Numerical Problems from Data Link Control (DLC) Layer

1. The following code vectors (101101, 110110 and 100011) are generated from a (6,3) parity check code. Find the rule for generating each of the parity checks. What is the minimum distance of this code? What is the error detection and correction capability of this code?

2. Frames of 1000 bits are sent over a 1 Mbps channel using a geostationary satellite whose propagation time from the earth is 270 msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used. What is the maximum achievable channel utilization for (a) stop-and-wait, (b) go-back-n and (c) selective repeat ARQs.

3. Consider a (7,4) cyclic code generated by g(x) = x3 + x + 1. (i) Illustrate the encoding procedure with the message vector 1101 using feedback shift register and verify with polynomial division using modulo-2 operations. (ii) Illustrate the decoding procedure for the received code vector corresponding to the transmitted code vector in step (i) with an error at 4th bit position and verify the same with polynomial division using modulo-2 operations.

4. Let Tmin be the minimum transmission time for data frames and Td be the propagation and processing delay in each direction. Find the maximum allowable value Tmax for frame transmission time such that a go-back-n ARQ system will never have to go back or wait in the following cases: (i) absence of transmission errors or lost frames and (ii) isolated errors can occur in the feedback direction.

5. A channel has a bit rate of 4 kbps and a propagation delay of 20 msec. Find what range of frame sizes does stop-and-wait ARQ give an efficiency of at least 50 percent?

6. The generator polynomial for a (15,7) cyclic code is g(x) = 1+x4 +x6 +x7 +x8 . Find the code vector (in systematic form) for the message polynomial m(x) = x2 + x3 + x4 . Assume that the first and last bits of the code vector T (x) for m(x) = x2 + x3 + x4 suffer transmission errors. Find the syndrome s(x) of the received code vector R(x). (syndrome is the reminder obtained by dividing R(x) by g(x).)

7. Design an optimum selective repeat ARQ (optimize the buffer space) for the round trip delay of 40 ms and frame transmission time of 1 ms. (i) What is the size of sender window and receiver window? (ii) How many bits are required to represent sequence and request numbers? (iii) When the sender window will get exhaust (go back)? (iv) What will be the frame error patterns (repeated frame error) to achieve the channel utilization of 50% and 25%?

8. The following code vectors (1011001, 1001110, and 1100101) are generated from a (7,4) parity check code. Find the rule for generating each of the parity checks. What is the minimum distance of this code? What is the error detection and correction capability of this code?

9. The generator polynomial for a (15,7) cyclic code is g(x) = 1+x4 +x6 +x7 +x8 . Find the code vector for the message 0011100, and draw the encoder circuit for generating the parity bits.

10. If each packet carries 1000 bits of data, how long does it take to send 1 million bits of data using (i) stop and wait ARQ, (ii) go-back-n ARQ and (iii) selective repeat ARQ. Assume that all three ARQs are using 3 bits for representing sequence numbers. The distance between sender and receiver is 5000 Km and the propagation speed is 2×10^8 m? Ignore transmission, waiting and processing delays. Assume no data or control frame is lost or damaged.

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