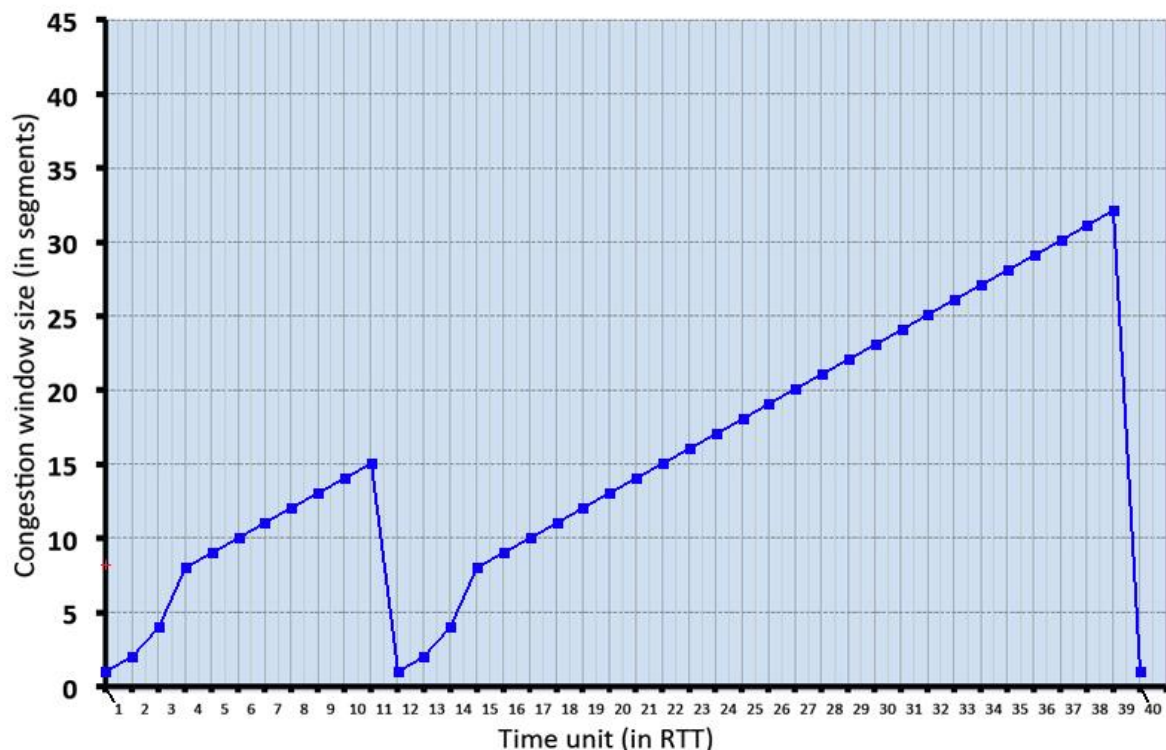


Homework 2
CSE 310 Fall 2022
Due date: **October 13, 2022; 11:59 PM**
Submission via Blackboard.

1. TCP in action! (20 points)

The figure below plots the evolution of TCP's congestion window at the beginning of each time unit (where the unit of time is equal to the RTT). Consider the evolution of TCP's congestion window in this example and answer the following questions. The initial value of cwnd is 1 and the initial value of ssthresh (shown as a red +) is 8.



(Format your answer as: 1, 3, 5, 9. For larger ranges > 10, you can list a range like "10-20" instead of listing all numbers.)

- Give the times at which TCP is in slow start.
- Give the times at which TCP is in congestion avoidance
- Give the times at which packets are lost via timeout.
- Give the times at which packets are lost via triple ACK.

- e. Give the times at which the value of `ssthresh` changes (if it changes between $t=3$ and $t=4$, use $t=4$ in your answer)

2. Transport Layer protocols. Give two scenarios where UDP may be preferred over TCP. Explain why. **(5 points)**

3. True or false? Please provide a reasoning (1-2 sentences) for your answer. (10 points)

- a. The size of the TCP `rwnd` never changes throughout the duration of the connection.
- b. The TCP segment has a field in its header for `rwnd`.
- c. Suppose Host A sends one segment with sequence number 38 and 4 bytes of data over a TCP connection to Host B. In this same segment the acknowledgment number is necessarily 42.
- d. Host A is sending Host B a large file over a TCP connection. Assume Host B has no data to send Host A. Host B will not send acknowledgments to Host A because Host B cannot piggyback the acknowledgments on data.
- e. Suppose Host A is sending a large file to Host B over a TCP connection. If the sequence number for a segment of this connection is m , then the sequence number for the subsequent segment will necessarily be $m+1$.

4. Sequence Numbers and ACKs (15 points)

A. **(5 points)** Suppose Host A sends two TCP segments back to back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110.

- (i) How much data is in the first segment?
- (ii) Suppose that the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number?

B. **(10 points)** 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?
- 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 timeout 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.