CS/ECE 438: Communication Networks for Computers Spring 2018
Problem Set 1 Due: start of class, Wednesday, Jan 31st

Network Overview, Physical Layer, Basic Probability and Network Utilities

Assigned reading: Peterson and Davie: Chapter 1. All problems carry equal weight. To receive full credit, show all of your work. This homework must be turned into the PS1 subfolder under your SVN repo. Please turn in a PDF file and include your name and netID in it. No handwritten solutions accepted.

Network Overview

1. Your company has a large data store that needs to backed up to a new site every week. You have two choices:
    a. Use your high-speed Internet connection and transfer all of the data over the Internet;
    b. Copy your data to a number of portable hard disks, drive them over in your van, then read data from the hard disks at the new site.

    Your Internet connection is 200 Mbps. The one-way latency to the remote site is 10ms. The read/write speed of your portable hard disks is 700 Mbps. Each disk can hold 2 TB. You can only copy to or read data from one disk at a time. You need to drive 2 hours to the new site. You have 15 TB of data to backup every week. Compute and compare the data rate for the two choices, from the moment you start moving the first byte, to the moment the last byte is online at its new location. Which one is faster?

2. Consider two machines, A and B, connected by a 200 Mbps Ethernet with four store-and-forward relay switches on the path between them. Suppose that no other machines are using the Ethernet, that each of the links between the machines and switches, as well as between each adjacent switch, introduces a propagation delay of 5μs, and that a switch begins transmitting a packet immediately after receiving the last bit of the packet.
    a. What is the total transfer time for a 512B packet, as measured from transmission of the first bit at A to receipt of the last bit at B?
    b. What is the effective bandwidth for transmission of a large file from A to B, assuming that packets of size 512B are used and that packet headers use 100B of the 512B? Assume that the nodes can send constantly, and in particular that the switches can simultaneously receive a packet from one side while transmitting a previous packet out the other side, and that A is not slowed down waiting for acknowledgements.
    c. What is the effective bandwidth if, after each transmission of a 512B packet, node A must wait for an 100-byte acknowledgement from B?

3. Suppose users share a 100 Gbps link. Also suppose each user requires 700 Mbps when transmitting, but each user only transmits 8 percent of the time. Whether a user is transmitting or not is an independent random variable with uniform distribution.
    a. When circuit switching is used, how many users can be supported?
    b. For the remainder of this problem, suppose packet switching is used. Suppose there are 1500 users. First, find an equation for the probability that at any given time, n users are transmitting simultaneously. (You only need to set up the equations)
    c. What is the probability that the link will get overloaded?

4. For each of the following links, calculate the bandwidth x delay product in bits using one-way delay.
    a. 15 Gbps Ethernet with a delay of 60 μs.
    b. 450 Mbps wireless link, with a one-way delay of 0.15 μs.
    c. 500 Mbps link through a satellite in geosynchronous orbit, 35,786 km high. The only delay is speed-of-light propagation delay.

5. Every year, an industrious CS student heads to Las Vegas to play in a poker tournament. There are seven rounds in the tournament, and the student must win each round to advance to the next. The student wins (50*n) chips in the nth round, if the student makes it that far, and has a 65% chance of winning each round they play.

Let m be the (statistical) mean number of chips earned by the student in a tournament, and let n be the mean number of rounds played per tournament. Use cycle analysis to find:

a. What fraction of years does the student make it to the final round?
b. m
c. n
d. m/n. Note that this ratio is the student's long-term rate of chips per round.

6. The Unix utility `whois` can be used to find the domain name corresponding to an organization, or vice versa. The information is provided by a *domain name registration* service provider. This utility is commonly shipped with linux, but it is not available on the ews machines. If you try it on your own linux machine with high probability you will find it available. Read the online man page for `whois` and experiment with it. For example, try `whois twitter.com`.

   Now, do a whois query for the following domains:

   `microsoft.com`
   `microsoot.com`
   `illinois.edu`
   `npr.org`
   `chelseafc.com`

   For each, turn in the registar and the date in which this record was created and/or activated and the expiration date, if present.

   Note: These are all domains that belong to an organization, which takes care of managing the various subdomains such as **www**.*company.com* or **mail**.*company.com*. But someone must have registered simply **com, edu, net, gov,** and all the other root domains, first! Do some more digging if this topic finds you interested, and have fun!