Homework assignment 1, CIS 427, Fall 2022

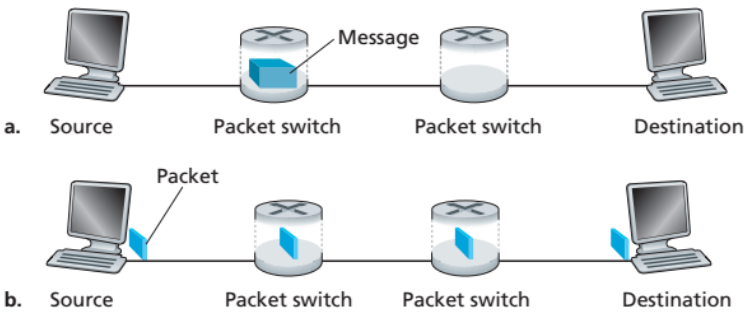
Submission Due: 11:59 PM, 9/22/2022.

Note we assume 1K = 1000, 1M = 1,000,000, 1G = 1,000,000,000, 1Byte = 8 bits

1. (15 points total, 5 points each.)
   This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.
   a. Express the propagation delay, d_{prop}, in terms of m and s.
   b. Determine the transmission time of the packet, d_{trans}, in terms of $L$and R.
   c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

2. (30 points total, a=b=5points, c=d=10 points)
   Suppose users share a 5 Mbps link. Also suppose each user requires 250 kbps when transmitting, but each user transmits only 10 percent of the time.
   a. When circuit switching is used, how many users can be supported?
   b. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.
   c. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously
   d. Find the probability that there are 21 or more users transmitting simultaneously. . (*no results needed! You will receive full credit for the correct equation)*

3. (30 points total, 6 points each.)
   In modern packet-switched networks, including the Internet, the source host segments long, application-layer messages (for example, an image or a music file) into smaller packets and sends the packets into the network. The receiver then reassembles the packets back into the original message. We refer to this process as *message segmentation*. Figure 1 illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is $8 \cdot 10^6$ bits long that is to be sent from source to destination in Figure 1. Suppose each link in the figure is 2 Mbps. Ignore propagation, queuing, and processing delays.



   a. Consider sending the message from source to destination *without* message segmentation. How long does it take to move the message from the source host to the first packet switch? Keeping in mind that each

switch uses store-and-forward packet switching, what is the total time to move the message from source host to destination host?

b. Now suppose that the message is segmented into 800 packets, with each packet being 10,000 bits long. How long does it take to move the first packet from source host to the first switch? When the first packet is being sent from the first switch to the second switch, the second packet is being sent from the source host to the first switch. At what time will the second packet be fully received at the first switch?

c. How long does it take to move the file from source host to destination host when message segmentation is used? Compare this result with your answer in part (a) and comment.

d. In addition to reducing delay, what are reasons to use message segmentation?

e. Discuss the drawbacks of message segmentation.

4. (25 points total, 10 for client-server, 10 for P2P, and 5 for observation)

Consider distributing a file of F=15 Gbits to N peers. The server has an upload rate of 30 Mbps, and each peer *i* has a download rate of *d_i* = 2 Mbps and an upload rate of u. For N = 10, 100, and 1,000 and u = 300 Kbps, 700 Kbps, and 2 Mbps, prepare a table of the minimum distribution time for each of the combinations of N and u for both client-server distribution and P2P distribution. Explain what you observe from the table.