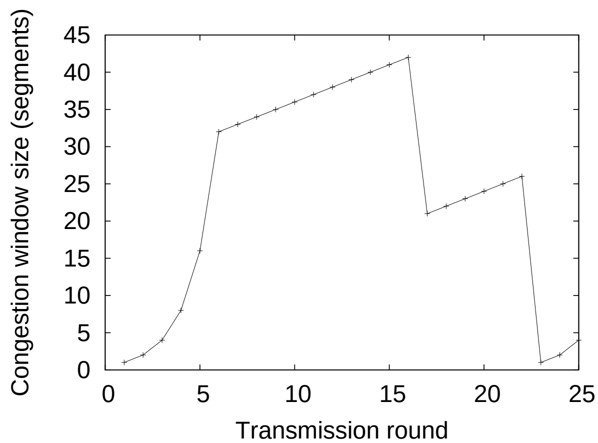
CS 536 Fall 2008 - Homework 2
Due 10/30/2008 in class

Problem 1 – 30 pts

TCP. Consider the following plot of TCP window size as a function of time.



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

1. Identify the intervals of time when TCP slow start is operating.
2. Identify the intervals when TCP congestion avoidance is operating.
3. After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout ?
4. After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout ?
5. What is the initial value of the `Threshold` at the first transmission round ?
6. What is the value of the `Threshold` at the 18th transmission round ?
7. What is the value of the `Threshold` at the 24th transmission round ?
8. During what transmission round is the 70th segment sent ?
9. Assuming a packet loss is detected after the 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of `Threshold`.
10. What is the average throughput in 20 rounds assuming an average of 10 ms per round and all segments are 1500 bytes?

Problem 2 – 20pts

No packet loss, no timer expiry. Host A wants to send an enormous file to Host B over a TCP connection. Over this connection there is never any packet loss and timers never expire. Denote the transmission rate of the link connecting host A to the Internet by R bps. Suppose that the process in Host A is capable of sending data into its TCP socket at a rate of S bps, where $S = 10 \times R$. Further suppose that the TCP receive buffer is large enough to hold the entire file, and the send buffer can hold only one percent of the file. What would prevent the process in Host A from continously passing data to its TCP socket at rate S bps ? TCP Flow control ? TCP Congestion control ? Or something else ? Elaborate.

Problem 3 – 30pts

TCP analysis. Recall the macroscopic description of TCP throughput. In the period of time from when the connection's rate varies from $W/(2RTT)$ to W/RTT, only one packet is lost (at the very end of the period). [15pts each]

1. Show that the loss rate (fraction of packets lost) is equal to

$$L = loss\ rate = \frac{1}{\frac{3}{8}W^2 + \frac{3}{4}W}.$$

2. Use the result above to show that if a connection has loss rate L, then its average rate is approximately given by

$$\approx \frac{1.22MSS}{RTT\sqrt{L}}.$$

Problem 4 – 20pts

RED. Let us suppose a router uses RED as a way to avoid congestion buildup in the network. The queue in the router is shared by two connections A and B. The average queue length is 10 packets while the min and max thresholds are 5 and 15 packets respectively, so the average queue length is halfway between the two thresholds. Assume the RED implementation uses a $maxP = 0.02$.

1. What is the drop probability for a new incoming packet for connection A if the number of packets queued from the time the queue length crossed the min threshold is 10.

2. Suppose A's congestion window consists of 8 packets. (Typically TCP congestion window is specified in bytes, but lets suppose all packets are of same size, so it does not matter.) Let B's congestion window also be of size 8 packets. Now a train of A's packets (8 of them) and B's packets (8 of them) arrive in sequence. When the first A packet arrived, the count of number of packets queued after is 5. What is the probability that A will not lose a packet ?. What is the probability that B will not lose a packet ?. To make these calculations easy, assume that none of the previous packets got dropped for each of A's as well as B's packets.