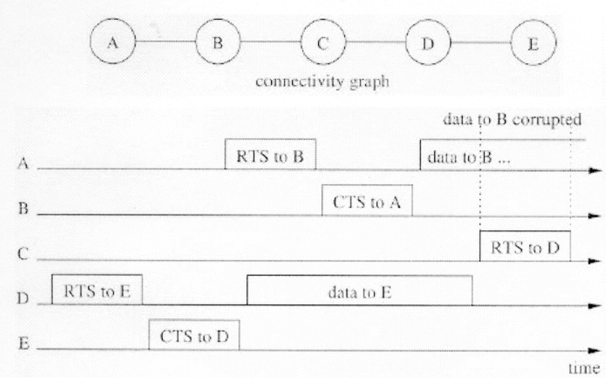
ECE 358
Problem set 5 Solution

Note:
The *efficiency* of a LAN is the fraction of time spent sending successful frames. The *access time* is the maximum amount of time a station has to wait to start transmitting. An *active* station is one that has data to send. The *latency* of a ring is the time required for a bit to travel all the way around the ring. For the token ring problems below, neglect the time required to emit or absorb a token.

Problem 2.
In an 802.11 wireless LAN using CSMA/CA, station S sends a data packet to station R (which is within range). Even if we assume that connectivity is symmetric (A can hear B if and only if B can hear A), and collisions are the only cause of errors, and RTS/CTS packets never collide with each other, it is still possible that R will fail to receive the data packet. Describe one way this might happen.



The figure above presents a scenario where the hidden-terminal problem is not solved by the RTS/CTS mechanism. The upper part of the figure shows the connectivity graph: there are 5 stations: A, B, C, D, and E. In the lower part of the figure, the transmissions of each station are shown. The problem starts when station C cannot "hear" the CTS from B to A: this is because C is within range of both B and D, and is "drowned" by the data transmission of D and the CTS transmission of B, so that it doesn't receive anything at all. Also, C cannot hear the data sent from A to B, since A and C are not in range. Therefore, when C "wakes up" (C heard the RTS from D to E, so decided to wait for the whole transmission from D to E) and wants to send a packet, say to D (it could be any other station), it "drowns" B when it sends an RTS to D. So, A's data to B gets corrupted, although their RTS/CTS handshake got through without problems.

Because of situations like the above, RTS/CTS is usually accompanied by an ACK from the receiver to the sender, after data has been transmitted. In the above case, B will not send an ACK back to A, so A will know that its data didn't get through and try again.

Problem 3.

a) When we examined the format of an Ethernet frame we noted that a number of bits are not data bits. Determine the fraction of data bits in a frame as a function of the packet length. Even if no time were wasted because of collisions, the data rate of the network would be limited by this fraction of the transmission rate. Compute this fraction for a packet length of 100 bytes and 1500 bytes.

b) The 200 computers in a research laboratory are attached to a 10Base-T Ethernet with an efficiency of 65 percent. The packets have 800 data bits. On the average, how many packets can each computer send every second?

a) Let $X \geq 0$ be the size of the data, in bytes. From the figure below (noting that there is a preamble of 8 bytes, the CRC is 4 bytes and the minimum data size is 46 bytes):

Destination address (6 bytes)	Source address (6 bytes)	type (2 bytes)	Data	CRC

A sample of Ethernet frame

we find that the length L(X) of the packet (in bytes) is given by
$L(X) = 8 + 18 + \max\{46, X\} = 26 + \max\{46, X\}$, for $0 \leq X \leq 1500$. Consequently, the fraction of data in the packet is given by X/L. If X = 100 bytes, then X/L is 100/126=0.794 while for X = 1500 bytes, X/L=0.982.

b) The efficiency of the network is 65%. A packet with 800 data bits, or 100 data bytes, has a total of 126 bytes, or 1008 bits. Consequently, the packet transmission rate per computer cannot exceed the following value: $\frac{.65 \times 10 \times 10^6}{200 \times 1008} = 32.24$ packets/s.

R3. 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 if $d_{prop} < L/R$? Why or why not.

ANS: There will be a collision in the sense that while a node is transmitting it will start to receive a packet from the other node

R8. Suppose nodes A, B, and C each attach to the same broadcast LAN (through their adapters). If A sends thousands of IP datagrams to B with each encapsulating frame addressed to the MAC address of B, will C's adapter process these frames? If so, will C's adapter pass the IP datagrams in these frames to the network layer C? How would your answers change if A sends frames with the MAC broadcast address?

ANS: C's adapter will process the frames to find the destination address, but the adapter will not pass the datagrams up the protocol stack. If the LAN broadcast address is used, then C's adapter will both process the frames and pass the datagrams up the protocol stack.

R 13. 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?

ANS: After the fifth collision, the adapter chooses from {0,1,2,…., 2^5-1}. The probability that it chooses 4 is 1/32. It waits K· 512 bit transmission times 4x512bit/(10Mbps) = 204.8 microseconds.