ECE/CSC570: Computer Networks
Spring 2020

Prof. Shih-Chun Lin

Homework 1

Due: 11:59pm, Monday, January 27, 2020

You are strongly encouraged to read Chapter 1 of our references (Tanenbaum and/or Kurose &Ross, either of them is ok) and revisit lecture notes and the Class Exercises. Then, solve the following problems.

1. Conceptual Question (15 points)

Which of the OSI layers or sub-layers (if appropriate) handle each of the following:

a. Providing reliable, connection-oriented path between source and destination. (5 points)
b. Determining alternate route for packets when the original route gets congested, e.g., routers on that path are dead. (5 points)
c. Determining which user 'owns' the wireless channel to the access point in 802.11b. (5 points)

2. Network Latency (20 points)

a. A factor in the delay of a store-and-forward packet-switching system is how long it takes to store and forward a packet through a switch. If switching time is 10 μsec, is this likely to be a major factor in the response of a client-server system where the client is in New York and the server is in California? Assume the propagation speed in copper and fiber to be 2/3 the speed of light in vacuum. (10 points)
b. A client-server system uses a satellite network, with the satellite at a height of 40,000 km. What is the best-case delay in response to a request? (10 points)

3. Network Protocol Stack (10 points)

What are two reasons for using layered protocols? What is one possible disadvantage of using layered protocols?

4. Network Metric Calculation (10 points)

A system has an *n*-layer protocol hierarchy. Applications generate messages of length *M* bytes. At each of the layers, an *h*-byte header is added. What fraction of the network bandwidth is filled with headers? (Express the answer by using the given parameters)

5. Network Topology (10 points)

Five routers are to be connected in a point-to-point subnet. Between each pair of routers, the designers may put a high-speed line, a medium-speed line, a low-speed line, or no line. If it takes 100 ms of computer time to generate and inspect each topology, how long will it take to inspect all of them?

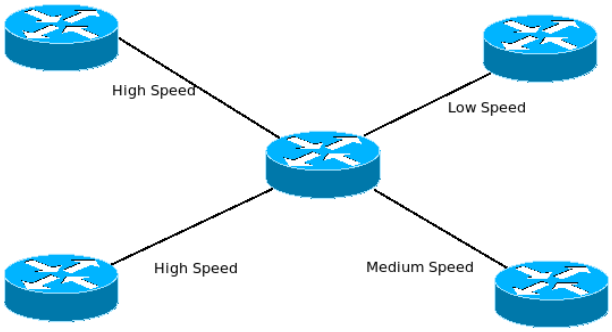

Figure 1: One of possible topologies.

6. Circuit & Packet Switching (15 points)

Consider the example in "Packet vs. Circuit Switching" slide with the following variation. Each user, when active, needs 400 Kbps bandwidth. There are total 30 such users wanting to get connected, where each user will be active with probability 0.2, all going through a link of 6 Mbps.

a. Under circuit switching, up to how many users can be supported on this link? (5 points)

b. Under packet switching, **write down** the probability that there are *k* active users out of 30. What is the average number of active users? What is the probability that the link is overloaded, i.e., when the link cannot support the bandwidth requirement of all active users? (10 points)
(Just write down the mathematical expression. You don't need to compute the exact number.)
Hint: Use binomial distribution.

7. Network Testing Tools (20 points)

a. The *ping* program allows you to send a test packet to a given location and see how long it takes to get there and back. Try using *ping* to see how long it takes to get from your location to several known locations. From these data, **plot the one-way transit time over the Internet as a function of distance.** You need to provide the results for **5 different Web sites**.
It is best to use universities since the location of their servers is known very accurately. For example, *berkeley.edu* is in Berkeley, California; *mit.edu* is in Cambridge, Massachusetts; *vu.nl* is in Amsterdam; The Netherlands; *www.usyd.edu.au* is in Sydney, Australia; and *www.uct.ac.za* is in Cape Town, South Africa. (10 points)

b. Perform a traceroute, *tracert* program, to a destination in the US. **Find** the number of Internet Service Providers (ISPs) between the source and destination and **name** the ISPs. **Repeat** the exercise for a destination in a different continent, e.g., Asia, Europe, Africa, Australia. Show the output **of both traceroutes**. (10 points)