Homework 4

Due date: 2019/12/17 13:10

Late submission: R508

1. (10%)
   UDP and TCP use 1's complement for their checksums. Suppose you are using 8-bit segments for the checksum mechanism and you have the following three 8-bit words: 00110011, 01111110, 10101010.
   a. (5%) What is the 1's complement sum of these words?
      sum = 01011100 checksum = 10100011
   b. (5%) Is it possible that a 1-bit error will go undetected? How about a 2-bit error?
      All one bit errors will be detected, but two bit errors can be undetected (e.g., if three becomes 01110011, 00111110, 10101010, the checksum won't change)
2. (20%)
   Consider a channel that can lose packets but has a maximum delay that is known. Modify protocol rdt2.1 to include sender timeout and retransmit. Informally argue why your protocol can communicate correctly over this channel.
   Add a timer, whose value is greater than the known round-trip propagation delay. We add a timeout event to the \wait for ACK or NAK0" and \Wait for ACK or NAK1" states. If the timeout event occurs, the most recently transmitted packet is retransmitted. Why this protocol will still work with the rdt2.1 receiver : Suppose the timeout is caused by a lost data packet, i.e. a packet on the sender-to- receiver channel. In this case, the receiver never received the previous transmission and, from the receiver's viewpoint, if the timeout retransmission is received, it looks exactly the same as if the original transmission is received. Suppose now that an ACK is lost. The receiver will eventually retransmit the packet on a timeout. But a retransmission is exactly the same action that is taken if an ACK is garbled. Thus the sender's reaction is the same with a loss, as with a garbled ACK. The rdt2.1. receiver can already handle the case of a garbled ACK.
3. (15%)
   Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time t, the next in-order packet that the receiver is expecting has a sequence number of k. Assume that the medium does not reorder messages. Answer the following questions:

a. (10%) What are the possible sets of sequence numbers inside the sender's window at time t? Please justify your answer.
Receiver expects k, so last 4 ACKs are k-1, k-2, k-3, k-4. If none of these ACKs are received by the sender, then the window of sender is (k-4, k-3,k-2,k-1). ACK k-5 must be received by sender because if it isn't, packet k-1 would not be sent. If all these ACKs are received by the sender, then the window of sender is (k,k+1,k+2,k+3). So all possible sets of window are: (k-4,k-3,k-2,k-1), (k-3,k-2,k-1,k), (k-2,k-1,k,k+1), (k-1,k,k+1,k+2),(k,k+1,k+2,k+3)

b. (5%) What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time t? Please justify your answer.
By the same argument in (a), we know they are k-1, k-2, k-3, k-4

4. (25%)
Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 126. 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 127, the source port number is 302, and the destination port number is 80. Host B sends an acknowledgment whenever it receives a segment from Host A.

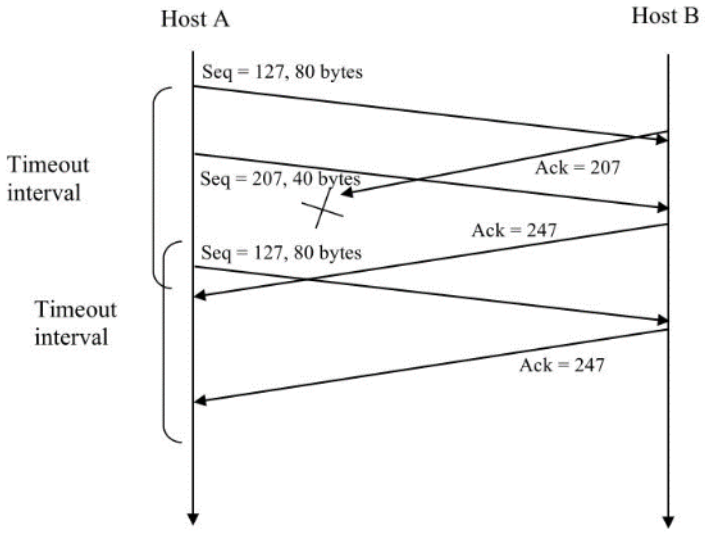
a. (5%) In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?
The sequence number is 207, the source port number is 302, and the destination port number is 80.

b. (5%) If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number?
The acknowledgment number is 207, the source port number is 80, and the destination port number is 302

c. (5%) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?
The acknowledgment number is 127.

d. (10%) 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, showing these segments and all other segments and acknowledgments sent. (Assume there is no additional packet loss.) For each segment in your figure, provide the sequence number and the number of bytes of data; for each acknowledgment that you add, provide the acknowledgment number.



5. (30%)

Consider Figure 1. Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

a. (3%) Identify the intervals of time when TCP slow start is operating.
[1,6] and [23,26]

b. (3%) Identify the intervals of time when TCP congestion avoidance is operating.
[6,17]

c. (3%) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
triple duplicate ACK

d. (3%) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
timeout

e. (3%) What is the initial value of ssthresh at the first transmission round?
32

f. (3%) What is the value of ssthresh at the 18th transmission round?
When loss is detected during transmission round 16, the congestion windows size is 42. Hence the threshold is 21 during the 18th transmission round.

g. (3%) What is the value of ssthresh at the 24th transmission round?
When loss is detected during transmission round 22, the congestion windows size is 29 or 26. Hence the threshold is 14 (taking lower oor of 14.5) or 13 during the 24th transmission round.

h. (3%) During what transmission round is the 70th segment sent?
During the 1st transmission round, packet 1 is sent; packet 2-3 are sent in the 2nd transmission round; packets 4-7 are sent in the 3rd transmission round; packets 8-15 are sent in the 4th transmission round; packets 16 to 31 are sent in the 5th transmission round; packets 32 to 63 are sent in the 6th transmission round; packets 64 to 96 are sent in the 7th transmission round. Thus packet 70 is sent in the 7th transmission round.

i. (3%) Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh?
The threshold will be set to half the current value of the congestion window (8) when the loss occurred and congestion window will be set to the new threshold value+3 MSS. (see bottom of page 275) Thus the new values of the threshold and window will be 4 and 7 respectively.

j. (3%) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round?
Threshold is 21, and congestion window size at 19th round is 4.

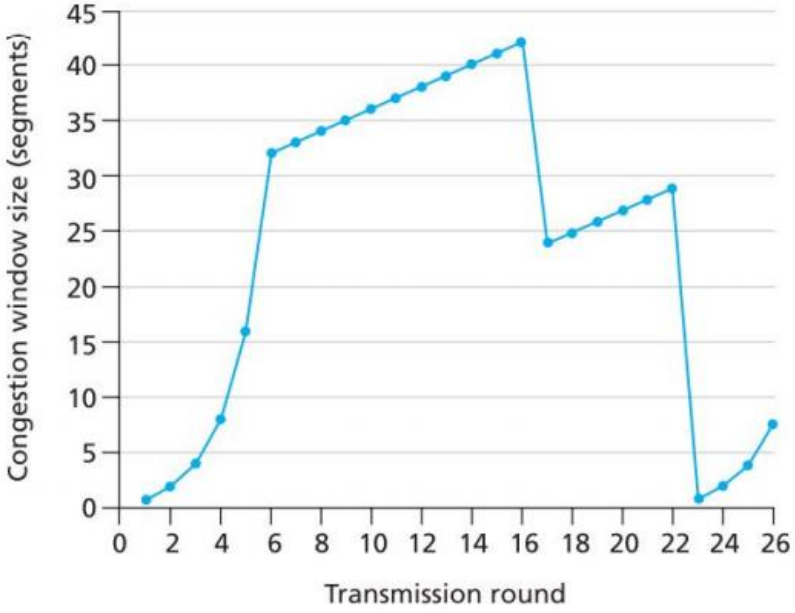


Figure 1: TCP window size as a function of time