

EIE 3333 Data and Computer Communications (2019/20)

Tutorial 3

Unit 3: Data Link Layer: Error Detection and Correction

Review Questions

1. How does a single-bit error differ from a burst error?
2. Discuss the concept of redundancy in error detection and correction.
3. Distinguish between forward error correction versus error correction by retransmission.
4. If we want to detect two-bit errors, what should be the minimum Hamming distance?
5. In CRC, show the relationship between the following entities (size means the number of bits):
 - a. The size of the dataword and the size of the codeword
 - b. The size of the divisor and the remainder
6. What kind of arithmetic is used to add data items in checksum calculation?
7. What kind of error is undetectable by the checksum?
8. Can the value of a checksum be all 0s (in binary)? Defend your answer. Can the value be all 1s (in binary)? Defend your answer.
9. Assume we are sending data items of 16-bit length. If two data items are swapped during transmission, can the traditional checksum detect this error? Explain.

Problems

1. What is the maximum effect of a 2-ms burst of noise on data transmitted at the following rates:
 - a. 1500 kps
 - b. 12 kbps
 - c. 100 kbps
 - d. 100 Mbps
2. Assuming even parity, find the parity bit for each of the following data units.
 - a. 1001011
 - b. 0001100
 - c. 1000000
 - d. 1110111
3. Calculate the Hamming pairwise distances and determine the minimum Hamming distance among the following codewords:
 - a. 00000, 10101, 01010
 - b. 000000, 010101, 101010, 110110

4. Would you expect that the inclusion of a parity bit with each character would change the probability of receiving a correct message?
5. Consider a frame consisting of two characters of four bits each. Assume that the probability of bit error is 10^{-3} and that is independent for each bit.
 - (a) What is the probability that the received frame contains at least one error?
 - (b) Now add a parity bit to each character. What is the probability?
6. Given the data word 10100111 and the divisor 10111
 - a. Show the generation of the codeword at the sender site.
 - b. Show the checking of the codeword at the receiver site (assume no error).
7. A sender has two data items to send: 0x4567 and 0xBA98. What is the value of the 16-bits checksum?
8. Assume that the probability that a bit in a data unit is corrupted during transmission is p . Find the probability that x number of bits are corrupted in an n -bit data unit for each of the following cases.
 - a. $n=8, x=1, p=0.2$
 - b. $n=16, x=3, p=0.3$
 - c. $n=32, x=10, p=0.4$