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-and-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

a. It is true. if sender sends packets 1,2,3 and t. At t1, receiver recevies their packs and sends Ack1 Ack2 Ack3. But before the sender can receive their Acks, the snder resends the packets. The sender receives the ack messages for packets .

b. true. like A, the sender can send a packet, the recieve can recieve and Ack it, but the sender can timeout before the Ack recieved. This makes sender send the packet again. the sender can then recieve the intial ack and move its window to packet 2.

c. true. an SR protocol with sender and reciever windoes functions the same as a stop and wait protocol. no out-of-sender packets can be buffered.

d. true, sr can request necessary packets while GBN requests entire window.

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 326. 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 327, the source port number is 40200, 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

a. sequence: 326 + 80 = 407 ,source port is 40200

b. ack is 427 source is 80 desination port is 40200

c. ack is 327

d. seq is 327, 80 bytes
req is 306, 40 bytes
ack is 307
ack 327

Problem 3

One of the three functions of a sliding window scheme is the orderly delivery of packets which arrive out of sequence. In Go-back-N, the receiver drops packets which arrives out of order. Assume the receiver sends an ACK for every packet it receives.

(a) What is the required buffer size (receiver's window size, RWS) at the receiver if sender's window size (SWS) = 23?

(b) In sliding window with SWS = RWS = 4, the minimum required `SeqNumSize` (the number of available sequence numbers) is 8. Calculate the minimum required `SeqNumSize` for

(i) a sliding window scheme with SWS = 4 and RWS = 2

(ii) a Go-back-N scheme with SWS = 4

Write your solution to Problem 3 in this box

a. The rws=1 buffer is the sie required because GBN doesn't buffer any packets and just takes the smallest seq. number, forgets about the rest.

b. seqnumsize = sws + rws = 6
ii) seqnumsize=5 because we need enough for sender window + 1.

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

sample rtt: 106
estimated rtt: (1-0.125)(100) + (0.125)(106) = 100.75 ms
devrtt: (1-0.25)(5) + .25/106 - 100.75 = 5.0625 ms
timeoutinterval: 100.75 + 4(5.0625) = 121 ms

sample rtt: 120
estimated rtt: (1.- 0.125) (100.75) + .125*120 = 103.156
devrtt: (1-.25)(5.0625) + .25/120 - 103.1526 = 8 ms
timeoutinterval: 103.156 + 4(8) = 135.156 ms

sample rtt: 140
estimated rtt: (1.0.125)(103.156) + .125*140 = 107.76
devrtt: (1-.25)(8) + .25(107.7-140) = 14 ms
timeoutinterval: 107.76 + 4 (14.0) = 164 ms

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

a. go back n, selective repeat, tcp:

go-back-n: 9 segments are sent and 8 ack sent
selective repeat: 6 segments sent 5 ack sent
tcp: 6 segments sent 5 ack sent

b. TCP will deliver the segments in the shortest time because of retransmission.