Reinaldo Daniswara
604840665

Problem 1

Answer True or False to the following questions and briefly justify your answer:

(a) With the Selective Repeat protocol, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

(b) With Go-Back-N, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

(c) The Stop&Wait protocol is the same as the SR protocol with a sender and receiver window size of 1.

(d) Selective Repeat can buffer out-of-order-delivered packets, while GBN cannot. Therefore, SR saves network communication cost (by transmitting less) at the cost of additional memory.

Write your solution to Problem 1 in this box

1a. True. For example, at time t0, sender send packets 1,2,3. At t1, the receiver sends ACK 1,2,3. However, at t2, the sender is timeout, and at t3 it sends again packets 1,2,3. Then, at t4 the receiver sends again the ACK, which should have already received by t1. This is outside the current window.

1b. True. The same example as 1a could be applied in here, as the number of window does not matter if the sender is timeout, before it receives the ACK.

1c. True because selective repeat protocol actually looks alike with stop and wait. And if it only uses 1 window, then Stop-Wait is same as SR.

1d. True that SR can buffer out of order packet as long as it is still inside the window, and yes it saves network communication cost by transmitting less at the cost of additional memory. For example, if the data lost happen frequently in a sequent package, retransmitting the whole packets again like GBN do is not efficient and wasting large amount of retransmission cost.

Problem 2

Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 226. 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 227, the source port number is 30002, and the destination port number is 80. Host B sends an acknowledgment whenever it receives a segment from Host A. Fill in the blanks for questions (a) – (c) directly; work out the diagram in the box for question (d).

(a) In the second segment sent from Host A to B, the sequence number is ______, source port number is ______, and destination port number is ______.

(b) If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, the ACK number is ______, the source port number is ______, and the destination port number is ______.

(c) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, the ACK number is ______.

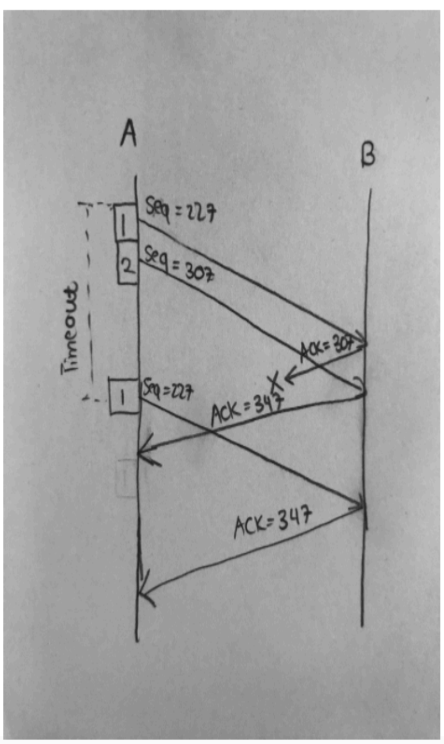
(d) Suppose the two segments sent by A arrive in order at B. The first acknowledgment is lost and the second acknowledgment arrives after the first timeout interval. Draw a timing diagram in the box below, showing these segments and all other segments and acknowledgment sent. Assume no additional packet loss. For each segment in your diagram, provide the sequence number and the number of bytes of data; for each acknowledgment that you add, provide the ACK number.

Write your solution to Problem 2 in this box

2a. The sequence number is 307, source port number is 30002, destination port number is 80

2b. The sequence number is 307, source port number is 80, destination port number is 30002

2c. ACK number is 227



2d.

Problem 3

In Fast Retransmit algorithm, we saw TCP waits until it has received three duplicate ACKs before performing a fast retransmit. Why do you think the TCP designers chose not to perform a fast retransmit after the first or second duplicate ACKs for a segment received?

Write your solution to Problem 3 in this box

3. TCP designers choose not to perform a fast retransmit after the first or second duplicate is because to avoid a retransmission redundancy. For example, if there are packets 1,2,3,4 and sender send packet 1, and it will receive ACK 1. But, packet 2 is loss, thus when sender send packet 3, it will get the duplicate of ACK 1. Then, when the sender send packet 4, then it will also receives ACK 1. Since this is the third duplicate, we know that packet 2 is lost. However, if after packet 3, instead of packet 4, receiver receives packet 2, then it will still send ACK 1, as a result sender will retransmit packet 2 again. Thus, there is a redundancy of retransmission here.

Problem 4

Suppose that three measured SampleRTT values are 106 ms, 120 ms, and 140 ms. Compute the EstimatedRTT after each of these SampleRTT values is obtained, assuming that the value of EstimatedRTT was 100 ms just before the first of these three samples were obtained. Compute also the DevRTT after each sample is obtained, assuming the value of DevRTT was 5 ms just before the first of these three samples was obtained. Last, compute the TCP TimeoutInterval after each of these samples is obtained.

Write your solution to Problem 4 in this box

4. For sampleRRT values are 106ms

EstimatedRTT = 0.125 * 106 + (1-0.125) * 100 = **100.75ms**

DevRTT = 0.25 * |106-100.75| + (1-0.25) *5 = **5.0625ms**

TimeoutInterval = 100.75 + 4 *5.0625 = **121ms**

sampleRRT = 120ms

EstimatedRTT = 0.125 * 120 + (1-0.125) * 100.75 = **103.15625ms**

DevRTT = 0.25 * |120-103.15625| + (1-0.25) *5.0625 = **8ms**

TimeoutInterval = 103.15 + 4 *8 = **135.15ms**

sampleRRT = 140ms

EstimatedRTT = 0.125 * 140 + (1-0.125) * 103.15 = **107.75ms**

DevRTT = 0.25 * |140-107.75| + (1-0.25) *8 = **14.06ms**

TimeoutInterval = 07.75 + 4 *14.06 = **164ms**

Problem 5

Compare Go-Back-N, Selective Repeat, and TCP (no delayed ACK). Assume that timeout values for all three protocols are sufficiently long, such that 5 consecutive data segments and their corresponding ACKs can be received (if not lost in the channel) by the receiving host (Host B) and the sending host (Host A), respectively. Suppose Host A sends 5 data segments to Host B, and the 2nd segment (sent from A) is lost. In the end, all 5 data segments have been correctly received by Host B.

(a) How many segments has Host A sent in total and how many ACKs has Host B sent in total? What are their sequence numbers? Answer this question for all three protocols.

(b) If the timeout values for all three protocols are much longer than 5RTT, then which protocol successfully delivers all five data segments in shortest time interval?

Write your solution to Problem 5 in this box

5a. Go-Back-N: Total segment will be 9, since 1,2,3,4,5. Because of 2 fail, then only 1 receives, then 2,3,4,5 is sent again. B sent 8 ACK, host B sent 4 ACK 1, because 2 lost, and 4 ACK with seq number 2,3,4,5.
Selective repeat: Total segment will be 6. Packet 2 will fail, while the rest still keeps in buffer, and only retransmit packet 2. B sent 5 ACK, where 4 ACK with seq number 1,3,4,5. And another one with ACK 2 after retransmission.
TCP: Total segment will be 6. Packet 2 will fail, while the rest still keeps in buffer, and only retransmit packet 2. B sent 5 ACK, where 4 ACK with seq number 2, and 1 ACK with seq number 6.

5b. TCP will be the fastest without timeout because it is using a fast retransmit protocol.