Error Detection and Correction

By

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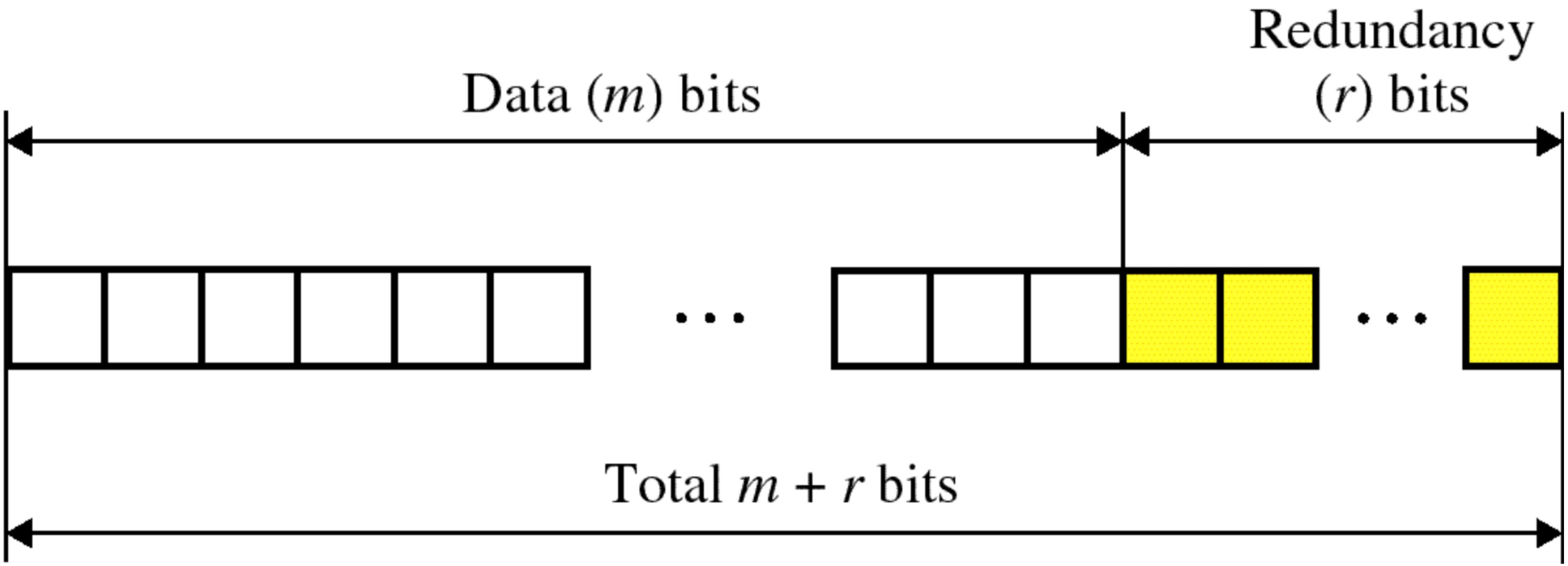
Error Correction



Error Correction – Hamming Code

- ✓ Consider 8 bit Data Word – 11000100
- ✓ Bit Position:

1	2	3	4	5	6	7	8	9	10	11	12
P1	P2	1	P4	1	0	0	P8	0	1	0	0

- ✓ The bits positions that are expressed in power of 2 are considered as Parity Bits

Error Correction – Hamming Code

- ✓ $1 = 2^0$
- ✓ $2 = 2^1$
- ✓ $3 = 2^0 + 2^1$
- ✓ $4 = 2^2$
- ✓ $5 = 2^2 + 2^0$
- ✓ $6 = 2^2 + 2^1$
- ✓ $7 = 2^2 + 2^1 + 2^0$
- ✓ $8 = 2^3$
- ✓ $9 = 2^3 + 2^0$
- ✓ $10 = 2^3 + 2^1$
- ✓ $11 = 2^3 + 2^1 + 2^0$
- ✓ $12 = 2^3 + 2^2$

- ✓ P1 = XOR (3,5,7,9,11)
- ✓ P2 = XOR (3,6,7,10,11)
- ✓ P4 = XOR (5,6,7,12)
- ✓ P8 = XOR (9,10,11,12)

Error Correction – Hamming Code

- ✓ Consider 8 bit Data Word – 11000100

- ✓ Bit Position: 1 2 3 4 5 6 7 8 9 10 11 12

Bit Position	1	2	3	4	5	6	7	8	9	10	11	12
	P1	P2	1	P4	1	0	0	P8	0	1	0	0

P1 = XOR(3,5,7,9,11) = 1 + 1 + 0 + 0 + 0 = 0
P2 = XOR(3,6,7,10,11) = 1 + 0 + 0 + 1 + 0 = 0
P4 = XOR(5,6,7,12) = 1 + 0 + 0 + 0 = 1
P8 = XOR(9,10,11,12) = 0 + 1 + 0 + 0 = 1

Error Correction – Hamming Code

- ✓ Consider 8 bit Data Word – 11000100

- ✓ Bit Position:

1	2	3	4	5	6	7	8	9	10	11	12
0	0	1	1	1	0	0	1	0	1	0	0

P1 = XOR(3,5,7,9,11) = 0
P2 = XOR(3,6,7,10,11) = 0
P4 = XOR(5,6,7,12) = 1
P8 = XOR(9,10,11,12) = 1

Error Correction – Hamming Code

- ✓ Bit Position: 1 2 3 4 5 6 7 8 9 10 11 12

Transmitted:	0	0	1	1	1	0	0	1	0	1	0	0
Received:	1	0	1	1	1	0	0	1	0	1	0	0

C1 = XOR(1,3,5,7,9,11) = Wrong 1 + P1 = 1 + 0 = 1

C2 = XOR(2,3,6,7,10,11) = 0 + P2 = 0 + 0 = 0

C4 = XOR(4,5,6,7,12) = 1 + P4 = 1 + 1 = 0

C8 = XOR(8,9,10,11,12) = 1 + P8 = 1 + 1 = 0

Error in Bit 1

Error Correction – Hamming Code

- ✓ Bit Position:

	1	2	3	4	5	6	7	8	9	10	11	12
Transmitted:	0	0	1	1	1	0	0	1	0	1	0	0
Received:	0	0	1	1	0	0	0	1	0	1	0	0

C1 = XOR(1,3,5,7,9,11) = 0 + Wrong P1 = 1 + 0 = 1

C2 = XOR(2,3,6,7,10,11) = 0 + P2 = 0 + 0 = 0

C4 = XOR(4,5,6,7,12) = 1 + Wrong P4 = 1 + 0 = 1

C8 = XOR(8,9,10,11,12) = 1 + P8 = 1 + 1 = 0

Error in Bit 5

Error Correction – Hamming Code

If $C = 0$ and $P = 0$,	No Error
If $C \neq 0$ and $P = 1$,	Single Bit Error, Can be Corrected
If $C \neq 0$ and $P = 0$,	Double Bit Error, Can be Detected, Can not be Corrected
If $C = 0$ and $P \neq 0$,	P13 Bit Error

References

- ✓ Book: Data communication and Networking
  Fourth edition
  By : BEHROUZ A FOROUZAN

- ✓ various relevant websites

Thank You