# Homework 2

**1.** Compare and Contrast the following flavors (implementations) of TCP using any and all resources at your disposal, in addition to your textbook. Be sure to cite your references at the end of your answer.

- TCP Reno
- TCP Tahoe
- TCP Vegas
- Fast TCP

**2.** *Simultaneous Open*: The TCP state transition diagram allows for the case where the two stations issue a SYN segment at nearly the same time. Draw the sequence of segment exchanges and use the TCP state transition diagram to show the sequence of states that are followed by the two stations in this case.

**3.** *Simultaneous Close*: The TCP state transition diagram allows for the case where the two stations issue a FIN segment at nearly the same time. Draw the sequence of segment exchanges and use the TCP state transition to show the sequence of states that are followed by the two stations in this case.

**4.** What is the impact on bandwidth utilization if the TCP timeout value is

**a.** too short
**b.** too long
**c.** Which is worse (a) or (b)? Why?
**d.** Would you prefer RFC 793 over the Jacobson-Karels algorithm for timer selection? Explain.

**5.** A fast typist can do 100 words a minute, and each word has an average of 6 characters. Demonstrate Nagle's algorithm by showing the sequence of TCP segment exchanges between a client, with input from our fast typist, and a server. Indicate how many characters are contained in each segment sent from the client. Consider the following two cases:

**a.** The client and server are in the same LAN and the RTT is 20 ms.
**b.** The client and server are connected across a WAN and the RTT is 100 ms.

**6.** Suppose that a TCP source (with unlimited amount of information to transmit) begins transmitting onto a link that has 1 Mbps in available bandwidth. Sketch congestion window versus time trajectory. Now suppose that another TCP source (also with unlimited amount of information to transmit) begins transmitting over the same link. Sketch the congestion window versus the time for the initial source.

**7.** Explain the relationship between advertised window size, RTT, delay-bandwidth product, and the maximum achievable throughput in TCP.

**a.** Plot the maximum achievable throughput versus delay-bandwidth product for an advertised window size of 65,535 bytes.
**b.** In the above plot include the maximum achievable throughput when the above window size is scaled up by a factor of $2^K$, where $K = 4, 8, 12$.
**c.** Place the following scenarios in the plot obtained in part (b):
**c.1** Ethernet with 1 Gbps and distance 100 meters
**c.2** 2.4 Gbps and distance of 6000 km
**c.3** Satellite link with speed of 45 Mbps and RTT of 500 ms

**c.4** 40 Gbps link with distance of 6000 km.