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# Data Communication CS601 Lecture No 24

Lecture Prepared By

Muhammad Abid Ali

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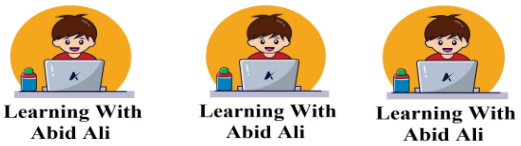
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## CS601 Lecture No 24 Topic 135 to 142

Types of Errors

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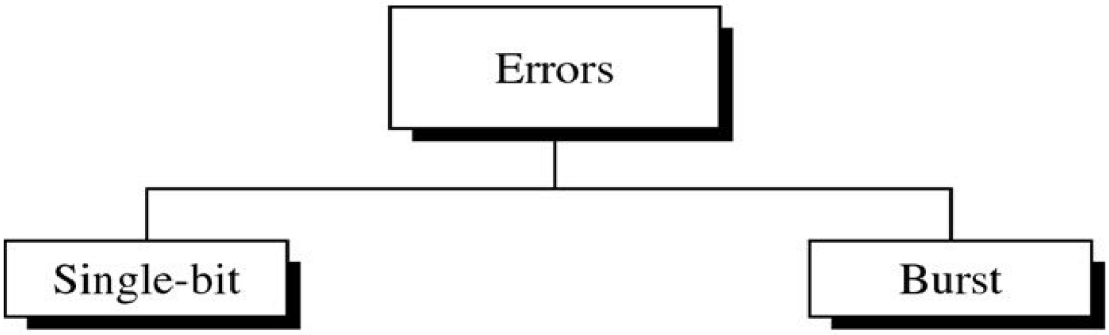
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## Type of Errors

- An electromagnetic signal is subject to interference from heat, magnetism, and other forms of electricity
- Single-bit error: $0 \rightarrow 1$ or $1 \rightarrow 0$
- Burst error: 2 or more bits have changed




- **Data transmission suffers unpredictable changes because of interference**
- **The interference can change the shape of the signal**

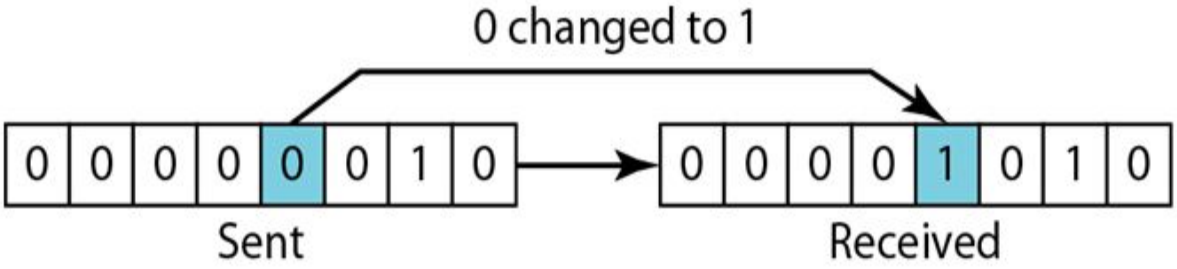
## Single-bit error

**Single-bit error means that only 1 bit of a given data unit (such as a byte, character, or packet) is changed from 1 to 0 or from 0 to 1**

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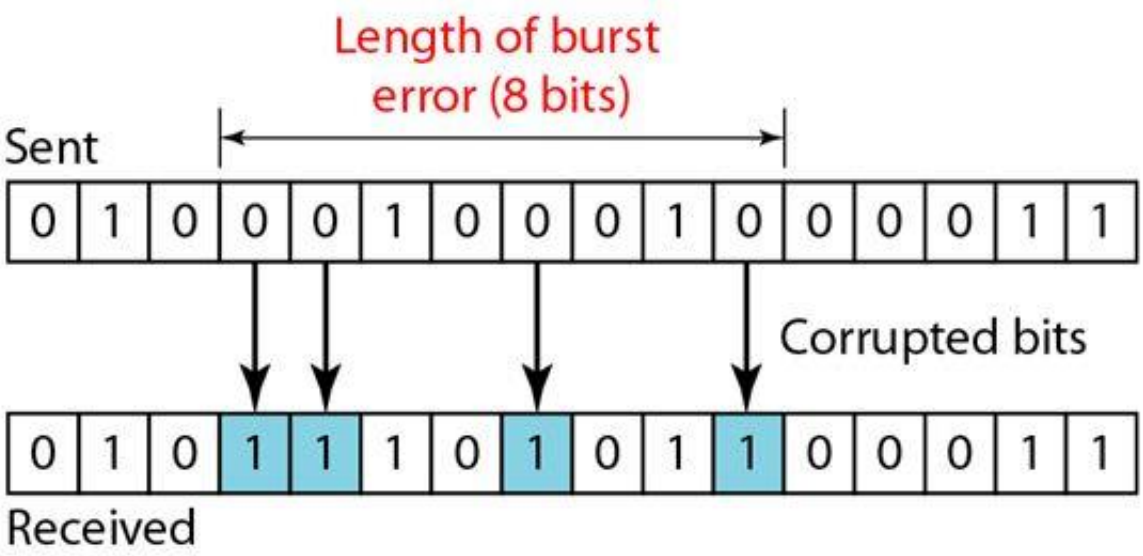
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## Burst Error

**Burst Error means that 2 or more bits in the data unit have changed from 1 to 0 or from 0 to 1**




## Number Of Impacted Bits Depend on Two Things

**Data rate**

**Duration of rate**

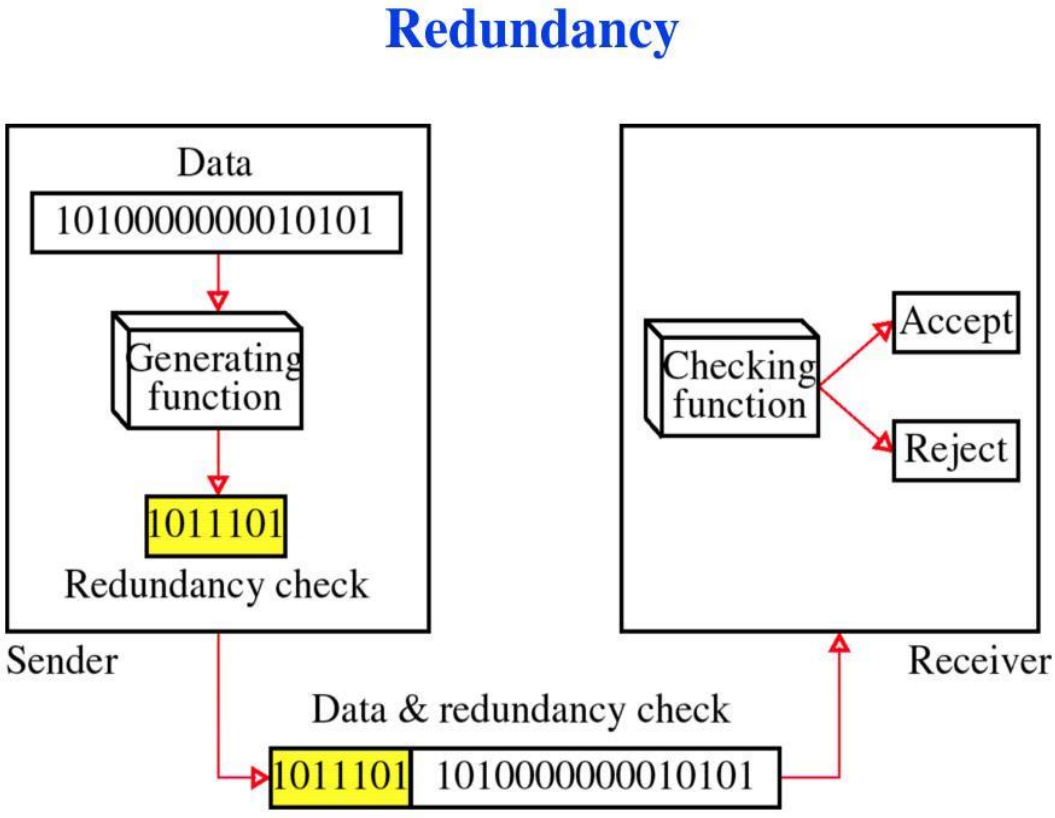
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## Redundancy

- **Central concept in detecting or correcting errors is Redundancy**
- **To be able to detect or correct errors, we send some extra bits with our data**
- **The presence of these redundant bits allows the receiver to detect or correct corrupted bits**




## Detection versus Correction

- **Correction is more difficult than the detection**
- **In error detection, we are only looking to see if any error has occurred (Yes or No)**

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- **We are not interested in the number of corrupted bits in Detection**
- **Single-bit error is same as a Burst error**
- In Error Correction, we need to know:
- The exact number of bits that are corrupted and,
- Their location in the message

## Types of Coding Schemes

- **Coding schemes can be divided into 2 broad categories:**
  - ✓ **Block Coding**
  - ✓ **Convolution Coding**

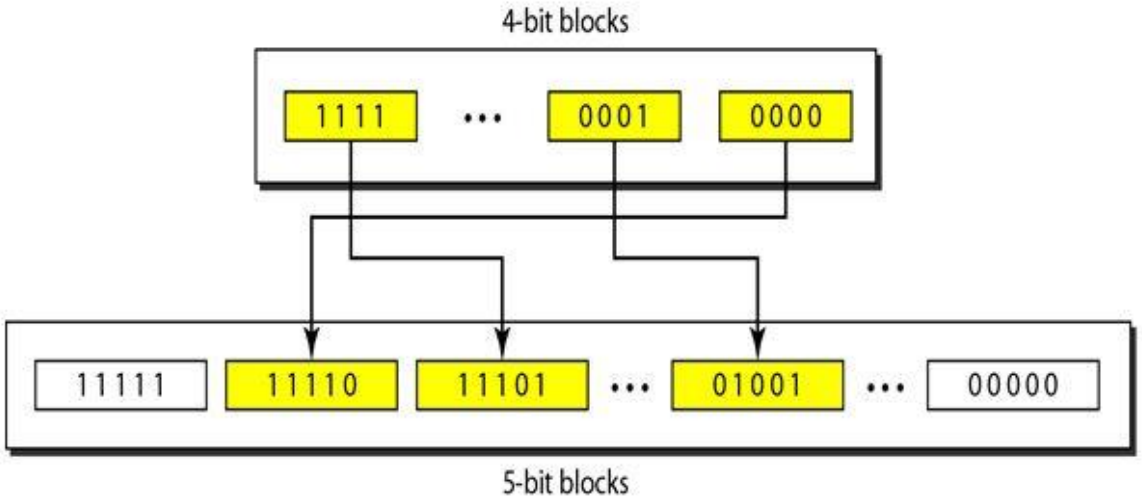
## Block Coding

- **We divide our message into blocks, each of 'k' bits, called datawords**
- **We add 'r' redundant bits to each block to make the length 'n = k + r'**
- **The resulting 'n-bit' blocks are called codewords**

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## BLOCK CODING in Error Detection

- **If the following two conditions are met, the receiver can detect a change in the original codeword:**
  - ✓ **The receiver has (or can find) a list of valid codewords**
  - ✓ **The original codeword has changed to an invalid one**

The sender creates code words out of data words by using a generator that applies the rules and procedures of encoding (discussed later). Each code word sent to the receiver may change during transmission. If the received code word is the same as one of the valid code words, the word is accepted; the corresponding data word is extracted for use.

If the received code word is not valid, it is discarded. However, if the code word is corrupted during transmission but the received word still matches a valid code word, the error remains undetected. This type of coding can detect only single errors. Two or more errors may remain undetected.

For example, consider the following table of data words and Code words:

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| *Datawords* | *Codewords* |
|---|---|
| 00 | 000 |
| 01 | 011 |
| 10 | 101 |
| 11 | 110 |

Assume the sender encodes the data word 01 as 011 and sends it to the receiver. Consider the following cases:

1. The receiver receives 011. It is a valid code word. The receiver extracts the data word 01 from it.

2. The code word is corrupted during transmission, and 111 is received (the leftmost bit is corrupted). This is not a valid code word and is discarded.

3. The code word is corrupted during transmission, and 000 is received (the right two bits are corrupted). This is a valid code word. The receiver incorrectly extracts the data word 00. Two corrupted bits have made the error undetectable.

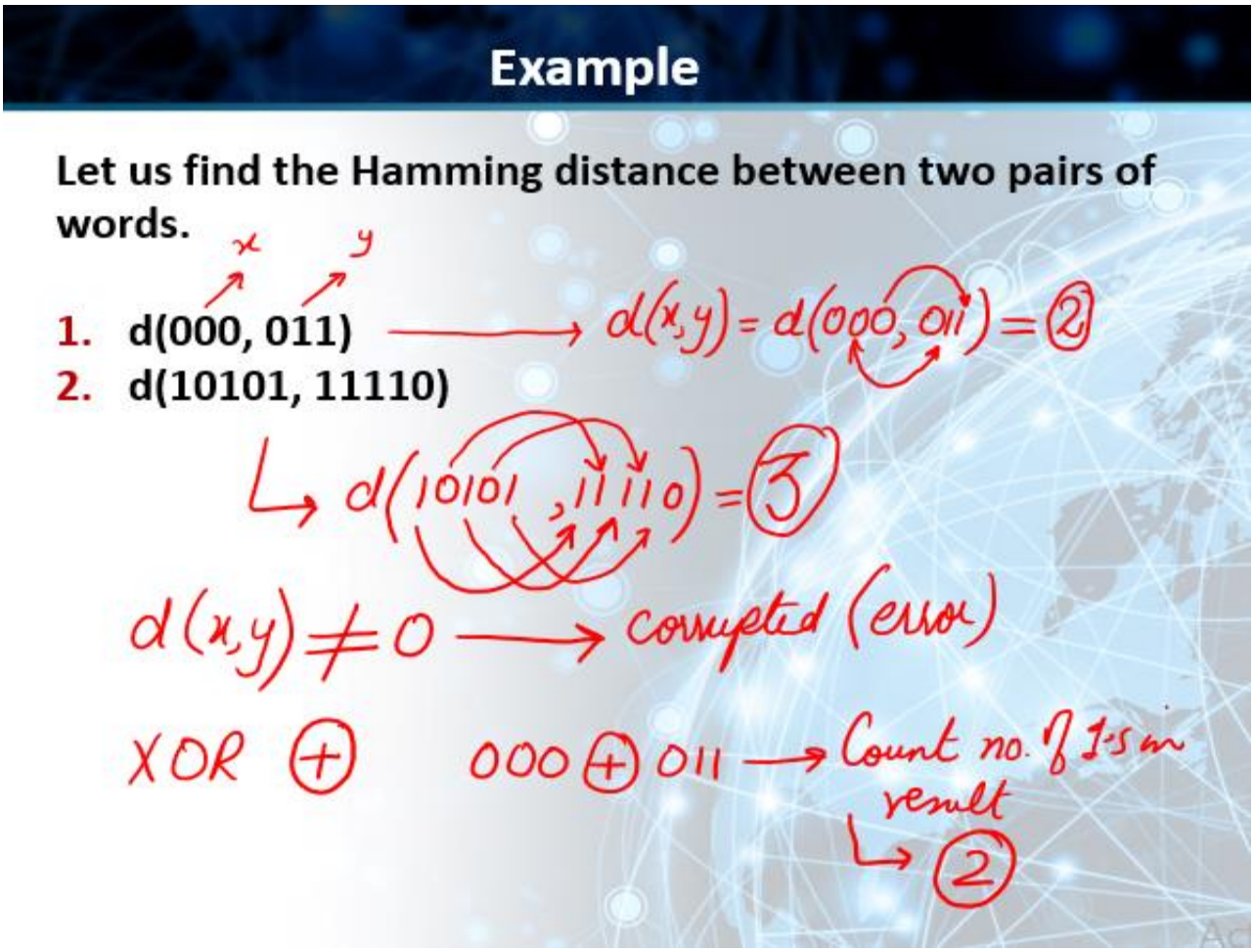
## Hamming Distance

- **Hamming Distance between two words of the same size is the number of differences between the corresponding bits**
- **Hamming Distance between two words x and y is *d* (x, y)**
- **Hamming distance between received codeword and sent codeword is number of bits corrupted**

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## Minimum Hamming Distance

- **Minimum Hamming Distance is smallest hamming distance between all possible pairs of codewords**
- **dmin= s+1**

**were, s →no. of detectable errors dmin→ minimum hamming distance**

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