University of Maryland Baltimore County
Department of Information Systems
Fall 2015

IS 450/650: Data Communications and Networks

Homework Assignment 2

Transport Layer

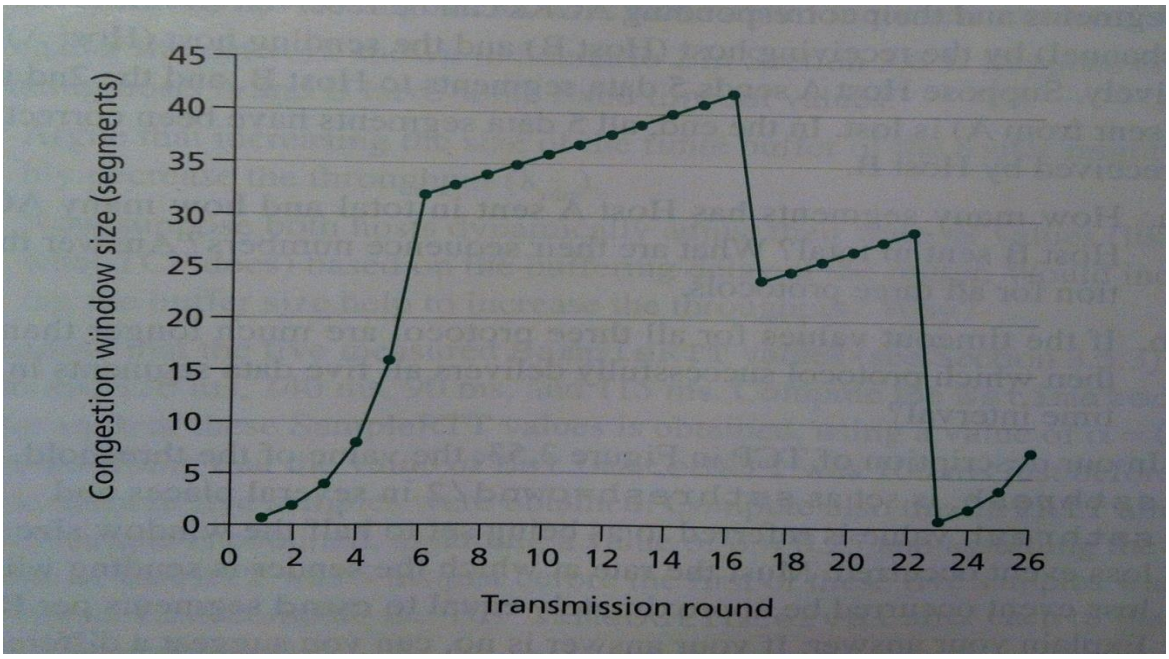
(Handed Out: November 10, 2015 (Tuesday), Due: November 17, 2015 (Tuesday) in class)

1. **(5 points)** In Go-Back-N protocol, only one timeout timer (for the oldest unACKed packet) is maintained at the sender. Explain why this is sufficient?

2. (30 points) Compare Go-Back-N, Selective Repeat, and TCP (no delayed ACK). Assume that the timeout values for all three protocols are sufficiently long such that 6 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 6 data segments to Host B, and the 3rd segment (sent from A) is lost. In the end, all 6 data segments have been correctly received by Host B. [Similar to Problem Number P37 in Chapter 3]

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 the following three protocols.
i) (**10 points**) Go-Back-N,
ii) (**10 points**) Selective Repeat, and
iii) (**10 points**) TCP

3. **(45 pts)** Assume the following graph shows the behavior of a TCP Reno connection, and answer each question with a short discussion justifying your answer. [Problem Number P40 in Chapter 3]



(a) (**5 points**) Identify the intervals of time when TCP slow start is operating.

(b) (**5 points**) Identify the intervals of time when TCP congestion avoidance is operating.

(c) (**5 points**) When does the sender detect segment loss by a timeout?

(d) (**5 points**) When does the sender detect segment loss by a triple duplicate?

(e) (**5 points**) What is the initial value of ssthresh at the first transmission round?

(f) (**5 points**) What is the value of ssthresh at the 18^{th} transmission round?

(g) (**5 points**) What is the value of ssthresh at the 24^{th} transmission round?

(h) (**5 points**) During what transmission round is the 70^{th} segment sent?

(i) (**5 points**) Assuming a packet loss is detected after the 26^{th} round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh?

4. (**20 points)** Assume that a TCP connection is just entering slow start phase at time 0. The congestion widow (CWND) is set to 1 MSS (maximum segment size). Assume that RTT is 10ms. Omit the transmission time (this means packets can be sent out instantly and corresponding ACKs can be received simultaneously if no loss). The receiving window is set to be infinite large and the slow start threshold (ssthresh) is set to be 16 MSS initially. Answer the following questions and give brief reasoning.

(a) (**10 points)** Assume no packet loss till 31ms, then what is the congestion window size?

(b) (**10 points)** Assume no packet loss till 61ms, then what is the congestion window size?