Module 1
Introduction

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Topics

1. Basics of analog communication systems
2. Sources of information
3. Types of communication channels
4. Frequency / Spectrum allocations
5. Baseband and bandpass signals

Objectives

1. To have a basic idea about electronic communication.

2. To understand the various categories of electronic communication.

3. To be aware of the electromagnetic spectrum.

Basics of analog communication systems

Basic Communication Model

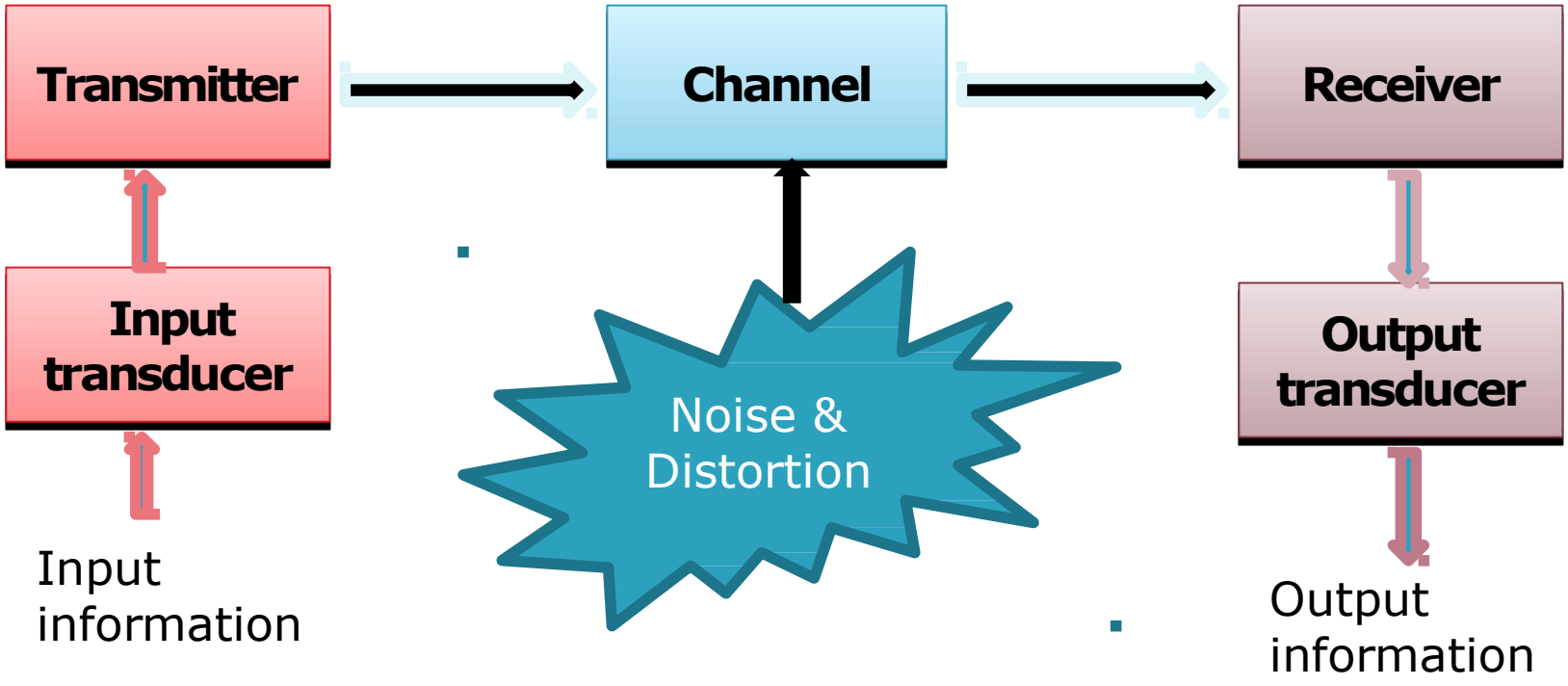
Basic communication model

Source – sender of the information

Sink – receiver that receives the information

Channel – transmission path/medium of the information between the source and sink

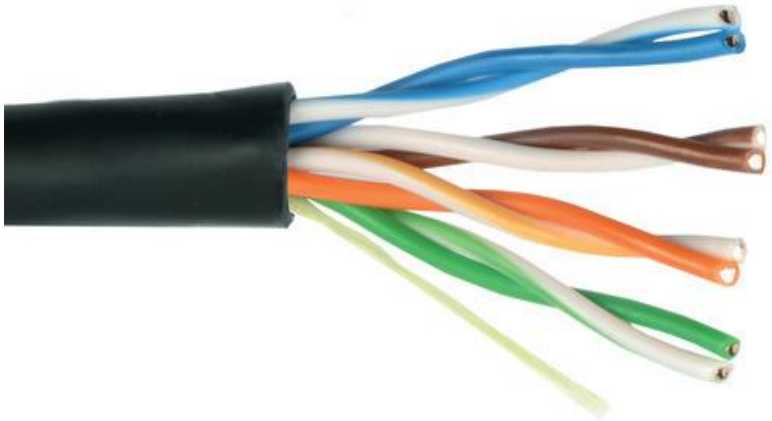
Block diagram of analog communication system



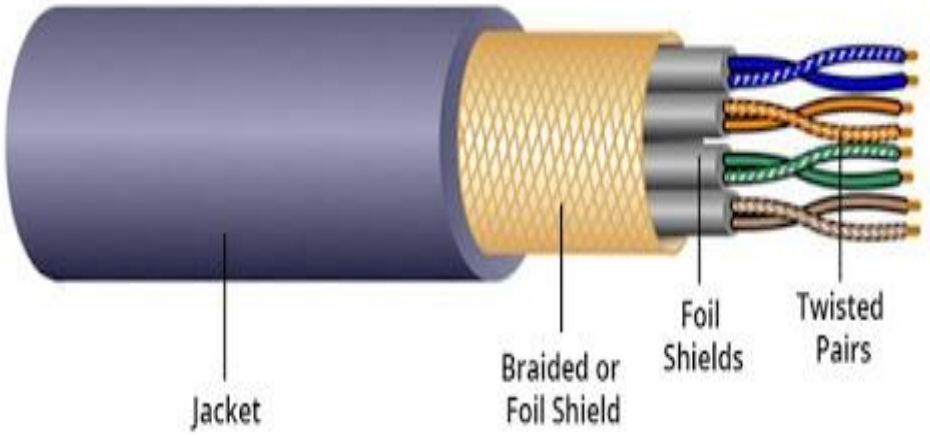
1.2 TYPES OF COMMUNICATION CHANNELS

Communication channel is the medium used for transmission of signals from one place to another. The channels could be either wired or wireless. Some of the channels are described below.

A) Twisted Wire Lines – The original telephone and telegraph transmission lines which are still in use today. Provides data rate up to kb/s.



Unshielded Twisted Pair

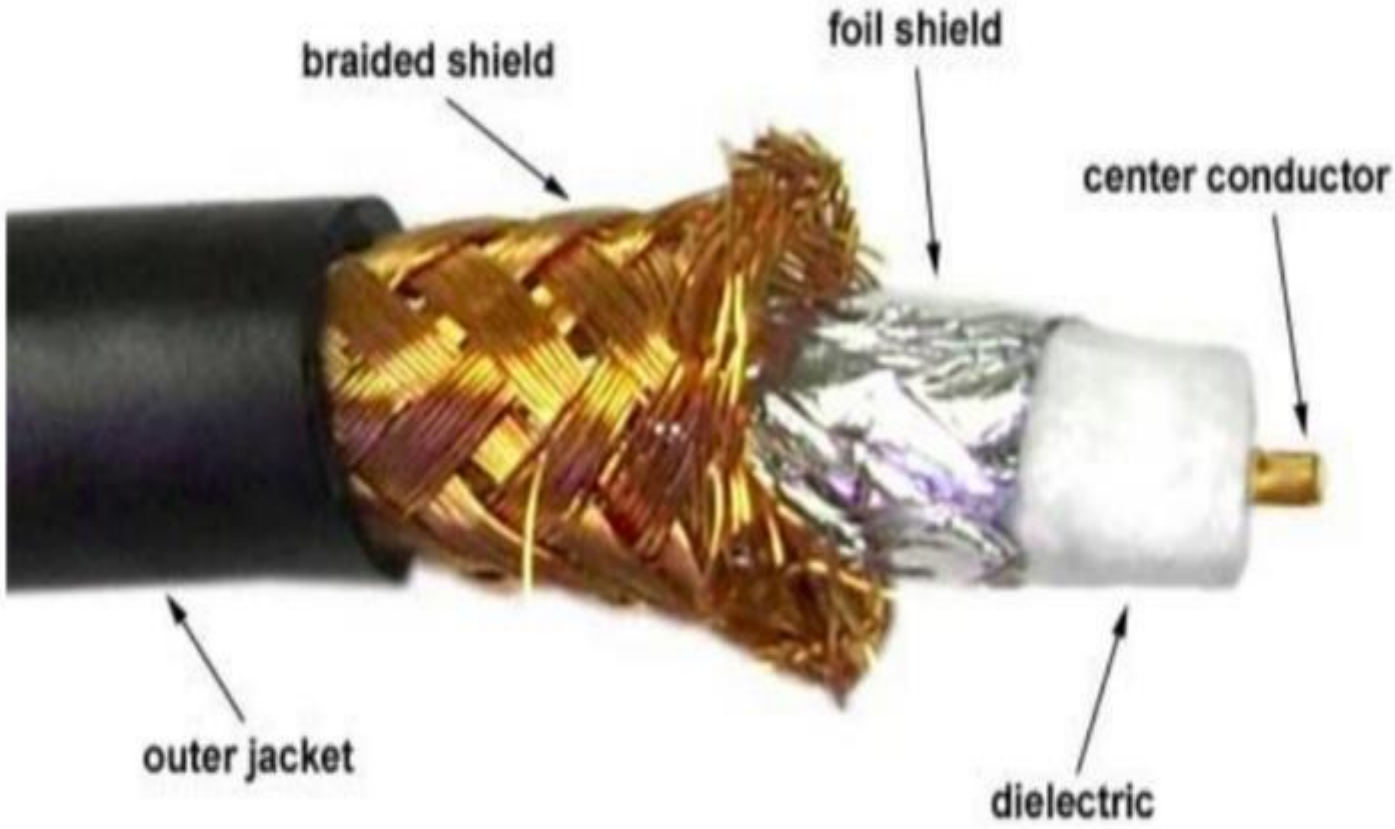


Shielded Twisted Pair

- Unshielded Twisted Pair (UTP): These generally comprise of wires and insulators.
- Shielded Twisted Pair (STP): They have a braided wired mesh that encases each pair of insulated wires.

B) Coaxial Cables – It consists of a single wire conductor at the centre of a cylindrical cable and an outer cable, typically a wire mesh separated by dielectric. It is used for television connection, LAN for computers etc.

COAXIAL CABLE



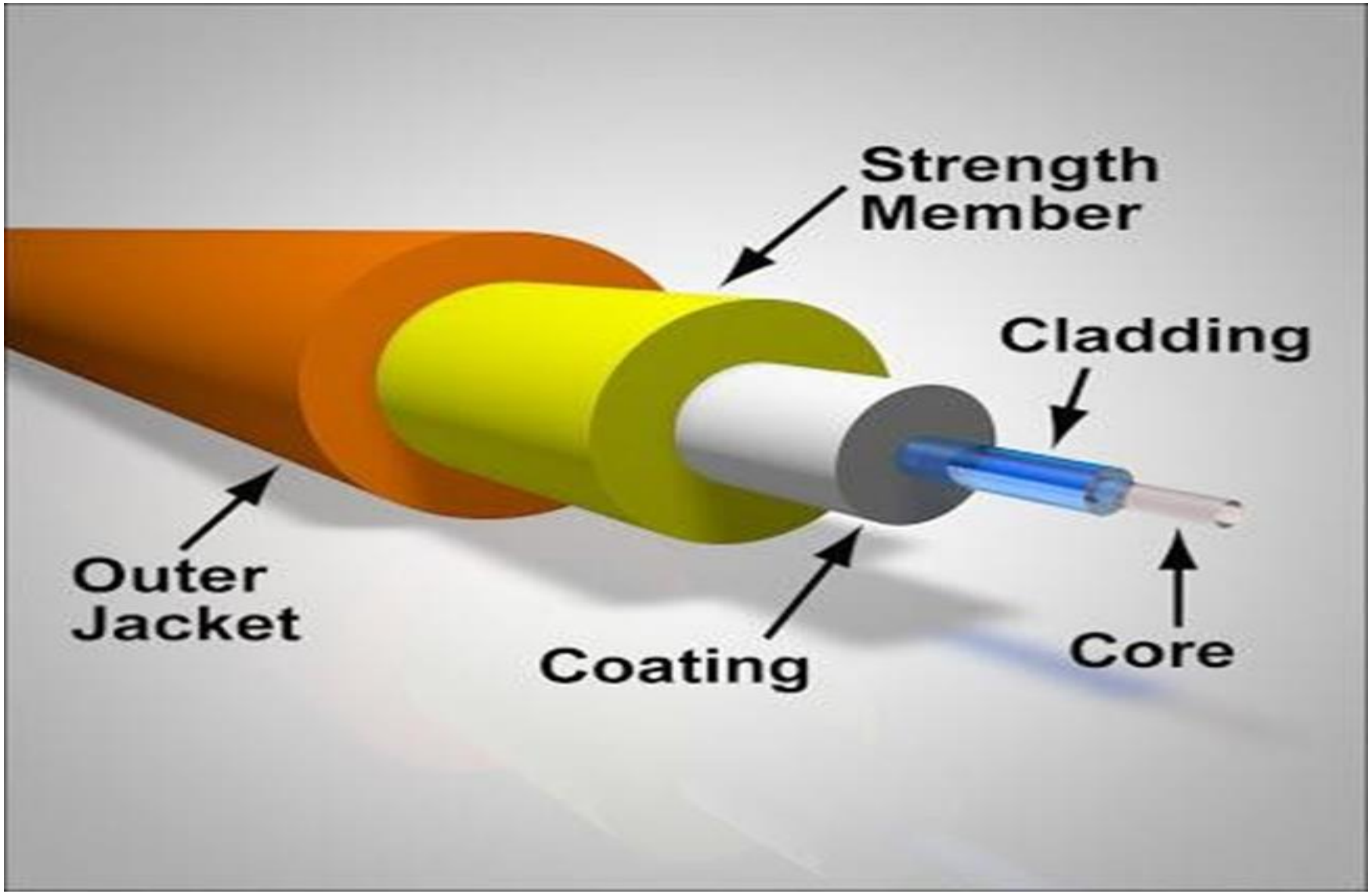
Coaxial cables

The important characteristics of co-axial cable are:

1. Two types of cables having 75 Ω and 50 Ω impedance are available.
2. Because of the shield, this cable has excellent noise immunity.
3. It has large bandwidth and low losses.
4. Suitable for point to point or point to multipoint applications. Most widely used medium for LANs.
5. Costlier than twisted pair cables, however cheaper than optical fiber cables.
6. It provides data rates of 8.5 Mb/s to 274 Mb/s.

C) Waveguides – This is a hollow conductor which sends or receives signals from transmitter or receiver antenna in radio propagation.
It has low bandwidth. Frequency range is between 300 MHz to 300 GHz.

D) Optical Fiber – It consists of a core that allows light wave to propagate through it. An outer layer called cladding ensures total internal reflection. It is increasingly used in the field of communication.


Strength
Member
Cladding
Outer
Jacket
Coating
Core

Optical fibers

1. Light is induced into the fiber using a light source such as Light Emitting Diode (LED) or laser. At the receiver side it is detected using a photo detector such as a phototransistor.
2. Higher bandwidth hence can operate at higher data rates.
3. Reduced losses as the signal attenuation is low.
4. Immune to electromagnetic interferences.
5. Small size and light weight.
6. Widely used in the backbone of networks.
7. Provides transmission rates from 45 Mb/s to 9.6 Gb/s.
8. Installation cost is higher than co-axial or twisted wire cables.
9. Now a day used in telephone systems, LANs.

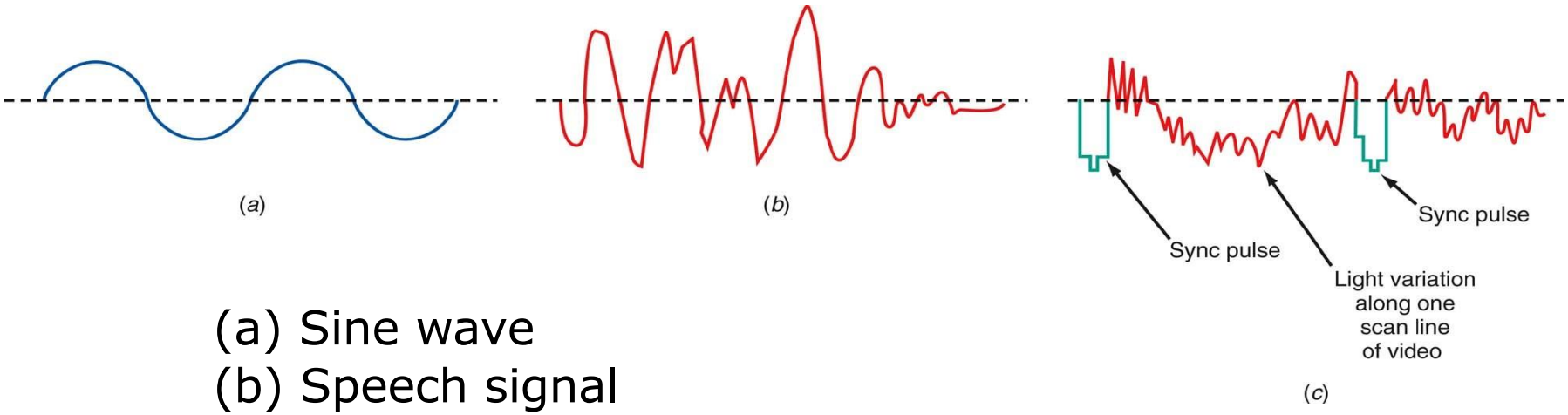
E) Radio – Radio is a wireless propagation.

Advantages of wireless communication

1. Installation of towers and associated equipment is cheaper than laying down a cable of 100 km length.
2. Less maintenance as compared to cables.
3. Repeaters can be used to reduce effect of noise.
4. Size of the transmitter and receiver reduces because of the use of high frequency.
5. Transmission takes place at frequencies between the range 2GHz to 40 GHz.
6. Ex. Satellite communication, mobile communication, sea to shore communication, etc.

Analog Communication

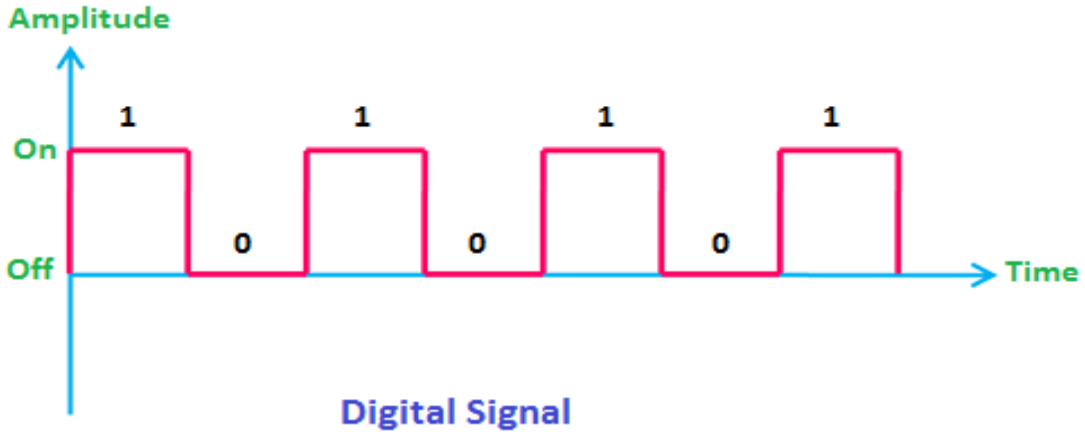
- Continuously varies with time
- Is less costly
- Requires less bandwidth
- Ex. Speech, Video



(a) Sine wave
(b) Speech signal
(c) Video (TV) signal

Digital Communication

- Has finite number of discrete levels.
- Less affected by noise.
- Long distance communication can use regenerative repeaters – devices placed at intermediate places which removes noise, regenerates original binary information and retransmits them.
- Coding techniques can be used to improve quality.



Digital Signal

Parameter	Analog	Digital
Signal	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
Waves	Represented by sine waves	Represented by square waves
Representation	Uses continuous range of values to represent information	Uses discrete or discontinuous values to represent information
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs, and other digital electronic devices.
Data transmissions	Subjected to deterioration by noise during transmission and write/read cycle.	Can be noise-immune without deterioration during transmission and write/read cycle.
Response to Noise	More likely to get affected reducing accuracy	Less affected since noise response are analog in nature

Parameter	Analog	Digital
Uses	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Bandwidth	Analog signal processing can be done in real time and consumes less bandwidth.	There is no guarantee that digital signal processing can be done in real time and consumes more bandwidth to carry out the same information.
Power	Analog instrument draws large power	Digital instrument draws only negligible power
Cost	Low cost and portable	Cost is high and not easily portable

Types of communication systems

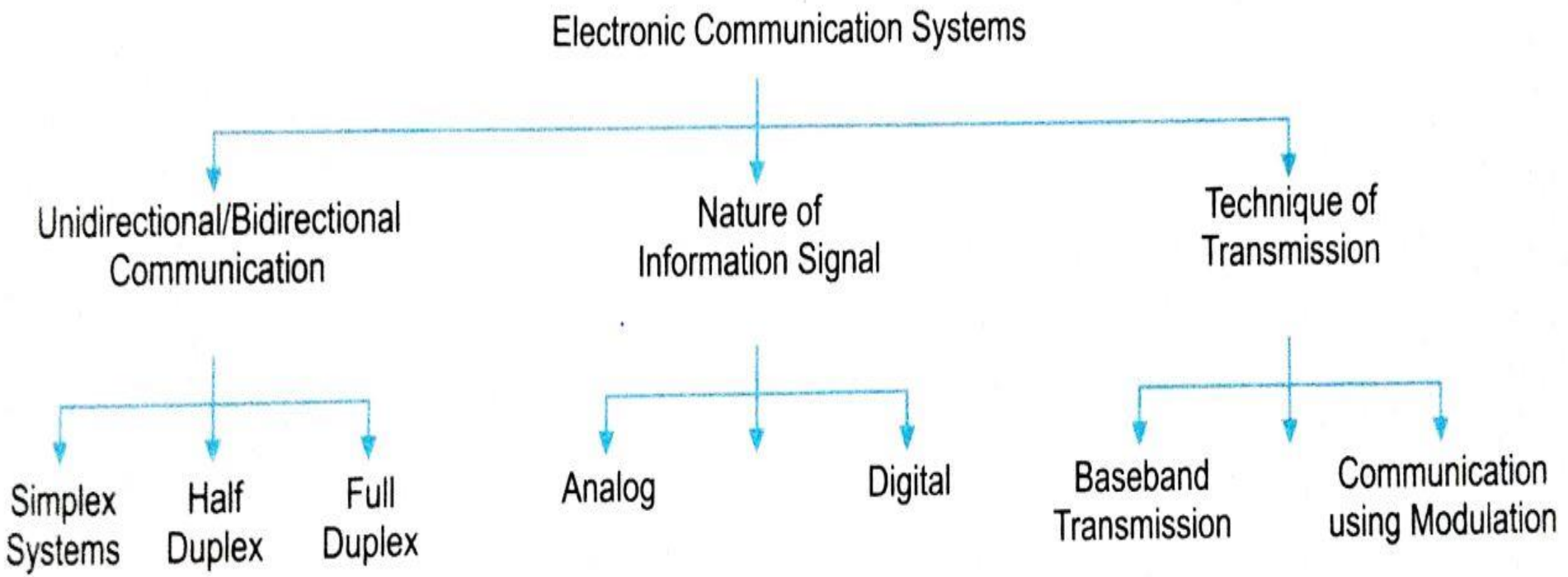
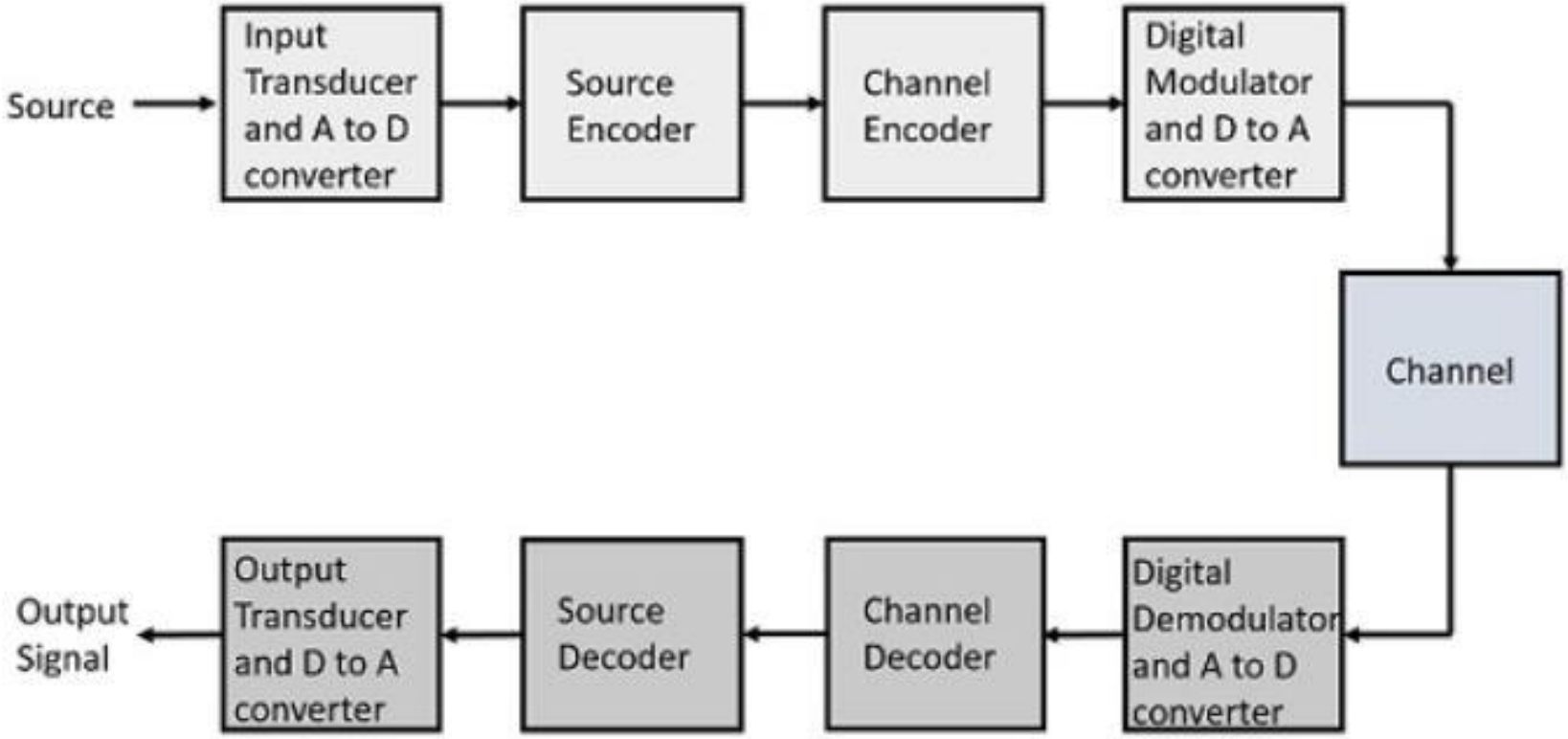


Fig. 1.15. Classification of electronic communication system

Block diagram of Digital communication system



Basic Elements of a Digital Communication System

Source

The source can be an **analog** signal. **Example**: A Sound signal

Input Transducer

This is a transducer which takes a physical input and converts it to an electrical signal (**Example**: microphone). This block also consists of an **analog to digital** converter where a digital signal is needed for further processes.

A digital signal is generally represented by a binary sequence.

Source Encoder

The source encoder compresses the data into minimum number of bits. This process helps in effective utilization of the bandwidth. It removes the redundant bits

Channel Encoder

The channel encoder, does the coding for error correction. During the transmission of the signal, due to the noise in the channel, the signal may get altered and hence to avoid this, the channel encoder adds some redundant bits to the transmitted data. These are the error correcting bits.

Digital Modulator

The signal to be transmitted is modulated here by a carrier. The signal is also converted to analog from the digital sequence, in order to make it travel through the channel or medium.

Channel

The channel or a medium, allows the analog signal to transmit from the transmitter end to the receiver end.

Digital Demodulator

This is the first step at the receiver end. The received signal is demodulated as well as converted again from analog to digital. The signal gets reconstructed here.

Channel Decoder

The channel decoder, after detecting the sequence, does some error corrections. The distortions which might occur during the transmission, are corrected by adding some redundant bits. This addition of bits helps in the complete recovery of the original signal.

Source Decoder

The resultant signal is once again digitized by sampling and quantizing so that the pure digital output is obtained without the loss of information. The source decoder recreates the source output.

Output Transducer

This is the last block which converts the signal into the original physical form, which was at the input of the transmitter. It converts the electrical signal into physical output (**Example**: loud speaker).

Output Signal

This is the output which is produced after the whole process. **Example** − The sound signal received.

Terminology related to communication

1. **Spectrum:** The frequency domain representation of the given signal.
2. **Bandwidth:** It is the portion of the EM spectrum occupied by a signal. Or it is the range of frequencies over which the information is present in the original signal.
3. **Channel bandwidth:** The range of frequencies required for the transmission of modulated signal.
4. **Baseband signal:** Message signal in its original frequency range.
5. **Baseband transmission:** Transmission of message signal in its original frequency range.
6. **Bandpass signal:** Message signal in its modulated frequency range.
7. **Bandpass transmission:** Transmission of Message signal in the modulated frequency range.

The radio frequencies which are used for two way communication encompasses a range of the EM spectrum which can be listed below.

Frequency band	Name	Application
30 – 300 Hz	Extremely Low Frequency (ELF)	Power Transmission
300 – 3000 Hz	Voice Frequency (VF)	Audio applications
3 – 30 kHz	Very Low Frequency (VLF)	Navy, Military communication
30 – 300 kHz	Low Frequency (LF)	Aeronautic & marine communication
300 – 3000 kHz	Medium Frequency (MF)	AM radio broadcasting
3 – 30 MHz	High Frequency (HF)	Amateur & CB communication
30 – 300 MHz	Very High Frequency (VHF)	FM, TV Broadcasting
300 – 3000 MHz	Ultra High Frequency (UHF) Microwave (above 1000 MHz)	Cellular phone, UHF TV channels
3 – 30 GHz	Super High Frequency (SHF)	Satellite & radar communication
30 – 300 GHz	Extremely High Frequency (EHF)	Satellites & specialized radar

Beyond the radio spectrum lies the optical spectrum which consists of infrared, visible light and ultra violet rays. The UV rays are generally not used in communication.

Thank you