Indian Institute of Information Technology, Nagpur

Course: Computer Networks (CSL 302, Core)

5th Semester

Topics Covered

- Physical Layer

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Introduction

- Signal
  - Information converted into electrical form and suitable for transmission
- Signals can be either analog or digital
  - Analog Signal
    - Continuous variations of voltage or current
  - Digital signal can take only discrete stepwise values
    - '0' corresponds to a low level of voltage/ current
    - '1' corresponds to a high level of voltage/ current

Bandwidth of a Signal and Medium

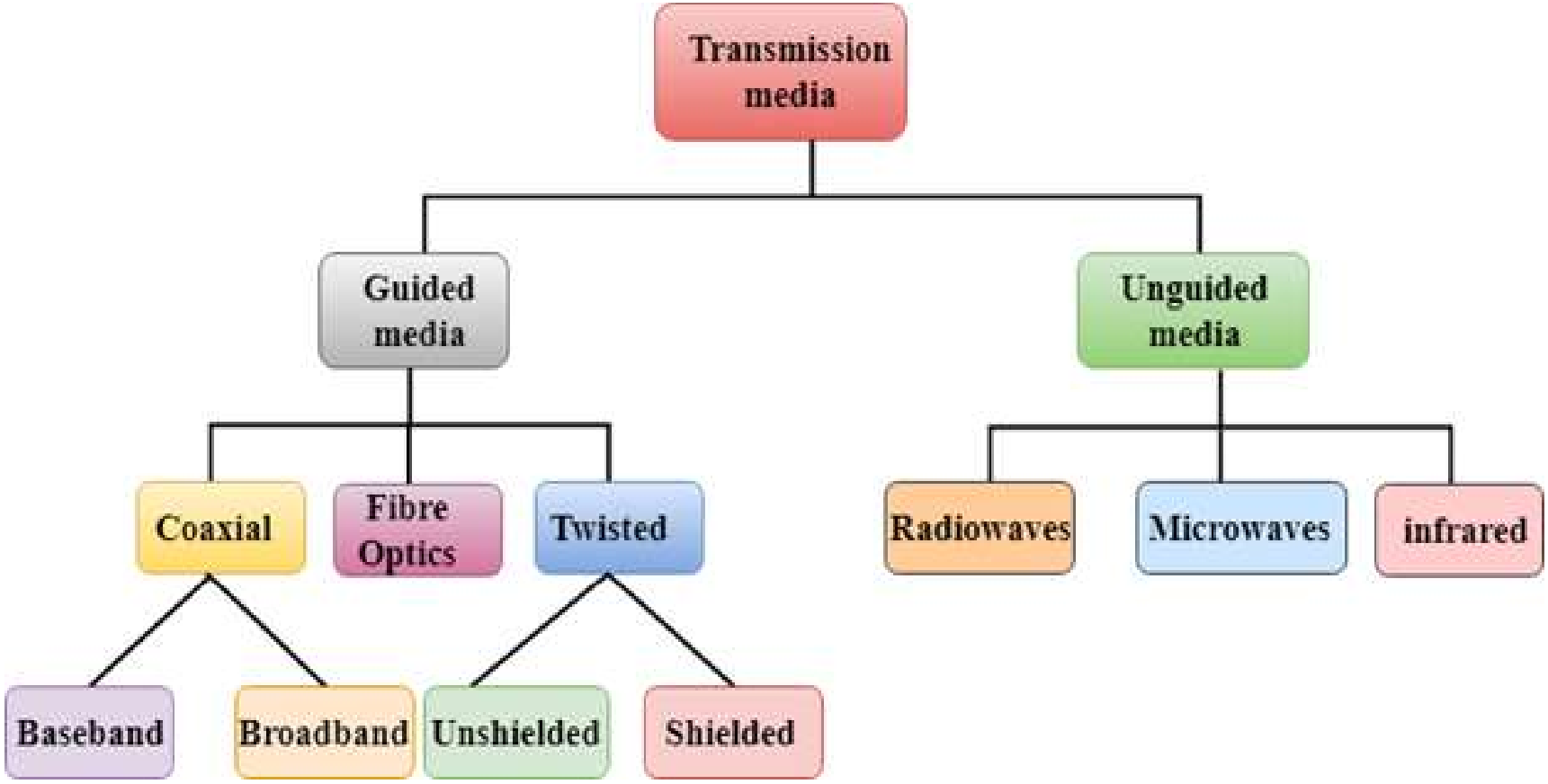
- Bandwidth of a Signal
  - In a communication system, the message signal can be voice, music, and picture or computer data
  - Each of these signals has different ranges of frequencies

Signals	Frequency Range	Bandwidth of signal
Speech	300 Hz to 3100 Hz	2800 Hz
Music	20 Hz to 20000 Hz	19980 Hz
Video	1500 MHz to 1506 MHz	6 MHz
Computer data	2000 MHz to 2600 MHz	600 MHz

Cont…

- Bandwidth of Transmission Medium
  - Different types of transmission media offer different bandwidths
  - Commonly used transmission media are wire, free space, and fibre optic cable
    - Coaxial cable offers a bandwidth of approximately 750 MHz
    - Communication through free space using radio waves takes place over a very wide range of frequencies: from a few hundreds of kHz to a few GHz.
    - Optical communication using fibres is performed in the frequency range of 1 THz to 1000 THz (microwaves to ultraviolet)

Transmission Media



Cont…

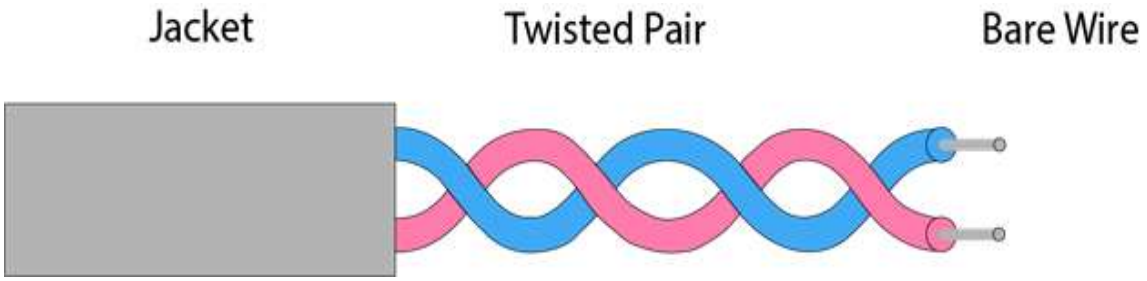
- Guided Media
  - The physical medium through which the signals are transmitted
  - Also known as Bounded media
- Unguided Transmission
  - Transmits the electromagnetic waves without using any physical medium
  - Also known as wireless transmission
  - Air is the media through which the electromagnetic energy can flow easily

Types of Guided Media

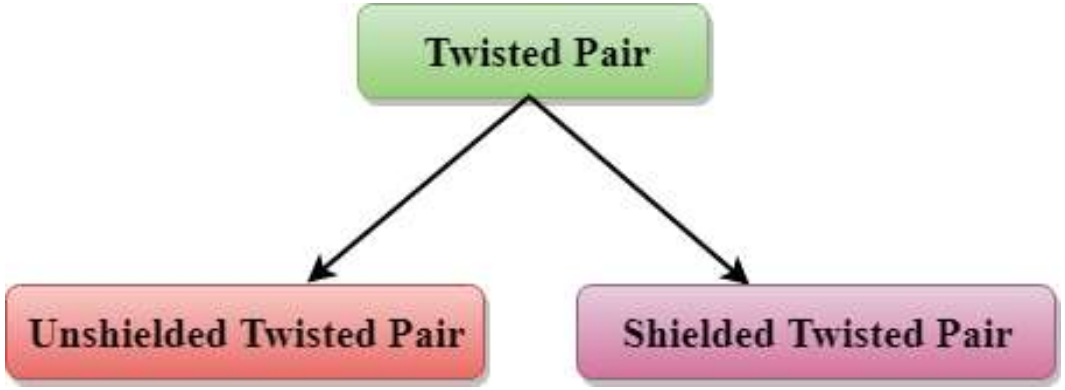
- Twisted pair
  - A physical media made up of a pair of cables twisted with each other
  - Consists of two insulated copper wires arranged in a regular spiral pattern
  - Frequency range 0 to 3.5 KHz
  - Cheap, lightweight and easy to install

Cont…

- Twisted pair



- Types of Twisted pair



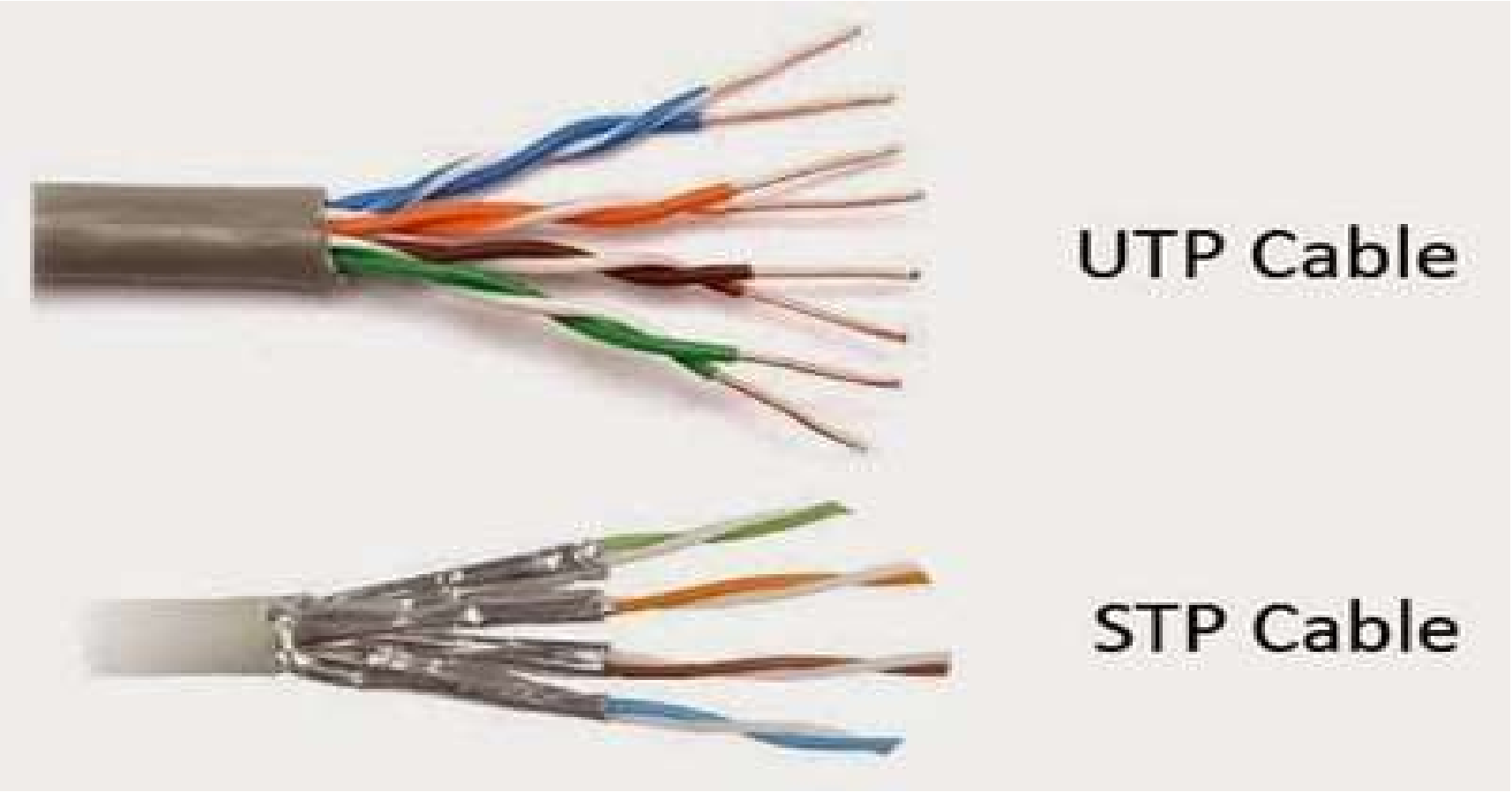
Unshielded Twisted Pair

- An unshielded twisted pair
  - widely used in telecommunication
- Various categories of the unshielded twisted pair cable
  - Category 1: used for telephone lines that have low-speed data
  - Category 2: can support up to 4Mbps
  - Category 3: can support up to 16Mbps
  - Category 4: can support up to 20Mbps, can be used for long-distance communication
  - Category 5: can support up to 200Mbps

Shielded Twisted Pair

- Cable - contains the mesh surrounding the wire that allows the higher transmission rate
- Characteristics
  - It is shielded that provides higher data transmission rate
  - Cost - not very high, not very low
  - Installation is easy
  - Higher capacity as compared to UTP cable
- Disadvantages
  - More expensive as compared to UTP and coaxial cable
  - Has a higher attenuation rate

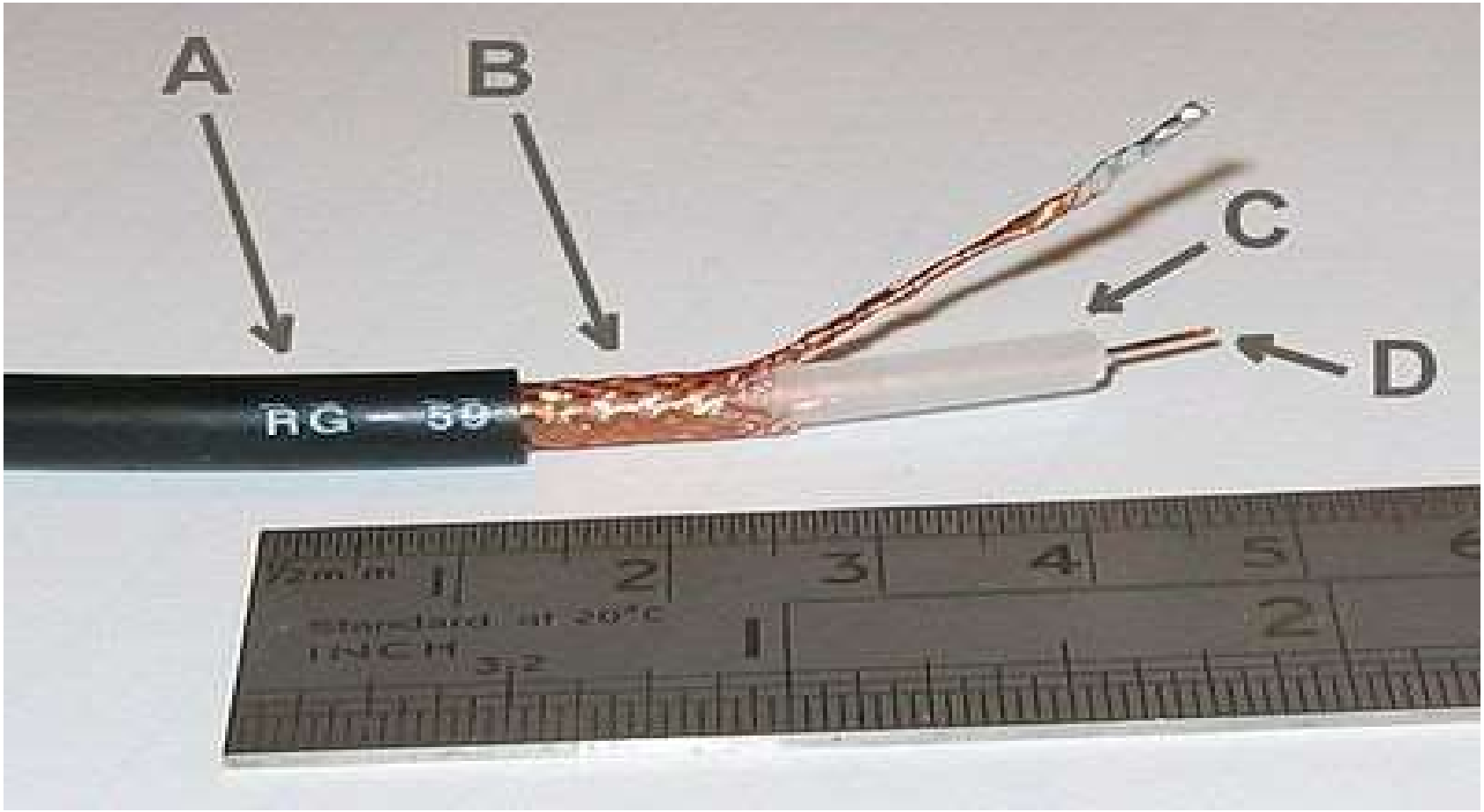
Cont…



Coaxial Cable

- Contains two conductors parallel to each other
  - inner conductor - made up of copper
  - outer conductor - made up of copper mesh
- Very commonly used transmission media, for example, TV wire is usually a coaxial cable
- Has a higher frequency as compared to Twisted pair cable

Cont…



Cont…

- Coaxial cables are of two types
  - Baseband transmission
  - Broadband transmission

Fiber Optics

- Permit transmission over longer distances and at higher bandwidths (data transfer rates) than electrical cables
- Optical Fiber is a flexible, transparent fiber made by drawing glass (silica) or plastic
- Fibers are used instead of metal wires
  - signals travel along them with less loss
  - immune to electromagnetic interference
- Used most often as a means to transmit light between the two ends of the fiber

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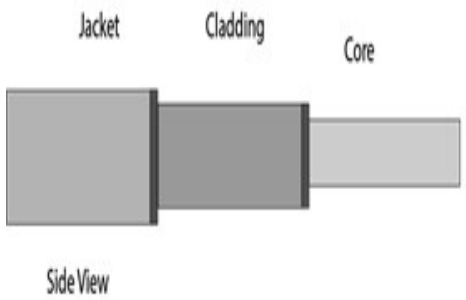
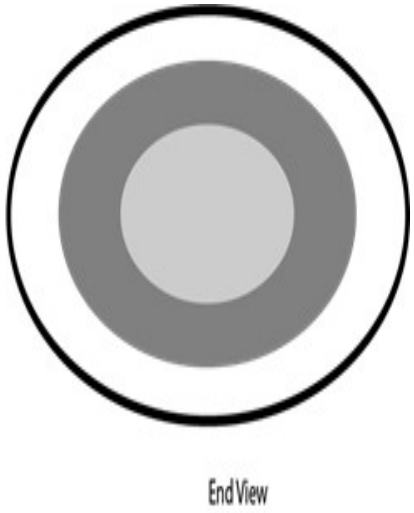
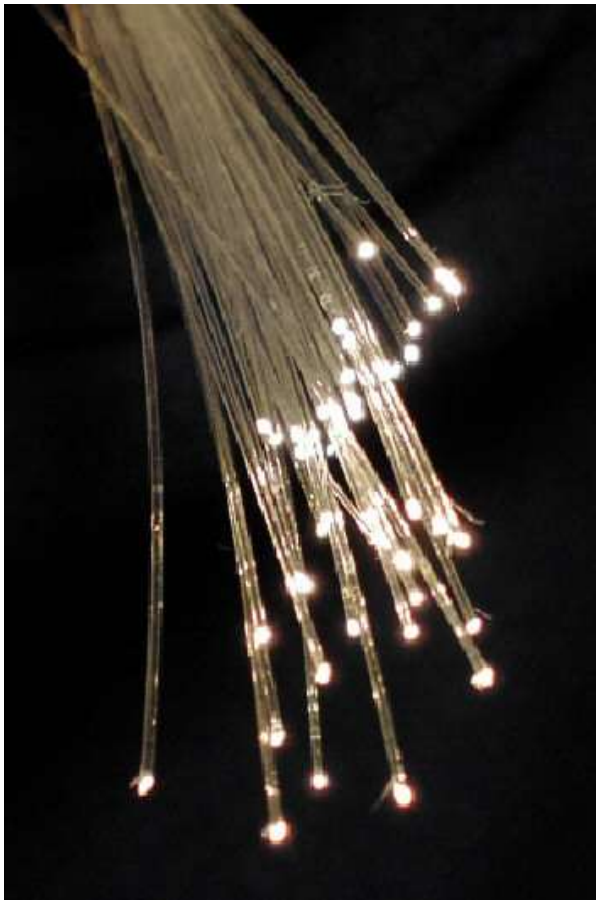
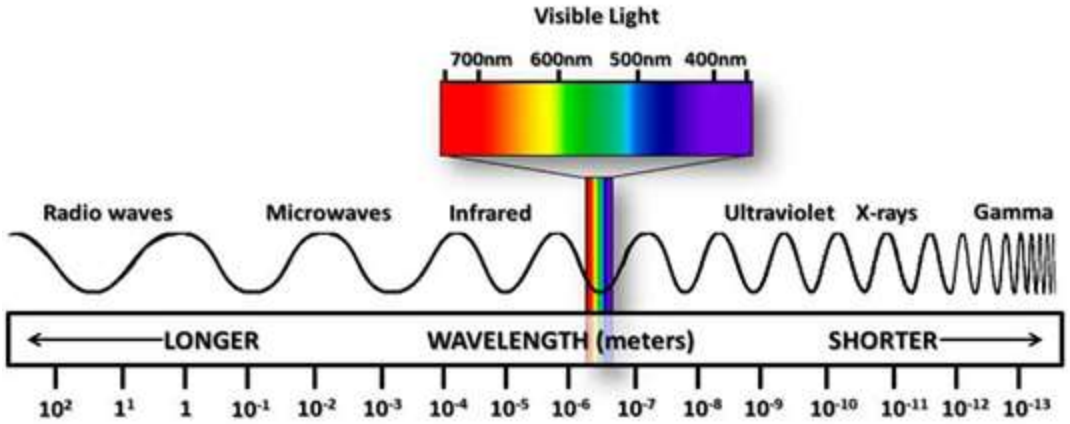






Unguided Transmission

- Unguided transmission
  - Transmits the electromagnetic waves without using any physical medium
- Also known as wireless transmission
- In unguided media, air is the media through which the electromagnetic energy can flow easily
- Broadly classified into three categories
  - Radio waves
  - Microwaves
  - Infrared

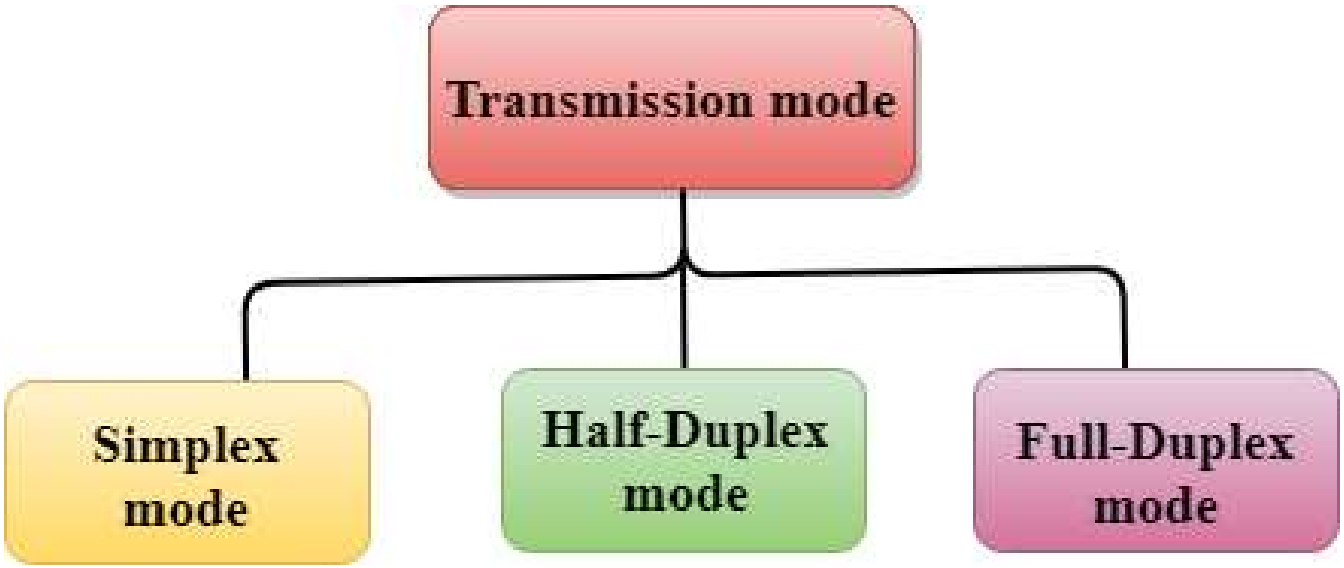


Transmission Mode

- Transmission mode
  - The way in which data is transmitted from one device to another device
  - Also known as the communication mode
  - Each communication channel has a direction associated with it, and transmission media provide the direction. Therefore, the transmission mode is also known as a directional mode
  - Defined in the physical layer

Cont…

- Transmission mode categories



Cont…

- Simplex mode
  - The communication is unidirectional, i.e., the data flow in one direction
  - A device can only send the data but cannot receive it or it can receive the data but cannot send the data
  - Not very popular, used in the business field as in sales that do not require any corresponding reply
  - Ex:
    - Radio station
    - Keyboard and Monitor

Cont…

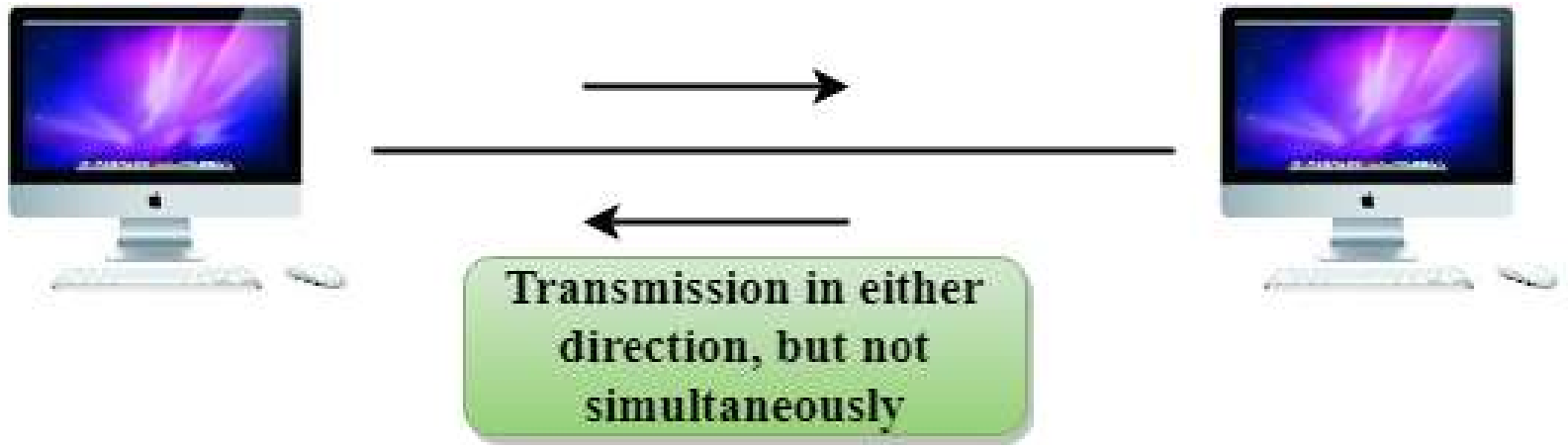
- Simplex mode

Cont…

- Half-duplex mode
  - The station can transmit and receive the data as well
  - Messages flow in both the directions, but not at the same time
  - The entire bandwidth of the communication channel is utilized in one direction at a time.
  - Possible to perform the error detection, and if any error occurs, then the receiver requests the sender to retransmit the data
  - Ex: A Walkie-talkie

Cont…

- Half-duplex mode

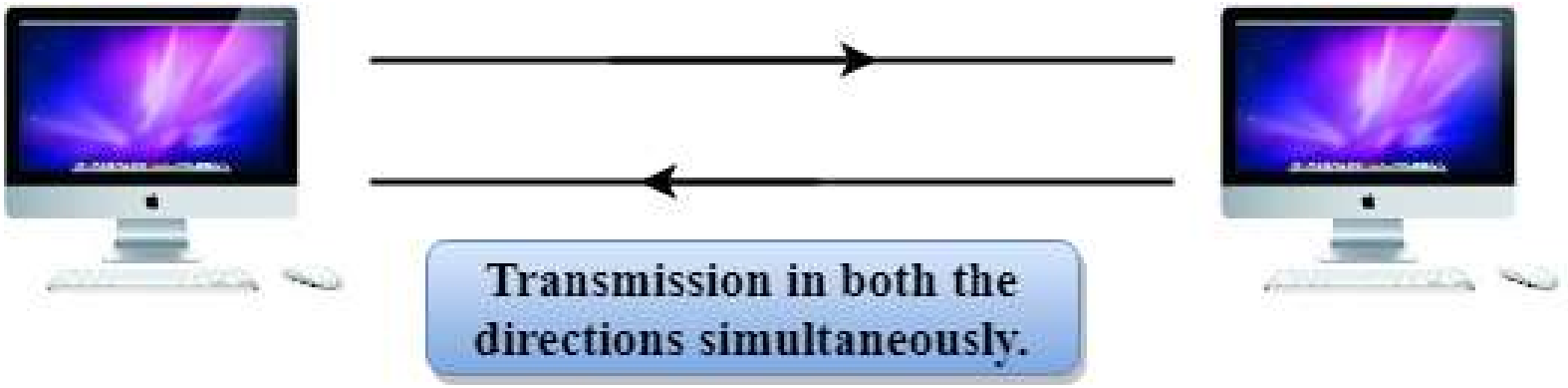


Cont…

- Full duplex mode
  - The communication is bi-directional, i.e., the data flow in both the directions
  - Both the stations can send and receive the message simultaneously
  - Full-duplex mode has two simplex channels
    - One channel has traffic moving in one direction, and another channel has traffic flowing in the opposite direction
  - The fastest mode of communication between devices
  - Ex: Telephone network

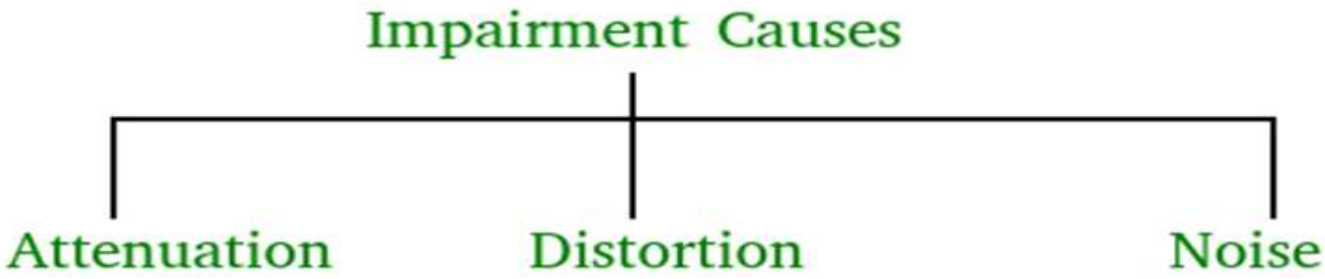
Cont…

- Full duplex mode



Transmission Impairment

- Transmission Impairment
  - Occurs when the received signal is different from the transmitted signal
  - Analog signals: resulting received signal gets different amplitude or the shape
  - Digitally signals: resulting received signal have changes in bits (0's or 1's)



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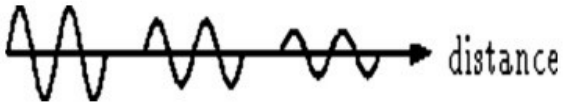
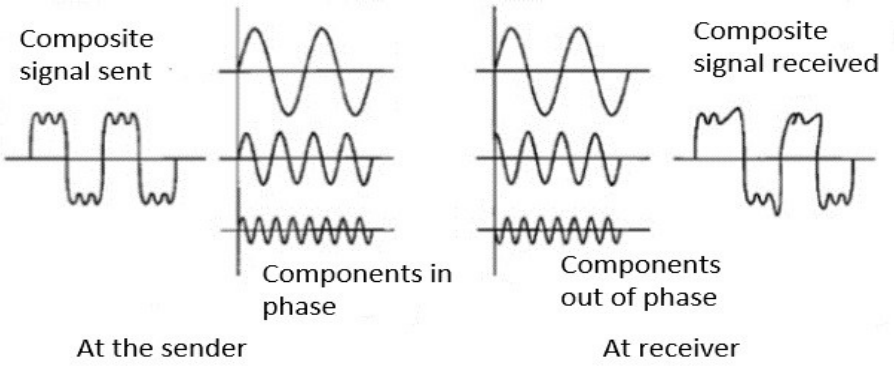
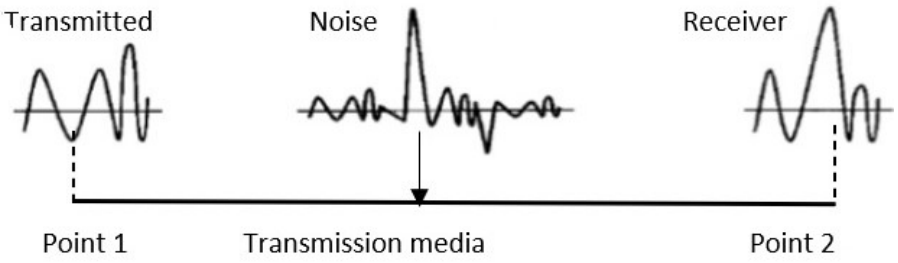

distance


Composite
signal sent
Components in
phase
At the sender
Composite
signal received
Components
out of phase
At receiver

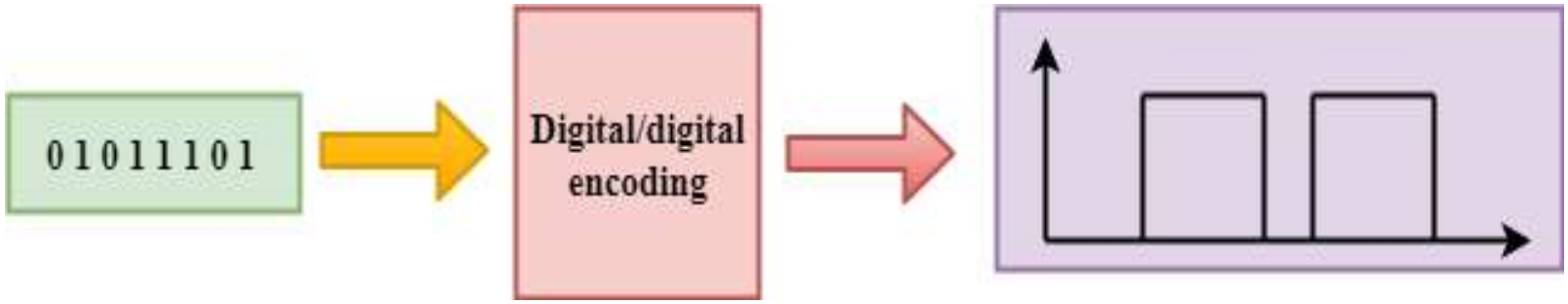

Transmitted
Noise
Receiver
Point 1
Transmission media
Point 2

Encoding Techniques

- Data can be represented either in analog or digital form
- The computers used the digital form to store the information
  - i.e. the data needs to be converted in digital form so that it can be used by a computer
- Digital-to-digital encoding is the representation of digital information by a digital signal

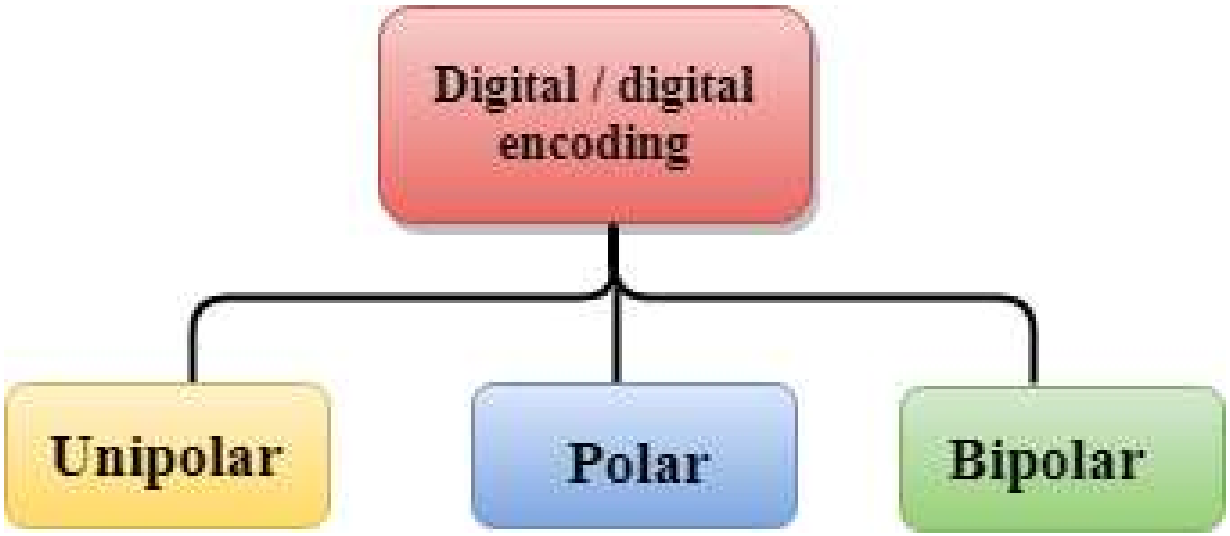
Cont…

- Digital-to-digital encoding
  - When binary 1s and 0s generated by the computer are translated into a sequence of voltage pulses that can be propagated over a wire,
  - Example



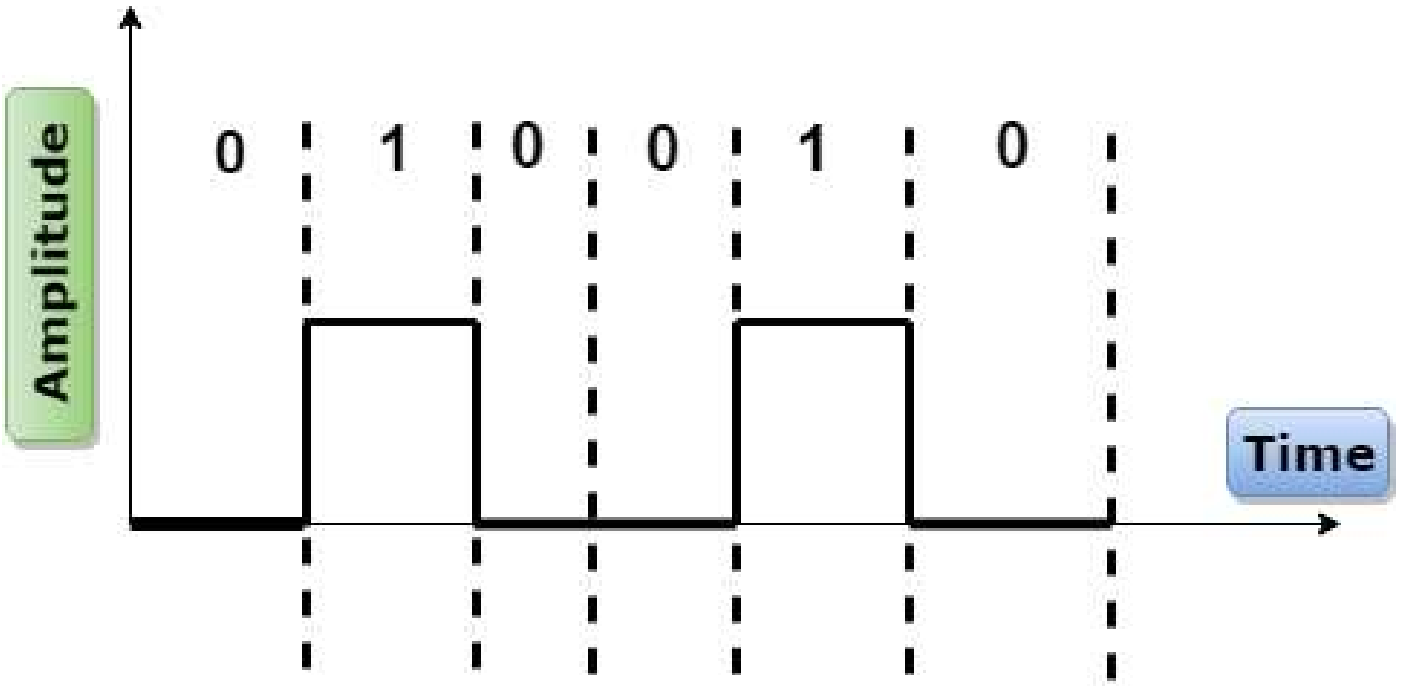
Cont…

- Digital-to-digital encoding is divided into three categories:



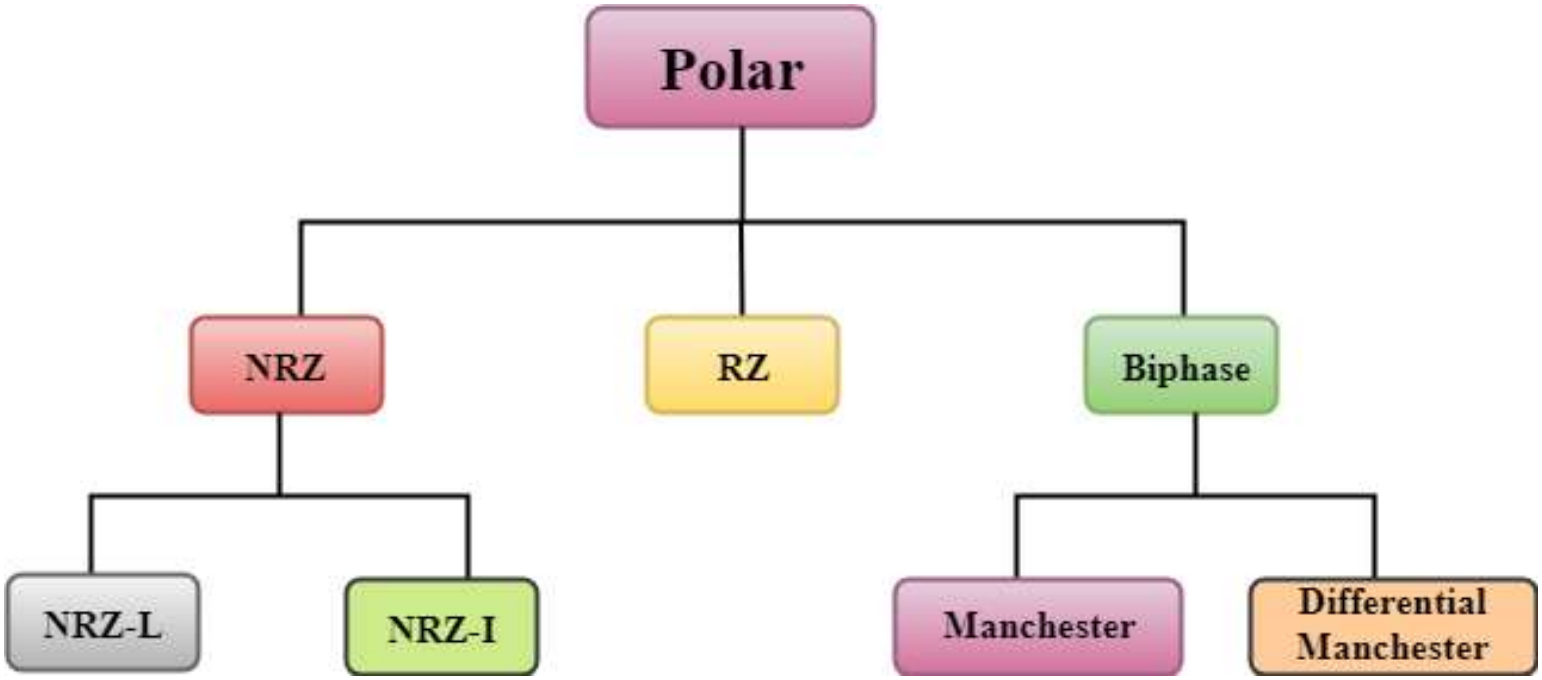
Cont…

- Unipolar Encoding



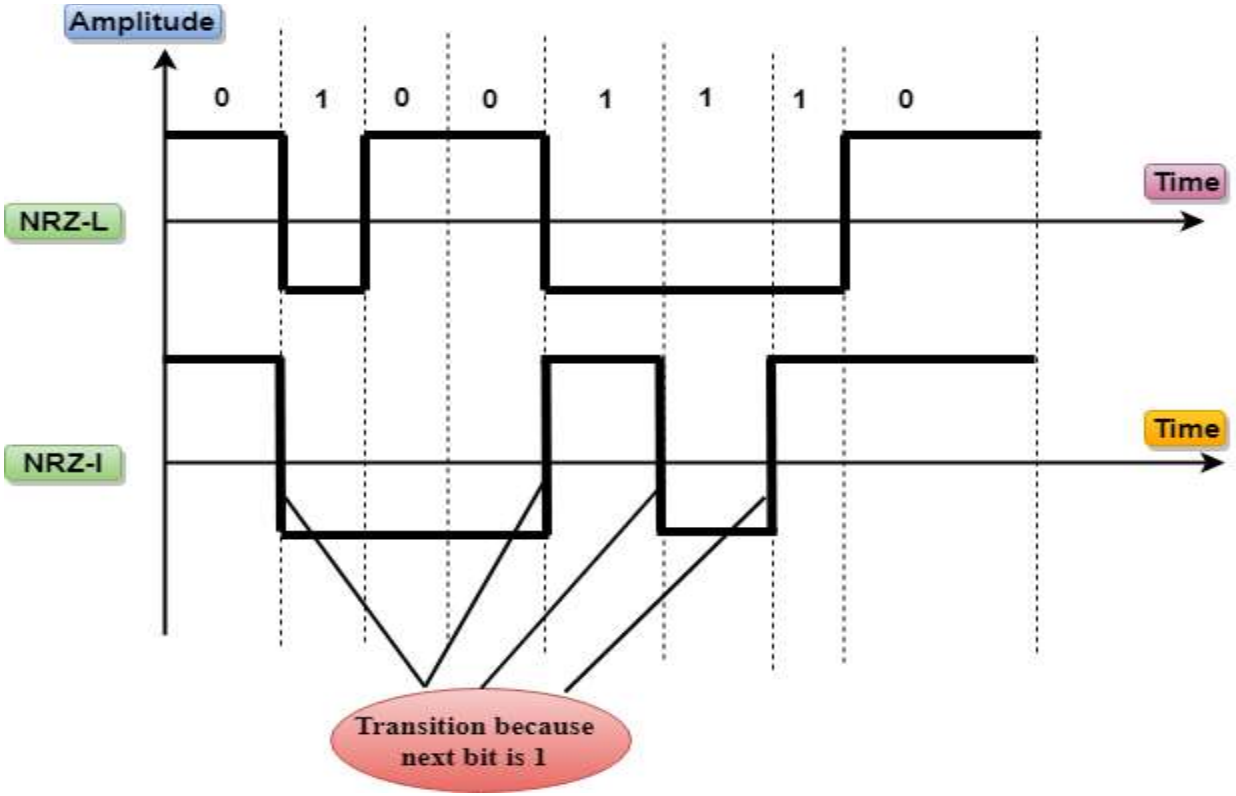
Cont…

- Polar Encoding



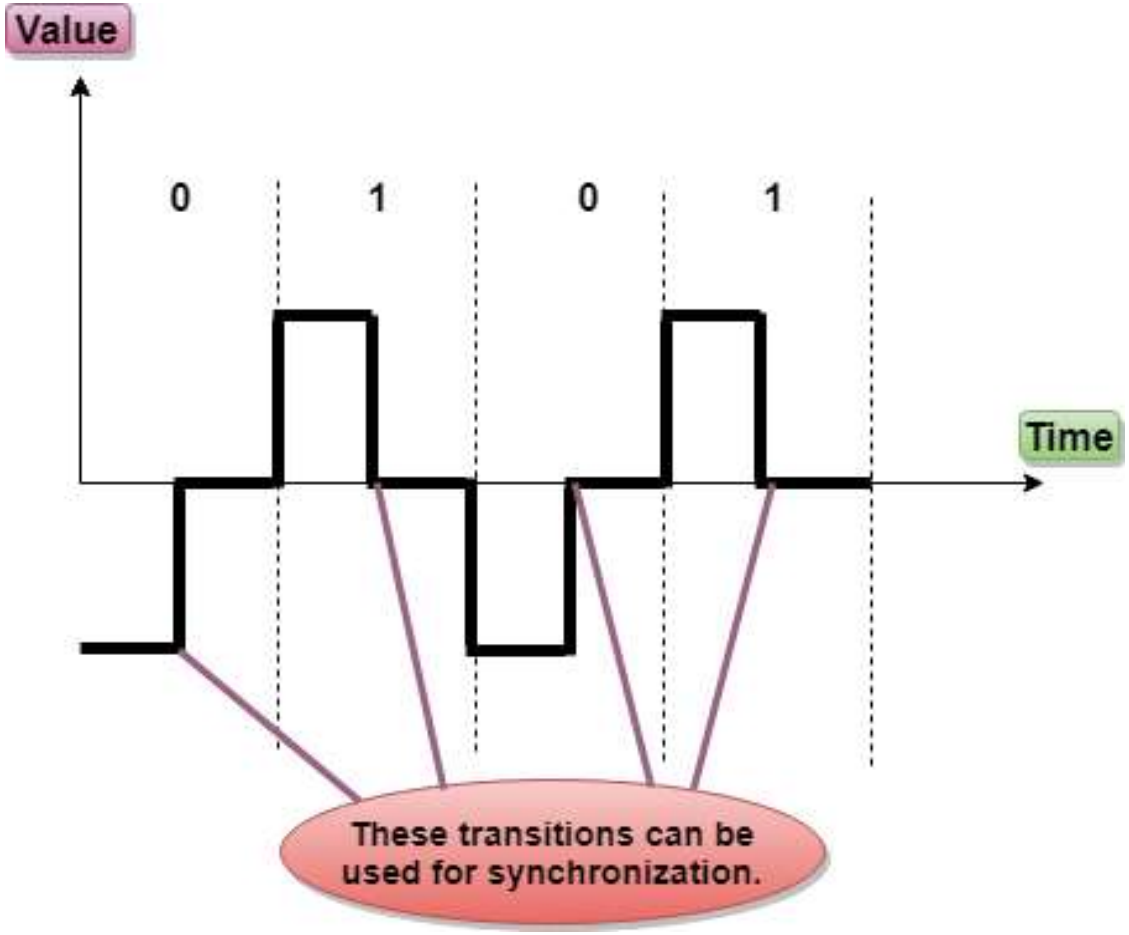
Cont…

- Non-return to Zero (NRZ)
  - The level of the signal can be represented either positive or negative



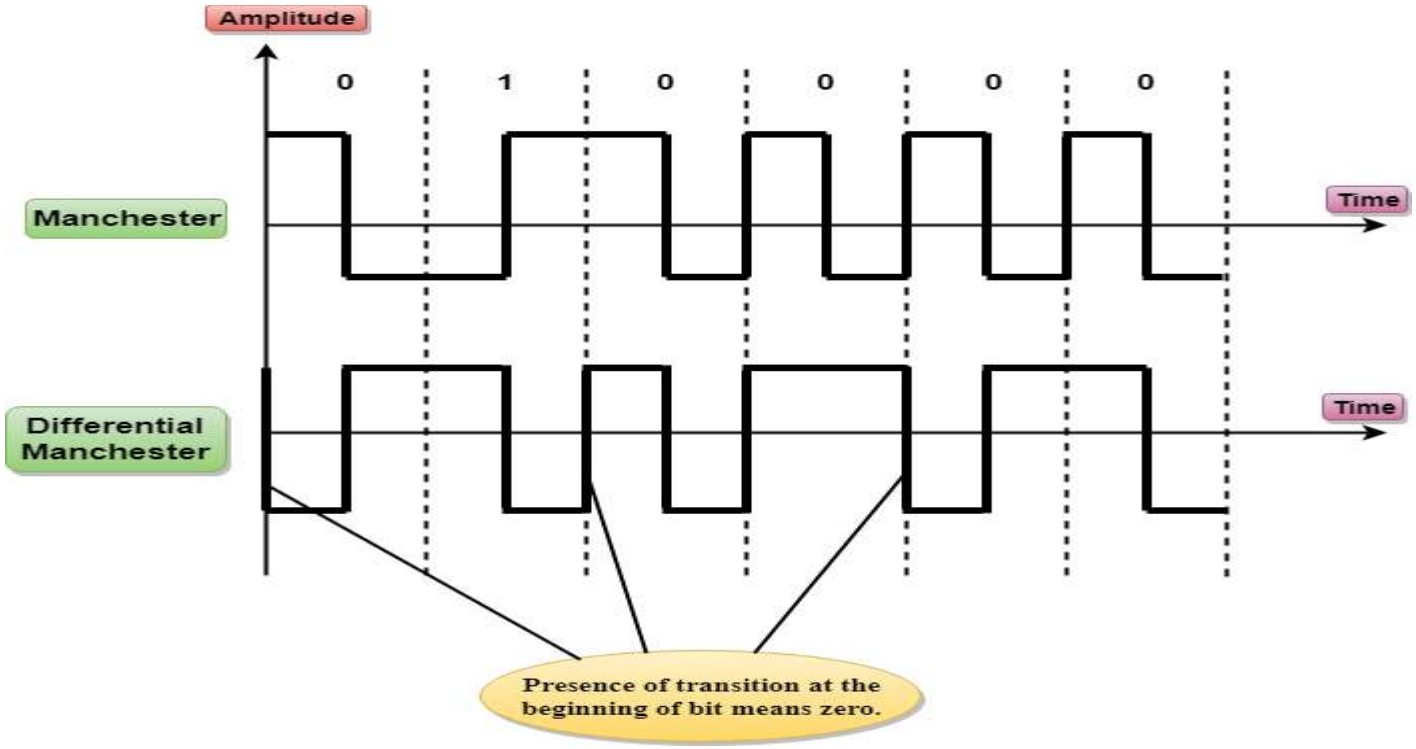
Cont…

- Return to zero (RZ)



Cont…

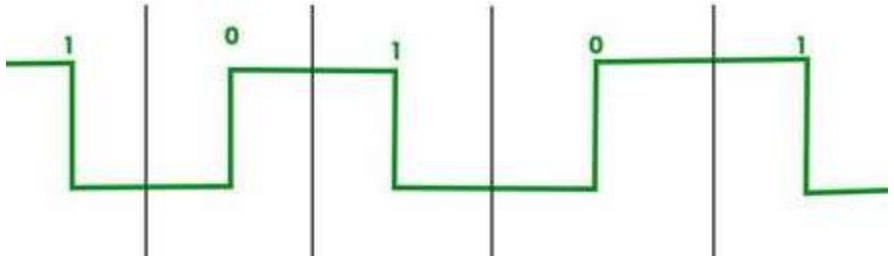
- Biphase
  - Signal changes at the middle of the bit interval but does not return to zero



Cont…

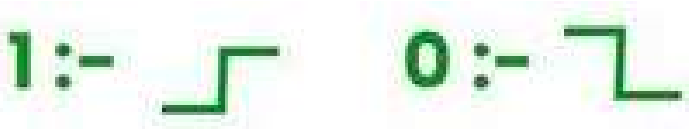
- Two types of conventions in Manchester encoding
  - Dr. Thomas conventions
  - IEEE 802.3 conventions
- Dr. Thomas: In this manchester encoding 0 is represented as low-to-high and 1 is represented as high-to-low.

10101



Cont…

- **IEEE 802.3:** In this manchester encoding, 0 is represented as high-to-low and 1 is represented as low-to-high.



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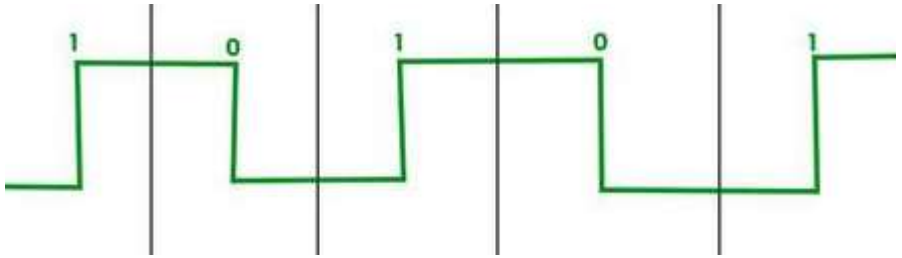
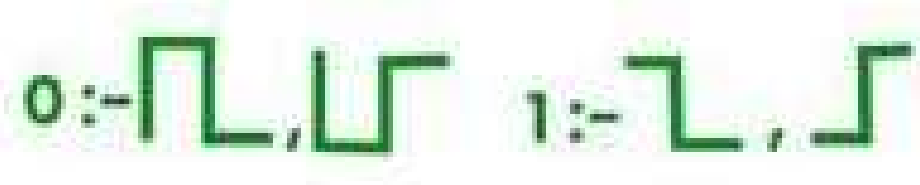


Cont…

- Differential Manchester Encoding
  - Presence and absence of transition indicate the value.
  - 0 should contain an edge but 1 should not contain any edge it should be continuous.



10100