M of N Code

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- M of n code is only error detection code with a code word length of n bits, where each code word contains exactly m instances of a "ones”

- All codewords share the same Hamming weight.

Encoding Message (1)

- The simplest implementation is to append a string of ones to the original data until it contains m ones, then append zeros to create a code of length n.

Encoding Message(2)

- 3 of 6 Code

Original 3 data bits	Appended bits	Encoded Message
000	111	000 111
001	110	001 110
010	110	010 110
100	110	100 110
101	100	101 100
110	100	110 100

Decoding Message(1)

- keep the original data bits and discard the appended bits

Encoded Message	Discarded Bits	Original 3 data bits
000 111	111	000
001 110	110	001
010 110	110	010
100 110	110	100
101 100	100	101
110 100	100	110
111 000	000	111

Detecting Error

- Regarding the error detection a single bit error will cause the code word to have either m + 1 or m – 1 "ones".

m + 1 case :
Original message : 000 111
Received message : 100 111
Error found!

m - 1 case :
Original message : 000 111
Received message : 000 110
Error found!

Undetected Errors

- If two bits with opposite value are affected by noise and consequently flip their values, this algorithm will not find a the error.

Original message : 101 100
Received message : 001 101

Error Correction Algorithm

- The receiver has a list where are stored all code words.
- Hamming distance is calculated with the received message and the messages stored in the list.
- The message associated with the lowest computation of hamming distance value will be the correct message.
- If more than one computation of hamming distance has the same value the message must be retransmitted.

Code words for error correction

H.D	000 111	001 110	010 101	011 100	100 011	101 010	110 001	111 000
000 111	0	2	3	4	2	2	4	6
001 110	2	0	4	2	4	2	6	4
010 101	2	4	0	2	4	6	2	3
011 100	4	2	2	0	6	4	3	2
100 011	2	4	4	6	0	2	2	4
101 010	4	2	6	4	2	0	4	2
110 001	4	6	2	4	2	4	0	2
111 000	6	4	4	2	4	2	2	0

Error Correction Algorithm - Example

Received Message with error 1: 001 111

Received Message with error 2: 100 001

Codewords	Hamming Distance message 1	Hamming Distance message 2
000 111	1	3
010 101	3	4
011 100	3	6
110 001	5	1
111 000	5	3

Questions?