

Exercises Sheet #4 : Data Link Layer

Communication Networks
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Exercise #1 :

Given the following data before applying framing at the data link layer :

A ESC ESC B C ESC FLAG FLAG D.

This data fragment occurs in the middle of a data stream for which the byte-stuffing algorithm is used.

Questions:

1. What is the output after byte-stuffing ?
2. What is the resulting frame ?

Exercise #2 :

A bit string, 011110111110111110, needs to be transmitted at the data link layer.

Questions:

1. What is the output after bit stuffing ?
2. What is the resulting frame ?

Exercise #3 :

The following character encoding is used in a data link protocol:

A: 01000111; **B:** 11100011; **FLAG:** 01111110; **ESC:** 11100000

Questions: Show the bit sequence transmitted (in binary) for the four-character frame:

A B ESC FLAG when each of the following framing methods are used:

- (a) Character count
- (b) Flag bytes with byte stuffing.
- (c) Starting and ending flag bytes, with bit stuffing.

Exercise #4 :

Given the output after applying “Flag bytes with byte stuffing” framing scheme :

FLAG A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D F FLAG.

Question : What is the original data (before applying framing) ?

Exercise #5 :

A station **S** tries to send a data packet 10011011 across a noisy channel. To ensure data integrity, an error detection/correction is used at the data link layer.

1. Calculate the parity bit for the data packet using even parity.
2. Apply the even parity check at the receiving station to the following frame : 100010101.
3. Encode the data packet using a C(8,12) Hamming code.
4. Using the previous Hamming code, verify if the following received data contains errors and correct it if any : 100101001100
5. Calculate the corresponding codeword when CRC with simplified generator polynomial $x^3 + x$ is used for error detection.

Exercise #6:

You are transmitting the following critical data {0x73, 0x69, 0x68, 0x65, 0x6D, 0x65} across a network. To ensure reliable data transfer, an error detection method is used at the data link layer.

Question : Calculate the corresponding codeword when internet checksums is used for error detection.

Exercise #7 :

Is there any error in the following Hamming codeword : 1010110?

1	0	1	0	1	1	0
D3	D2	D1	C2	D0	C1	C0

Exercise #8 (Optional):

Consider the following coding scheme using block coding C(3, 6):

Datawords	Codewords
000	000000
100	100110
010	010011
110	110101
001	001101
101	101011
011	011110
111	111000

- 1) A receiver receives the message 101111. Is this message correct ?
- 2) A receiver receives the message 101111. What is the message transmitted ?
- 3) Determine the Hamming distance of this coding scheme ?
- 4) How many bit errors can be detected by this code ?
- 5) How many bit errors can be corrected by this code ?