

EE3009 Data Communications and Networking

Quiz 2 (Solution)

Semester A, 2014/15

1. Let the length of each packet be L bytes. To have utilization equal to 50%, we must have

$$L * 8 \text{ bits} / 80 \text{ Mbps} = 20 \text{ microseconds}$$
$$L = 20$$

Therefore, the length of each packet is 200 bytes.

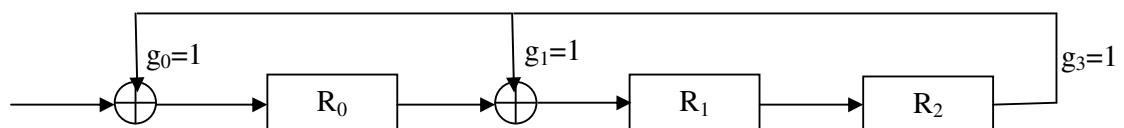
2. Suppose that there are three terminals A, B, and C. Terminal B can hear the transmissions from both A and C, while terminals A and C cannot hear each other. When terminals A and C transmit to B at the same time, they cannot detect that there is a collision. In that case, collision detection does not work. This is what we call the hidden terminal problem.

If MACA is used, the sender will send a short message called RTS to the receiver first. For example, assume A transmits an RTS to B first. Then B will transmit a CTS message. As C will also hear this CTS message, it will wait until A finishes transmitting its data packet, thus avoiding collision with A.

- 3.
- a) $k = pq$, $n = (p + 1)(q + 1)$, or equivalently $pq + p + q + 1$
 - b) min. distance = 4
 - c) 4-bit error may not be detected.
4. The sender adds one extra 9 whenever there are five consecutive 1s in the data so that the receiver does not mistake the data for a flag.

5.

- a) The shift register implementation is shown below:



b) The CRC bits can be found by using the following table:

Clock	Input	R ₀	R ₁	R ₂
0	---	0	0	0
1	1	1	0	0
2	1	1	1	0
3	0	0	1	1
4	0	1	1	1
5	0	1	0	1
6	0	1	0	0
7	0	0	1	0
8	0	0	0	1
9	0	1	1	0
10	0	0	1	1

c) *I'm sorry that there are some ambiguities in this question, as the term "burst error" has different definitions in the literature. For this reason, the following two answers are both acceptable:*

If burst error is defined as consecutive bit errors, then the answer is:

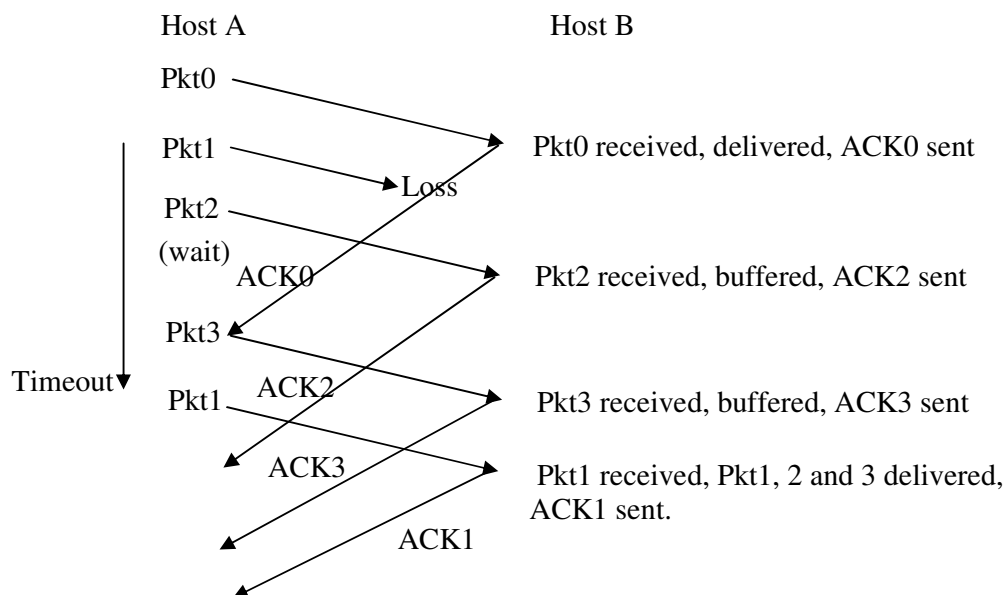
Yes, it can, because 1111 can be detected by the code.

If error pattern of 1011, 1101 and 1111 are all classified as burst error of length 4, then the answer is:

No, it cannot. For example, if there is a burst error of the form 1011, then the code cannot detect it.

6.

a) The diagram is shown below:



- b) The transmission time of one packet = 500 bytes / 10 Mbps = 0.4 ms
 At $t = 1.0004$ s, Host A re-transmits Pkt1.
 At $t = 1.0004$ s + 0.4 ms = 1.0008 s, Host B receives all the four packets.
- c) If Go-Back-N is used, then Host A needs to re-transmit Pkt 1, 2, and 3. Host B will receive all packets at $t = 1.0004$ s + 0.4 * 3 ms = 1.0016s.

7.

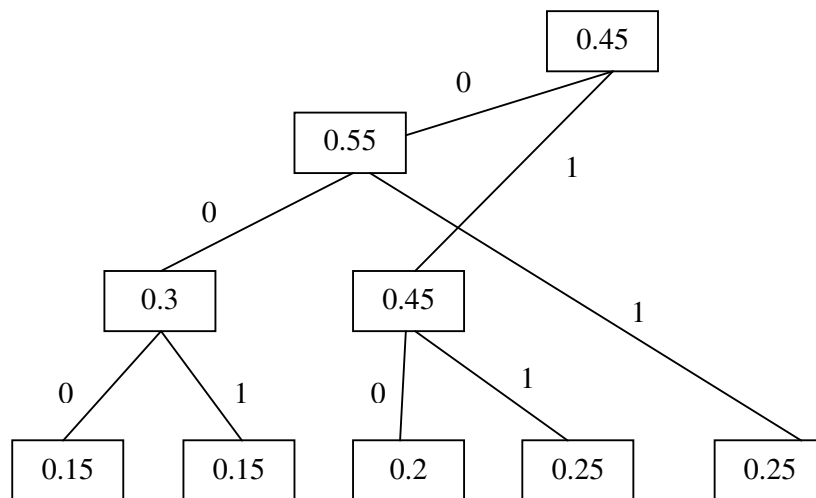
- a) The code is not prefix-free, since the codeword of "A" is a prefix of the codeword of "B".
- b) The code is uniquely decodable, since the end of a codeword is marked by a *following 0*.

8.

- a) The entropy of X is given by

$$H(x) = 2(-0.25 \log_2 0.25) + (-0.2 \log_2 0.2) + 2(-0.15 \log_2 0.15) \\ = 2.285 \text{ bits}$$

- b) The Huffman code can be constructed as follows:



The codewords for the five symbols are shown below:

a : 01
 b : 11
 c : 10
 d : 001
 e : 000

- c) The average code length is

$$L = 2 (0.25+0.25+0.2) + 3 (0.15+0.15) = 2.3 \text{ bits}$$