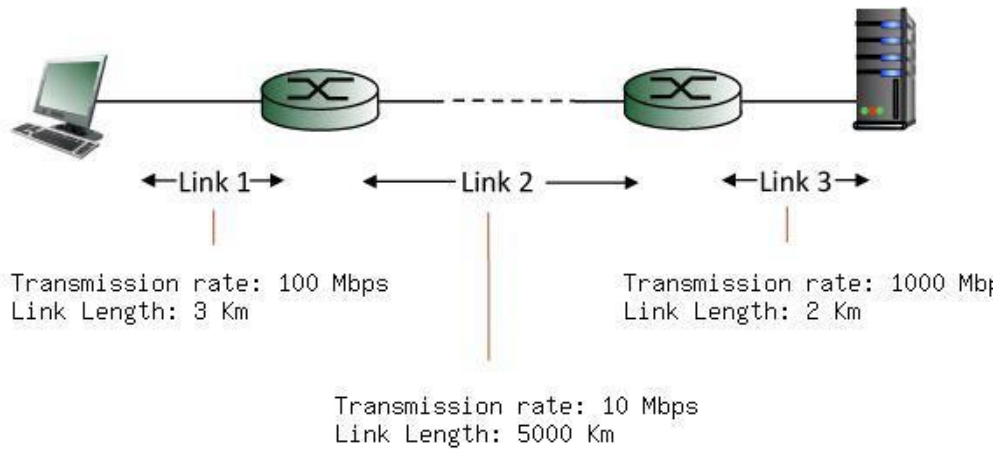# Homework 1

Due: Tuesday 11:59 PM, September 19,2023

1. (15 points) Consider a packet switching architecture.

   a. List and briefly describe the four main components of delay.
   b. Concisely describe the difference between transmission and propagation delay.
   c. How would the propagation delay be affected if the length of the packet is increased?

2. (10 points) Suppose we have an application that transmits data continuously at a steady rate (e.g., N-bits are sent every T time units, where T is small and fixed) for a long time.

   a. Which network type would be more appropriate for this application: circuit-switched or packet-switched? Justify your answer.
   b. Now, consider a circuit-switched network that has a 150 Mbps link capacity where each user requires a bandwidth of 10 Mbps when transmitting, but are only active 10 percent of the time. What is the maximum number of users that can be supported? Justify your answer.

3. (15 points) Consider a packet-switched network that has a 150 Mbps link capacity where each user requires a bandwidth of 10 Mbps when transmitting but are only active 10 percent of the time. Also, assume that there are 29 packet switching users.

   a. Calculate the probability that exactly one user (i.e., any one of the 29 users) is transmitting at a given time, while the remaining are not. Using binomial distribution, show the formula for the calculation and the final result to 6 decimal places. Note that it may be easier to write a program to find the final value.
   b. Now, calculate the summative probability that any up to 15 of the 29 users (i.e., 0, 1, 2, 3, …, 14, or 15 users) are transmitting at the same time, while the remaining users are not. Using binomial distribution, show the formula for the calculation and the final result to 6 decimal places. Note that it may be easier to write a program to find the final value.
   c. What is the probability to 6 decimal places that more than 15 of the 29 users are transmitting at the same time? What does this mean about the number of users supported under packet switching versus circuit switching for this scenario?

4. (25 points) Consider the following network:

Transmission rate: 100 Mbps
Link Length: 3 Km

Transmission rate: 10 Mbps
Link Length: 5000 Km

Transmission rate: 1000 Mbp
Link Length: 2 Km

You may assume a packet length of 8000 bits and ignore queueing and processing delays. Use a propagation speed of 3×10^8 m/sec in the following calculations.

   a. Calculate the transmission and propagation delays on Link 1.
   b. Calculate the transmission and propagation delays on Link 2.
   c. Calculate the transmission and propagation delays on Link 3.
   d. Assuming the processing and queueing delays are negligible (i.e., 0), calculate the end-to-end delay from the left host (when begin transmitting first bit of a packet) to the right host (when the last bit of that packet is received).
   e. For Link 1, determine the distance at which the transmission delay d_{trans} equals the propagation delay d_{prop}.

5. (15 points) Consider the following circuit-switched network where there are 4 links available between each router:
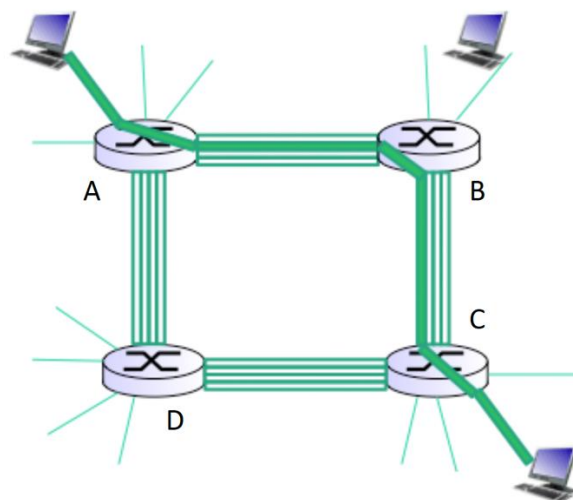
    a. Determine the maximum number of simultaneous connections supported at any one time in this network.

    b. Suppose that users at the A router want to connect to end users at the C router. Determine the maximum number of simultaneous connections supported at any one time in this network for this scenario.

    c. Now, suppose that we have 4 users at the A router wanting to connect to end users at the C router and 4 users at the B router wanting to connect to end users at the D router. Is it possible to simultaneously make these 8 connections in this network? Justify your answer.

6. (5 points) Suppose that you have 200 terabytes (note that bytes, not bits, are used here) of data on a drive that you need delivered within 24 hours, but preferably faster. If your company has a dedicated 10 Gbps link available to transfer this data, would it be better to use FedEx overnight delivery (will be delivered in 24 hours, but no earlier) or transmit the data on your dedicated link if these are your only options? Show calculations to justify your answer.

7. (10 points) Networked systems are organized into protocol layers.

    a. Briefly identify and describe two advantages of protocol layers.

    b. Briefly identify and describe two disadvantages of protocol layers

8. (5 points) Suppose that you have a multiplexer (mux) with 5 different inputs at the following bit-rates: (A) 20 Kbps, (B) 8 Kbps, (C) 12 Kbps, (D) 8 Kbps, and (E) 4 Kbps. Using a fixed slot size in the frame, how would you organize a single asynchronous TDM link receiving the output of the mux? That is, how many time slots are needed? Draw a diagram of a single frame, labeling each slot appropriately.

Submission guideline: You will include your student ID, name, section and course code in your submission file. Name your submission file as CSC138-HW1. Submit your work with legible handwriting for handwritten copies. You can submit handwritten or digital version of assignment as per your choice. You are required to submit a PDF file on your submission window.