Fall Term 2006
TelCom 2310
Computer Networks
Monday 3:00 pm - 5:50 pm
Sennott Square 6110
http://www.cs.pitt.edu/∼znati/tel2310.html

Homework 1
Due Date : 9/18/2006

Problem 1

Consider a packet-switched network of N nodes connected by the following topologies:

- Star: one central node (hub) and all other nodes are attached to the hub.
- Loop: each node connects to two other nodes to form a closed loop.
- Fully connected: Each node if directly connected to all other nodes

1. For each case above, give the average number of hops between stations.
2. Prove that for any fixed set of node locations, the minimum possible total length of a tree interconnecting all nodes is less than the minimum possible length of any ring interconnecting all nodes.

Problem 2

Assume that writing a program of N lines of code costs N^2 units. If the program is written in a modular form, however, a module of n lines costs $a^2 + n^2$ to develop. The cost a^2 is caused by the need to follow the specifications of the modular construction.

1. Compute the number of modules, k, that minimizes the cost of writing a program of N lines, assuming that each module has N/k lines?
2. For what value of N is it preferable to decompose a program of N lines into modules rather than to write it as a single program?

Problem 3

Define the following parameters for a communication network:

- N = number of hops between two given end systems,
- L = message length in bits,
- B = data rate, in bits per second (bps), on all links,
- P = packet size
- H = overhead (header) bits per packet, and
- S = call setup time, and
- D = propagation delay.

For $N = 4$, $L = 3200$, $B = 9600$, $P = 1024$, $H = 16$, $S = 0.2$, and $D = 0.001$ and ignoring queueing delay and processing overhead, compute the end to end delay for:

1. Circuit switching, and
2. Datagram packet switching.

Problem 4

One of the main benefits of packet switching is *pipelining*. The simultaneous use of communications circuits yields considerable gains in efficiency. The relative performance of packet switching, however, can be further improved by using an optimal packet length. The objective of this homework is to derive the maximum packet size for a given transmission network.

1. Let M represent the total length of a message in bits, including the fixed overhead added by upper layers but excluding overhead bits added to each packet for fragementation and reassembly purposes. Let n_h be the number of overhead bits added to each packet (packet header), and let K_{max} be the maximum packet length including packet header. Compute the total number of bits, N_{bits}, that must be transmitted to send the message.
2. Ignoring the queueing and processing delays at the intermediate packet switching nodes, compute the total time, T, required to transmit a message of size M over j links with equal transmission rate, R bits per second (bps), connecting the source to the destination.

Problem 5

Assume that you have to submit a programming term project to your professor. The program is composed of 3 files, each file containing in average 250,000 characters. You can Each character is 8 bits. You can either submit the paper electronically, or ride your bicycle and submit your paper personally.

1. Assuming that you can ride at 18km/hr from your house to the office of the professor. For what range of distances can you submit your paper faster by riding your bicycle to your professor's office than sending it over a 300 bps modem using asynchronous transmission? (1 character=8 bits).

Problem 6

You are asked to design a network to connect 100 people. Each link in the network provides for directional communication between two people.

1. Assume that the mean distance between two people is 1 km. How much physical media (wire, optical fiber, ...) is necessary to directly link every person to every other person.
2. Assume that out of any group of 10 people, only one person will be communicating at a time (i.e., there will be five distinct person-to-person links at any one time).
   (a) Propose a more efficient way to connect all the people together. (Argue why it is more efficient)
   (b) What sort of equipment requirements are there for your network.