Computer Networks

Spring 2022

Homework Assignment of Week 8 (Transport Layer)

Problem 1: English Textbook Chapter 3, R14

R14. True or false?

a. Host A is sending Host B a large file over a TCP connection. Assume Host B has no data to send Host A. Host B will not send acknowledgments to Host A because Host B cannot piggyback the acknowledgments on data.

b. The size of the TCP `rwnd` never changes throughout the duration of the connection.

c. Suppose Host A is sending Host B a large file over a TCP connection. The number of unacknowledged bytes that A sends cannot exceed the size of the receive buffer.

d. Suppose Host A is sending a large file to Host B over a TCP connection. If the sequence number for a segment of this connection is *m*, then the sequence number for the subsequent segment will necessarily be *m*+1.

e. The TCP segment has a field in its header for `rwnd`.

f. Suppose that the last `SampleRTT` in a TCP connection is equal to 1 sec. The current value of `TimeoutInterval` for the connection will necessarily be $\geqslant$1 sec.

g. Suppose Host A sends one segment with sequence number 38 and 4 bytes of data over a TCP connection to Host B. In this same segment the acknowledgment number is necessarily 42.

Problem 2: English Textbook Chapter 3, R15

R15. Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110.

a. How much data is in the first segment?

b. Suppose that the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number?

Problem 3: English Textbook Chapter 3, R17

R17. Suppose two TCP connections are present over some bottleneck link of rate *R* bps. Both connections have a huge file to send (in the same direction over the bottleneck link). The transmissions of the files start at the same time. What transmission rate would TCP like to give to each of the connections?

Problem 4: English Textbook Chapter 3, P40 a)-e)

P40. Consider Figure 3.58 . 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.

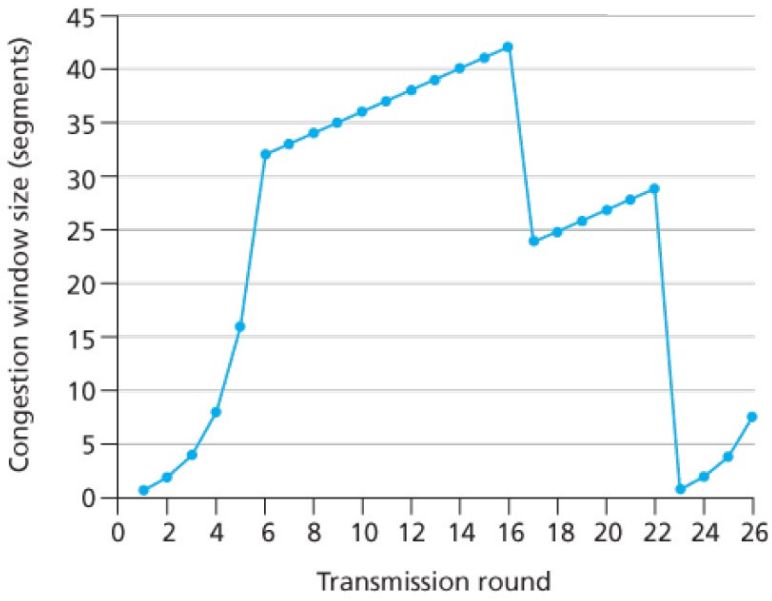

Figure 3.58 TCP window size as a function of time

a. Identify the intervals of time when TCP slow start is operating.

b. Identify the intervals of time when TCP congestion avoidance is operating.

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

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

e. What is the initial value of *ssthresh* at the first transmission round?

Problem 5: English Textbook Chapter 3, P45

P45. Recall the macroscopic description of TCP throughput. In the period of time from when the connection's rate varies from *W*/(2 RTT) to *W/RTT*, only one packet is lost (at the very end of the period).

a. Show that the loss rate (fraction of packets lost) *L* is equal to $\frac{1}{\frac{3}{8}W^2+\frac{3}{4}W}$

b. Use the result above to show that if a connection has loss rate *L*, then its average rate is approximately given by $\frac{1.22MSS}{RTT\sqrt{L}}$