

Week 1. Tutorial Problems

R11-extended. Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R_1 and R_2 , respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L ? (Ignore queuing, propagation delay, and processing delay.)

- Now assume packet length $L=1500$ byte, $R_1=1\text{Mbps}$, $R_2=2\text{Mbps}$, calculate the end-to-end Delay.
- Now assume packet length $L=1200$ byte, $R_1=3\text{Mbps}$, $R_2=2\text{Mbps}$, calculate the end-to-end Delay.

P2. Equation 1.1

$$d_{\text{end-to-end}} = N \frac{L}{R} \quad (1.1)$$

gives a formula for the end-to-end delay of sending one packet of length L over N links of transmission rate R . Generalize this formula for sending P such packets back-to-back over the N links.

P3. Consider an application that transmits data at a steady rate (for example, the sender generates an N -bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time.

Answer the following questions, briefly justifying your answer:

- Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
- Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Further-more, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

P8. Suppose users share a 10 Mbps link. Also suppose each user requires 200 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of packet switching versus circuit switching in Section 1.3.)

- When circuit switching is used, how many users can be supported?
- For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.
- (optional) Suppose there are 60 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)