CS6330/CS4330: COMPUTER NETWORKS
ASSIGNMENT 3

R15. 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.

a. How much data is in the first segment?
b. 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?

P1. Suppose Client A initiates a Telnet session with Server S. At about the same time, Client B also initiates a Telnet session with Server S. Provide possible source and destination port numbers for

a. The segments sent from A to S.
b. The segments sent from B to S.
c. The segments sent from S to A.
d. The segments sent from S to B.
e. If A and B are different hosts, is it possible that the source port number in the segments from A to S is the same as that from B to S?
f. How about if they are the same host?

P2. Consider **Figure 3.5**. What are the source and destination port values in the segments flowing from the server back to the clients' processes? What are the IP addresses in the network-layer datagrams carrying the transport-layer segments?

P3. UDP and TCP use 1s complement for their checksums. Suppose you have the following three 8-bit bytes: 01010011, 01100110, 01110100. What is the 1s complement of the sum of these 8-bit bytes? (Note that although UDP and TCP use 16-bit words in computing the checksum, for this problem you are being asked to consider 8-bit sums.) Show all work. Why is it that UDP takes the 1s complement of the sum; that is, why not just use the sum? With the 1s complement scheme, how does the receiver detect errors? Is it possible that a 1-bit error will go undetected? How about a 2-bit error?

P4.

a. Suppose you have the following 2 bytes: 01011100 and 01100101. What is the 1s complement of the sum of these 2 bytes?
b. Suppose you have the following 2 bytes: 11011010 and 01100101. What is the 1s complement of the sum of these 2 bytes?
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 doesn't change.

P5. Suppose that the UDP receiver computes the Internet checksum for the received UDP segment and finds that it matches the value carried in the checksum field. Can the receiver be absolutely certain that no bit errors have occurred? Explain.

P25. We have said that an application may choose UDP for a transport protocol because UDP offers finer application control (than TCP) of what data is sent in a segment and when.

a. Why does an application have more control of what data is sent in a segment?
b. Why does an application have more control on when the segment is sent?

P26. Consider transferring an enormous file of *L* bytes from Host A to Host B. Assume an MSS of 536 bytes.

a. What is the maximum value of *L* such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes.
b. For the *L* you obtain in (a), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously.

P27. 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.

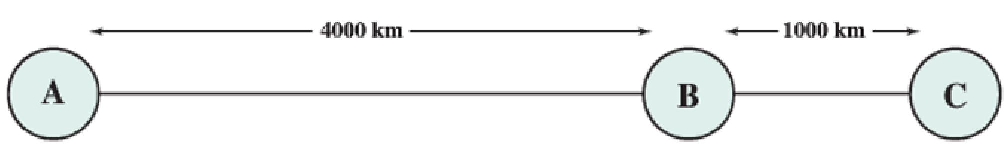
a. In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?
b. If the first segment arrives before the second segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and 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.

P36. In **Section 3.5.4**, we saw that TCP waits until it has received three duplicate ACKs before performing a fast retransmit. Why do you think the TCP designers chose not to perform a fast retransmit after the first duplicate ACK for a segment is received?

P37. In the figure below frames are generated at node **A** and sent to node **C** through node **B**. Determine the minimum data rate required between nodes **B** and **C** so that the buffers of node **B** are not flooded, based on the following:

- The data rate between **A** and **B** is 100 kbps.
- The propagation delay is 5 $\mu s/\mathbf{km}$ for both lines.
- There are full-duplex lines between the nodes.
- All data frames are 1000 bits long; ACK frames are separate frames of negligible length.
- Between **A** and **B**, a sliding-window protocol with a window size of 3 is used.
- Between **B** and **C**, stop-and-wait is used.
- There are no errors.

Hint: In order not to flood the buffers of B, the average number of frames entering and leaving B must be the same over a long interval.



P38. Neighboring nodes **A** and **B** use a sliding-window protocol with a 3-bit sequence number. As the ARQ mechanism, go-back-N is used with a window size of 4. Assuming **A** is transmitting and **B** is receiving, show the window positions for the following succession of events:

a. Before **A** sends any frames
b. After **A** sends frames 0, 1, 2 and receives acknowledgment from **B** for 0 and 1
c. After **A** sends frames 3, 4, and 5 and **B** acknowledges 4 and the ACK is received by **A**

P39. A World Wide Web server is usually set up to receive relatively small messages from its clients but to transmit potentially very large messages to them. Explain, then, which type of ARQ protocol (selective reject, go-back-N) would provide less of a burden to a particularly popular WWW server.

WIRESHARK LAB 3: TCP & UDP

The lab (part 1 & part 2) has been uploaded to the Canvas system under the Wireshark Labs section. You are required to:

1. **submit** screenshots of your work
2. **answer** the questions in the lab document.