Homework 2 for CSE/EE 461 (Winter 2001)

Due: Wed, Jan 24, 2001, at the beginning of class. (Out: Wed, Jan 17, 2001.)
Note: Be sure to show your reasoning to be eligible for partial credit.

1. CRCs.

a), b) Peterson Ch2, Ex15

c) CRC are typically placed on the wire at the end of the frame (that is, they are the last portion transmitted). Why?

2. Checksums. Peterson Ch2, Ex13

3. Error Distributions. You are the system designer for a link layer protocol, and are trying to decide on the kind of error protection to provide. Frames are being carried across a telephone circuit, and the measured bit error rate is 10^{-4} (that is, one in 10000 bits is an error on average). The maximum frame size is 576 bytes. Assume that errors occur as random bit errors.

a) What is the probability that the frame will have no errors? One or fewer errors? Two or fewer errors? (Hint: Recall the binomial distribution from the first homework.)

b) Describe how much error detection and error correction capability you require if the residual error rate (which is the rate of frames that have undetected errors) must be less than one frame in 1000 and retransmissions must be used for less than 10% of the frames.

Now assume that you build a system to the specifications you gave in part b), and it performs poorly. Further investigation shows that errors do not occur as random bits, but rather as random bursts (a sequence of bit errors). Bursts of length 1 through 15 are equally likely, and bursts of 16 or more bits are too rare to be observed. To simplify your analysis though, assume that all errors are bursts of exactly 8 bits and all bytes are either error-free or error bursts.

c) As before, what is the probability that the frame will have no errors? One or fewer errors? Two or fewer errors? (Hint: First convert all relevant parameters into what they would correspond to for bytes, not bits.)

d) As before, describe how much error detection and error correction capability you require if the residual error rate (which is the rate of frames that have undetected errors) must be less than one frame in 1000 and retransmissions must be used for less than 10% of the frames.

4. Token Ring. Consider a token ring LAN. In your answers below, ignore the bit overhead of the token itself.

a) Assume that one station has an endless stream of data to send and the other stations are idle. What level of utilization (or fraction of the available bandwidth)

can the station achieve as a function of the maximum token holding time (THT) and the token rotation time (TRT), assuming early token release?

b) What does your answer above become if delayed token release is used?
c) Assume that all N stations have an endless stream of data to send. What level of utilization can the combination of all N stations achieve, again as a function of THT and TRT, assuming early token release?
d) What does your answer above become if delayed token release is used?

5. Ethernet Collision Detection. Consider a classic Ethernet with collision detection, where stations sense for collisions while transmitting their frames, and when a collision is detected further send a jam signal to ensure that all active stations detect the collision. Successful collision detection between two senders A and B requires that both A and B be transmitting when the others signal (either frame transmission or jam) reaches them. This translates into the requirement for a minimum frame size. For the parts below, give your answer in terms of physical Ethernet parameters as appropriate, such as distance (D), bit rate (R) and propagation speed (S). (Hint: Read the textbook carefully before answering any parts of this question.)

a) Explain how collision detection could fail if it was possible to send packets shorter than the allowed minimum.
b) Suppose station A sees the medium idle and begins transmitting. How long is the interval during which some other station might begin sending and cause a collision? This is also called the time to acquire the medium.
c) Suppose station A sees the medium idle and begins transmitting. How long is the interval during which A might hear of a collision with another station?
d) Give a formula for the minimum frame size required for successful collision detection.
e) Fast Ethernet operates at 100Mbps, ten times as fast as 10Mbps, yet both have the same minimum frame size. Explain how this can be the case.

6. Ethernet Capture. Peterson Ch2, Ex37

7. 2D Parity. Consider the even two dimensional parity code shown in Peterson Figure 2.16 where the data plus parity bits form a block of 7 bytes. Consider errors that consist of N individual, random bit errors

a) Under what conditions will an error go undetected?
b) For which values of N from 1 to 8 is it possible to have undetected errors?
c) Now consider the possibility that some of the errors could be in the parity bits themselves. How does this change your answers to the above parts.

□□□