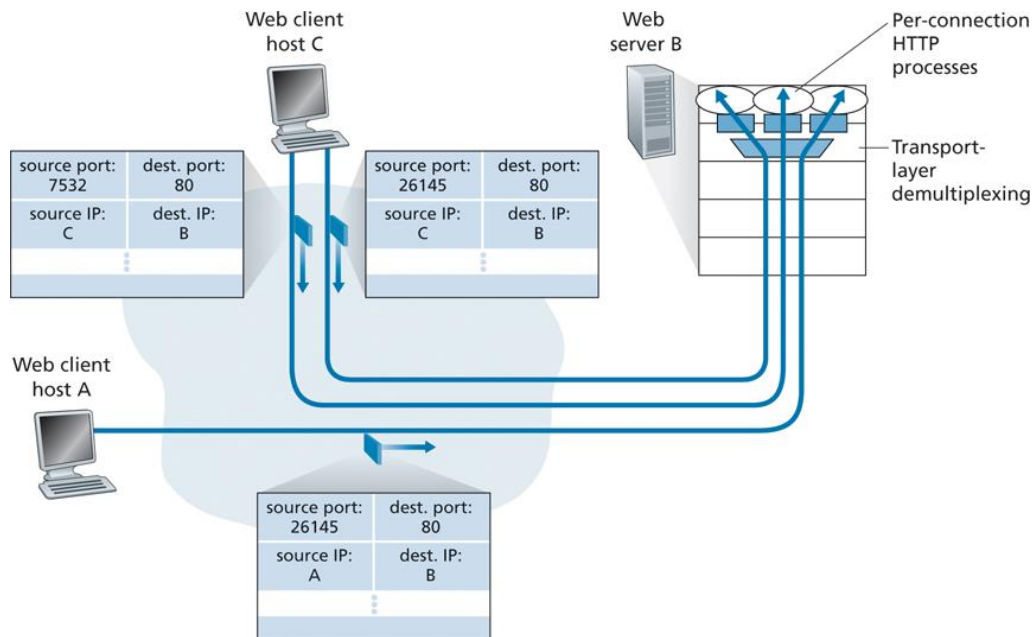**P2.** Consider **Figure 3.5**. What are the source and destination port values in the segments flowing from the server back to the clients' processes? What are the IP addresses in the network-layer datagrams carrying the transport-layer segments?


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?

P14. Consider a reliable data transfer protocol that uses only negative acknowledgments. Suppose the sender sends data only infrequently. Would a NAK-only protocol be preferable to a protocol that uses ACKs? Why? Now suppose the sender has a lot of data to send and the end-to-end connection experiences few losses. In this second case, would a NAK-only protocol be preferable to a protocol that uses ACKs? Why?

P15. Consider the cross-country example shown in **Figure 3.17**. How big would the window size have to be for the channel utilization to be greater than 98 percent? Suppose that the transmission rate is 1 Gbps, the one-way propagation delay is 15ms, and the packet size is 1,500 bytes, including both header fields and data.
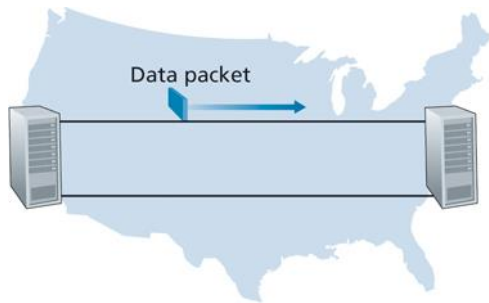
a. A stop-and-wait protocol in operation
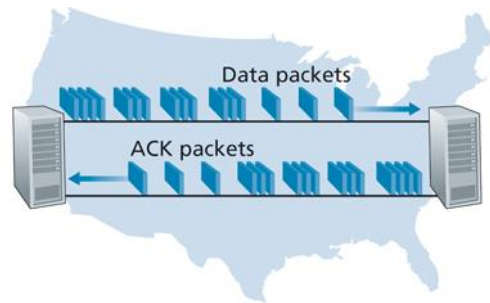
b. A pipelined protocol in operation

P22. Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time t, the next in-order packet that the receiver is expecting has a sequence number of k. Assume that the medium does not reorder messages. Answer the following questions:

    a. What are the possible sets of sequence numbers inside the sender's window at time t? Justify your answer.

    b. What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time t? Justify your answer.

P24. Answer true or false to the following questions and briefly justify your answer:

    a. With the SR protocol, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

    b. With GBN, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

    c. The alternating-bit protocol is the same as the SR protocol with a sender and receiver window size of 1.

    d. The alternating-bit protocol is the same as the GBN protocol with a sender and receiver window size of 1.

You also need to do the following problem:

Suppose that a Go-Back-N protocol is used, where 3 bits are used for the sequence number. Show, by an example, that a window size W=8 will not work.