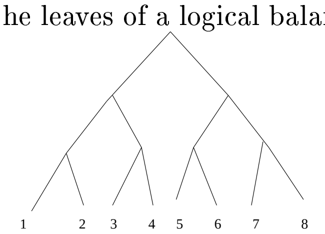
CSE/EE 461
Assignment 6
Due Friday, November 21, 1997

Your solutions must contain the derivation of your answers.

1. In this problem we analyze the performance of a deterministic binary tree protocol for CSMA/CD.

   Assume we have n stations where n is a power of two. The n stations are numbered 1 to n and are organized as the leaves of a logical balanced binary tree as shown below.

   The deterministic binary tree protocol is similar to the binary tree protocol except that stations do not flip coins. If a collision starts a contention interval then those stations numbered 1 to $n/2$ contend before the stations numbered $n/2+1$ to n. More generally, if the stations in an interval $[i, j]$ are contending and there is a collision, then the stations in the subinterval $[i, \lfloor (i+j)/2 \rfloor]$ contend before the stations in the subinterval $[\lfloor (i+j)/2 \rfloor + 1, j]$ contend. In the example above suppose 3, 4, and 5 begin a contention interval. We have the following scenario

slot	1	2	3	4	5	6	7
who attempted	3 4 5	3 4		3 4	3	4	5

   (a) Modify the binary tree algorithm to make it execute the deterministic binary tree algorithm.

   (b) Demonstrate an example of a contention interval of length $1 + 2\log_2 n$ in which only two stations are contending.

   (c) Prove that the average contention interval length for two stations contending among n is $5 - \frac{2log_2n}{n-1}$. Assume $n \geq 2$ and n is a power of 2. (Hint: This can be shown by induction on k where $n = 2^k$.)

(d) Give a general recursive formula for the average length of a contention interval when k stations are contending out of n. Your formula should work for $n \geq k$ and n is a power of 2.

2. In this problem we examine the utilization of a simple collision free reservation protocol.

   Assume that a reservation requires one slot and transmissions are k slots long. For simplicity assume that a slot is of unit length. With n stations total, reservations are made in n consecutive slots. Those stations that make reservations then take turns transmitting. Following these transmissions, a new round of reservations begins.

   (a) In a lightly loaded network, assume that exactly one station is continuously trying to transmit. What is the utilization of the network as a function of n and k?

   (b) In a heavily loaded network, assume that all stations are continuously trying to transmit. What is the utilization of the network as a function of n and k?

   (c) For $n = 100$, plot the utilization of the reservation protocol for both light loads and heavy loads for $k = 10, 20, 30, ..., 100$.