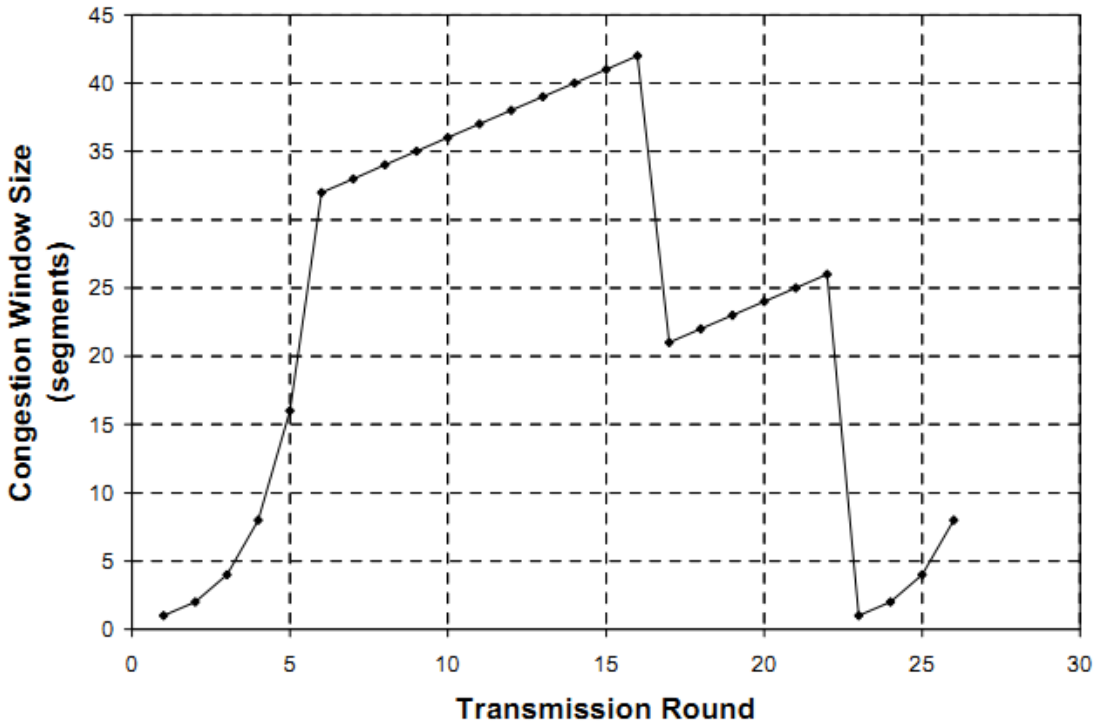
Advanced Computer Networks

Homework 3

Assigned: April 26, 2013

Due: May 10, 2013

1. 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.

(a) Identify the intervals of time when TCP slow start is operating.

(b) Identify the intervals of time when TCP congestion avoidance is operating (AIMD).

(c) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?

(d) What is the initial value of ssthreshold at the first transmission round?

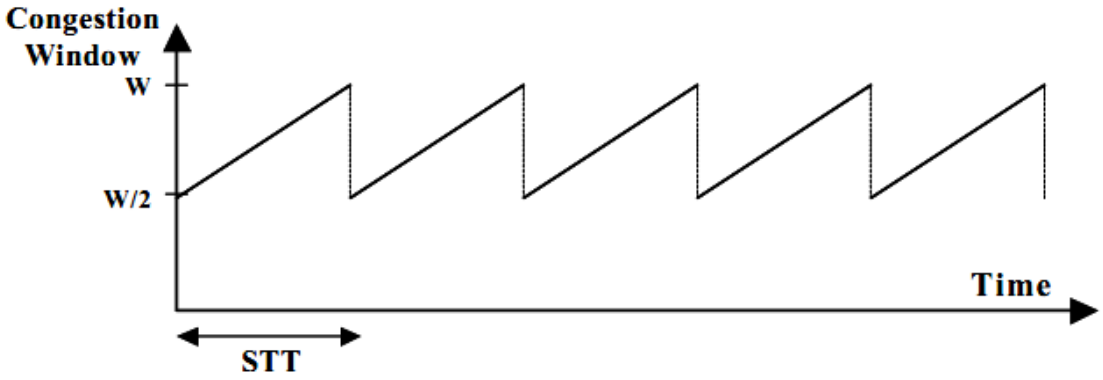
(e) What is the value of ssthreshold at the 18th transmission round?

(f) What is the value of ssthreshold at the 24th transmission round?

(g) During what transmission round is the 70th segment sent?

(h) 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 ssthreshold?

2. Consider the figure of TCP sawtooth diagram below:



The picture above shows the famous TCP saw tooth behavior. We are assuming that fast retransmit and fast recovery always work, i.e. there are no timeouts and there is exactly one packet lost at the end of each "tooth". We are assuming that the flow control window is large and that the sender always has data to send, i.e. throughput will be determined by TCP congestion control.

In the picture, W represents the congestion window size at which a congestion packet loss occurs (expressed in maximum transfer units). You can assume that W is large, so feel free to approximate (W-1) or (W+1) by W. STT represents the "saw tooth time" expressed in seconds.

The aim of this exercise is to derive the average throughput of a TCP connection as a function of the roundtrip time (RTT), the maximum transfer unit (MTU), and the packet loss rate (PLR) for the connection. Please use the notation suggested by the figure, i.e. W and STT, as intermediate values if you need them.

(a) Calculate the STT as a function of W, and the RTT. (Hint: the congestion window goes from W/2 to W in one STT, and remember the congestion window is increased by 1 MTU every RTT).

(b) How much data is sent in one STT? (Hint: how much data is sent each RTT?)

(c) What is the average throughput of the connection?

(d) What is the average packet loss rate? (Hint: How many losses occur per STT?)

(e) What is the relationship between the throughput and the packet loss rate?