ELEC 3120: Computer Communication Networks

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Homework 1
Due: October 03 (Monday) 9:00 a.m.
Full marks: 60

Notes:

1) This assignment contains five problems, each with several parts. Answer them as clearly and concisely as possible and show how you obtain the answers. Solely giving the final numerical result without showing the procedure on how it is obtained will lead to a deduction of most of your points in the corresponding problem even if the numerical result is correct.
2) You may discuss ideas with others in the class, but your solutions and presentations must be your own. Do not look at anyone else's solutions or copy them from anywhere.
3) Please upload a scanned copy of your solutions to the Canvas System on the due date. No late submission will be accepted.

P1. (14 pts.) Consider two hosts, A and B, connected by a single link of rate R. 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. (2pts)

b. Determine the transmission time of the packet, d_{trans}, in terms of L and R. (2pts)

c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay. (2pts)

d. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet? (2pts)

e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet? (2pts)

f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet? (2pts)

g. Suppose $s = 2.5\times10^8$, $L = 60$ bits, and $R = 65$ kbps. Find the distance m so that d_{prop} equals d_{trans}. (2pts)

P2. (12 pts.) Suppose users share a 4.5 Mbps link. Also suppose each user requires 250 kbps when transmitting, but each user transmits only 15 percent of the time. (See the discussion of packet switching versus circuit switching.)

a. When circuit switching is used, how many users can be supported? (2pts)

b. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting. (2pts)

c. Suppose there are 200 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.) (4pts)

d. Find the probability that there are 25 or more users transmitting simultaneously. (4pts)

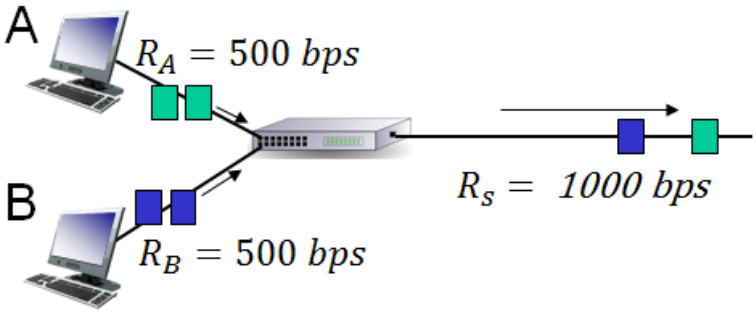
P3. (10 pts.) (a) Suppose *10* packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length *50bits*, and the link has transmission rate *5Mbps*. What is the average queuing delay for the *10* packets? (5pts) (b) Now suppose that *10* such packets arrive to the link every 10^{-4}seconds. What is the average queuing delay of a packet? (5pts)

P4. (10 pts.) Consider the scenario illustrated as following. Assume R_s is 20 Mbps, R_c is 10 Mbps, and the server is continuously sending traffic to the client.

a. Assuming the router between the server and the client can buffer at most four messages. After how many messages sent by the server will packet loss starts occurring at the router? (4pts)

b. Generalizing that the router can buffer *m* messages. After how many messages sent by the server will packet loss starts occurring at the router? (6pts)

P5. (14 pts.) Consider users A and B who share a link with rate of R_S=1000bps to send their data. Both users generate two consecutive packets of L=1000 bits length and these packets arrive at the switch through two dedicated links of each 500bps rate. Please answer the following questions.



a. Assume that user B sends its first packet ε seconds after user A sends its first packet. What is the average queuing delay at the switch (i.e., average queueing delay of the 6 packets at the switch and ε is a very small positive value)? (6pts)

b. Now, assume that user B sends its first packet 1 second after user A sends its first packet. What is the average queuing delay at the switch? (4pts)

c. Please compare parts (a) and (b) in terms of the average queuing delay at the switch and traffic intensity in the switch. Also, explain the reasons for the difference in the results of part (a) and (b) if any. (4pts)