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?

   b. (5%) Is it possible that a 1-bit error will go undetected? How about a 2-bit error?

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.

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.

   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.

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?

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?

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

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.

b. (3%) Identify the intervals of time when TCP congestion avoidance is operating.

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

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

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

f. (3%) What is the value of ssthreshat the 18th transmission round?

g. (3%) What is the value of ssthreshat the 24th transmission round?

h. (3%) During what transmission round is the 70th segment sent?

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?

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?

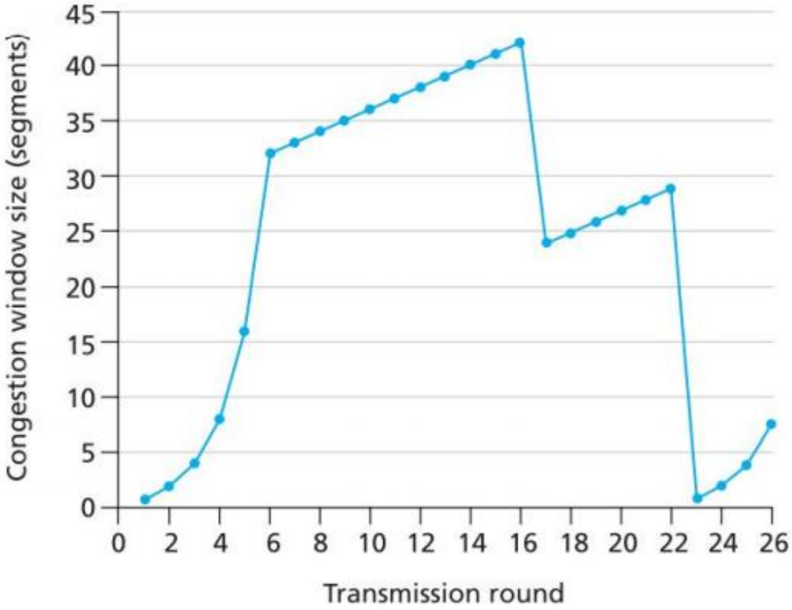

Figure 1: TCP window size as a function of time