CS & IT ENGINEERING

COMPUTER NETWORKS

Error Control

Lecture No-1

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TOPICS TO BE COVERED

Error Detection and Error Correction

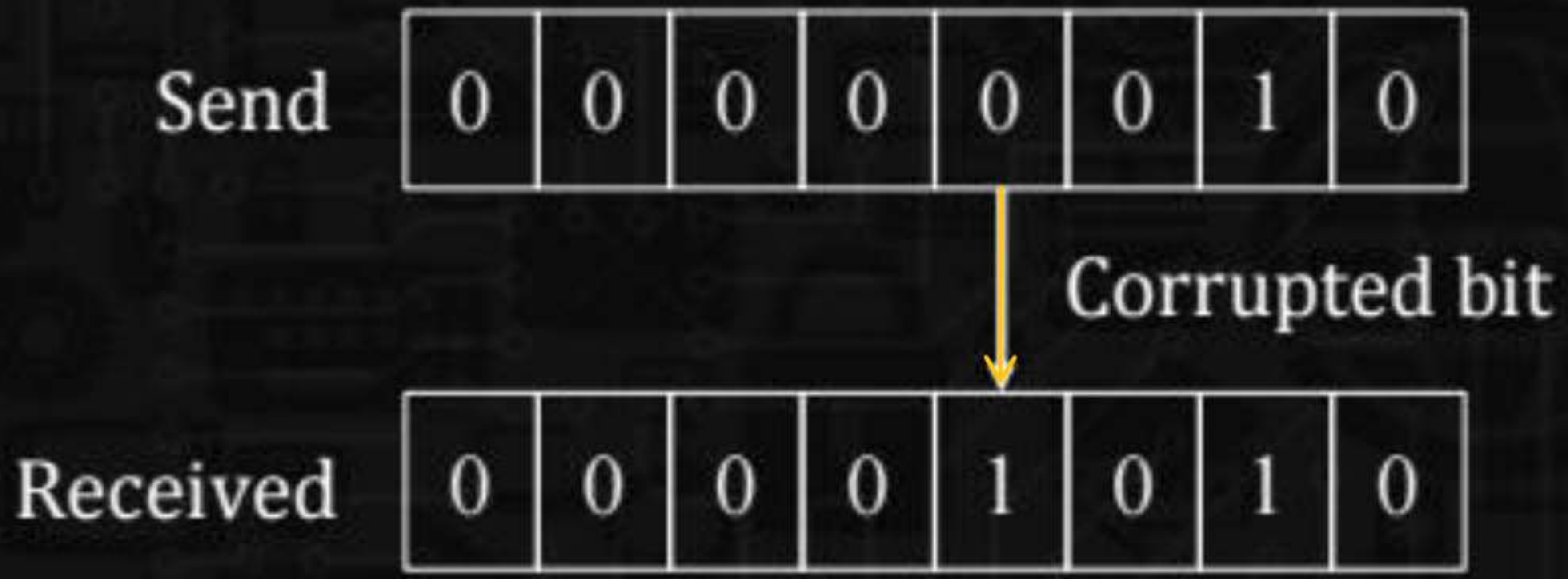
Error

If data received is not same as the data sent then this means error has occurred

- Types of Errors
  - Single-Bit Error
  - Burst Error

Single bit error:

The term single bit error means that only 1 bit of given data unit is changed from 1 to 0 or 0 to 1.



Burst Error :

The term burst Error means that 2 or more bits in the data unit have changed from 1 to 0 or from 0 to 1.

← Burst length = 4 →

Send	0	1	0	0	1	0	1	0
Received	0	1	1	0	1	1	1	0

Note :

- No. of corrupted bits or affected bits depends on the data rate and duration of noise
- Burst error is more likely to occur than a single bit error.

→ No. of corrupted bits or affected bits = Data rate * Noise duration

(1) Data rate = 1 Kbps = 10^3 bits/sec

Noise duration = $\frac{1}{10}$ sec

No. of corrupted bits or affected bits = $10^{\cancel{3}}$ bits/$\cancel{sec}$ * $\frac{1}{\cancel{10}}$ $\cancel{sec}$

= 100 bits

(2) Data rate = 1 Mbps = 10^6 bits/sec

Noise duration = $\frac{1}{10}$ sec

No. of corrupted bits or affected bits = $10^{\cancel{6}}$ bits/$\cancel{\text{sec}}$ * $\frac{1}{\cancel{10}}$ $\cancel{\text{sec}}$

$= 10^5$ bits

$= 100000$ bits

Error control

Error detection

Error correction

~~₹ 5000~~ $\boxed{5K}$

₹ 4500

Redundancy :

1. The central concept in Detecting or correcting error is Redundancy.
2. To be able to detect or correct the errors, we need to send some extra bits with our data. These redundant bits are added by the sender and removed by the receiver.

Error Control

Error detection

Error correction

Data + Data

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Sent : 10 10 10 10

Rcvd : 10 0 0 1 1 1 0

: 10 10 10 10

Error detection :

In Error detection we are only Looking to see if any error has occurred. The answer is simple Yes or No. we are not even interested in the number of corrupted bits. A single bit error is same for us as a Burst Error.

Error Correction :

In Error correction we need to know the exact number of bits that are corrupted and more importantly, their location in the message.

Error Detection & Error Correction

Note :

- Correction of error is more difficult than detection
- If we need to correct a single error in an 8 bit data unit, we need to consider eight possible error locations.

Data = 10101010 = $^8C_1 = 8$

- If we need to correct two error in an 8 bit data unit, we need to consider 28 possibilities.

Data = 10101010

$^8C_2 = \frac{8 \times 7}{2} = 28$

Error Control

Error detection | Error correction

1.	Simple Parity	1.	Hamming code
2.	2D parity		
3.	Check sum (NL|TL)=2B		
4.	CRC (DLL) = 4B		

5. Data + Data

➢ Once noticed error simply discard	➢ Capability of correcting error
➢ Ask for retransmission	➢ does not required retransmission
	➢ Hamming code can correct single bit Error

Logic for Error Detection

Logic for error detection :

- Error detection is based on block coding.
- In block coding ,we divide our message into blocks ,each of size k bits called data words
- We add ‘r’ redundant bits [redacted] to each data words and resulting word is called as codewords of length n i.e. n=k+r
- In place of sending data words we send corresponding codewords

message = 00|01|10|11

$\underbrace{00}_{\text{dataword}}$

Let $K=2$ and $r=1$ bit so dataword is of 2 bits and codeword is of 3 bits i.e $n=K+r \Rightarrow 2+1$

Dataword	Codeword
00	000
01	011
10	101
11	110

$(n>K)$

Data word = K bit $\downarrow$ 2^K combination

codeword = n bits $\downarrow$ 2^n combination

$2^n - 2^K$ codeword that are Not used

$\Downarrow$

Invalid codework

Dataword	valid codeword
00 →	000
01 →	011
10 →	101
11 →	110

Codeword = 3 bits

000 ✓
001 X
010 X
011 ✓
100 X
101 ✓
110 ✓
111 X

Invalid codeword

$2^n - 2^k \to$ Invalid codeword

$2^3 - 2^2 = 4 \to$ Invalid codeword

Codeword

Valid codeword (2^k)

Invalid code work ($2^n - 2^k$)

- With k bits we can create a combination of 2^k datawords ,with n bits we can create a combination 2^n called codeword
- We know that n>k , there exist one to one correspondence b/w codeword and dataword
- Hence $\boxed{2^n - 2^k}$ are invalid codeword
- Hence $\boxed{2^k}$ are valid codeword

Error detection using block code :

If the following 2 conditions are met ,the receiver can detect a change in the original codeword

1. The receiver has a list of original codeword
2. The original codeword has changed to invalid one

Dataword	Valid codeword
00	000
01	011
10	101
11	110

Each codeword sent to the receiver may change during transmission

1. If The received codeword is same as the one of the valid codeword ,the word is accepted

(1) 000 (sent) —No error→ 000 (Rcvd) ⇒ Valid code word ⇒ Accepted

2. The received codeword is not valid, it is discarded.

(2) 000 (sent) —1 bit error→ 100 (Rcvd) ⇒ Invalid code word ⇒ Rejected by Receiver
(Rcvr can detect the error)

3. The codeword is corrupted during transmission but the received word still matches a valid codeword ,the error remains undetected

Rcvr Fails to Detect the error

(3) 000 (sent) —2 bit error→ 110 (Rcvd) ⇒ Valid code word ⇒ Accepted


THANK YOU
GW
SOLDIERS !