

## **Unit-1 Data Communication Fundamentals**

- 1. Introduction of Ancient, Electronic and Computerized Methods of Communication.**
- 2. Digital and Analog Data**
- 3. Data transmission Modes (Simplex, Half Duplex and Full Duplex)**
- 4. Types of Transmission media: Guided and Unguided**
- 5. Guided Transmission Media:**
  - **Twisted Pair**
  - **Coaxial Cables**
  - **Fiber Optics**
- 6. Unguided Transmission Media:**
  - **Radio Waves**
  - **Micro Waves**

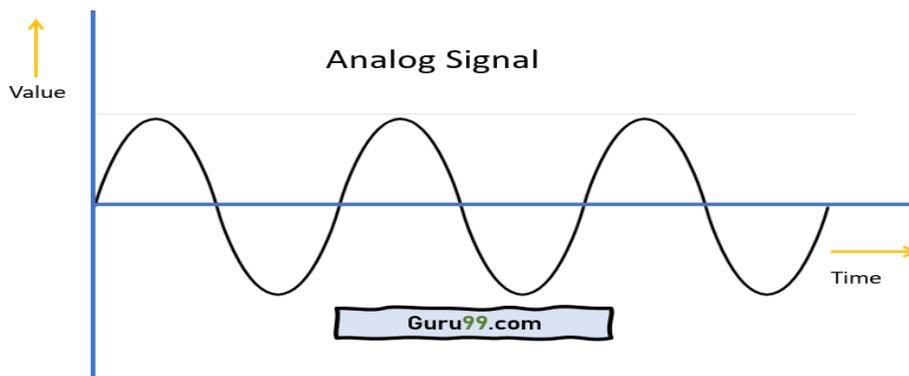
## Digital and Analog Data

### What is Signal or data?

A signal is an electromagnetic or electrical current that is used for carrying data from one system or network to another. The signal is a function that conveys information about a phenomenon.

### What is an Analog Signal?

Analog signal is a continuous signal in which one time-varying quantity represents another time-based variable. These kind of signals works with physical values and natural phenomena such as earthquake, frequency, volcano, speed of wind, weight, lighting, etc.



### Analog Signal

#### Characteristics OF Analog Signal

- These type of electronic signals are time-varying
- Minimum and maximum values which is either positive or negative.
- It can be either periodic or non-periodic.
- Analog Signal works on continuous data.
- The accuracy of the analog signal is not high when compared to the digital signal.
- It helps you to measure natural or physical values.
- Analog signal output form is like Curve, Line, or Graph, so it may not be meaningful to all.

#### Advantages of Analog Signals

- Easier in processing
- Best suited for audio and video transmission.
- It has a low cost and is portable.
- It has a much higher density so that it can present more refined information.
- Not necessary to buy a new graphics board.
- Uses less bandwidth than digital sounds
- Provide more accurate representation of a sound
- It is the natural form of a sound.

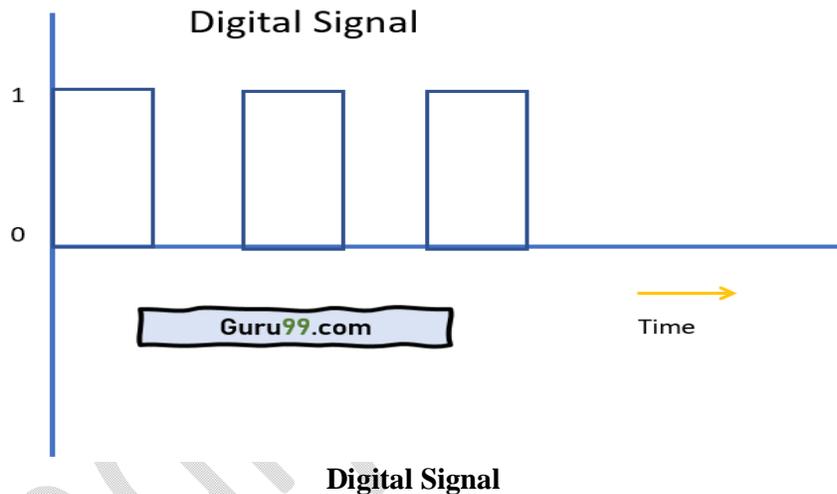
#### Disadvantages of Analog Signals

- Analog tends to have a lower quality signal than digital.
- The cables are sensitive to external influences.
- The cost of the Analog wire is high and not easily portable.
- Low availability of models with digital interfaces.

- Recording analog sound on tape is quite expensive if the tape is damaged
- It offers limitations in editing
- Tape is becoming hard to find
- It is quite difficult to synchronize analog sound
- Quality is easily lost
- Data can become corrupted
- Plenty of recording devices and formats which can become confusing to store a digital signal
- Digital sounds can cut an analog sound wave which means that you can't get a perfect reproduction of a sound
- Offers poor multi-user interfaces

### What is a Digital Signal?

A digital signal is a signal that is used to represent data as a sequence of separate values at any point in time. It can only take on one of a fixed number of values. This type of signal represents a real number within a constant range of values.



### Characteristics of Digital Signals

- Digital signals are continuous signals
- This type of electronic signals can be processed and transmitted better compared to analog signal.
- Digital signals are versatile, so it is widely used.
- The accuracy of the digital signal is better than that of the analog signal.

### Advantages of Digital Signals

- Digital data can be easily compressed.
- Any information in the digital form can be encrypted.
- Equipment that uses digital signals is more common and less expensive.
- Digital signal makes running instruments free from observation errors like parallax and approximation errors.
- A lot of editing tools are available
- You can edit the sound without altering the original copy
- Easy to transmit the data over networks

### Disadvantage of Digital Signals

- Sampling may cause loss of information.
- A/D and D/A demands mixed-signal hardware
- Processor speed is limited
- Develop quantization and round-off errors
- It requires greater bandwidth
- Systems and processing is more complex.

## Analog vs. Digital

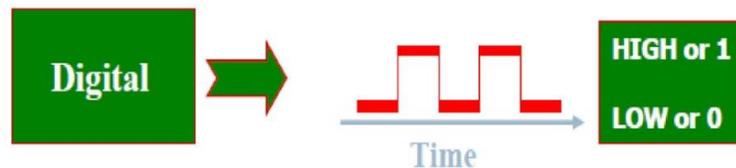
Analog signal- one whose output varies **continuously** in step with the input.

Example:



Digital signal- one whose output varies at discrete voltage levels commonly called HIGH or LOW (1 or 0).

Example:



3

### Comparison chart or difference between Analog and Digital Data

	Analog	Digital
<b>Signal</b>	Analog signal is a continuous signal which represents physical measurements.	Digital signals are discrete time signals generated by digital modulation.
<b>Waves</b>	Denoted by sine waves	Denoted by square waves
<b>Representation</b>	Uses continuous range of values to represent <u>information</u>	Uses discrete or discontinuous values to represent information
<b>Example</b>	Human voice in air, analog electronic	Computers, CDs, DVDs, and other

	<b>Analog</b>	<b>Digital</b>
	devices.	digital electronic devices.
<b>Technology</b>	Analog technology records waveforms as they are.	Samples analog waveforms into a limited set of numbers and records them.
<b>Data transmissions</b>	Subjected to deterioration by noise during transmission and write/read cycle.	Can be noise-immune without deterioration during transmission and write/read cycle.
<b>Response to Noise</b>	More likely to get affected reducing accuracy	Less affected since noise response are analog in nature
<b>Flexibility</b>	Analog hardware is not flexible.	Digital hardware is flexible in implementation.
<b>Uses</b>	Can be used in analog devices only. Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
<b>Applications</b>	Thermometer	PCs, PDAs
<b>Bandwidth</b>	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.
<b>Memory</b>	Stored in the form of wave signal	Stored in the form of binary bit
<b>Power</b>	Analog instrument draws large power	Digital instrument drawS only negligible power
<b>Cost</b>	Low cost and portable	Cost is high and not easily portable
<b>Errors</b>	Analog instruments usually have a scale which is cramped at lower end and give considerable observational errors.	Digital instruments are free from observational errors like parallax and approximation errors.

### **Data transmission Modes (Simplex, Half Duplex and Full Duplex)**

Transmission mode refers to the mechanism of transferring of data between two devices connected over a network. It is also known as communication mode. Buses and networks are designed to allow communication to occur between individual devices that are interconnected.

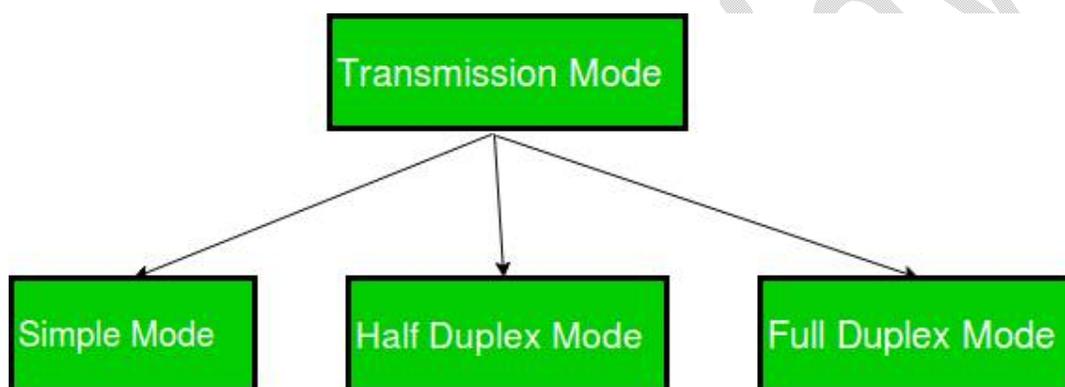
In other word Data Transmission mode defines the direction of the flow of information between two communication devices. It is also called Data Communication or Directional Mode. It specifies the direction of the flow of information from one place to another in a computer network.

- 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.
- The transmission mode is defined in the physical layer.

**Data Transmission mode defines the direction of the flow of information between two communication devices. It is also called Data Communication or Directional Mode.** It specifies the direction of the flow of information from one place to another in a computer network.

There are three types of transmission mode:-

1. **Simplex Mode**
2. **Half-Duplex Mode**
3. **Full-Duplex Mode**



## Simplex Mode

In simplex transmission mode, the communication between sender and receiver occurs in only **one direction**. The sender can only send the data, and the receiver can only receive the data. The receiver cannot reply to the sender.

In other word Simplex is the data transmission mode in which the data can flow only in one direction, i.e., the **communication is unidirectional**. In this mode, a sender can only send data but cannot receive it. Similarly, a receiver can only receive data but cannot send it.

Simplex transmission can be thought of as a one-way road in which the traffic travels only in one direction—no vehicle coming from the opposite direction is allowed to drive through.

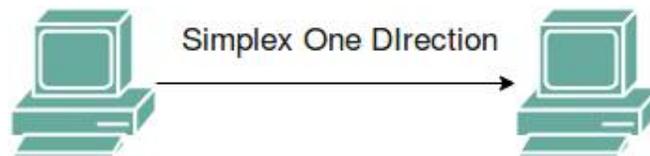
To take a keyboard / monitor relationship as a best an example of it, the keyboard can only send the input to the monitor, and the monitor can only receive the input and display it on the screen. The monitor cannot reply, or send any feedback, to the keyboard.

This transmission mode is not so popular because we cannot perform **two-way communication** between the sender and receiver in this mode. It is mainly used in the business field as in sales that do not require any corresponding reply. It is similar to **a one-way street**.

This transmission mode is not so popular because we cannot perform two-way communication between the sender and receiver in this mode.

For Example, Radio and TV transmission, keyboard, mouse, etc

Examples of simplex Mode are loudspeakers, television broadcasting, television and remote, keyboard and monitor etc.



**Following are the advantages of using a Simplex transmission mode:**

1. It utilizes the full capacity of the communication channel during data transmission so that more data can be transmitted at a time.
2. It has the least or no data traffic issues as data flows only in one direction.

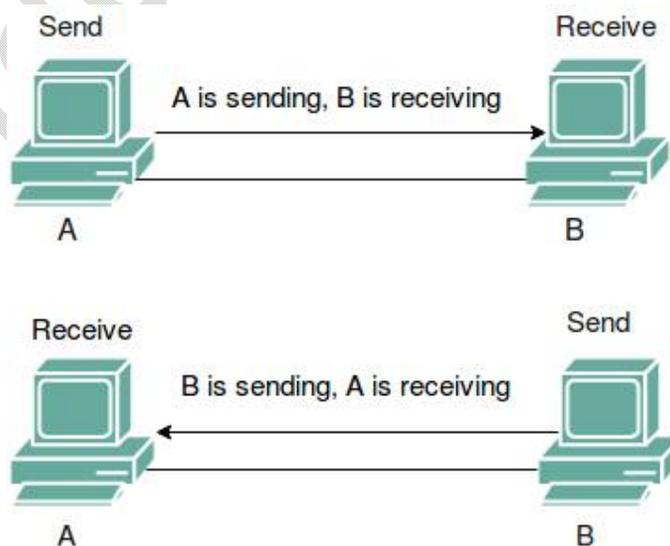
**Following are the disadvantages of using a Simplex transmission mode:**

1. It is unidirectional in nature having no inter-communication between devices.
2. There is no mechanism for information to be transmitted back to the sender (No mechanism for acknowledgement).
3. Communication is unidirectional, so it has no inter-communication between devices.

## HALF DUPLEX Mode

Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time.

Half-Duplex is the data transmission mode in which the data can flow in both directions but in one direction at a time. It is also referred to as Semi-Duplex. In other words, each station can both transmit and receive the data but not at the same time. When one device is sending the other can only receive and vice-versa.



In this type of transmission mode, the entire capacity of the channel can be utilized for each direction. Transmission lines can carry data in both directions, but the data can be sent only in one direction at a time.

This type of data transmission mode can be used in cases where there is no need for communication in both directions at the same time. It can be used for error detection when the sender does not send or the receiver does not receive the data properly. In such cases, the data needs to be transmitted again by the receiver.

For Example, Walkie-Talkie, Internet Browsers, etc.

The communication between sender and receiver occurs in both directions in half duplex transmission, but only one at a time. The sender and receiver can both send and receive the information, but only one is allowed to send at any given time. Half duplex is still considered a one-way road, in which a vehicle traveling in the opposite direction of the traffic has to wait till the road is empty before it can pass through.

For example, in walkie-talkies, the speakers at both ends can speak, but they have to speak one by one. They cannot speak simultaneously.

**Following are the advantages of using a half-duplex transmission mode:**

1. It facilitates the optimum use of the communication channel.
2. It provides two-way communication.

**Following are the disadvantages of using a half-duplex transmission mode:**

1. The two-way communication can not be established simultaneously at the same time.
2. Delay in transmission may occur as only one way communication can be possible at a time.

## **Full-Duplex**

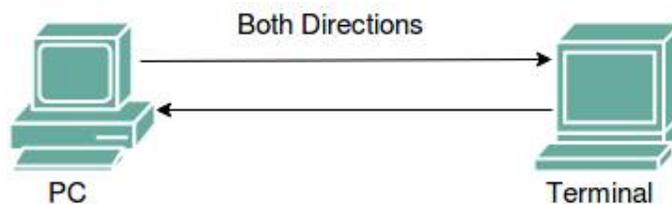
**Full-Duplex is the data transmission mode in which the data can flow in both directions at the same time. It is bi-directional in nature.** It is two-way communication in which both the stations can transmit and receive the data simultaneously.

In full duplex transmission mode, the communication between sender and receiver can occur simultaneously. The sender and receiver can both transmit and receive at the same time. Full duplex transmission mode is like a two-way road, in which traffic can flow in both directions at the same time.

Full-Duplex mode has double bandwidth as compared to the half-duplex. The capacity of the channel is divided between the two directions of communication. This mode is used when communication in both directions is required simultaneously.

For Example, a Telephone Network, in which both the persons can talk and listen to each other simultaneously.

For example, in a telephone conversation, two people communicate, and both are free to speak and listen at the same time.



**Following are the advantages of using a full-duplex transmission mode:**

1. The two-way communication can be carried out simultaneously in both directions.
2. It is the fastest mode of communication between devices.

**Following are the disadvantages of using a half-duplex transmission mode:**

1. The capacity of the communication channel is divided into two parts. Also, no dedicated path exists for data transfer.
2. It has improper channel bandwidth utilization as there exist two separate paths for two communicating devices.

#### Comparison Chart

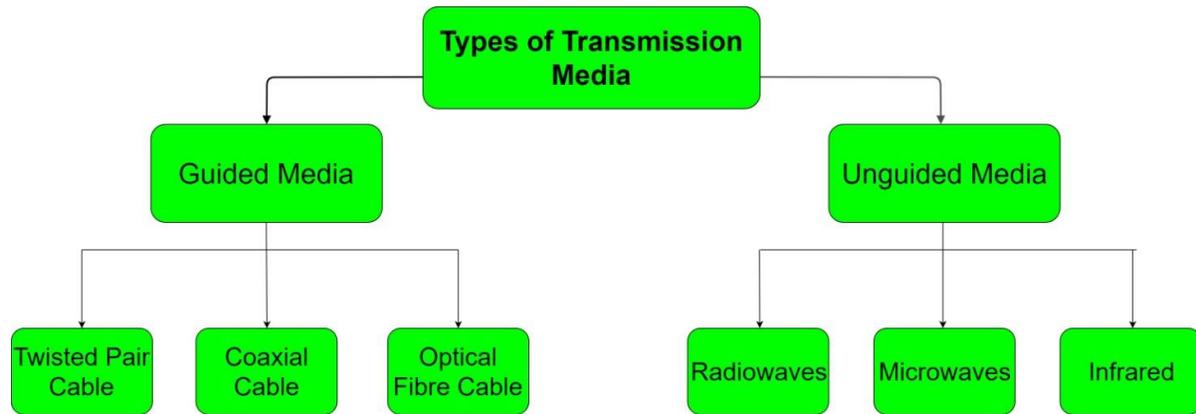
Basis for Comparison	Simplex	Half Duplex	Full Duplex
Direction of Communication	Unidirectional	Two-directional, one at a time	Two-directional, simultaneously
Send / Receive	Sender can only send data	Sender can send and receive data, but one at a time	Sender can send and receive data simultaneously
Performance	Worst performing mode of transmission	Better than Simplex	Best performing mode of transmission
Example	Keyboard and monitor	Walkie-talkie	Telephone

#### Types of Transmission media: Guided and Unguided

The transmission medium can be defined as a pathway that can transmit information from a sender to a receiver. Transmission media are located below the physical layer and are controlled by the physical layer. Transmission media are also called communication channels.

#### Different Types of Transmission Media

Transmission media is classified into two types namely wired media & wireless media. The medium characteristics of wired media are more significant but, in wireless media the signal characteristics are important.



### Guided Media (Bounded)

This kind of transmission media is also known as wired otherwise bounded media. In this type, the signals can be transmitted directly & restricted in a thin path through physical links.

Guided transmission media are also called bounded media or wired media. They comprise cables or wires through which data is transmitted. They are called guided since they provide a physical conduit from the sender device to the receiver device. The signal traveling through these media are bounded by the physical limits of the medium.



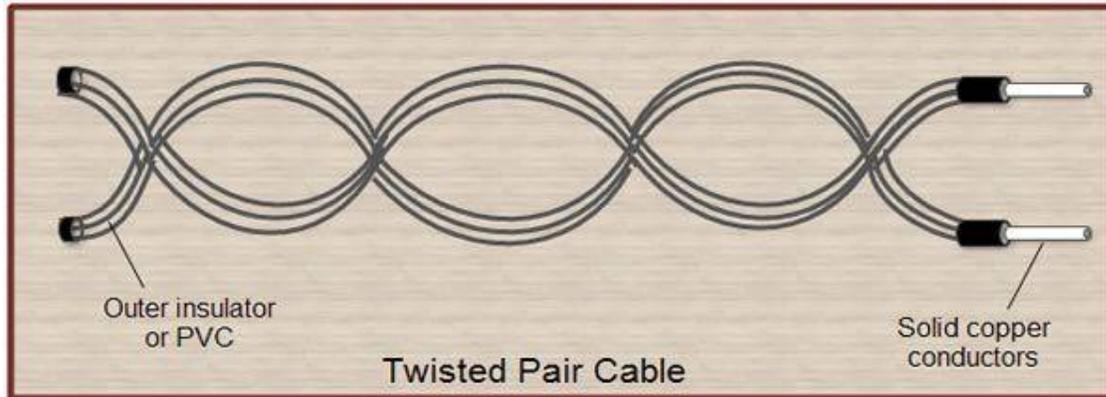
The main features of guided media mainly include **secure, high-speed, and used in small distances**. This kind of media is classified into **three** types which are discussed below.

A signal travelling along any of these media is directed and contained by the physical limits of the medium. Twisted-pair and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of electric current. Optical fibre is a cable that accepts and transports signals in the form of light.

#### 1) Twisted Pair Cable –

A twisted-pair cable is a cable made by intertwining two separate insulated wires. There are two twisted pair types: shielded and unshielded. A STP (Shielded Twisted Pair) cable has a fine wire mesh surrounding the wires to protect the transmission and a UTP (Unshielded Twisted Pair) cable

does not. Shielded cable is used in older telephone networks, as well as network and data communications to reduce outside interference. The illustration gives an example of how the inside of these looks.



This cable is the most commonly used and is cheaper than others. It is lightweight, cheap, can be installed easily, and they support many different types of network. Some important points :

- Its frequency range is 0 to 3.5 kHz.
- Typical attenuation is 0.2 dB/Km @ 1kHz.
- Typical delay is 50  $\mu$ s/km.
- Repeater spacing is 2km.

Twisted Pair is of two types:

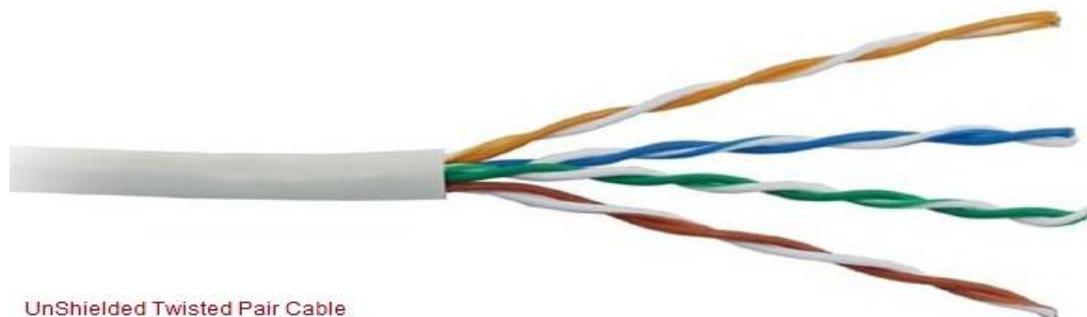
- **Unshielded Twisted Pair (UTP)**
- **Shielded Twisted Pair (STP)**

### **Unshielded Twisted Pair (UTP)**

This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications.

It is the most common type of telecommunication when compared with Shielded Twisted Pair Cable which consists of two conductors usually copper, each with its own color plastic insulator. Identification is the reason behind colored plastic insulation.

UTP cables consist of 2 or 4 pairs of twisted cable. Cable with 2 pair use **RJ-11** connector and 4 pair cable use **RJ-45** connector.



**Advantages:**

1. Installation is easy
2. Flexible
3. Cheap
4. It has high speed capacity,
5. 100 meter limit
6. Higher grades of UTP are used in LAN technologies like Ethernet.
7. High speed capacity

It consists of two insulating copper wires (1mm thick). The wires are twisted together in a helical form to reduce electrical interference from similar pair.

**Disadvantages:**

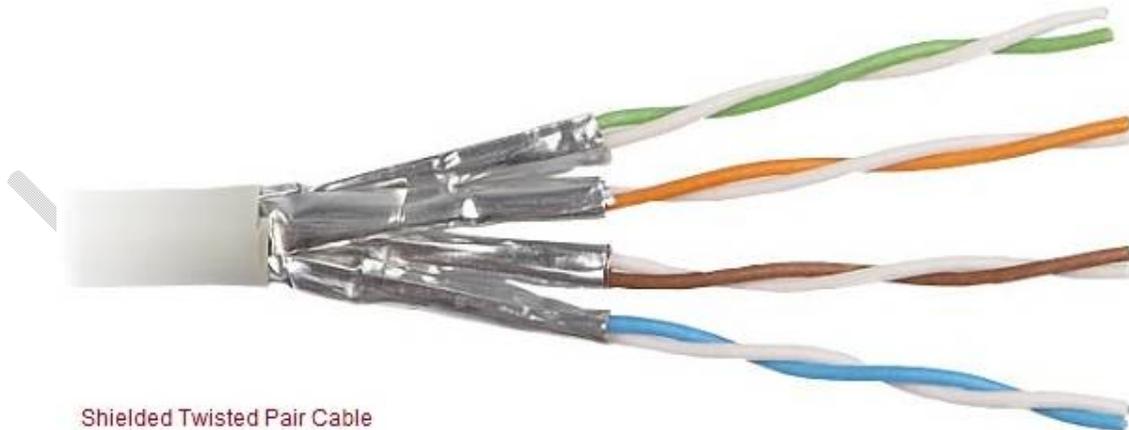
1. Susceptible to external interference
2. Lower capacity and performance in comparison to STP
3. Short distance transmission due to attenuation
4. Bandwidth is low when compared with Coaxial Cable
5. Provides less protection from interference.

**Shielded Twisted Pair (STP)**

This type of cable consists of a special jacket to block external interference. It is used in fast-data-rate Ethernet and in voice and data channels of telephone lines.

This cable has a metal foil or braided-mesh covering which encases each pair of insulated conductors. Electromagnetic noise penetration is prevented by metal casing. Shielding also eliminates crosstalk (explained in KEY TERMS Chapter).

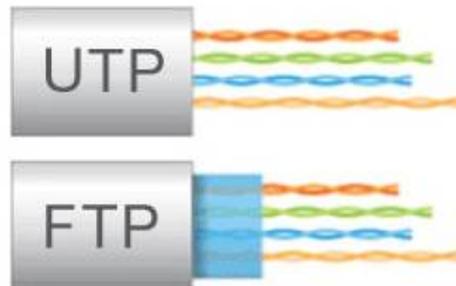
It has same attenuation as unshielded twisted pair. It is faster than the unshielded and coaxial cable. It is more expensive than coaxial and unshielded twisted pair.

**Advantages:**

1. Easy to install
2. Performance is adequate
3. Can be used for Analog or Digital transmission
4. Increases the signaling rate
5. Higher capacity than unshielded twisted pair
6. Eliminates crosstalk

### Disadvantages:

1. Comparatively difficult to install and manufacture
2. More expensive
3. Bulky / huge/ large
4. Heavy



### Coaxial Cable –

#### Definition of Coaxial Cable?

A coaxial cable is a type of shielded and insulated copper cable that is used in computer networks and to deliver cable TV services to end users. It was first commercially implemented in the early 1940s and is used for both baseband and broadband data communication services.

Coaxial cable is also known as coax, which is derived from the geometric axis created between a shield and insulator.

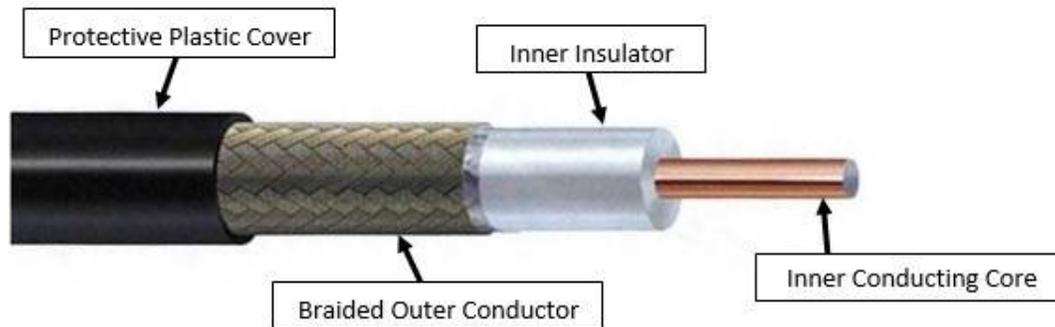
Coaxial cables, commonly called coax, are copper cables with metal shielding designed to provide immunity against noise and greater bandwidth. Coax can transmit signals over larger distances at a higher speed as compared to twisted pair cables.

#### Structure of Coaxial Cables

Coax has a central core of stiff copper conductor for transmitting signals. This is covered by an insulating material. The insulator is encased by a closely woven braided metal outer conductor that acts as a shield against noise. The outer conductor is again enclosed by a plastic insulating cover. The structure is shown in the following figure –

Here the most common coaxial standards.

- 50-Ohm RG-7 or RG-11 : used with thick Ethernet.
- 50-Ohm RG-58 : used with thin Ethernet
- 75-Ohm RG-59 : used with cable television
- 93-Ohm RG-62 : used with ARCNET.



### Categories of Coaxial Cables

Coaxial cables are categorized into three types as per radio government (RG) ratings –

- RG – 59: Has impedance of 75Ω and used in cable TV
- RG – 58: Has impedance of 50Ω and used in thin Ethernet
- RG – 11: Has impedance of 50Ω and used in thick Ethernet

### Applications of Coaxial Cables

- In analog telephone networks: A single coaxial network can carry about 10,000 voice signals.
- In digital telephone networks: A coax has a data rate of 600 Mbps.
- In cable TV networks
- In traditional Ethernet LANs
- In MANs



Advantages:

- High Bandwidth
- Better noise Immunity
- Easy to install and expand
- Inexpensive

### Advantages of Coaxial Cables

1. It can be used for both analog and digital transmission.
2. It offers higher bandwidth as compared to twisted pair cable and can span longer distances.
3. Because of better shielding in coaxial cable, loss of signal or attenuation is less.

4. Better shielding also offers good noise immunity.
5. It is relatively inexpensive as compared to optical fibers.
6. It has lower error rates as compared to twisted pair.
7. It is not as easy to tap as twisted pair because copper wire is contained in plastic jacket.

#### **Disadvantages of Coaxial Cables**

1. It is usually more expensive than twisted pair.
2. Single cable failure can disrupt the entire network

#### **Applications of Co-axial Cables:**

- (1) Analog telephone networks.
- (2) Digital telephone network.
- (3) Cable TV
- (4) Traditional Ethernet LANs
- (5) Digital transmission
- (6) Thick Ethernet

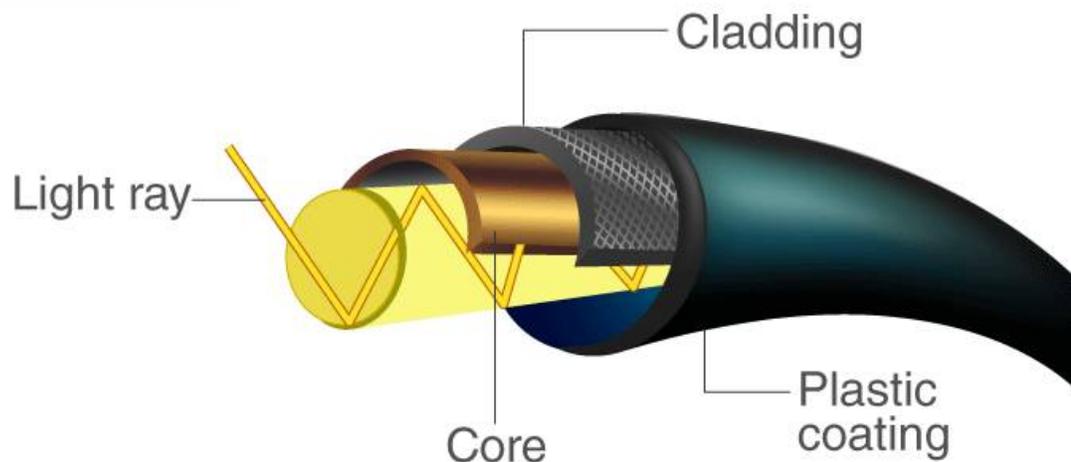
#### **(iii) Optical Fibre Cable –**

It uses the concept of reflection of light through a core made up of glass or plastic. The core is surrounded by a less dense glass or plastic covering called the cladding. It is used for transmission of large volumes of data.

This cable uses the notion of light reflected through a core that is made with plastic or glass. The core is enclosed with less thick plastic or glass and it is known as the cladding, used for large volume data transmission.



OR



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**Advantages:**

- Increased capacity and bandwidth
- Light weight
- Less signal attenuation
- Immunity to electromagnetic interference
- Resistance to corrosive materials

**Disadvantages:**

- Difficult to install and maintain
- High cost
- Fragile
- unidirectional, ie, will need another fibre, if we need bidirectional communication

**2. Unguided Transmitted Media:**

It is also known as unbounded otherwise wireless transmission media. It doesn't require any physical medium to transmit electromagnetic signals. The main features of this media are less secure; the signal can be transmitted through air, and applicable for large distances. There are three types of unguided media which are discussed below.

**Features:**

- Signal is broadcasted through air
- Less Secure
- Used for larger distances

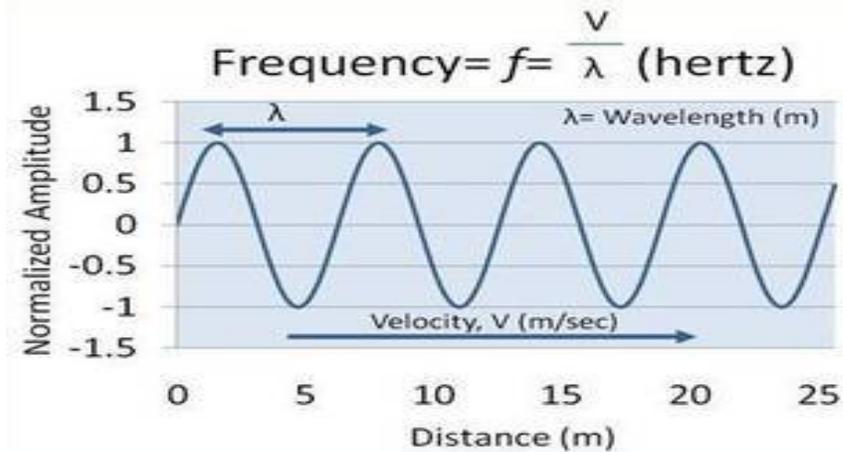
There are 3 major types of Unguided Media:

1. Radio Waves
2. Micro Wave
3. Infrared

**What are radio waves?**

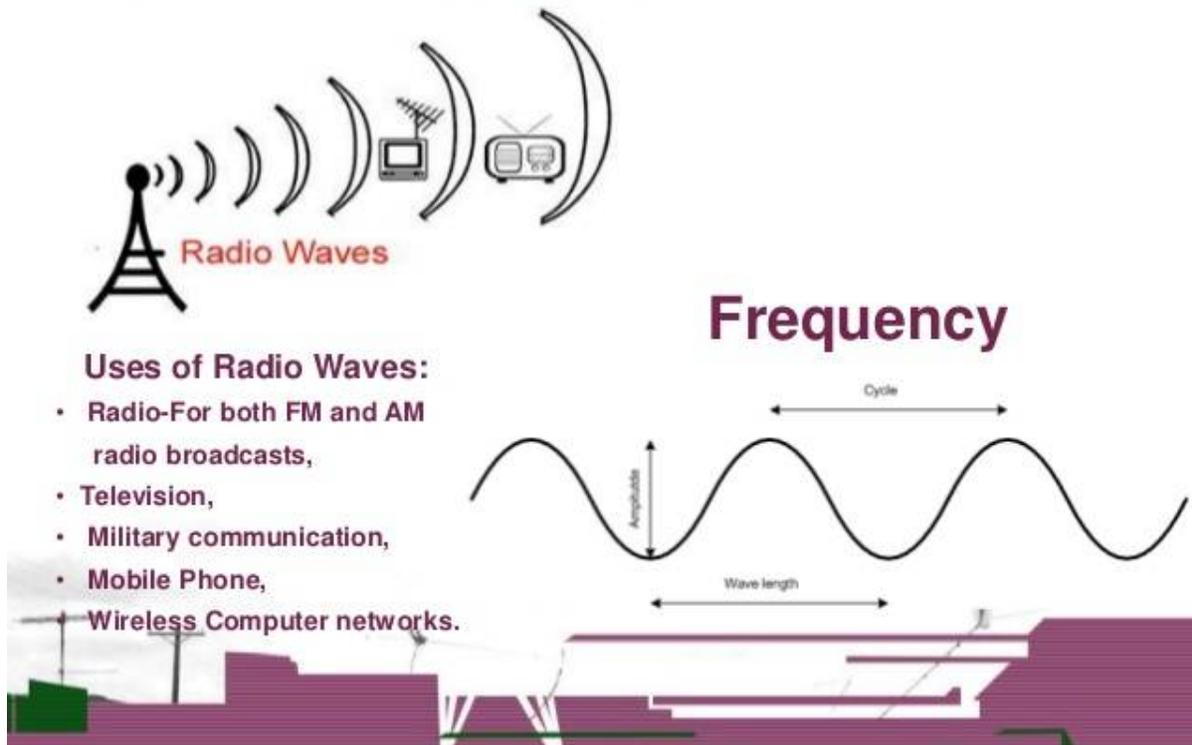
Radio waves are a type of **electromagnetic radiation**/waves best-known for their use in communication technologies, such as television, mobile phones and radios. These devices receive

radio waves and convert them to mechanical vibrations in the speaker to create sound waves.



- The basic building block of radio communications is a radio wave.
- Like waves on a pond, a radio wave is a series of repeating peaks and valleys.
- The entire pattern of a wave, before it repeats itself, is called a cycle.
- The wavelength is the distance a wave takes to complete one cycle.
- The number of cycles, or times that a wave repeats in a second, is called frequency.
- Frequency is measured in the unit hertz (Hz), referring to a number of cycles per second.
- One thousand hertz is referred to as a kilohertz (KHz), 1 million hertz as a megahertz (MHz), and 1 billion hertz as a gigahertz (GHz).
- The range of the radio spectrum is considered to be 3 kilohertz up to 300 gigahertz.
- A radio wave is generated by a transmitter and then detected by a receiver.
- An antenna allows a radio transmitter to send energy into space and a receiver to pick up energy from space.
- Transmitters and receivers are typically designed to operate over a limited range of frequencies.

# Radio Waves System



## Uses of Radio Waves:

- Radio-For both FM and AM radio broadcasts,
- Television,
- Military communication,
- Mobile Phone,
- Wireless Computer networks.

## (ii) Microwaves –

The distance covered by the signal is directly proportional to the height of the antenna. Frequency Range:1GHz – 300GHz. These are majorly used for mobile phone communication and television distribution.

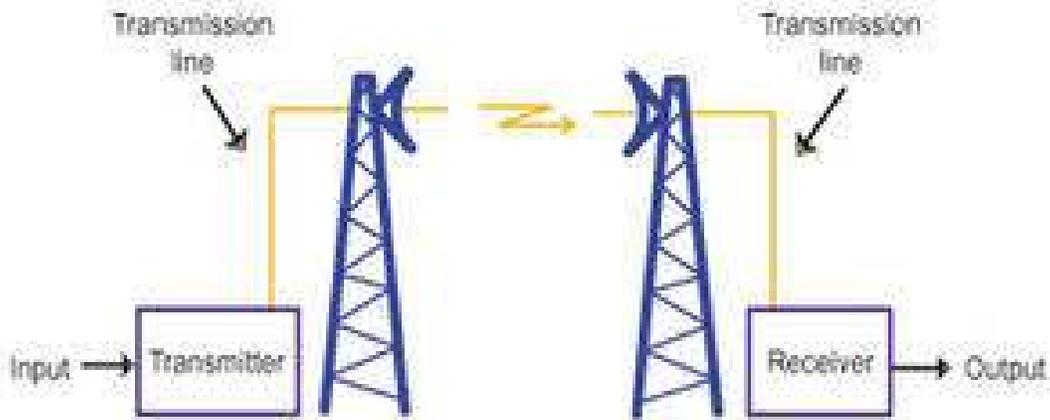
Microwave is a line-of-sight wireless communication technology that uses high frequency beams of radio waves to provide high speed wireless connections that can send and receive voice, video, and data information.

Microwave radio transmission is commonly used in point-to-point communication systems on the surface of the Earth, in satellite communications, and in deep space radio communications. Other parts of the microwave radio band are used for radars, radio navigation systems, sensor systems, and radio astronomy.

The term microwave refers to electromagnetic energy having a [frequency](#) higher than 1 [gigahertz](#) (billions of cycles per second), corresponding to [wavelength](#) shorter than 30 centimeters.

A Microwave link is a communication system that bridges radio signals, to transmit data between two or more fixed locations. Multiple microwave links make up a microwave network.

Microwave links are used for point-to-point communications. This is because of the small length of their waves that allows for antennas to direct them in narrow beams which can be pointed directly at the receiving antenna.



**(iii) Infrared –**

Infrared waves are used for very short distance communication. They cannot penetrate through obstacles. This prevents interference between systems. Frequency Range:300GHz – 400THz. It is used in TV remotes, wireless mouse, keyboard, printer, etc.

Infrared waves are those between the frequencies 300GHz and 400THz in the electromagnetic spectrum. Their wavelengths are shorter than microwaves but longer than visible light. Infrared propagation is line of sight.

They cannot penetrate walls and sun's infrared rays interfere with these rays. So cannot be used for long – range communication. As their usage is confined within closed space, they do not need any government permissions for their applications.



### Applications of Infrared Waves in Communications

- Remote controls for television, stereos and other home appliances.
- Wireless LANs
- Wireless modem, keyboard, mouse, printer etc
- Fire detectors
- Night vision systems
- Intrusion detection systems
- Motion detectors
- **Difference between Radio wave, Microwave and Infrared waves :**

Sr. No.	Basis	Radiowave	Microwave	Infrared wave
1.	Direction	These are omni-directional in nature.	These are unidirectional in nature.	These are unidirectional in nature.
2.	Penetration	At low frequency, they can penetrate through solid objects and walls but high frequency they bounce off the obstacle.	At low frequency, they can penetrate through solid objects and walls. at high frequency, they cannot penetrate.	They cannot penetrate through any solid object and walls.
3.	Frequency range	Frequency range: 3 KHz to 1GHz.	Frequency range: 1 GHz to 300 GHz.	Frequency range: 300 GHz to 400 GHz.
4.	Security	These offers poor security.	These offers medium security.	These offers high security.
5.	Attenuation	Attenuation is high.	Attenuation is variable.	Attenuation is low.

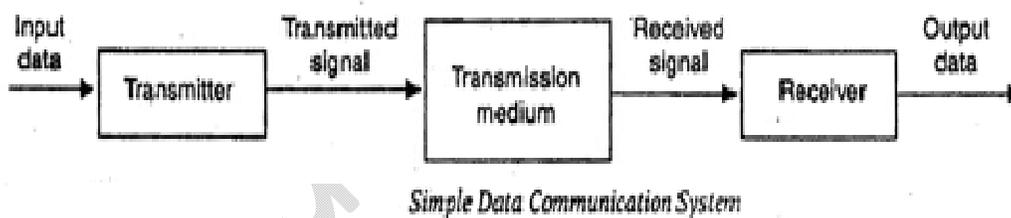
Sr. No.	Basis	Radiowave	Microwave	Infrared wave
6.	Government Licence	Some frequencies in the radiowaves require government license to use these.	Some frequencies in the microwaves require government license to use these.	There is no need of government license to use these waves.
7.	Usage Cost	Setup and usage Cost is moderate.	Setup and usage Cost is high.	Usage Cost is very less.
8.	Communication	These are used in long distance communication.	These are used in long distance communication.	These are not used in long distance communication.

## Introduction of Ancient, Electronic and Computerized Methods of Communication

### Introduction

Data communication refers to the exchange of data between a source and a receiver via form of transmission media such as a wire cable. Data communication is said to be local if communicating devices are in the same building or a similarly restricted geographical area.

The meanings of source and receiver are very simple. The device that transmits the data is known as source and the device that receives the transmitted data is known as receiver. Data communication aims at the transfer of data and maintenance of the data during the process but not the actual generation of the information at the source and receiver.



### What is Electronic Communication

“Electronic communications is the transmission of information using advanced techniques such as computer modems, facsimile (fax) machines, voice mail, electronic mail, teleconferencing, video-cassettes and private television network.”

Some widely used electronic and computerized communication technologies or media of electronic communication are discussed below-

**Telephone:** The most commonly and most widely used electronic device of communication is telephone. By telephone, people can transmit information orally within a minute. Recently-developed satellite telephoning system has added new dimension in telecommunication system. In most of the cases, it is the easiest and less expensive way of communicating distance people.

### Fax

Fax is short for '**facsimile**' which means '**copy**'.

A fax machine is a device that can send a **copy of a paper document** over the **telephone network**.

- The sending fax **converts** the **light/dark areas** of the printed document into **noises**.
- These noises travel through the **phone system** and are received by another fax machine.
- The receiving fax machine **converts** the **noises** into **printed marks** on a piece of paper - making a copy of the original document.

**Electronic Mail or E-Mail:** E-mail is one of the most widely used and most popular methods of modern communication system. E-mail is a system that allows **messages** to be **sent** and **received** by **computers**.

**Voice Mail or V-Mail:** Voice mail is a form of e-mail. It is used to send the voice of the sender instead of sending written message to the receiver. The mechanism of sending message here is almost same as in case of e-mail. It is useful to communicate with the original voice tone of the sender.

**Tele-Text:** Tele-Text is an electronic device of broadcasting written messages through television. Tele-text is widely used to present strict and concise information when it is to be sent to a large number of audiences at a time. Business reports, stock market or exchange reports, weather reports etc are useful to present through tele-text.

**Video-text:** Video-text is a device of collecting and storing information. Here information is collected by using telecommunication network and is broadcasted to the audience like the tele-text. Important message or information or report can be preserved by videotext.

**Teleconferencing:** Under teleconferencing system people staying at different places can hold talks or meetings over telephone. Here everyone involved in the meeting is able to hear each other and can share information with one another as if they were all placed in one room. It can save both money and time of the executives.

**Videoconferencing:** Videoconferencing is the latest version of teleconferencing system. Under this method people can meet and work together without being gathered in one room. They can hear and see each other over the television or video screen and can share information with one another. Now-a-days multinational companies use videoconferencing method as a widely used means of communication in order to keep touch with the executives staying miles away from the head office. It also saves money and time of high officials.

**Multimedia:** Multimedia is an excellent invention for upgrading the communication system. Multimedia is a combination of many media brought together to transfer messages. These media can include graphics, photo, music, voice, text and animation. When all of these elements are placed together on computer screen, they become multimedia. It can be effectively used for advertising and publicity campaigns. It is very powerful means of communication.

**Internet:** Internet is the latest and most amazing development that has changed the way of live regarding communication. It is the world's largest computer network linked together by telephone lines, radio links or satellite links.