Homework(1)

- **1.** In both parts of Fig. 6-6, there is a comment that the value of SERVERPORT must be the same in both client and server. Why is this so important?

- **2.** Imagine that a two-way handshake rather than a three-way handshake were used to set up connections. In other words, the third message was not required. Are deadlocks now possible? Give an example or show that none exist.

- **3.** Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets?

Homework(2)

- **4.** A client sends a 128-byte request to a server located 100 km away over a 1-gigabit optical fiber. What is the efficiency of the line during the remote procedure call?

- **5.** Datagram fragmentation and reassembly are handled by IP and are invisible to TCP. Does this mean that TCP does not have to worry about data arriving in the wrong order?

- **6.** The maximum payload of a TCP segment is 65,495 bytes. Why was such a strange number chosen?

Homework(3)

- **7.** If the TCP round-trip time, RTT, is currently 30 msec and the following acknowledgements come in after 26, 32, and 24 msec, respectively, what is the new RTT estimate using the Jacobson algorithm? Use $\alpha=0.9$.

- **8.** To get around the problem of sequence numbers wrapping around while old packets still exist, one could use 64-bit sequence numbers. However, theoretically, an optical fiber can run at 75 Tbps. What maximum packet lifetime is required to make sure that future 75-Tbps networks do not have wrap around problems even with 64-bit sequence numbers? Assume that each byte has its own sequence number, as TCP does.

- **9.** Consider that only a single TCP (Reno) connection uses one 10Mbps link which does not buffer any data. Suppose that this link is the only congested link between the sending and receiving hosts. Assume that the TCP sender has a huge file to send to the receiver, and the receiver's receive buffer is much larger than the congestion window. We also make the following assumptions: each TCP segment size is 1,500 bytes; the two-way propagation delay of this connection is 150 msec; and this TCP connection is always in congestion avoidance phase, that is, ignore slow start.
  - **a.** What is the maximum window size (in segments) that this TCP connection can achieve?
  - **b.** What is the average window size (in segments) and average throughput (in bps) of this TCP connection?
  - **c.** How long would it take for this TCP connection to reach its maximum window again after recovering from a packet loss?