Transport Layer and TCP

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

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

3. *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?*

4. *Both UDP and TCP use port numbers to identify the destination entity when delivering a message. Give two reasons for why these protocols invented a new abstract ID (port number), instead of using process IDs, which already existed when these protocols were designed.*

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

6. *Consider the effect of using slow start on a line with a 10-msec round-trip time and no congestion. The receive window is 24 KB and the maximum segment size is 2KB. How long does it take before the first full window can be sent?*

7. *Suppose that the TCP congestion window is set to 18 KB and a timeout occurs. How big will the window be if the next four transmission bursts are all successful? Assume that the maximum segment size is 1 KB.*

8. *A TCP machine is sending windows of 65,535 bytes over a 1-Gbps channel that has a 10-msec one-way delay. What is the maximum throughput achievable? What is the line efficiency?*

9. *What is the fastest line speed at which a host can blast out 1500-byte TCP payloads with a 120-sec maximum packet lifetime without having the sequence numbers wrap around? Take TCP, IP, and Ethernet overhead into consideration. Assume that Ethernet frames may be sent continuously.*

10. *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.*

11. *Calculate the bandwidth-delay product for the following networks: (1) T1 (1.5 Mbps), (2) Ethernet (10Mbps), (3) T3 (45 Mbps), and (4) STS-3 (155 Mbps). Assume an RTT of 100 msec. Recall a TCP header has 16 bits reserved for Window Size. What are its implications in light of your calculations?*

12. *What is the bandwidth-delay product for a 50-Mbps channel on a geostationary satellite? If the packets are all 1500 bytes (including overhead), how big should the window be in packets?*