# CS118 Homework 7 Due: Nov.29 6pm, 2012

1. In Section 5.3, we provided an outline of the derivation of the efficiency of slotted ALOHA. In this problem we'll complete the derivation.
   a. Recall that when there are $N$ active nodes, the efficiency of slotted ALOHA is $Np(1-p)^{N-1}$. Find the value of $p$ that maximizes this expression.
   b. Using the value of $p$ found in (a), find the efficiency of slotted ALOHA by letting $N$ approach infinity. Hint: $(1-1/N)^N$ approaches $1/e$ as $N$ approaches infinity.

2. Suppose four active nodes – node A, B, C and D – are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability $p$. The first slot is numbered slot 1, the second slot is numbered slot 2, and so on.
   a. What is the probability that node A succeeds for the first time in slot 5?
   b. What is the probability that some node (either A, B, C or D) succeeds in slot 4?
   c. What is the probability that the first success occurs in slot 3?
   d. What is the efficiency of this four-node system?

3. Consider a 100 Mbps 100BASE-T Ethernet with all nodes directly connected to a hub. To have an efficiency of 0.50, what should be the maximum distance between a node and the hub? Assume a frame length of 1000 bytes and that there are no repeaters. Does this maximum distance also ensure that a transmitting node A will be able to detect whether any other node transmitted while A was transmitting? Why or why not? How does your maximum distance compare with the actual 100 Mbps standard? Assume that the signal propagation speed in 100BASE-T Ethernet is $1.8 \times 10^8$ m/sec.

4. Suppose two nodes, A and B, are attached to opposite ends of an 800 m cable, and that they each have one frame of 1500 bits (including all headers and preambles) to send to each other. Both nodes attempt to transmit at time t = 0. Suppose there are four repeaters between A and B, each inserting a 20-bit delay. Assume the transmission rate is 100 Mbps, and CSMA/CD with backoff intervals of multiples of 512 bits is used. After the first collision, A draws K = 0 and B draws K = 1 in the exponential backoff protocol. Ignore the jam signal and the 96-bit time delay.
   a. What is the one-way propagation delay (including repeater delays) between A and B in seconds? Assume that the signal propagation speed is $2 \cdot 10^8$ m/sec.
   b. At what time (in seconds) is A's packet completely delivered at B?
   c. Now suppose that only A has a packet to send and that the repeaters are replaced with switches. Suppose that each switch has a 20-bit processing delay in addition to a store-and-forward delay. At what time, in seconds, is A's packet delivered at B?