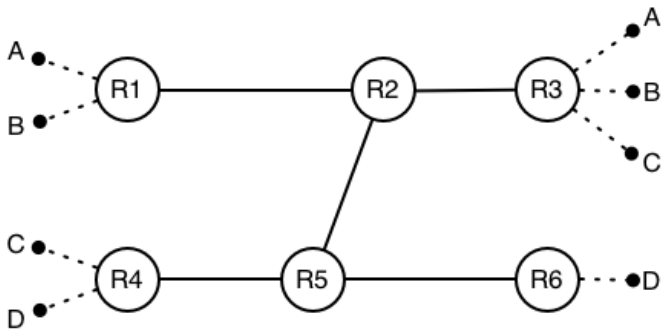
1. What window size W (expressed in packets) is required to fully utilize the network capacity under the following parameter settings? Packet size is 1250 bytes (10 Kbits), round trip time is 200 ms, and bandwidth of the network path is 10 Mbps.
2. Let a TCP sender send packets with 1000 bytes of data payload per packet, and let the receiver use the cumulative ACK scheme to acknowledge received packets. Consider the following scenario where the sender has sent packets with the following sequence numbers: 5000, 6000, 7000, and 8000. Assume that all packets are received. If the receiver were to send an ACK packet after receiving the packet with sequence number 8000, what is the acknowledgement number sent with this packet?
3. Consider the same setting as the previous question with the sender having sent packets with the following sequence numbers: 5000, 6000, 7000, and 8000. Assume that the third packet with sequence number 7000 is lost, but the other three packets are delivered. If the receiver were to send an ACK packet after receiving the packet with sequence number 8000, what is the acknowledgement number sent with this packet?
4. Consider the network topology shown in the figure with four flows (A, B, C, and D), which flow from left to right (i.e., A flows from R1 on the left to R3 on the right, B flows from R1 on the left to R3 on the right, C flows from R4 on the left to R3 on the right, etc.). Assume that all links have unit capacity. If the flows are allocated based on max-min fair allocation, what is the link utilization of the link R5-R6?



5. Consider the effect of using slow start on a network path with a 10 millisecs round trip time and no congestion (i.e., assume there is no packet loss). Assume that the flow is able to inject back-to-back packets with very little delay and that the bottleneck link introduces minimal separation between packets as it transmits them. If the flow starts out by sending one packet at time t=0, how many packets are sent between time t=30 ms and t=40 ms?
6. Consider a TCP flow over a 10 millisecs round trip time path. Assume that it is in the Additive Increase phase of transmission and also assume that it transmitted 10 packets between time t=100ms and t=110ms. What is the expected number of packets the flow would transmit between t=120ms and t=130ms assuming that there was no packet loss during this Additive Increase phase?
7. Consider the following sequence of ACK packets from a receiver: ACK packet #1 with ack number 3000, ACK packet #2 with ack number 4000, ACK packet #3 with ack number 5000, ACK packet #4 with ack number 5000, ACK packet #5 with ack number 5000, ACK packet #6 with ack number 5000, and ACK packet #7 with ack number 5000. Assume that the sender employs Fast Retransmit. Which packet is retransmitted by the sender and when is it retransmitted?
8. Which one of the following statements about TCP is true?
9. multiple applications on a given machine cannot open the same port on that machine
10. TCP data could be delivered out of order to the application
11. if the sender does not receive an acknowledgement for a packet, then the packet was lost
12. multiple senders cannot send messages to the same TCP port at a given destination