Homework for Chapter 6

1. In our example transport primitives of Fig. 6-2, LISTEN is a blocking call. Is this strictly necessary? If not, explain how a nonblocking primitive could be used. What advantage would this have over the scheme described in the text?
2. Suppose that the clock-driven scheme for generating initial sequence numbers is used with a 15 bit wide clock counter. The clock ticks once every 100 msec, and the maximum packet lifetime is 60 sec. How often need resynchronization take place
   a. in the worst case?
   b. when the data consumes 240 sequence numbers/min?
3. Why does the maximum packet lifetime, T, have to be large enough to ensure that not only the packet but also its acknowledgements have vanished?
4. Consider a connection-oriented transport-layer protocol that uses a time-of-day clock to determine packet sequence numbers. The clock uses a 10 bit counter, and ticks once every 125 msec. The maximum packet lifetime is 64 sec. If the sender sends 4 packets per second, how long could the connection last without entering the forbidden region?
5. Discuss the advantages and disadvantages of credits versus sliding window protocols.
6. Two hosts simultaneously send data through a network with a capacity of 1 Mbps. Host *A* uses UDP and transmits a 100 bytes packet every 1 msec. Host *B* generates data with a rate of 600 kbps and uses TCP. Which host will obtain higher throughput?
7. Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets?
8. 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?
9. Consider the situation of the previous problem again. Compute the minimum possible response time both for the given 1 Gbps line and for a 1 Mbps line. What conclusion can you draw?
10. 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?
11. In Fig. 6-36, we saw that in addition to the 32 bit acknowledgement field, there is an ACK bit in the fourth word. Does this really add anything? Why or why not?
12. Consider a connection that uses TCP Reno. The connection has an initial congestion window size of 1 KB, and an initial threshold of 64. Assume that additive increase uses a step-size of 1 KB. What is the size of the congestion window in transmission round 8, if the first transmission round is number 0?
13. In a network whose max segment is 128 bytes, max segment lifetime is 30 sec, and has 8 bit sequence numbers, what is the maximum data rate per connection?
14. 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 wraparound problems even with 64 bit sequence numbers? Assume that each byte has its own sequence number, as TCP does.
15. Calculate the bandwidth-delay product for the following networks:
    (1) T1 (1.5 Mbps),
    (2) Ethernet (10 Mbps),
    (3) T3 (45 Mbps), and
    (4) STS-3 (155 Mbps).

    Assume an RTT of 100 msec. Recall that a TCP header has 16 bits reserved for Window Size. What are its implications in light of your calculations?