Homework 6, Due Date: 10:00am 03/13/2014, Cutoff Date: 10:00am 03/18/2014
Submission: Hardcopy at the beginning of the class.

Textbook, Page 293, P26. Consider transferring an enormous file of L bytes from Host A to Host B. Assume an MSS of 536 bytes.

(a) What is the maximum value of L such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes.

(b) For the L you obtain in (a), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data- link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously. (Hint: it is assumed that the window size N is large enough such that the segments can be sent out back to back without the need to wait for the next sequence number to be available and there is no loss of packet or ack.)

Textbook, Page 293, P27. 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) In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?

(b) 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) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number? (Hint: The reliability control used in TCP is basically a GBN approach with some variation.)

(d) 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 time-out 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. **(hint: draw all the segments and ACKs that are exchanged between Hosts A and B involved in delivering these two segments)**

Problem A. Referring to the Slide 38 titled "TCP Flow Control", if RcvBuffer = 4096 bytes, 1280 bytes data is buffered,

(a) what is the **`rwnd`** value in the TCP header of the next receiver-to-sender segment?

(b) When the sender receives the above TCP segment, it has sent out 2560 bytes not yet ACKed. At most how many more bytes can the sender send out before receiving any ACK?

Problem B. (a) List the following three TCP segments in the order of being transmitted in the TCP 3-way handshake for establishing a TCP connection; (b) describe the sender and receiver of EACH TCP segment as *client-to-server* or *server-to-client*; (c) what is the initial sequence number chosen by the client; (d) what is the initial sequence number chosen by the server?

TCP Segment [SYNBit = 1, Seq = 58, ACKbit = 1, ACKnum = 126]
TCP Segment [ACKbit = 1, ACKnum = 59]
TCP Segment [SYNBit = 1, Seq = 125]

Problem C. Given that the client initiates the procedure of closing a TCP connection, the last byte sent from client to server before closing has a sequence number of 1,742, the last byte sent from server to client before closing has a sequence number of 6,029, (a) list four TCP segments exchanged between client and server for closing a TCP connection, where EACH TCP Segment must be described in the **format** used in Problem B; (b) describe the sender and receiver of EACH TCP segment as *client-to-server* or *server-to-client*.

Problem D. The initial ssthresh is 16, the sender experiences a 3-duplicate-ACKs event right after the 11th transmission round, and then the sender experiences a timeout event right after the 15th round, draw the congestion window size (in segments) as a function of transmission round for the time between 0 and the 20th round if (a) TCP Tahoe is used for congestion control; and (b) TCP Reno is used for congestion control. Draw these TWO cases in TWO SEPARATE figures although the figure in Slide 49 titled "TCP: switching from slow start to CA" illustrates both cases.