1. Consider a network path with a 100ms round-trip time and a 100Mbps bottleneck link between two hosts, A and B. At time t1, host A connects to host B using TCP (including its connection management and congestion control protocols) and then sends 60Kbytes of data to it, sending the last byte of data at time t2. Assume the packet size available for carrying data is 1500bytes, there are no packet losses and there is sufficient buffering at the receiver. What is the average data throughput delivered between times t1 and t2?

2. Consider a reliable data transfer protocol that uses only negative acknowledgements (i.e. messages from the receiver indicating that particular data was not received). 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?

3. TCP’s fast retransmit mechanism resends a packet after receiving three duplicate acknowledgements from the receiver. Why do you think the designers of TCP didn’t resend a packet after receiving a single duplicate acknowledgement? What were they worried about?

4. Explain why TCP excludes retransmitted packets when estimating the round-trip time. Give an example the demonstrates the problem with using these packets for RTT estimation.