ECE 358: Tutorial Set 1

Problems with a "*" will be solved in the tutorial sessions

Problem 2*. Consider two hosts A and B connected via n hops ($n \geq 2$):

$$A \leftrightarrow R_1 \leftrightarrow R_2 \leftrightarrow \ldots \leftrightarrow R_{n-1} \leftrightarrow B$$

That is, $R_1, \ldots, R_{n-1}$ are routers, and A is connected to R_1 by a point-to-point link, R_1 is connected to R_2 by a point-to-point link, and so on. Assume all links have the same capacity C (in bps). Also assume the propagation delay of the links to be negligible and that no packets from other hosts exist on the path from A to B (this is a very unrealistic assumption). Consider a file of size *S* (in bits) to be transmitted from A to B.

a) How much time does it take to transmit a packet of size L from A to B?
b) The optimal way to break up the file into packets, in order to minimize the total delay, is to divide it into a number of equal-sized packets (believe us!). How many packets is optimum? (Notice that when the packet is split into smaller packets, separate headers/trailers are added to each of the smaller packets. Assume the size of headers/trailers to be H for packets of any size.) Comment.

Problem 5*. Suppose users share a 2-Mbps link. Also suppose each user requires 300 Kbps when transmitting, but each user only transmits 12 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 M users. Find the probability that at any given time, n users are transmitting simultaneously.
d. Find the probability that there are 7 or more users transmitting simultaneously.
e. Assume M=10. Find the probability that there are 7 or more users transmitting simultaneously.
f. What would be a "reasonable" value for M?

Problem 6*: Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps.
a. Assuming no other traffic in the network, what is the throughput for the file transfer. Try the following 3 cases: a "fluid" (water-like) case, a message switching case and a packet switching case.
b. Suppose the file is 4 million bytes. Roughly, how long will it take to transfer the file to Host B for each of these 3 cases?

The following problems were taken from an earlier version of the textbook.

R15*: Suppose users share a 2 Mbps link. Also suppose each user transmits continuously at 1 Mbps when transmitting, but each user transmits only 20 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. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?
c. Find the probability that a given user is transmitting.
d. Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously. Find the fraction of time during which the queue grows.

P12*: Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queuing delay for the N packets?

P20*: Consider problem Pl8 but now with a link of R = 1 Gbps.
a. Calculate the bandwidth-delay product, $R.d_{prop}$.
b. Consider sending a file of 400,000 bits from Host A to Host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that will be in the link at any given time?
c. What is the width (in meters) of a bit in the link?