CSCE 560 Homework 5
Chapter 6 – Link Layer
Fall 18

Assigned: **Monday, 19 Nov**
Due: **Monday, 3 Dec, 1400**

You must include these questions in your submitted solution. In other words, your submission must include the question listed followed by your solution with the answer clearly indicated (e.g., put a box or circle around the final answer).

Problem 1. Chapter 6, R4
Suppose two nodes start to transmit at the same time a packet of length L over a broadcast channel of rate R. Denote the propagation delay between the two nodes as d_{prop}. Will there be a collision detected if $d_{prop} < L/R$? Why or why not?

Problem 2. Chapter 6, R6
In CSMA/CD, after the fifth collision, what is the probability that a node chooses K = 4? The result K = 4 corresponds to a delay of how many seconds on a 10 Mbps Ethernet?

Problem 3. Chapter 6, R11
Why is an ARP query sent within a broadcast frame? Why is an ARP response sent within a frame with a specific destination MAC address?

Problem 4. Chapter 6, R12
For the network in Figure 6.19, the router has two ARP modules, each with its own ARP table. Is it possible that the same MAC address appears in both tables? Why or why not?

Problem 5. Chapter 6, P5
Consider the 5-bit generator, G=10011, and suppose that *D* has the value 1010101010. What is the value of *R*? You must show you derivation of *R*.

Problem 6. Chapter 6, P8
In Section 6.3, 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 $Np(1-p)^{N-1}$. Mathematically derive the value of p that maximizes this expression.

b. Using the value of p found in part (a), find the efficiency of slotted ALOHA by letting N approach infinity. Hint: $(1 - 1/N)^N$ approaches 1/e as N approaches infinity.

Problem 7. Chapter 6, P18
Suppose nodes A and B are on the same 10 Mbps Ethernet bus, and the propagation delay between the two nodes is 325 bit times. Suppose CSMA/CD and Ethernet packets are used for this broadcast channel. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? If the answer is yes, then A incorrectly believes that its frame was successfully transmitted without a collision. *Hint:* Suppose at time t = 0 bit times, A begins transmitting a frame. In the worst case, A transmits a minimum size frame of 512+64 bit times. (The additional 64 bits are for the preamble and the start frame delimiter.) So A would finish transmitting the frame at t = 512+64 bit times. Thus the answer is no, if B's signal reaches A before bit time t = 512+64 bits. In the worst case, when does B's signal reach A?

Problem 8. Supplemental Problem 1
Suppose two nodes, A and B, are attached to opposite ends of a 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 10 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 interframe 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 2×10^8 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?

Problem 9. Supplemental Problem 2
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 to the actual 100 Mbps standard? Assume that the signal propagation speed in 100Base-T Ethernet is 1.8×10^8 m/s.