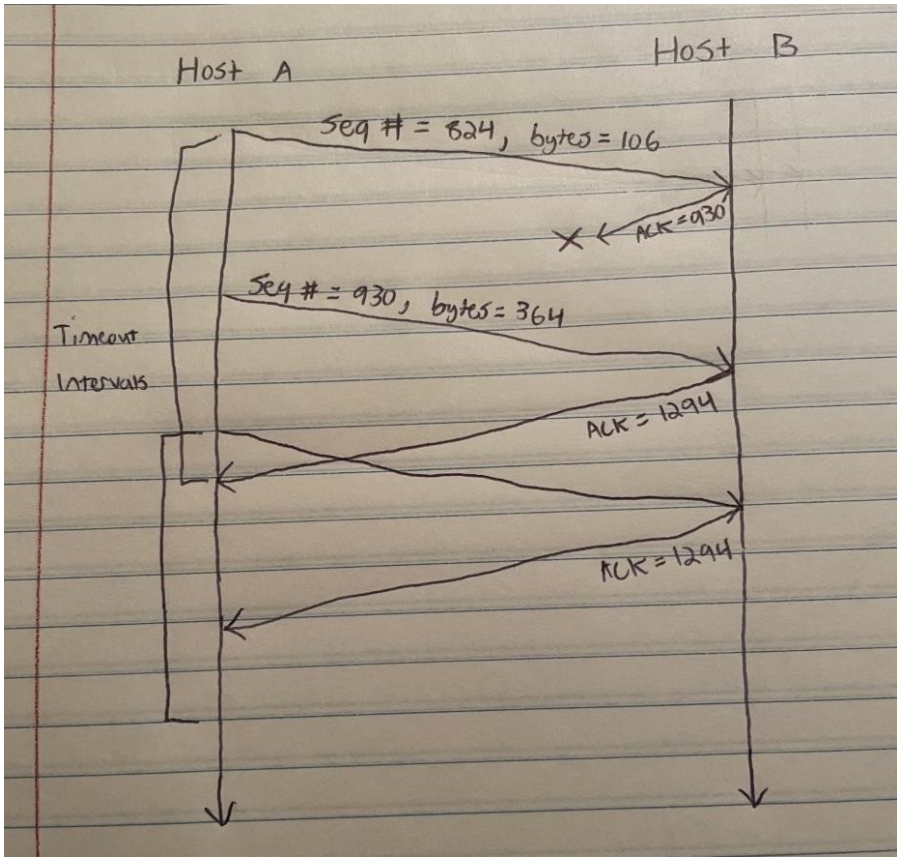
b. acknowledgement number = 824

c. acknowledgement number = 106 + 824 = 930

source port number = 7852

destination port number = 5387

d.



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4. First, we must consider the Go-Back-N (GBN) protocols where the sender is allowed to transmit multiple packets (when available) without waiting for an acknowledgment, but is constrained to have no more than some maximum allowable number of unacknowledged packets in the pipeline and the Selective Repeat (SR) protocols where unnecessary retransmissions are avoided by having the sender retransmit only those packets that it suspects were received in error at the receiver. Next, to find the largest allowable sender window that will avoid the occurrence of problems such as that in Figure 3.27 (too-large windows) in the textbook for each of these protocols we must consider a packet, X, and window size, Y. If the window has not received or acknowledged any packets prior to X, then the window would be [X-Y, X-1]. If the window has received and acknowledged the packet prior to X, the window would be [X, X+Y-1]. This results in the lower edge of the window being X-Y and the leading edge being X+Y-1. Since we are trying to avoid too-large of a window and find the largest allowable sender window, we should consider a sequence number space Z. The sequence number space should hold twice the window size, Y, worth of sequence numbers and the window size should be half of the sequence number space. Therefore, the largest allowable sender window should be half of the sequence number space, Z/2.

5.

Transmission	Sender's Congestion Window (kB)	Threshold (kB)
0	1	80
1	2	80
2	4	80
3	8	80
4	16	80
5	32	80
6	64	80
7	80	80
8	81	80
9 - Timeout	40	40
10	1	40
11	2	40
12	4	40
13	8	40
14 – Triple Duplicate ACK	16	40
15	8	8
16	9	8
17	10	8

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6. a.

GBN: Host A sends 14 segments in total because it must resend segments 3-8. Host B sends 13 ACKs. The sequence numbers are 1,2,3,3,3,3,3,3,4,5,6,7,8.

SR: Host A sends 8 segments in total including the one that failed. Host B sends 8 ACKs. The sequence numbers are 1,2,4,5,6,7,8,3.

TCP: Host A sends 9 segments in total because it initially sends 8 then resends 3. Host B sends 8 ACKs back. The sequence numbers are 3,3,3,3,3,3,3,9

b. TCP protocol will successfully deliver all 8 data segments in the shortest time interval because it does not wait until time out and it uses fast retransmit.