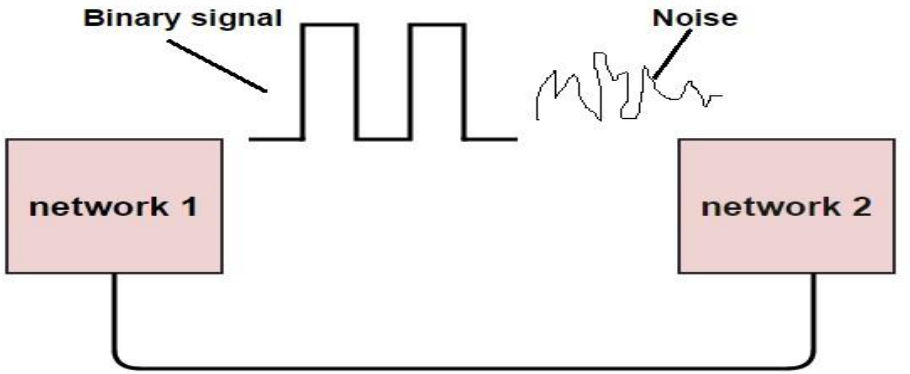
Error detection and Correction Code

Error Detection Code

Error in digital system is the corruption of data due to external noise

Failure may be temporary or permanent.



If 1 is changed to zero or 0 is changed to 1, it is called “Bit error”.

errors are transferred from one communication system to another, along with the data.

If these errors are not detected and corrected, data will be lost

Types of Error detection

- Parity Checking
- Cyclic Redundancy Check (CRC)
- Longitudinal Redundancy Check (LRC)
- Check Sum

Error Correction Code

Hamming Code

Parity Bit

Parity bit (P) is an extra bit included in the message to make the total number of 1 either even or odd

If ODD parity chosen P is such that total number of bit is odd.

If EVEN parity chosen P is such that total number of bit is even.

Parity bit generated during transmission end and send along with message.

At destination parity of received message is check.

If parity at received end is not same as transmission end implies at least one bit changed (bit error occurs)

3 bit data			Message with even parity		Message with odd parity	
A	B	C	Message	Parity	Message	Parity
0	0	0	000	0	000	1
0	0	1	001	1	001	0
0	1	0	010	1	010	0
0	1	1	011	0	011	1
1	0	0	100	1	100	0
1	0	1	101	0	101	1
1	1	0	110	0	110	1
1	1	1	111	1	111	0

MCQ

Assign the proper even parity bit for 1010.

(a)11010

(b)01010

(c)01101

(d)1111

MCQ

Assign the proper odd parity bit for 101101.

(a)0101101

(b)1101101

(c)1101101

(d)1010101

Hamming Code

Hamming code is a set of error-correction codes that can be used to **detect and correct the errors**

Redundant bits are extra binary bits that are generated and added

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2^r ≥ m + r + 1
where, r = redundant bit, m = data bit
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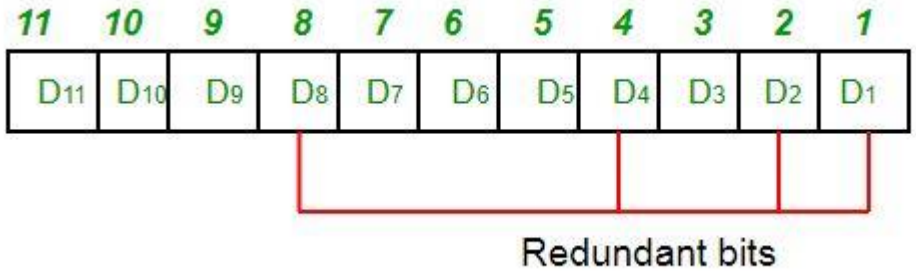
If data bits is 7, then the number of redundant bits can be calculated using = 2^4 ≥ 7 + 4 + 1, redundant bits= 4

Hamming Code uses the extra parity bits to allow the identification of an error.

- Write the bit positions starting from 1
- All the bit positions that are a power of 2 are marked as parity bits (1, 2, 4, 8, etc)
- All the other bit positions are marked as data bits
- Each data bit is included in a unique set of parity bits, as determined its bit position in binary form



MCQ

How many parity bits required to generate hamming code if message contain 16 bits.

(a) 2

(b) 3

(c) 4

(d) 5

Hamming code example

Data to be transmitted is 1011001

11	10	9	8	7	6	5	4	3	2	1
1	0	1	R8	1	0	0	R4	1	R2	R1

The number of data bits = 7
The number of redundant bits = 4
The total number of bits = 11
The redundant bits are placed at positions corresponding to power of 2➔1, 2, 4, and 8

Determining the Parity bits for Even Parity

R1 bit is calculated using parity check at all the bits positions whose binary representation includes a 1 in the least significant position.R1: bits 1, 3, 5, 7, 9, 11

11	10	9	8	7	6	5	4	3	2	1
1	0	1		1	0	0		1		R1

For even parity R1=0

R4 bit is calculated using parity check at all the bits positions whose binary representation includes a 1 in the third significant position.R4: bits 4, 5, 6, 7

11	10	9	8	7	6	5	4	3	2	1
1	0	1		1	0	0	R4	1	1	0

For even parity R4=1

R2 bit is calculated using parity check at all the bits positions whose binary representation includes a 1 in the second position from the least significant bit.R2: bits 2,3,6,7,10,11

11	10	9	8	7	6	5	4	3	2	1
1	0	1		1	0	0		1	R2	0

For even parity R2=1

R5 bit is calculated using parity check at all the bits positions whose binary representation includes a 1 in the fourth position from the least significant bit.R2: bits 8, 9, 10, 11

11	10	9	8	7	6	5	4	3	2	1
1	0	1	R8	1	0	0	1	1	1	0

For even parity R8=0

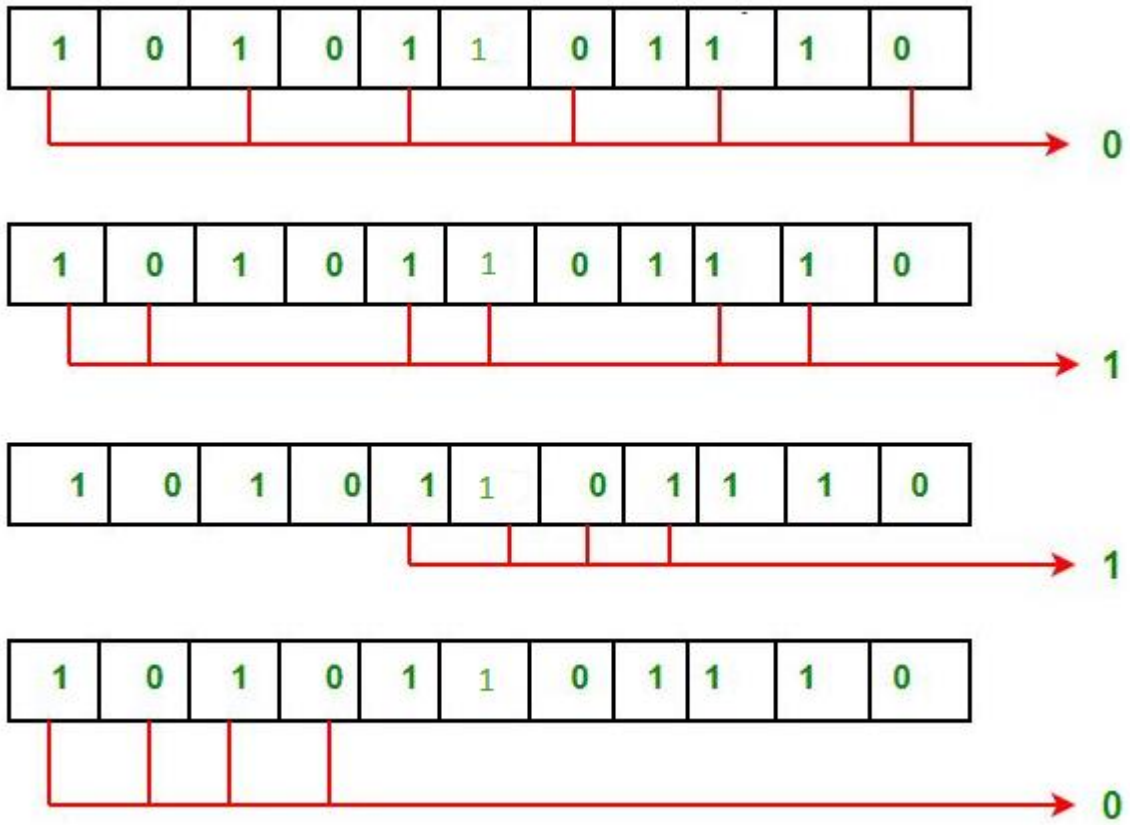
Thus, the data transferred is:

11	10	9	8	7	6	5	4	3	2	1
1	0	1	0	1	0	0	1	1	1	0

Error detection and correction

If 6th bit is changed from 0 to 1 during data transmission
Find parity bit (R1,R2,R4 and R8) again (with their position diussed in last slide)

Gives new parity values in the binary number 0110, implied error detected on 6th bit



Determine the hamming code for the data bits 10110 using odd parity?