Université Paris Dauphine
Computer Networks

Homework 2: Link Layer

To prepare for the next two problems, review the operation of Slotted ALOHA and derive its efficiency yourself. You can check section 6.3.2 for the guidelines. If you get confused, try to look up for the meaning of efficiency. Warning: It is not to derive the maximum efficiency! Feel free to do so, but this is not going to be asked in your exams.

Problem 1: Suppose four active nodes—nodes 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 4?
b) What is the probability that some node (either A, B, C or D) succeeds in slot 5?
c) What is the probability that the first success occurs in slot 4?
d) What is the efficiency of this four-node system?

Problem 2: Consider two nodes, A and B, that use the slotted ALOHA protocol to contend for a channel. Suppose node A has more data to transmit than node B, and node A's retransmission probability p_A is greater than node B's retransmission probability, p_B.

a) Provide a formula for node A's average throughput, i.e., the fraction of time it successfully transmits. What is the total efficiency of the protocol with these two nodes?
b) If $p_A = 2p_B$, is node A's average throughput twice as large as that of node B? Why or why not? If not, how can you choose p_A and p_B to make that happen?

Problem 3: Consider the following setup: A 1000m long 1Gbps Ethernet network uses CSMA/CD to control access to a shared copper cable as shown in Figure 1 (a). The Ethernet specification requires that if a collision occurs, it must detect the collision before it finishes transmitting a packet.

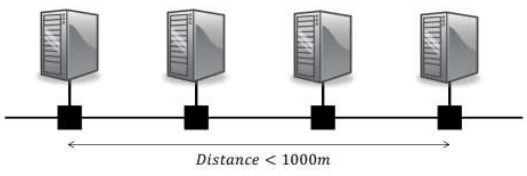

Figure 1 (a) : Line topology

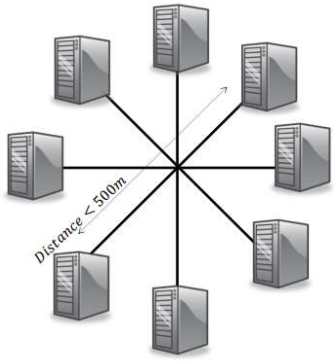

Figure 1 (b) : Star topology

a) What is the size of the minimum packet in the line topology? Express your answer in bits or bytes. (Assume the speed of propagation is 2×108m/s.)
b) If the Ethernet network is upgraded to 10Gbps, how does this affect the minimum size packet we can use? Explain why this might be a problem.
c) If we replace the long shared copper cable with a “broadcast star” topology in Figure 1 (b) in which no two hosts are now more than 500m apart, what is the new minimum packet size for the 1Gbps Ethernet network?
d) Today, CSMA/CD is not commonly used in wired Ethernet networks. Instead, end hosts are typically connected to their nearest Ethernet switch using a full duplex cable (which means there is a separate, independent channel for transmit and receive). Explain why this kind of network does not require CSMA/CD.