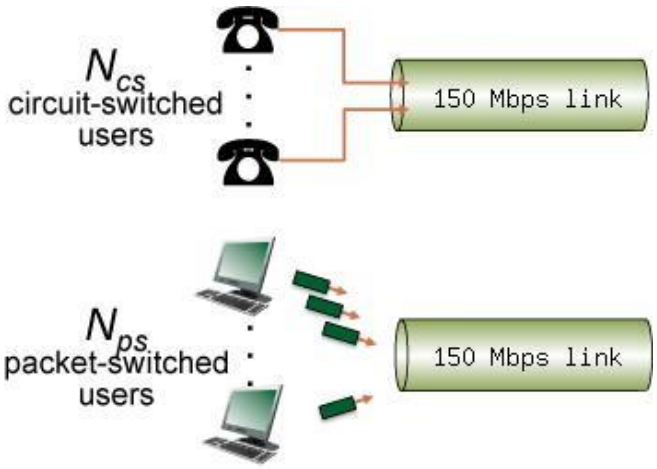
1. Consider the two scenarios below:

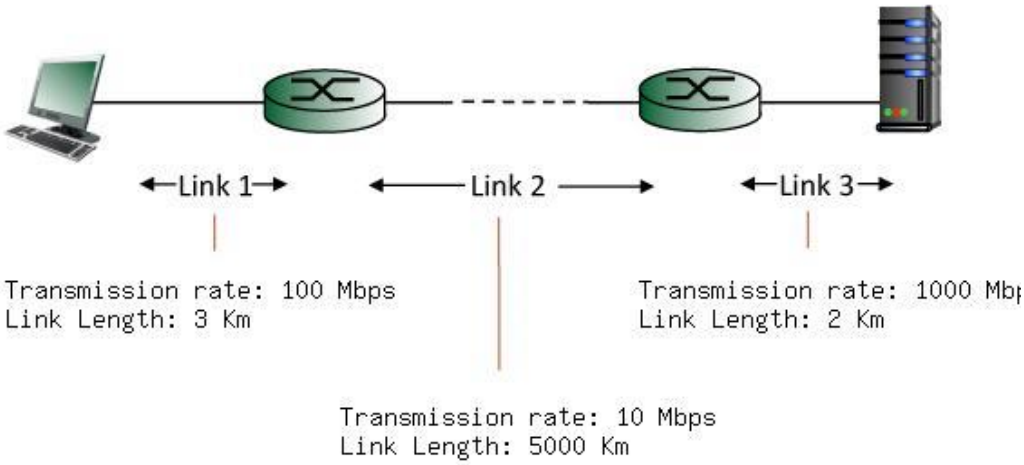
   - A circuit-switching scenario in which N_{cs} users, each requiring a bandwidth of 10 Mbps, must share a link of capacity 150 Mbps.
   - A packet-switching scenario with N_{ps} users sharing a 150 Mbps link, where each user again requires 10 Mbps when transmitting, but only needs to transmit 10 percent of the time.



Answer the following questions:

a. When circuit switching is used, what is the maximum number of circuit-switched users that can be supported? Explain your answer.
b. For the remainder of this problem, suppose packet switching is used. Suppose there are 29 packet-switching users (i.e., N_{ps} = 29). Can this many users be supported under circuit-switching? Explain.
c. What is the probability that a given (*specific*) user is transmitting, and the remaining users are not transmitting?
d. What is the probability that one user (*any* one among the 29 users) is transmitting, and the remaining users are not transmitting? When one user is transmitting, what fraction of the link capacity will be used by this user?
e. What is the probability that any 15 users (of the total 29 users) are transmitting and the remaining users are not transmitting? (Hint: you will need to use the binomial distribution).
f. What is the probability that *more* than 15 users are transmitting? Comment on what this implies about the number of users supportable under circuit switching and packet switching.

2. Consider the figure below, with three links, each with the specified transmission rate and link length.



Find the end-to-end delay (including the transmission delays and propagation delays on each of the three links, but ignoring queuing delays and processing delays) from when the left host begins transmitting the first bit of a packet to the time when the last bit of that packet is received at the server on the right. The speed of light propagation delay on each link is 3x10**8 m/sec. Note that the transmission rates are in Mbps and the link distances are in Km. Assume a packet length of **8000** bits. Give your answer in milliseconds.

3. Complete the Wireshark "Getting Started" Lab exercise found on the K&R Companion Website. The goal of this first lab is primarily to introduce you to Wireshark. Answer the following questions to demonstrate that you've been able to get Wireshark up and running, and have explored some of its capabilities.

a. What are 3 different protocols that appear in the protocol column in the unfiltered packet-listing window in step 7 of the exercise?
b. How long did it take from when the HTTP GET message was sent until the HTTP OK reply was received? (By default, the value of the Time column in the packet listing window is the amount of time, in seconds, since Wireshark tracing began. To display the Time field in time-of-day format, select the Wireshark View pull-down menu, then select Time Display Format, then select Time-of-day.)
c. What is the Internet address of the gaia.cs.umass.edu (also known as wwwnet.cs.umass.edu)? What is the Internet address of your computer?