Spring 2021 - ECE 1150

Assignment 1

Question 1:

a) Suppose an application where many users need to send data with relatively large rate for a short duration, but each will send with a relatively low probability. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Justify your answer

b) Consider an application that transmits data at a constant rate (for example, the sender generates an N-bit unit of data every k time units, where k is fixed). Also, when such an application starts, it will continue running for a relatively long period of time.
Would a packet-switched network or a circuit-switched network be more appropriate for this application? Justify your answer

Question 2:

a) Briefly describe different network topologies and point out a limitation of each.

b) Classify a network based on the direction of communications and point out the main differences between each category

c) How can you classify a network based on the geographical coverage?

Question 3: Assume that there are 3 hops between two devices, A and B. The processing delay of interconnecting devices is 5µsec. All links have a speed of 1Mbits/second. Signal propagates in the link with the speed of light ($3x10^8$ m/sec), and the length of each link is 1 km. With packet switched networking, the packet size is 1050Bytes, which includes 50 Bytes header (i.e., payload is [1050-50] Bytes). There are 10 packets that need to be transmitted from A to B.

(a) What is the total delay for A to send the 10 packets to B using packet switching?
(b) What is the throughput of packet switching? What is the efficiency?
(c) Assume the same amount of information bits need to be transmitted over a circuit switching network. Let the total time needed for both setting up and terminating the connection be 70 µsec. What is the total delay in this case?
(d) What is the throughput of a circuit switching network? What is the efficiency? Compare the results to (b) and comment on your answer.

Question 4:

An image is 800 × 600 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 56-kbps modem channel? Over a 1-Mbps cable modem? Over a 10-Mbps Ethernet? Over 100-Mbps Ethernet? Over gigabit Ethernet?

Question 5:

Suppose users share a 3 Mbps link. Also suppose each user requires 150 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 at a time?

b. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (Hint: Use the binomial distribution.)

Use any software (e.g. Matlab) to plot the probability for different values of n. (e.g. n =10, 20, 30, 40,….120).

Comment on your result.

Question 6:

In a user application, a packet of size 240 bytes is sent to a server, then the server responds with a packet of size 10 bytes. Assume that the number of hops in the path between client and server is two. Ignore processing delays and let the one-way end-to-end propagation delay (i.e. total propagation delay over the path from source to destination) be 2µsec. For a good user experience, the application can tolerate a maximum delay of 10 msec from the time the user starts sending the packet until the user receivers the entire response from the server. All links have the same bit rate.

(a) What is the minimum bit rate?

(b) Assume that the server waits on average of 5msec before it responds to a user. What is the minimum bit rate in this case?

(c) If the user could purchase data service of 56Kbps (dialup modem), 256 kbps (entry level DSL) or 1Mbps (premium DSL). Which technology would support this application? Discuss.

Question 7 (Simple hands-On exercise)

In this exercise, you will trace and observe the route of the packets on a network, when connecting to website www.pitt.edu. You can use the command "traceroute" on a Terminal (on MAC OSX)/cmd (on windows) to observe the route of your request.

Traceroute sends three probe packets to all routers from the source (your computer) to the destinations (www.pitt.edu), and shows you the number of hops in the path, the IP address of each router along the multi-hop path and the delay encountered by three probe packets at each hop. Follow the following steps:

- Firstly, open the terminal on your system.
    - For a Windows system, you can do Start → Run and type cmd in the dialog.
    - For MAC users, you can do a Spotlight Search for Terminal or you can go to Applications - Utilities - Terminal.
- In the terminal, type traceroute(MAC)/ tracert(windows) www.pitt.edu.

a) Please attach a screenshot of the results you obtained from terminal or cmd window.

b) What are the number of hops from your device to the destination (www.pitt.edu)?