CY3100 Homework 2 Data Link Layer

1. (a) For a 10 bit word with parity check, find P_1; P_2; P_3 for $P_B = 10^{-2}$ and 10^{-5}.
(b) Give a general expression for these 3 probabilities in an n bit string.
(c) For an n bit word and P_B above, what is P[bit 3 is wrong]? P[only bit 5 is wrong]? P[exactly 2 bits are wrong]?

1-EXTRA. Suppose P_B = 0:1 = 10□1. For a 10 bit word with parity check, find P_1; P_2; P_3. Find the exact values.

2. Suppose that the following 5 words of 6 bits each are to be transmitted: 001101, 110011, 101010, 111101, 000011. (a) Write out the frame to be transmitted as an array, filling in the VRC and LRC parity bits. (b) Show how an undetected error can occur by inverting some bits.

3. (Cyclic Redundancy Check) Compute the FCS F for the following messages using long division. Then show the logic circuit that implements this, and check the resulting frame $T = 2_n M + F$ for errors. (a) M = 110101001, P = 1101. (b) M = 1101110111, P = 1011. (c) M = 1001100110, P = 1001.

4. For a,b,c of (3) above, show the transmitted message if Hamming code is used. Next, invert a bit somewhere in each message and show the parity bits and how they point it out.

5. Consider the stop and wait protocol (simple, i.e., no sequence number). (a) Use a timing diagram to show the possible sequences of messages that may occur. (b) Give an expression for the maximum channel utilization. Remember, max utilization occurs when the sender sends as fast as possible and no errors occur.

6. (a) What problem(s) of stop-and-wait was alternating bit protocol meant to solve? Show how it was solved, using a timing diagram.
(b) What is the utilization of alternating bit? How much of an improvement is this on S-and-W?

7. A channel has a data rate of 4 kbps and a propagation delay of 20 ms. For what range of frame sizes does stop-and-wait give an eficiency of at least 0.50?

8. (a) Give an example of a protocol specified as a CFSM which has a deadlock. (b) Give an example for which the analysis never terminates, that is, which has an infinite number of states. Show why this is the case.

9. Let A and B be two stations connected over a full duplex HDLC link (go-back-N protocol, window size 7). Assume both have data to send to the other, and that initially $N_s = N_r = 0$ for both A and B. Assume the following sequence takes place:
(1) A sends 3 data frames to B;
(2) B sends 1 ack (Ack3) to A;
(3) A sends 3 more data frames to B;
(4) B send 1 data frame to A.
(a) assuming no errors, what are the values of N_s and N_r in both A and B after each 1,2,3 and 4?

(b) Assume the second and fourth data frames sent by A are lost; and that B's first ack is lost. Show the resulting altered sequence of messages on a timing diagram, and give the final values of send and receive sequence numbers in both machines.

10. (a) What is the minimum range of sequence numbers for the go-back-N protocol, say for a window size of m? Explain why. (b) Same question for selective repeat.

11. Why is forward error correction generally not used in data communications? Can you think of a situation in which it would be profitable?

12. Suppose you are transmitting a frame over a data link, with a high error rate. For the following, how many frames would you expect to transmit before getting a successful transmission on average?
(a) Prob[good transmission] is 0.7; (b) Prob[good transmission] is 0.3; (c) Prob[good transmission] is 0.15; (d) Prob[good transmission] is 0.8.

13. A channel has a data rate of 2 Mbps and a propagation delay of 200 ms. Suppose frame size is 500K bits. What window size is needed using go-back-N for a utilization of 0.6, assuming an error free channel?
(b) Now suppose that P[frame in error] is 10^{-3}. Repeat part (a).
(c,d) Repeat parts (a,b) for a selective repeat protocol.