Network Architectures 3329 **Name:** ____________________
Spring 2018 **Homework 3**
02/28/2018 **Due Spring break**

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1. (a) Suppose you have the following 2 bytes: 01011100 and 01100101. What is the 1s complement of the sum of these 2 bytes?

   Solution: Adding the two bytes gives 11000001. Taking the ones complement gives 00111110.

   (b) Suppose you have the following 2 bytes: 11011010 and 01100101. What is the 1s complement of the sum of these 2 bytes? Now suppose a cache is installed in the institutional LAN. Supposethe the miss rate is 0.4. Find the total response time.

   Solution: Adding the two bytes gives 01000000; the ones complement gives 10111111.

   (c) For the bytes in part (a), give an example where one bit is flipped in each of the 2 bytes and yet the 1s complement doesnt change.

   Solution: First byte = 01010100; second byte = 01101101.

2. Consider an idealized case of two hosts, one located on the West Coast of the United States and the other located on the East Coast, as shown in the following figure. The speed-of-light round-trip propagation delay between these two end systems, RTT, is approximately 30 milliseconds. Suppose that they are connected by a channel with a transmission rate, R, of 1 Gbps (10^9) bits per second). With a packet size, L, of 1,000 bytes (8,000 bits) per packet, including both header fields and data, the time needed to actually transmit the packet into the 1 Gbps link is $d_{tran} = L/R = 8$ microseconds. How big would the window size have to be for the channel utilization to be greater than 98 percent? Suppose that the size of a packet is 1,500 bytes, including both header fields and data.

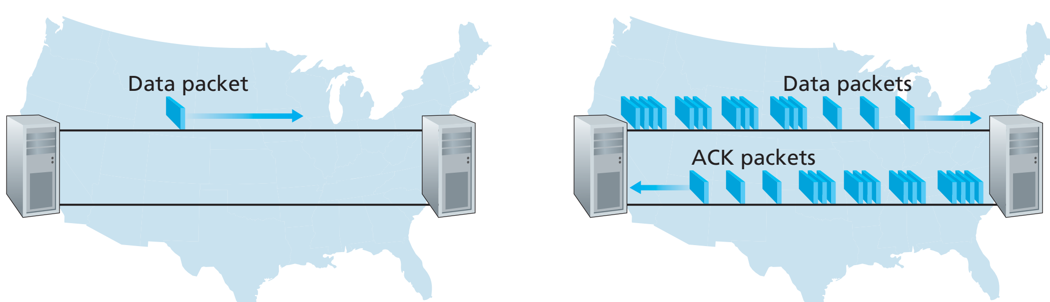

Figure 1: Example

Solution: It takes 12 microseconds (or 0.012 milliseconds) to send a packet, as 1500*8 / 109=12 microseconds. In order for the sender to be busy 98 percent of the time, we must have util = 0.98 = (0.012n) / 30.012 or n approximately 2451 packets.

3. 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?

   Solution: In the second segment from Host A to B, the sequence number is 207, source port number is 302 and destination port number is 80.

   (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?

   Solution: If the first segment arrives before the second, in the acknowledgement of the first arriving segment, the acknowledgement number is 207, the source port number is 80 and the destination port number is 302.

   (c) If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?

   Solution: If the second segment arrives before the first segment, in the acknowledgement of the first arriving segment, the acknowledgement number is 127, indicating that it is still waiting for bytes 127 and onwards.

4. Consider the following figure. 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.

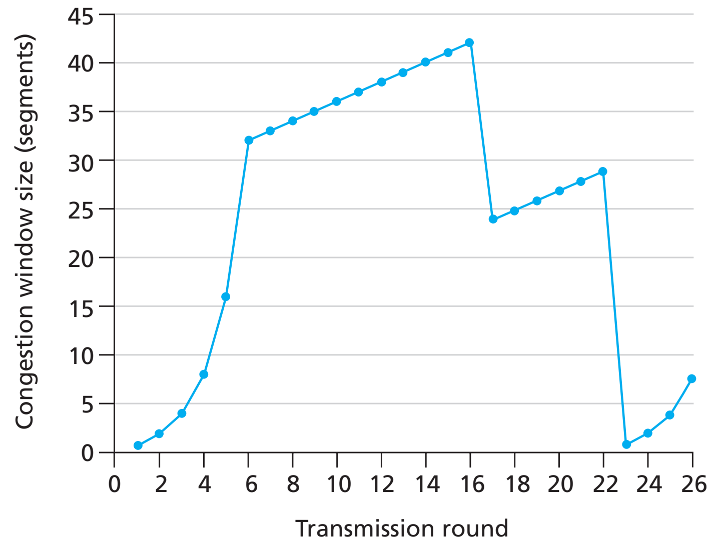

Figure 2: TCP window size as a function of time

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

Solution: TCP slowstart is operating in the intervals [1,6] and [23,26].

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

Solution: After the 16th transmission round, packet loss is recognized by a triple duplicate ACK. If there was a timeout, the congestion window size would have dropped to 1.

(c) What is the value of ssthresh at the 18th transmission round?

Solution: The threshold is set to half the value of the congestion window when packet loss is detected. When loss is detected during transmission round 16, the congestion windows size is 42. Hence the threshold is 21 during the 18th transmission round.

(d) Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16th round. What are the ssthresh and the congestion window size at the 19th round?

Solution: Threshold is 21, and congestion window size is 1.