

EE3009 Data Communications and Networking

Quiz 2 (Solution)

Semester A, 2015/16

1. In Manchester coding, a waveform is used to represent 0 while another waveform is used to represent 1. In Differential Manchester coding, the same two waveforms are used. If the bit is 0, the waveform is the same as the previous waveform (corresponding to the previous bit). Otherwise, if the bit is 1, the other waveform will be used.

2.

- a) The CRC bit pattern is 1.

$$\begin{array}{r} 111 \\ 11 \overline{)1000} \\ \underline{11} \\ 10 \\ \underline{11} \\ 10 \\ \underline{11} \\ 1 \end{array}$$

- b) The CRC bit pattern is 0.

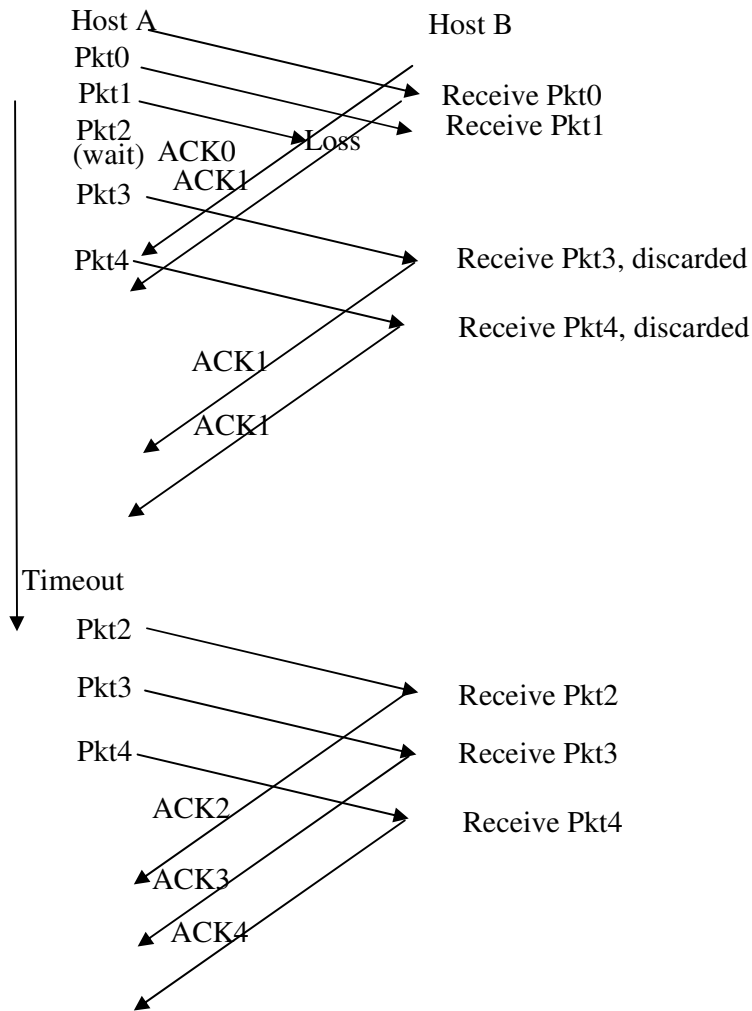
$$\begin{array}{r} 100 \\ 11 \overline{)1100} \\ \underline{11} \\ 00 \\ \underline{00} \\ 00 \\ \underline{00} \\ 0 \end{array}$$

- c) Even parity check.

3. The Nyquist rate is 6000 symbols per second. Each symbol represents two bits. Therefore, the maximum bit rate is 12 kbps.

4. 11011111011011110110101

5.



6. A sender can use an RTS packet to reserve the channel first. As this control message is short, the chance of collision with other packets is low. After receiving this RTS packet, the access point will broadcast a CTS packet, which notifies all terminals (which may be hidden from the sender). The sender can then transmit its data packet and collision is thus avoided.

7.

a) The parity bit positions are A, B, D.

b) The codeword is A B 1 D 0 1 1

The parity bits are

$$A = 1 + 0 + 1 = 0$$

$$B = 1 + 1 + 1 = 1$$

$$D = 0 + 1 + 1 = 0$$

c) The received codeword is 0 1 1 0 1 1 1

The syndrome is calculated as follows:

$$s_1 = 0 + 1 + 1 + 1 = 1$$

$$s_2 = 1 + 1 + 1 + 1 = 0$$

$$s_3 = 0 + 1 + 1 + 1 = 1$$

$$(s_3, s_2, s_1) = (1, 0, 1)$$

$$S = 101_2 = 5$$

The syndrome indicates the position of the erroneous bit. Since $S = 5$, the fifth bit is in error.

d) Minimum distance = 3. It can correct all single-bit errors.

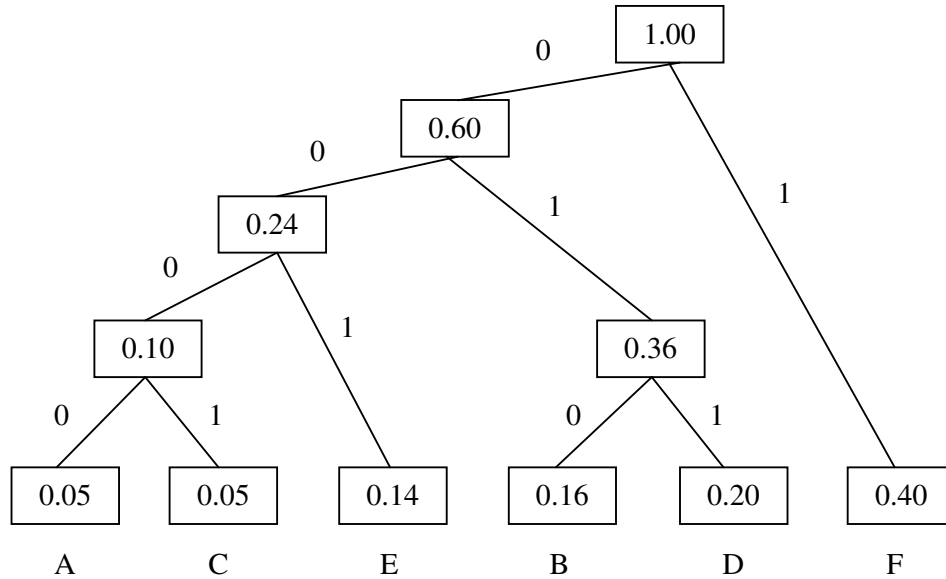
8.

a) The length of the code would be 3 bits.

b) Entropy of X is a lower bound, and can be found as follows:

$$H(X) = (-0.05 \log_2 0.05) \times 2 - 0.16 \log_2 0.16 - 0.2 \log_2 0.2 - 0.14 \log_2 0.14 - 0.4 \log_2 0.4 \\ = 2.245 \text{ bits}$$

c) The code can be constructed by building a binary tree as follows:



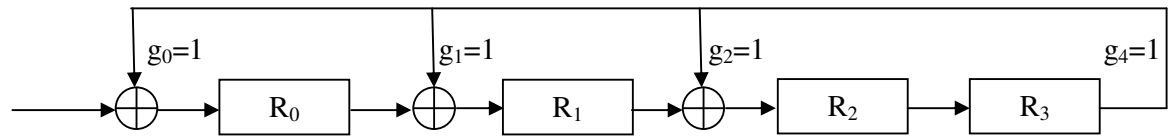
Average code length

$$= 0.05(4) + 0.05(4) + 0.14(3) + 0.16(3) + 0.2(3) + 0.4(1) \text{ bits} \\ = 0.2 + 0.2 + 0.42 + 0.48 + 0.6 + 0.4 \text{ bits} \\ = 2.3 \text{ bits}$$

9. There would not be a collision between the frames transmitted by A and B. The propagation delay is $900\text{m} / 2 \times 10^8 \text{ m/s} = 4.5 \mu\text{sec}$, so when node B attempts to transmit at time $t = 10 \mu\text{sec}$, the first bit of A's transmission has already arrived at node B. At time $t = 10 \mu\text{sec}$, A would be transmitting, and B would sense that the channel is busy, and then defer its transmission.

10.

- a) The generator has five bits 10111, so four redundant bits will be generated. Therefore, four registers are needed.



b)

Clock	Input	R ₀	R ₁	R ₂	R ₃
0	----	0	0	0	0
1	1	1	0	0	0
2	0	0	1	0	0
3	1	1	0	1	0
4	1	1	1	0	1
5	0	1	0	0	0
6	0	0	1	0	0
7	0	0	0	1	0
8	0	0	0	0	1

Therefore, the CRC bits are 1000.