

Assignment 1

ECE1150 - Introduction to Computer Networks

University of Pittsburgh

(100 points)

1. (5 points) Briefly explain the composition of the typical wired network, explaining which topology is adopted for which kind of network structure?
2. (a) (8 points) Briefly describe different network topologies and point out a limitation of each.
(b) (4 points) How can you classify a network based on the geographical coverage? Explain.
3. (a) (5 points) 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) (5 points) 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.
4. (a) (8 points) Briefly explain the advantages and disadvantages of packet switching as opposed to circuit switching?
(b) (2 points) What is the information contained in a packet?
5. (25 points) Assume that there are 5 hops between two devices, A and B. The processing delay of interconnecting devices is 10 μ sec. All links have a speed of 1 Mbits/second. Signal propagates in the link with the speed of light (3×10^8 m/sec), and the length of each link is 3 km. With packet switched networking, the packet size is 1100 Bytes, which includes 100 Bytes header (i.e., payload is $1100 - 100 = 1000$ Bytes). There are 8 packets that need to be transmitted from A to B. Answer the following questions showing your calculations with the equations.
(a) (8 points) What is the total delay for A to send the 8 packets to B using packet switching?
(b) (4 points) What is the throughput of packet switching? What is the efficiency?
(c) (8 points) Assume same amount of information bits needs to be transmitted over a circuit switching network. Let the total time needed for both setting up and terminating the connection be 100 μ sec. What is the total delay in this case?
(d) (5 points) What is the throughput of a circuit switching network? What is the efficiency? Compare the results to (b) and comment on your answer.

6. (7 points) An image is 2000×1000 pixels with 5 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 100 Kbps modem channel? Over a 1 Mbps cable modem? Over a 10-Mbps Ethernet? Over 100-Mbps Ethernet? Over gigabit Ethernet?
7. (10 points) Suppose users share a 5 Mbps link. Also suppose each user requires 200 Kbps when transmitting, but each user transmits only 10 percent of the time.
 - (a) (2 points) When circuit switching is used, how many users can be supported at a time?
 - (b) (8 points) Suppose there are 80 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. $n = 10, 20, 30, 40, \dots, 80$). Comment on your result.
8. (14 points) In a user application, a packet of size 500 bytes is sent to a server, then the server responds with a packet of size 100 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 4 μ sec. 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 receives the entire response from the server. All links have the same bit rate.
 - (a) (6 points) What is the minimum bit rate?
 - (b) (6 points) Assume that the server waits for 5 msec on average before it responds to a user. What is the minimum bit rate in this case?
 - (c) (2 points) If the user could purchase data service of 56 Kbps (dialup modem), 256 Kbps (entry level DSL) or 2 Mbps (premium DSL), which technology would support this application? Discuss.
9. (7 points) **Hands-On Exercise for all the students**

In this exercise, you will trace and observe the route of the packets on a network, when connecting to website www.google.com. You can use the command “tracert” on a Terminal (on MAC OSX) or 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 destination (www.google.com), 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 below steps:

 - First, 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 (without the quotes) “tracert www.google.com” (for MAC) or “tracert www.google.com” (for Windows). From the observations:
 - (a) (5 points) Attach a screenshot of the results you obtained from terminal or cmd.
 - (b) (2 points) What are the number of hops from your device to the destination (www.google.com)?