ECE 4380/6380: Computer Communications **Spring 2017**
Problem Set 10 **Due: in class, Friday, April 21**

Assigned reading: Peterson and Davie, Chapter 5, Sections 1 and 2. All problems have equal weight.

1. **TCP transition diagram**. Chapter 5, number 5.
2. **Advertised window**. Chapter 5, number 6
3. **Sequence number wrap**. Chapter 5, number 8
4. **TCP transition diagram**. Consider the TCP state transition diagram. Consider a server and a client process that are initially both in the CLOSED state. The following sequence of transitions is typical:

Event	Action
1.	Server moves to LISTEN
2.	Client moves to SYN_SENT
3.	Server moves to SYN_RCVD
4.	Client moves to ESTABLISHED
5.	Server moves to ESTABLISHED

After this sequence, both are in the ESTABLISHED state.

(a) Using the same format, continue this sequence of events, assuming that the server process executes close, but that the client process continues to send data to the server (which the server continues to receive). What is the state of the server and what is the state of the client after this sequence?

(b) Suppose after the sequence of transitions from (a) is complete, the client executes a close. Show the next sequence of events, leading to both client and server in the CLOSED state.

(c) Suppose the initial FIN message sent from the server to the client (when the server first decided to close) is lost. Describe how TCP continues, and in particular the impact of the loss on your answer to part (a).

5. **TCP adaptive timeout**. (variation of Chapter 5, number 29. Also, see solution in book for problem 27) Consider the Jacobson/Karels algorithm as described on page 399 with $\delta = 1/8$, $\mu = 1$ and $\phi = 4$. Suppose at time 0 the variable values are EstimatedRTT = 1.1 and Deviation = 0.15. In order to focus on the timing (rather than send window size) we assume that the send window size is one segment, so that each time a segment is transmitted the sender waits for an ACK or timeout. Suppose a new segment is transmitted at time 0. Number the segments, beginning with number 1 for the segment sent at time 0. Suppose the round trip response time for each transmission from time 0 onwards is 5 seconds. Find how many times each of the segments is transmitted.

   Comment 1: Here is how it starts out. Segment 1 is transmitted at time 0 with a timeout of 1.7, and again at time 1.7 with a timeout of 3.4 (the timeout will occur at time 1.7+3.4=5.1). The ACK for the first transmission is received at time 5, before the second time out. Thus, segment 1 is transmitted a total of two times. At time 5, the second packet is transmitted with a timeout of 3.4, and so on. From some segment on, all segments will be transmitted once (however, just because a segment is transmitted only once does not mean all future segments are also only transmitted once—instead look at the RTT, estimated RTT, and timeout values).
   Comment 2: Note that the Jacobson/Karels algorithm is used to calculate the estimated RTT and set the value of the timeout after a new estimate of the RTT is available. The Karn/Partridge algorithm is used to determine when to sample the RTT and what to do with the timeout when there is a retransmission. Here are some additional details of the Karn/Partridge backoff algorithm, as described in P&D. Upon receiving an ACK for a segment that was transmitted only one time, the variables EstimatedRTT and Deviation are updated using the measured SampleRTT, and the value of Timeout is set to EstimatedRTT + 4×Deviation. The variables EstimatedRTT and Deviation are not updated under any other circumstances. Whenever a segment is retransmitted, the value of TimeOut is set to twice its previously used value. Note that if all ACKs received during some time interval are for segments that were sent more than once, then EstimatedRTT and Deviation stay constant during the timer interval, and the variable TimeOut is doubled each time a retransmission is required. (If you would like more detail see Stevens, *TCP/IP Illustrated*, vol. 1, 1994.)