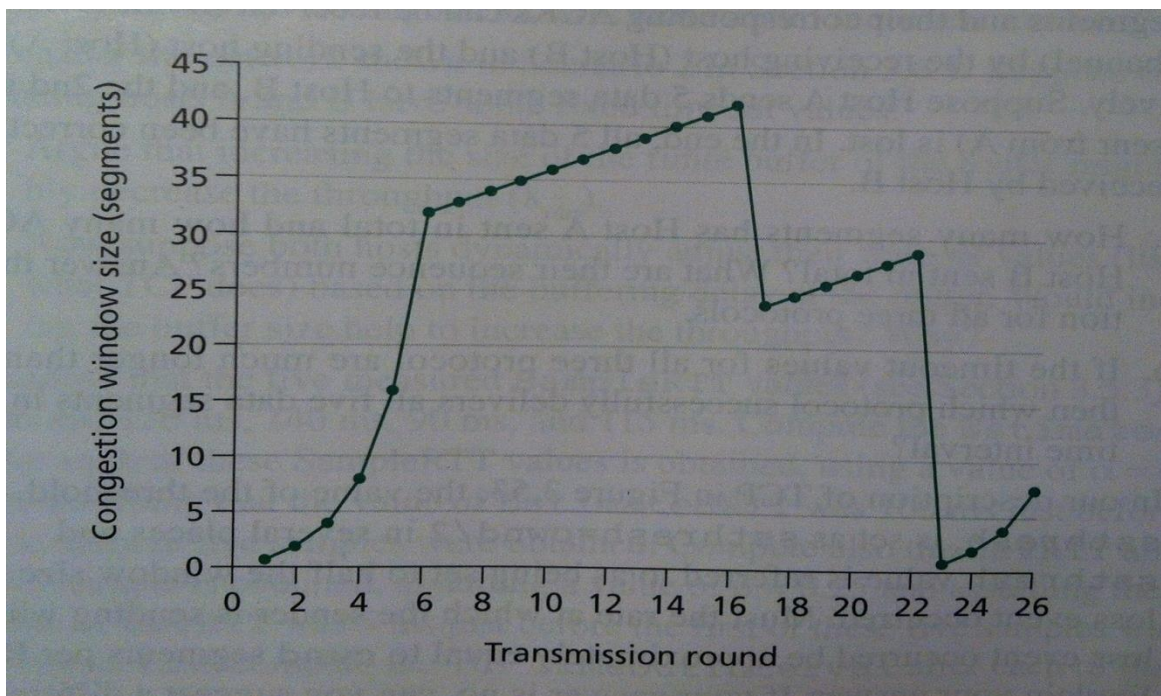


University of Maryland Baltimore County  
Department of Information Systems  
Spring 2015  
**IS 450/650: Data Communications and Networks**  
**Homework Assignment 2**  
**Transport Layer**

(Handed Out: April 14, 2015 (Tuesday), Due: April 28, 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)** Consider the GBN (Go-Back-N) 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. [Problem Number P22 in Chapter 3]
  - (a) **(15 points)** What are the possible sets of sequence numbers inside the sender's window at time  $t$ ? Justify your answer. [Hints: Consider the two cases when all of these ACK's have been received at sender or none of the ACKs have been received at the sender.]
  
  - (b) **(15 points)** What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time  $t$ ? Justify your answer.
  
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<sup>th</sup> transmission round?
- (g) **(5 points)** What is the value of ssthresh at the 24<sup>th</sup> transmission round?
- (h) **(5 points)** During what transmission round is the 70<sup>th</sup> segment sent?
- (i) **(5 points)** Assuming a packet loss is detected after the 26<sup>th</sup> 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 window (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?