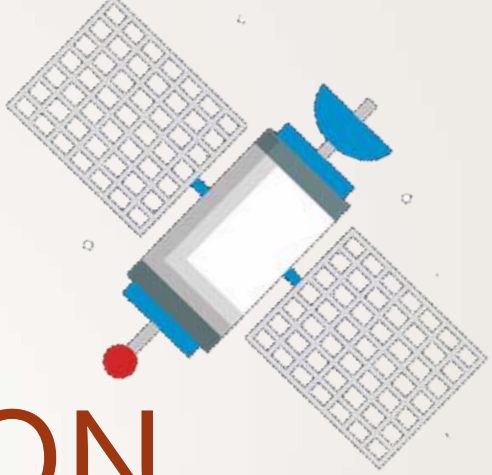
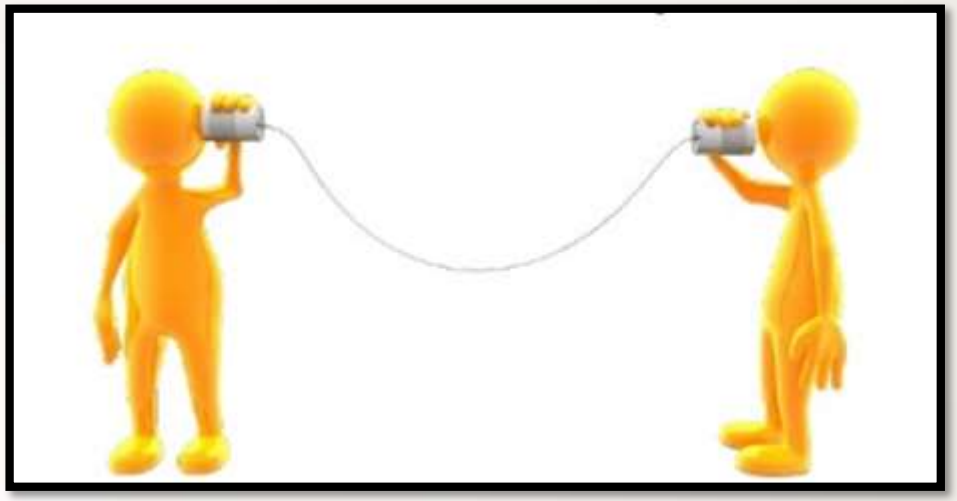


UNIT VI COMMUNICATION SYSTEMS

UNIT-VI

Need for Modulation – Block diagram of analog communication System – AM, FM, PM Definitions and Waveforms – Comparison of Digital and Analog communication system – Block diagram of Digital Communication system – Electromagnetic Spectrum – Wired and Wireless Channel – Block diagram of communication systems – Satellite Communication – Cellular Mobile Communication – Fibre Optical Communication System.

What is Communication?



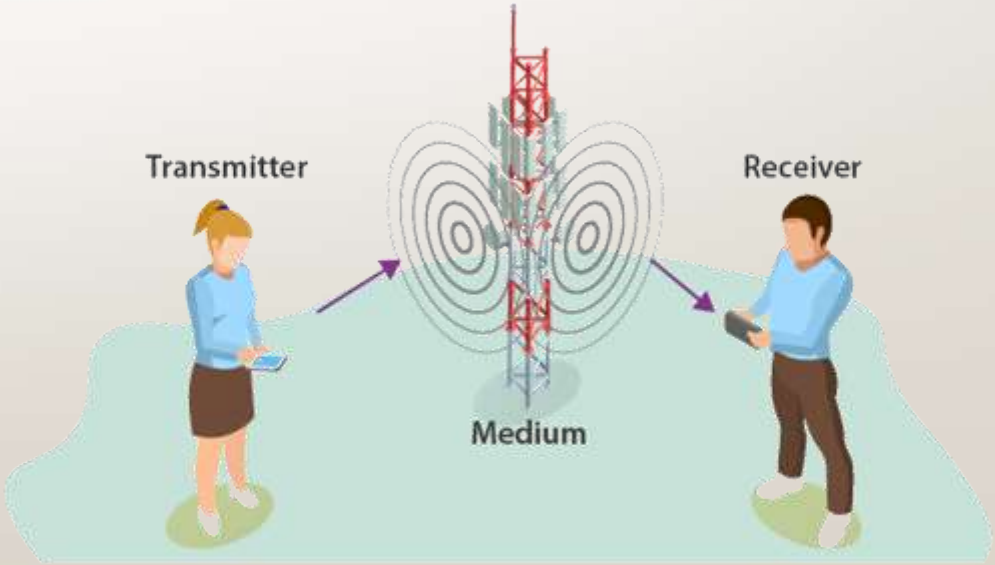
- Communication is the process of establishing connection or link between two points for information exchange.

(OR)

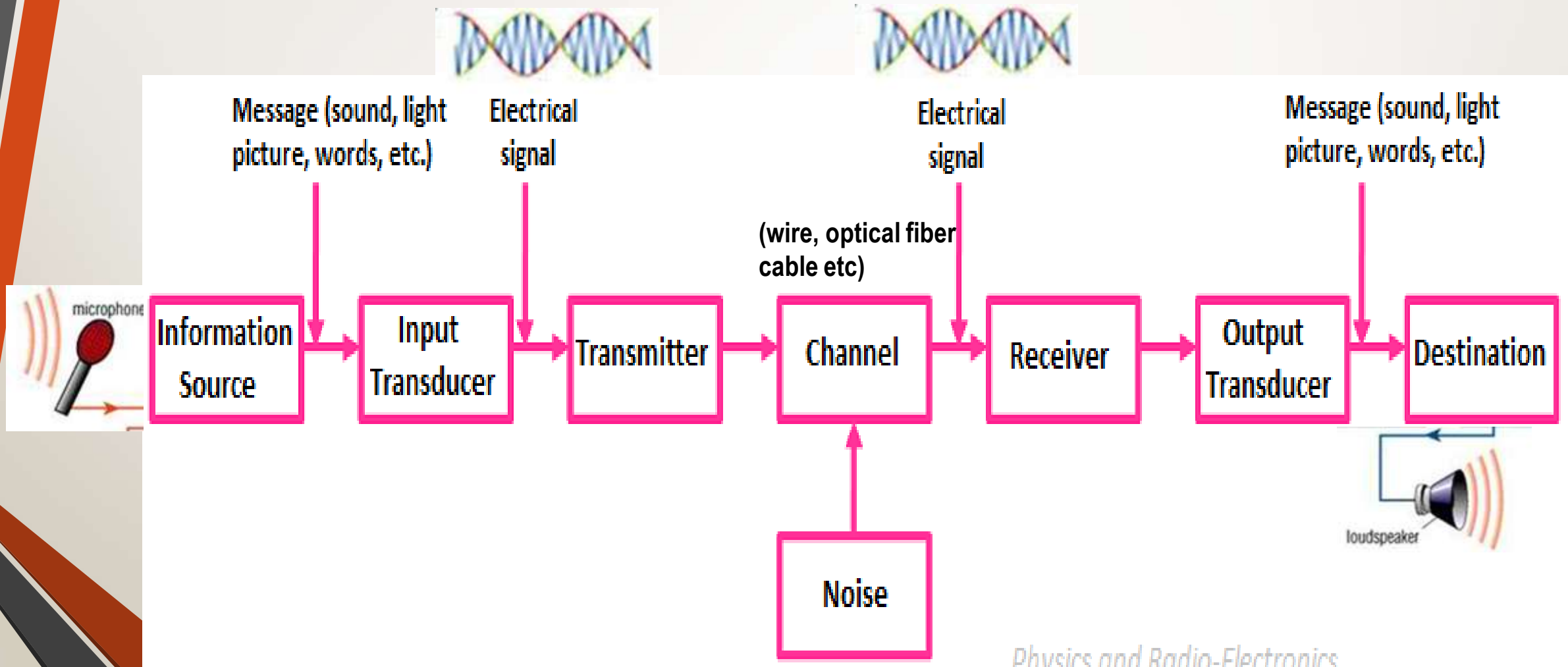
- Communication is simply the basic process of exchanging information.

Communication

- **Communication** is simply the act of transferring information from one place, person or group to another.
- The **communication system** is a **system** which describes the information exchange between two points either wired or wireless.
- The major elements of communication are the **Transmitter** of information, **Channel or medium** of communication and the **Receiver** of information.



Model of communication system



Input Transducer

- A transducer is a device which converts one form of energy into another form.
- The message from the information source may or may not be electrical in nature. In a case when the message produced by the information source is not electrical in nature, an input transducer is used to convert it into a time-varying electrical signal.
- For example, in case of radio-broadcasting, a microphone converts the information or message which is in the form of sound waves into corresponding electrical signal

Transmitter

- The function of the transmitter is to process the electrical signal from different aspects.
- For example in radio broadcasting the electrical signal obtained from sound signal, is processed to restrict its range of audio and is often amplified.
- Modulation is the main function of the transmitter. In modulation, the message signal is superimposed upon the high-frequency carrier signal.
- All these processing's of the message signal are done just to ease the transmission of the signal through the channel.

The Channel and The Noise

- The term **channel** means the medium through which the message travels from the transmitter to the receiver. In other words, we can say that the function of the channel is to provide a physical connection between the transmitter and the receiver.

point-to-point channels	broadcast channels
• Example of point-to-point channels are wire lines, microwave links and optical fibres. • Wire-lines operate by guided electromagnetic waves and they are used for local telephone transmission	• On the other hand, the broadcast channel provides a capability where several receiving stations can be reached simultaneously from a single transmitter. • An example of a broadcast channel is a satellite in geostationary orbit, which covers about one third of the earth's surface

Noise is an unwanted signal which tend to interfere with the required signal. Noise signal is always random in character. Noise may interfere with signal at any point in a communication system.

Receiver and Destination

- The main function of the **receiver** is to reproduce the message signal in electrical form from the distorted received signal.
- This reproduction of the original signal is accomplished by a process.
- **Destination** is the final stage which is used to convert an electrical message signal into its original form.
- For example in radio broadcasting, the destination is a loudspeaker which works as a transducer i.e. converts the electrical signal in the form of original sound signal.

Examples

Internet

Televisio
n

Telephon

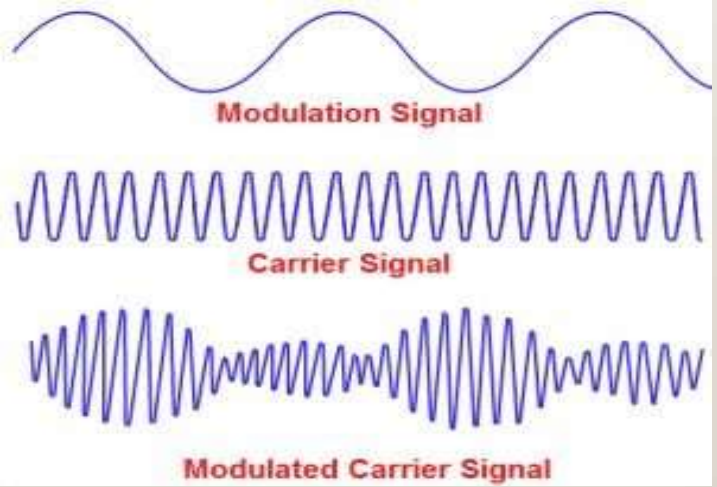
Fax

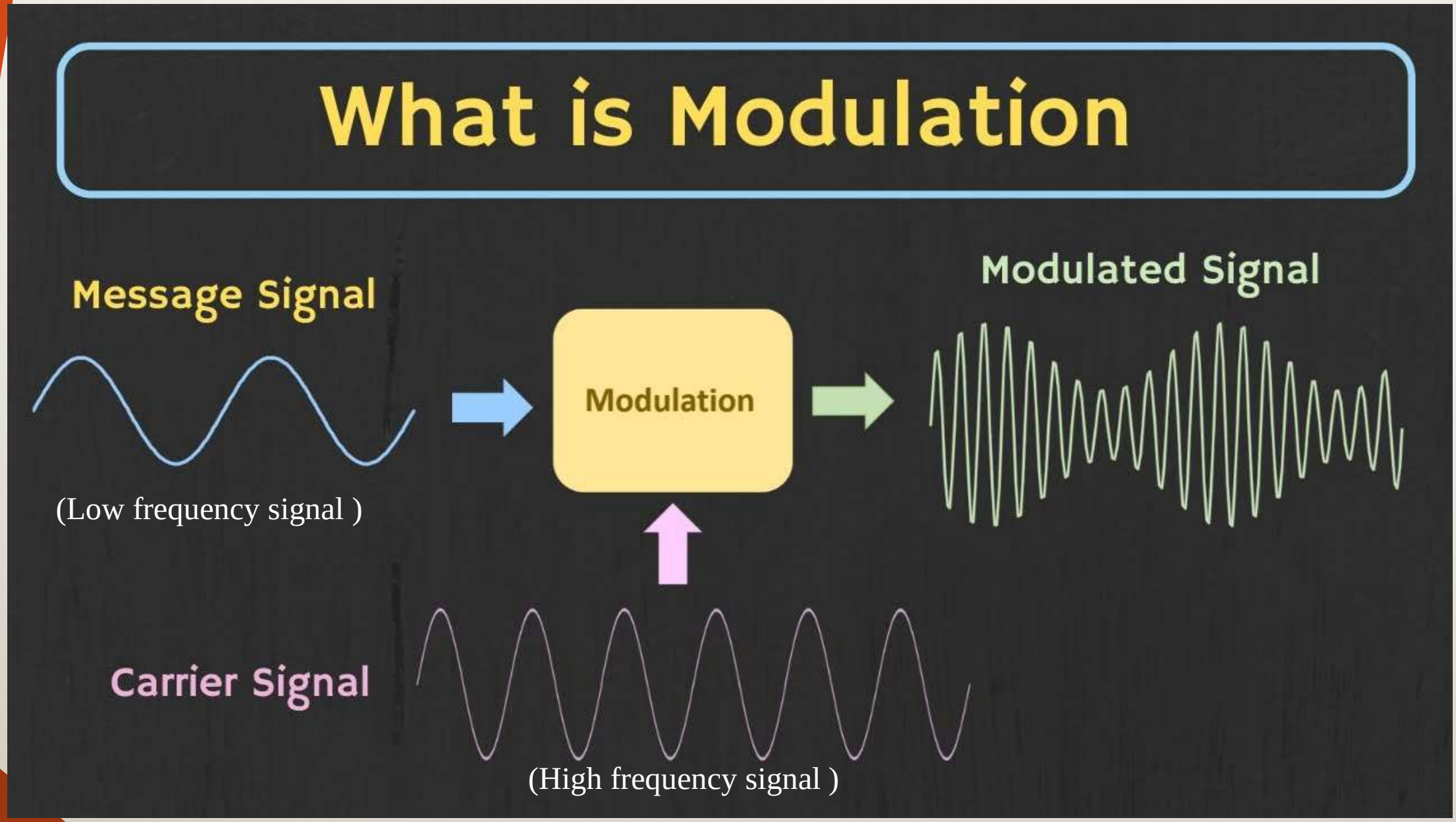
Analog signal	Digital signal
Continuous signals	Discrete signals
	
Represented by sine waves	Represented by square waves
Human voice, natural sound, analog electronic devices are few examples	Computers, and other Digital electronic devices
Continuous range of values	Discontinuous values
Records sound waves as they are	Converts into a binary waveform.
Only be used in analog devices.	Suited for digital electronics like computers, mobiles and more.

What is Modulation?

- Modulate = Regulate
- The process of regulating is modulation
- One physical quantity is changing in accordance with another physical quantity.

- Carrier signal is changing with message signal in electrical communication.




What is Modulation
Message Signal
Modulated Signal
Modulation
(Low frequency signal)
Carrier Signal
(High frequency signal)

Modulation

- Modulation is the process of **converting data into electrical signals** optimized for transmission.
- In other words, Modulation is the process of **superimposing a low frequency signal on a high frequency carrier signal**.

(Note: Voice signal-> ***upto 3kHz*** & Audible Spectrum-> ***20Hzto 20kHz***)

$$f(t) = A\sin(\omega t + \phi)$$

Where A -> **amplitude**,

ω ->**frequency**,

ϕ ->**phase angle**.

The Role of Modulation

- How can we communicate with people from distant places?
- We need something which will carry our message to desire place(carrier signal).
- Modulation can only do the process to take carrier signal with our message signal.
- Without modulation, our message signal will not be received by destination.

Need for modulation

- The main reason is the disturbance of noise.
- After transmitting, our message signal can be attacked by unwanted signals in the channel.
- Message signal can be modified into unwanted signal by noise.
- Because of noise, modulation must be done before transmitting.

Need for modulation Cont…

Factors that suggest need of modulation

1. Practicable Size of Antenna

- Speech and music signal(20Hz – 20kHz) can only travel for a few distance.
- To receive the transmitted signal, the length of antenna should be a quarter-wavelength of the frequency used.
- If frequency is 20kHz, wavelength will be 15km and the height of antenna will become 3.75km which is impossible to install.

➢ When we add high frequency signal(10MHz) with our message signal, frequency becomes high(10.02MHz).

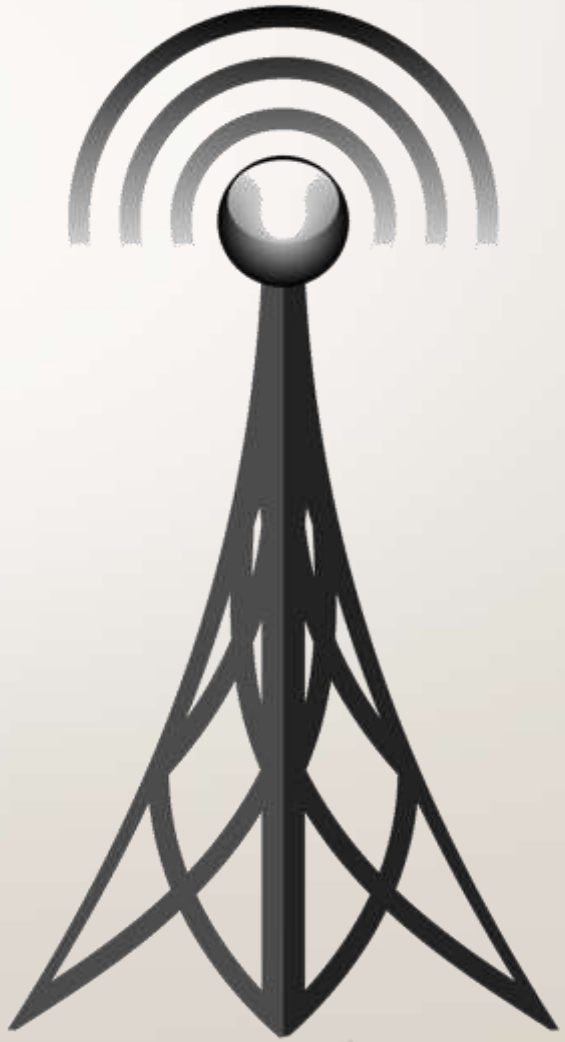
➢Then the wavelength will low(30m) and the height of antenna will become practicable(7.5m).

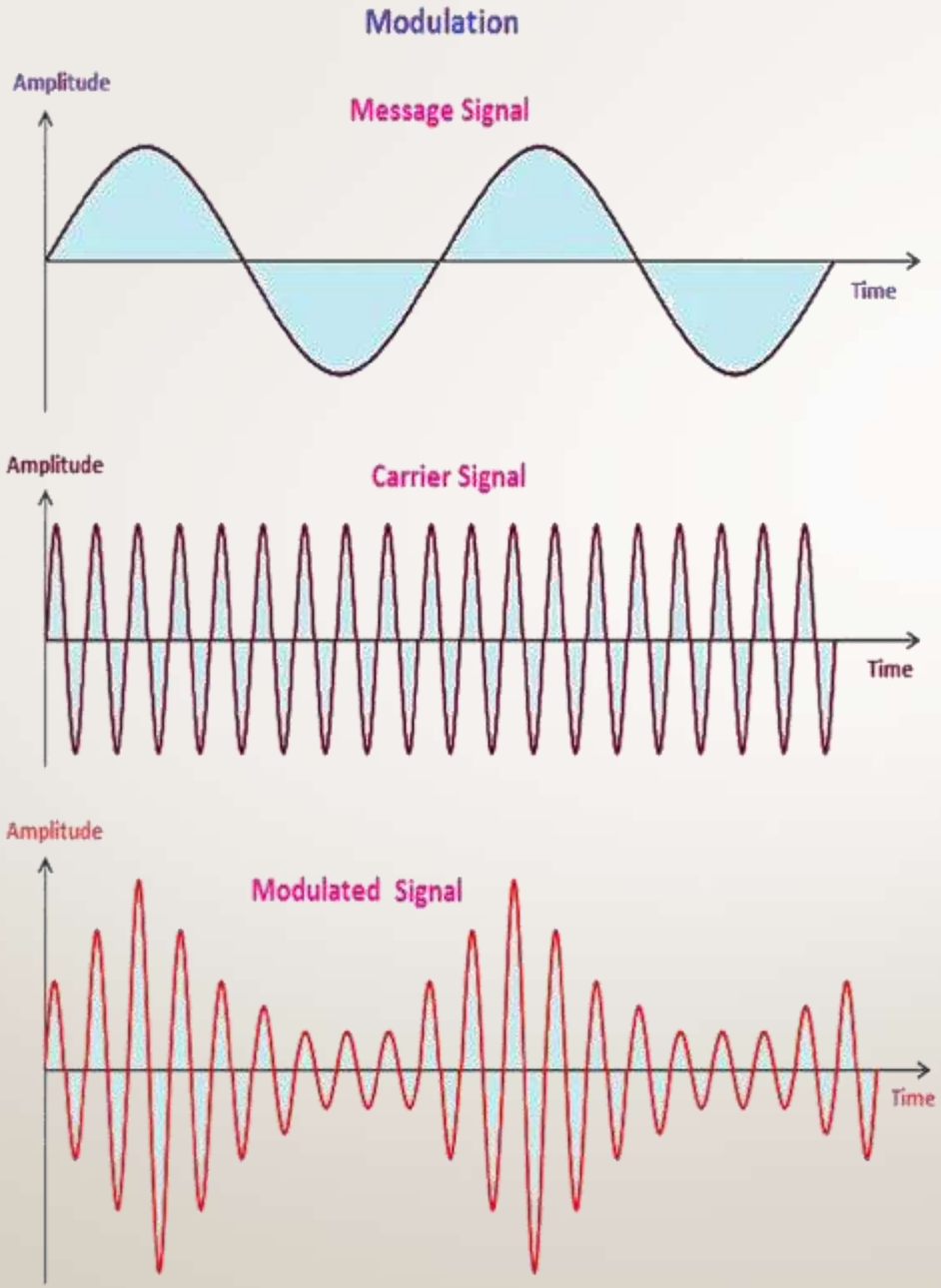
2. **Power Radiation**

- Without modulation, the frequency of signal is low, wavelength will large and Power will low
- If Power is very low, it will not reach destination and noise can also be added in the channel
- If we used modulation, the frequency of modulating signal is high and radiated power will become high.

Need for Modulation

- Avoid the **mixing of signals**
- Increases the **range of communication**.
- Reduces the **height of antenna**.
- Improves the **quality of reception**.
- Avoid the **multiplexing of signals**.
- Allow **bandwidth adjustments**.





Baseband signal : The signal which contains a message to be transmitted.

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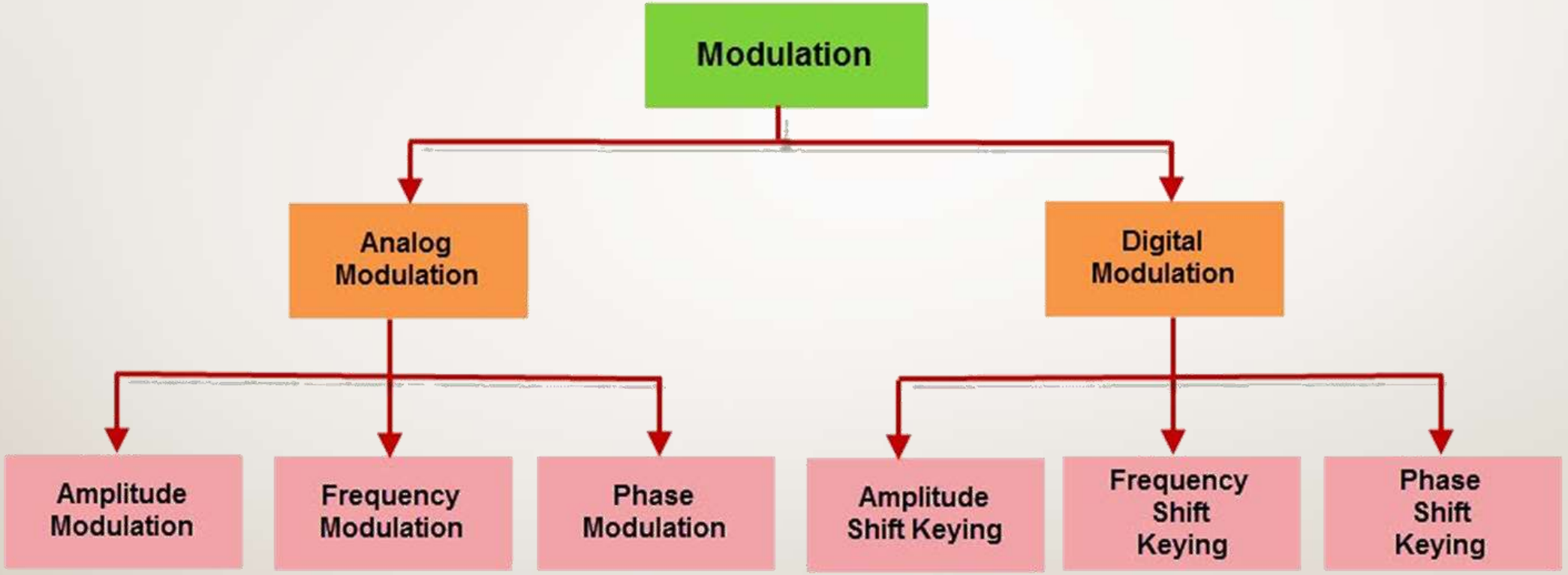
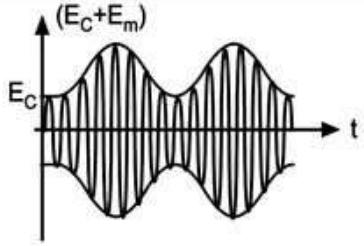
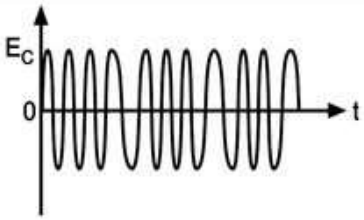
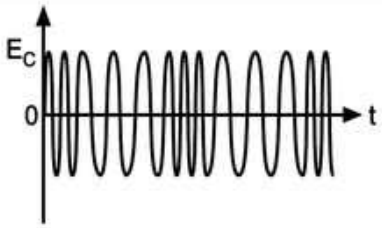
Carrier signal*(Sinusoidal Signal)* **:**The high frequency signal which has a certain phase, frequency, and amplitude but contains no information.

Modulated signal : The resultant signal after the process of modulation

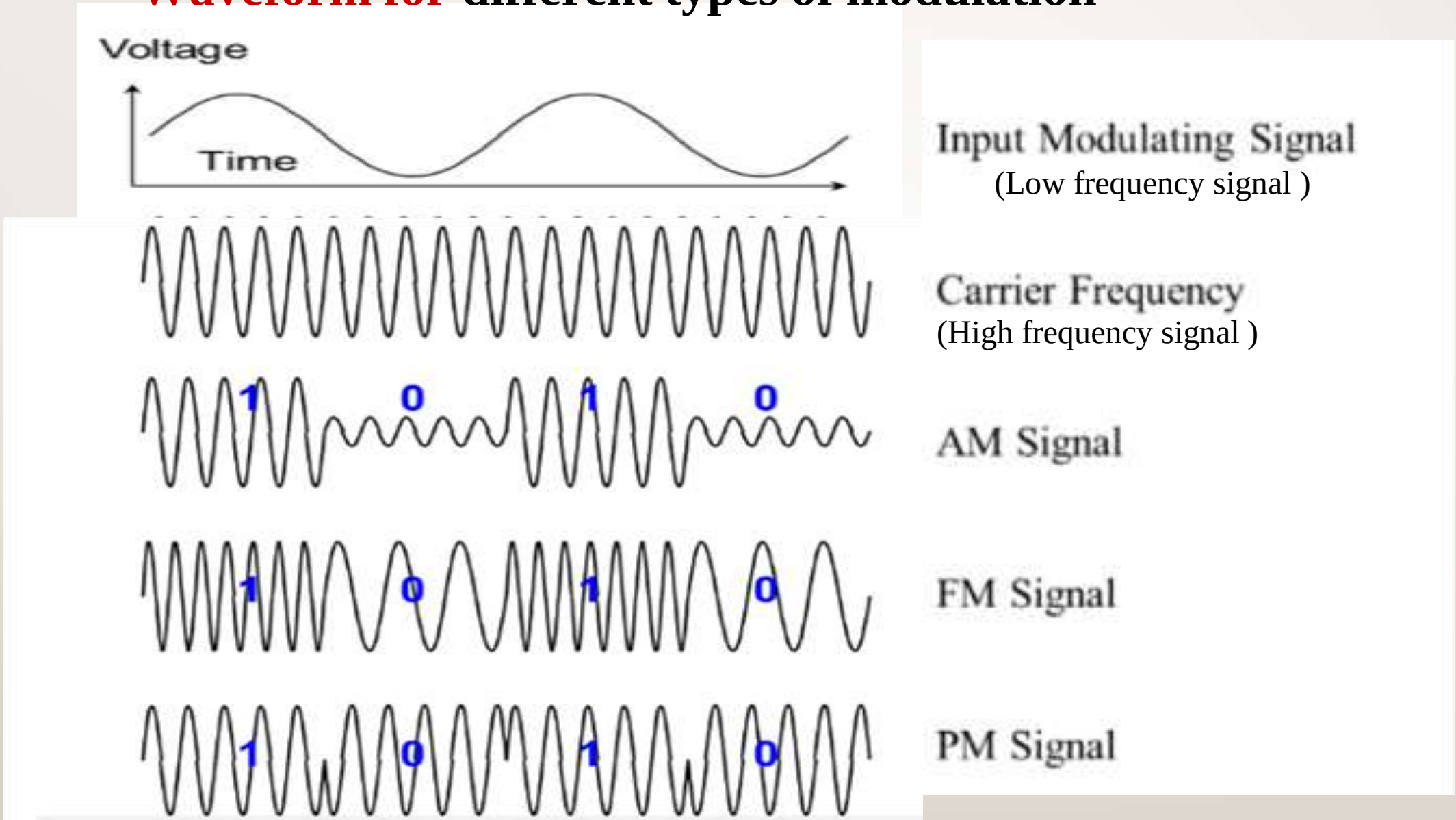
Types of Modulation



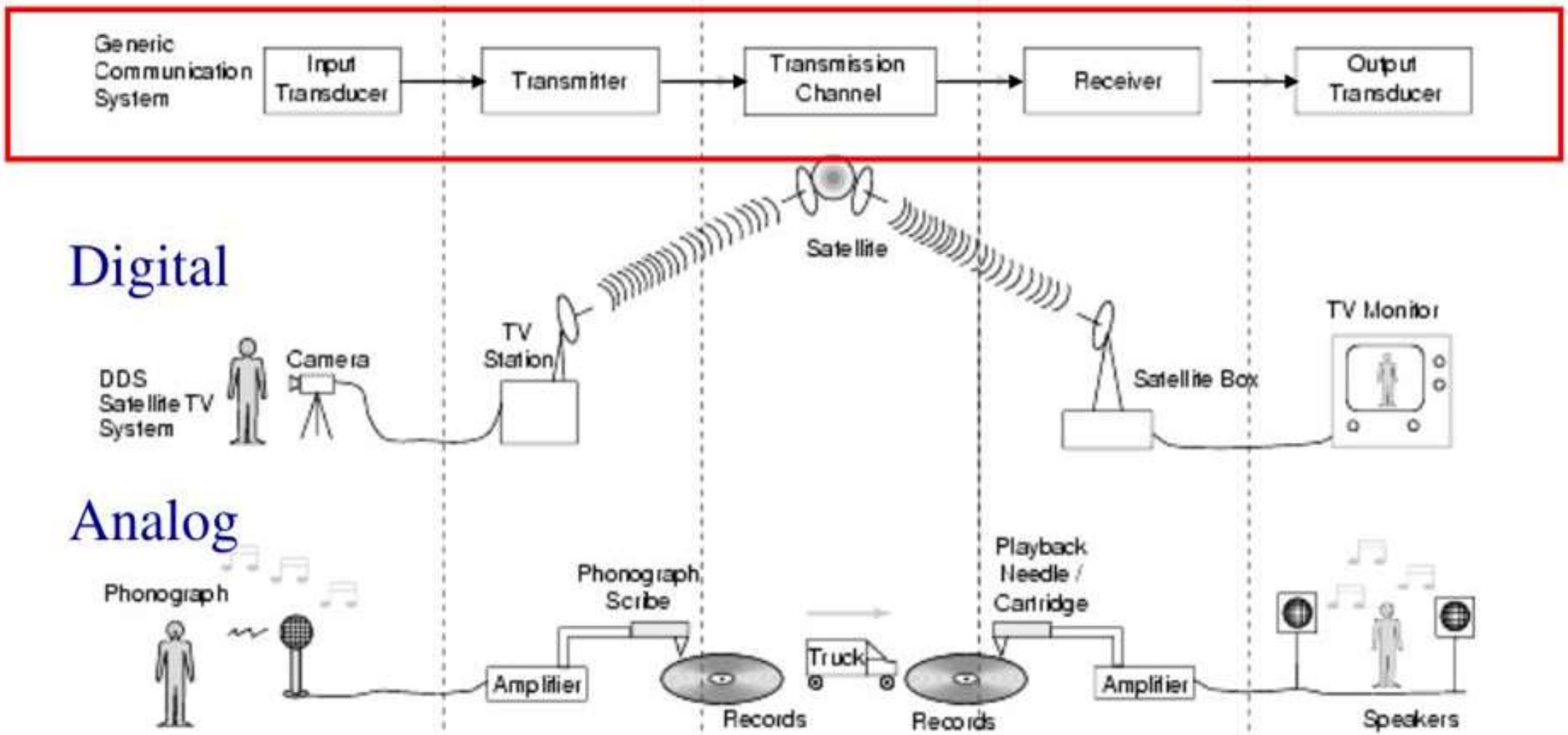
Types AM, FM, PM Definition, Waveforms

Sr. No.	Parameter	AM	FM	PM
1.	Definition	Amplitude modulation is a technique of modulation, in which amplitude of carrier varies in accordance with amplitude of modulating signal. Keeping frequency and phase constant.	Frequency modulation is a technique of modulation, in which frequency of carrier varies in accordance with amplitude of modulating signal. Keeping amplitude and phase constant.	Phase modulation is a technique of modulation in which phase of carrier varies in accordance with amplitude of modulating signal. Keeping amplitude and frequency constant.
1.	Definition	Amplitude modulation is a technique of modulation, in which amplitude of carrier varies in accordance with amplitude of modulating signal. Keeping frequency and phase constant.	Frequency modulation is a technique of modulation, in which frequency of carrier varies in accordance with amplitude of modulating signal. Keeping amplitude and phase constant.	Phase modulation is a technique of modulation in which phase of carrier varies in accordance with amplitude of modulating signal. Keeping amplitude and frequency constant.
2.	Waveforms	 **Fig. 2.3**	 **Fig. 2.4**	 **Fig. 2.5**

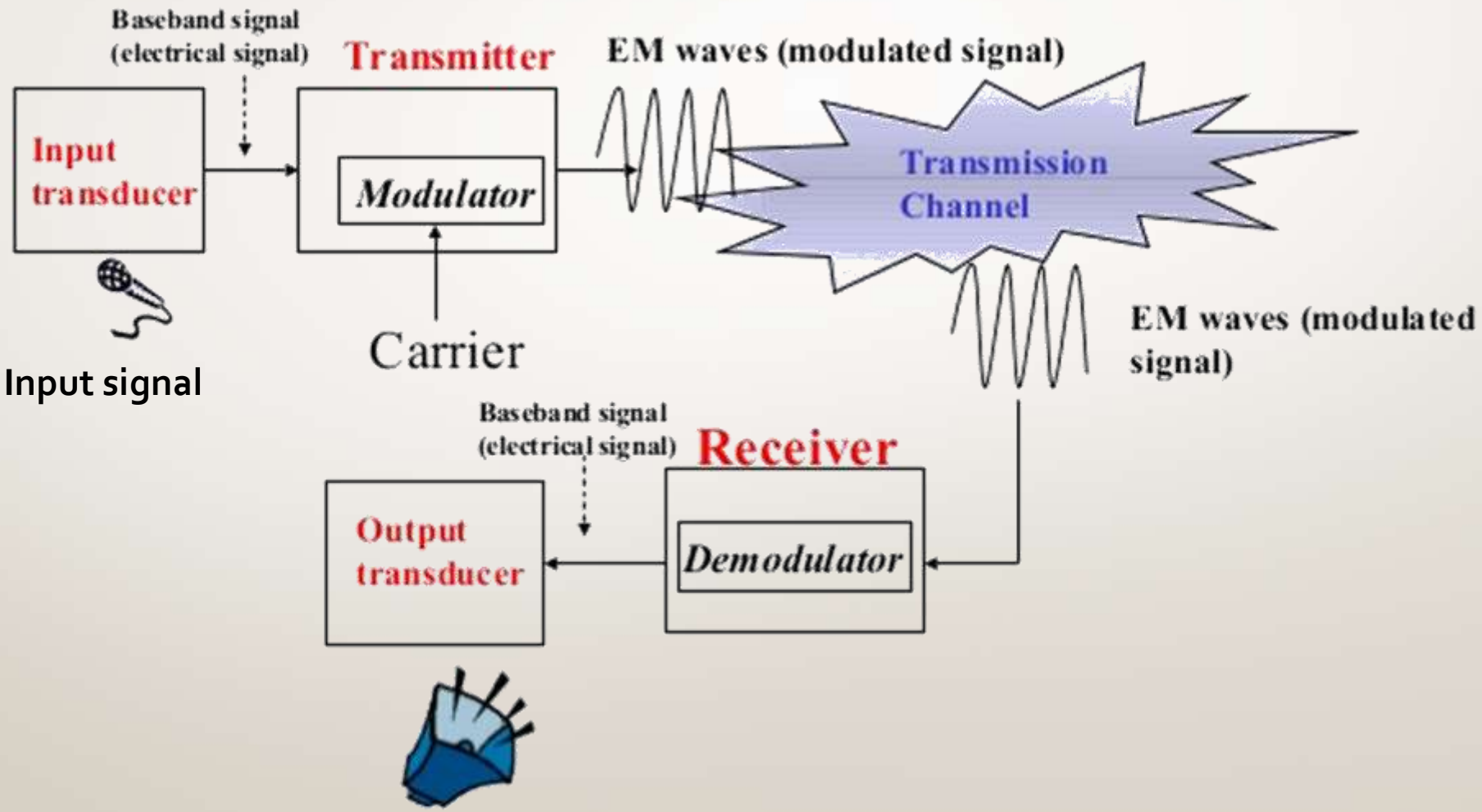
Waveform for different types of modulation



Analog and Digital System



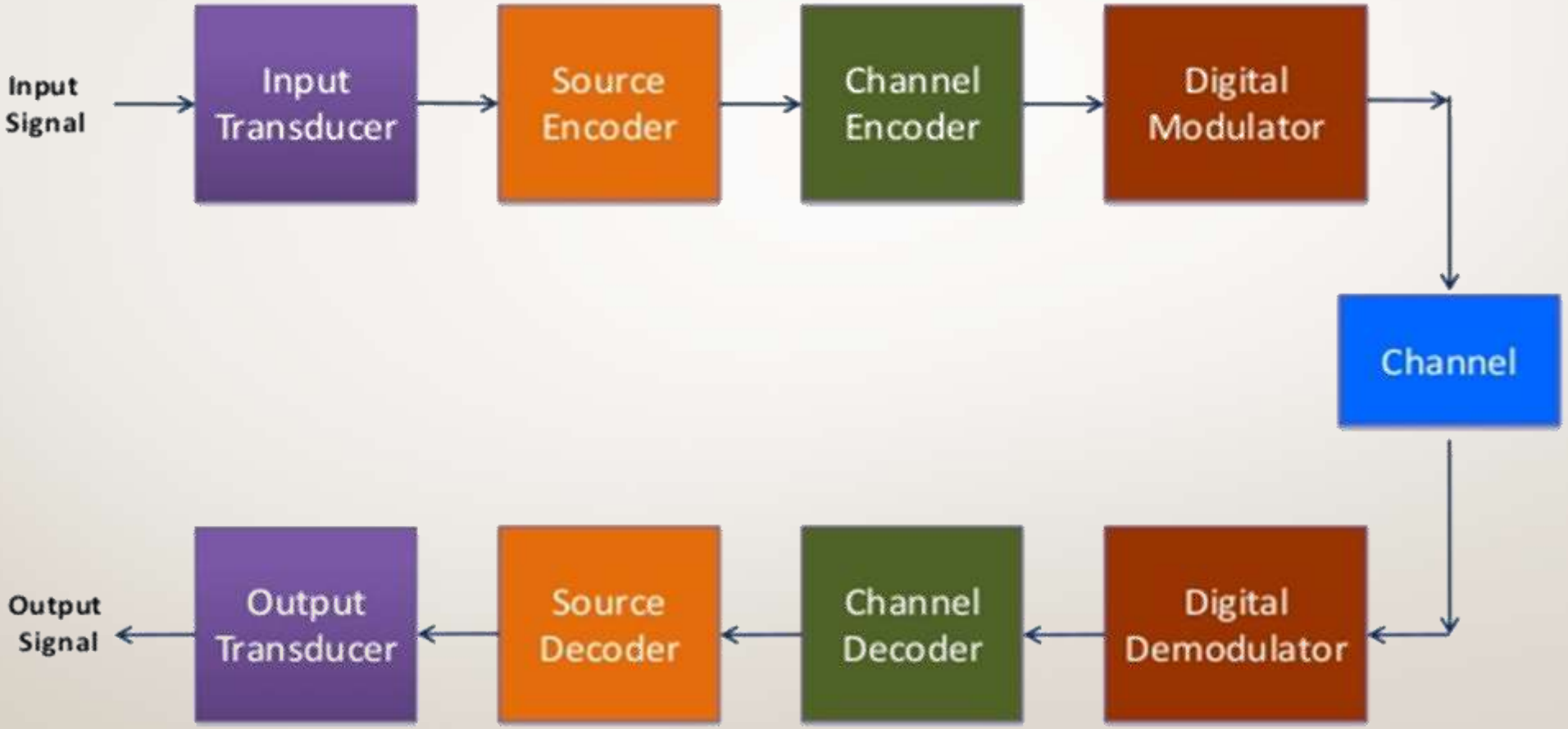
Analog Communication System (Block Diagram)



Its Working

1. **Input signal:** This input signal can be in the form of a sound signal like speech, pictures or form of data information
2. **Input transducer:** Used to convert it into a suitable electrical signal***(microphones, TV)***
3. **Transmitter:** The function of the transmitter is to convert the electrical equivalent of the information to a suitable form so that it can transfer over long distance ***(Amplifier, Oscillator, Mixer)***.
4. **Channel:** The communication channel is the medium used for transmission of electrical signal from one place to other ***(wires, cables, optical fibres or free space).***
5. **Receiver:** The receiver always converts the modulated signal into original signal***(Amplifier, Oscillator, Mixer)***
6. **Output transducer:** Output transducer converts electrical signal into the original form i.e. sound or TV pictures etc. ***(Loudspeaker, data and image convertor).***

Digital Communication system (Block Diagram)



- Information source
  - Analog Data: Microphone, speech signal, image, video etc…
  - Discrete (Digital) Data: keyboard, binary numbers, hex numbers, etc…
- Analog to Digital Converter (A/D)
  - Sampling:
    - Converting continuous time signal to a digital signal
  - Quantization:
    - Converting the amplitude of the analog signal to a digital value
  - Coding:
    - Assigning a binary code to each finite amplitude in the

- Source encoder
  - Represent the transmitted data more efficiently and remove redundant information
    - How? “write Vs. rite”
    - Speech signals frequency and human ear “20 kHz”
  - Two types of encoding:
  - Lossless data compression (encoding)
    - Data can be recovered without any missing information
  - Lossy data compression (encoding)
    - Smaller size of data
    - Data removed in encoding can not be recovered again

- Channel encoder:
  - To control the noise and to detect and correct the errors that can occur in the transmitted data due the noise.
- Modulator:
  - Represent the data in a form to make it compatible with the channel
    - Carrier signal “high frequency signal”
- Demodulator:
  - Removes the carrier signal and reverse the process of the Modulator

- Channel decoder:
  - Detectsand corrects the errors in the signal gained from the channel
- Source decoder:
  - Decompresses the data into it’s original format.
- Digital to Analog Converter:
  - Reverses the operation of the A/D
  - Needs techniques and knowledge about sampling, quantization, and coding methods.
- Information Sink
  - The User

Why should we use digital communication?

- Ease of regeneration
  - Pulses “ 0 , 1”
  - Easy to use repeaters
- Noise immunity
  - Better noise handling when using repeaters that repeats the original signal
  - Easy to differentiate between the values “either 0 or 1”
- Ease of Transmission
  - Less errors
  - Faster !
  - Better productivity

Why should we use digital communication?

- Ease of multiplexing
  - Transmitting several signals simultaneously
- Use of modern technology
  - Less cost !
- Ease of encryption
  - Security and privacy guarantee
  - Handles most of the encryption techniques

Disadvantage !

- The major disadvantage of digital transmission is that it requires a greater transmission bandwidth or channel bandwidth to communicate the same information in digital format as compared to analog format.

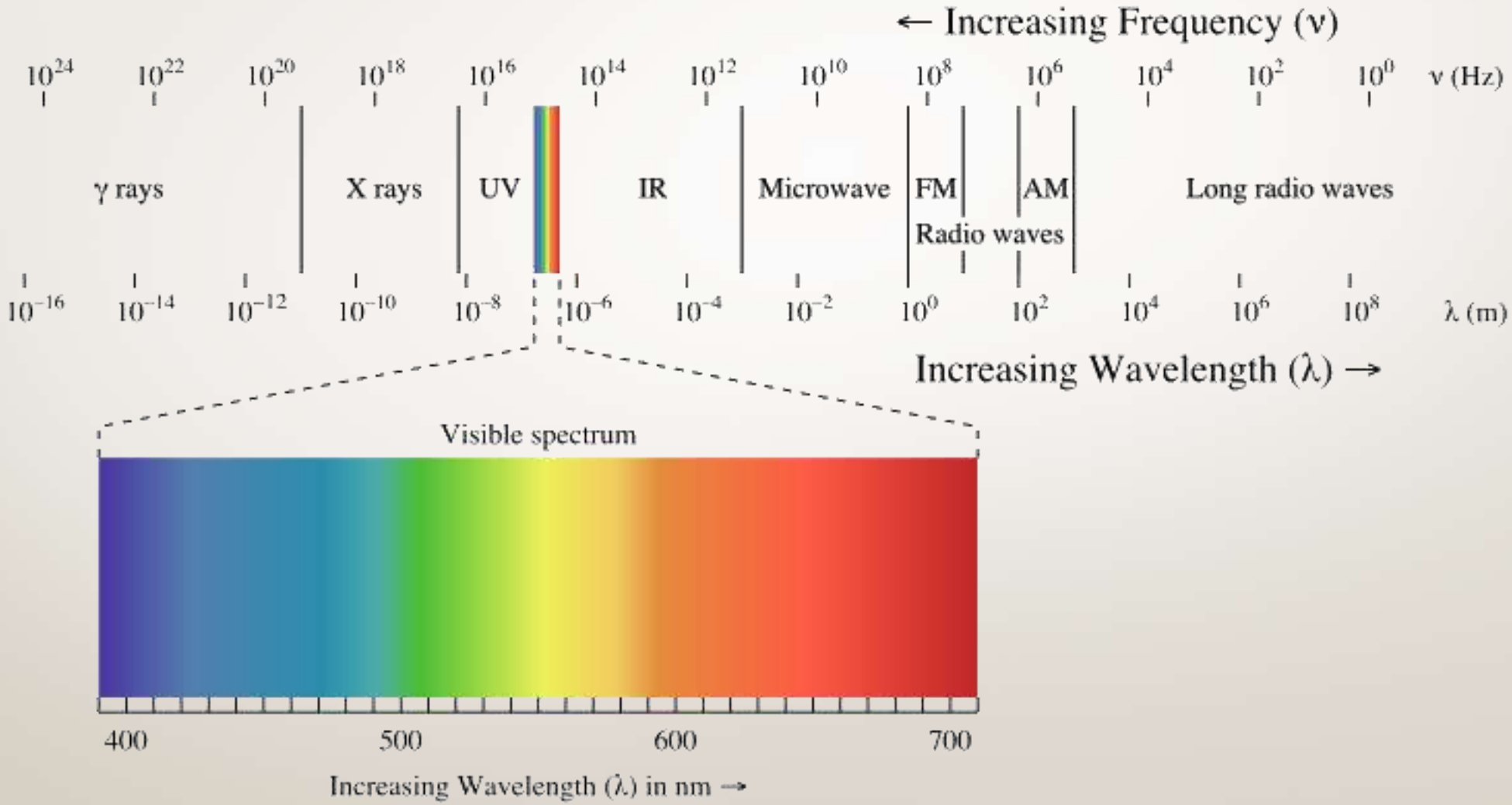
Comparison of Digital and Analog communication system

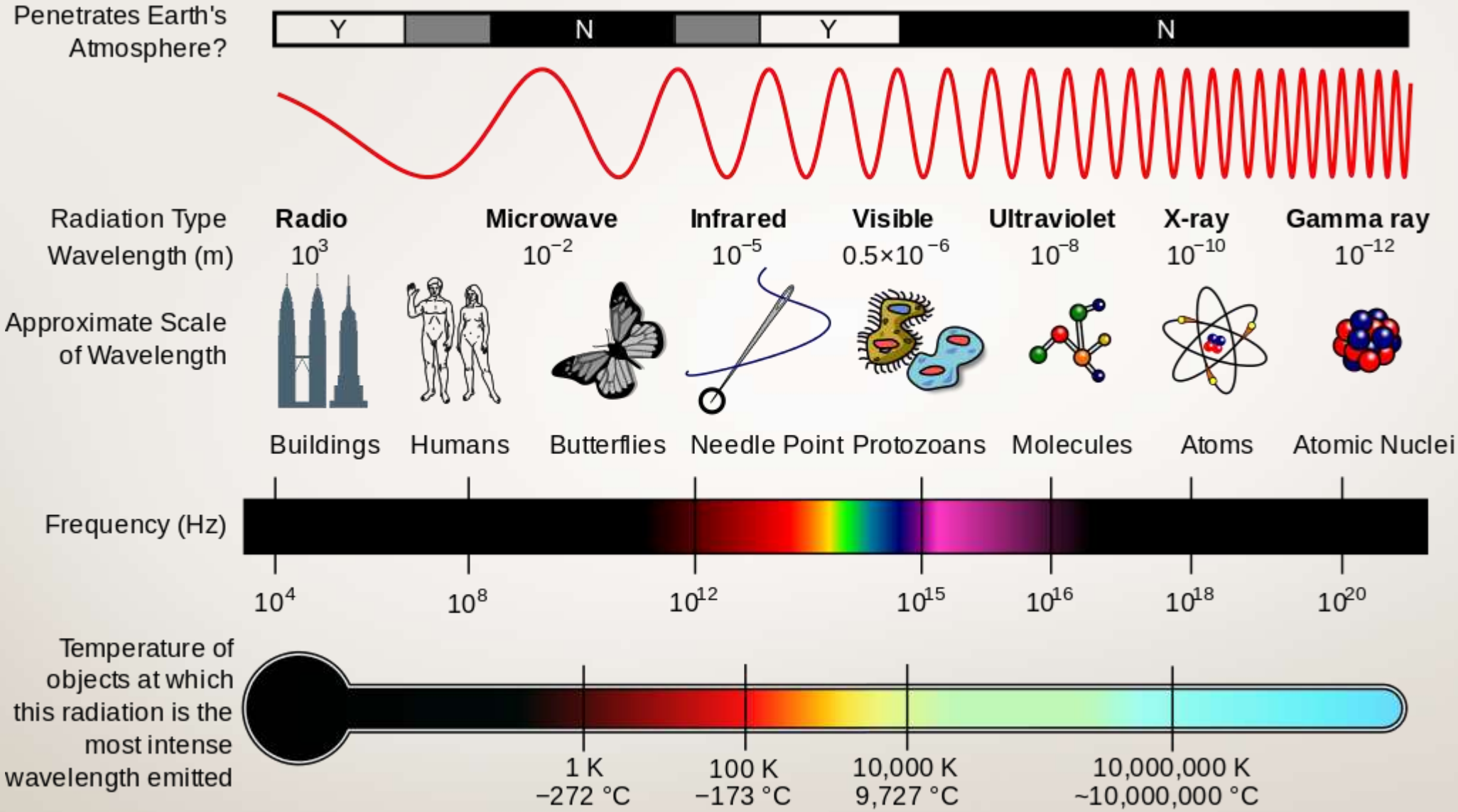
S. No.	Analog signal	Digital Signal
1	Analog signals are continuous signals	Digital signals are discrete signals.
2	Analog signal uses continuous values for representing the information.	A digital signal uses discrete values for representing the information.
3	Analog signals can be affected by the noise during the transmission.	Digital signals cannot be affected by the noise during transmission.
4	Accuracy of Analog signal is affected by the noise.	Digital signals are noise-immune hence there accuracy is less affected
5	Devices which are using analog signals are less flexible	Device using digital signals are very flexible
6	Analog signals consumes less bandwidth	Digital signals consume more bandwidth.
7	Analog signal are stored in the form of continuous wave form.	Digital signals are stored in the form of binary bits "0", "1".
8	Analog signals have low cost.	Digital signals have high cost.
9	Analog signals are portable.	Digital signals are not Portable.
10	Analog signals give observation error	Digital Signals doesn't give observation error.

Electromagnetic Spectrum

- The electromagnetic spectrum is the *range of frequencies* of electromagnetic radiation and their respective **wavelengths and photon energies.**
- The electromagnetic spectrum covers electromagnetic waves with frequencies ranging from below **one hertz to above 10^{25} hertz.**
- Electromagnetic spectrum begins at the low frequency (long wavelength) & end of the spectrum consists of: **radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays at the high-frequency** (short wavelength) end.

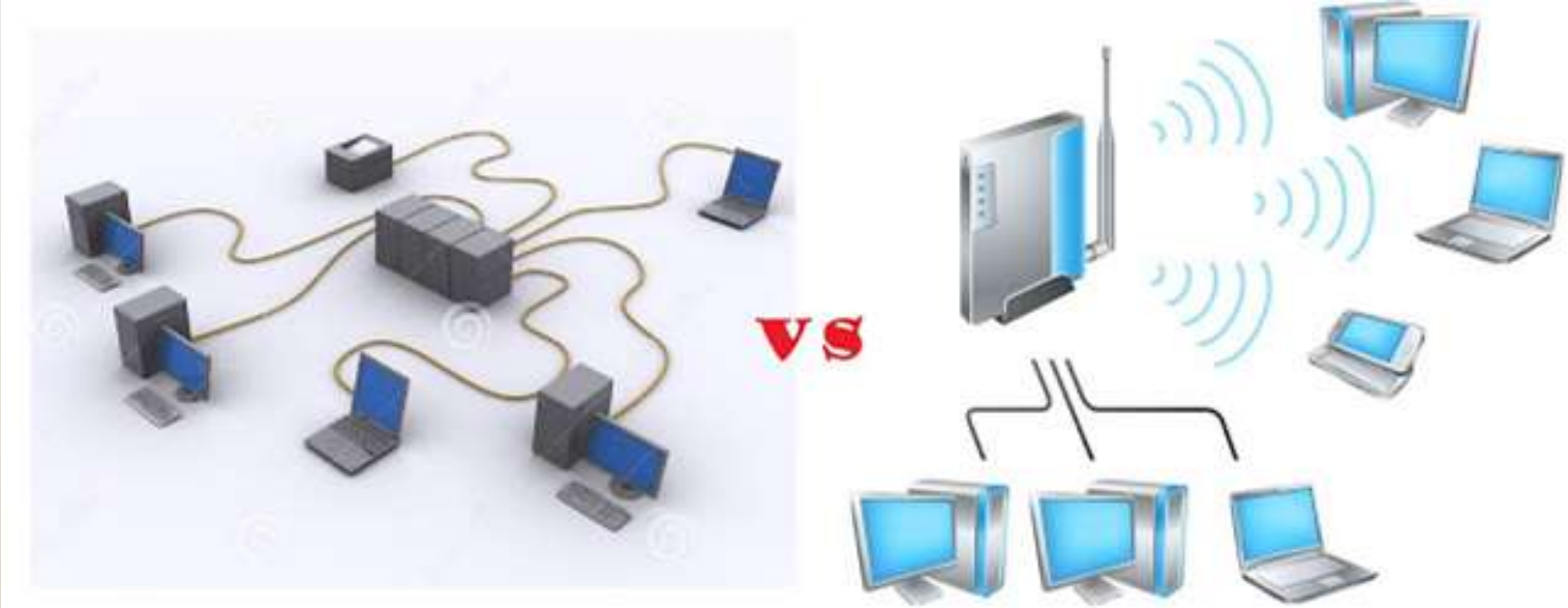
Types of Electromagnetic Radiation that exist in our universe





Electromagnetic Spectrum, showing various properties across the range of frequencies and wavelengths

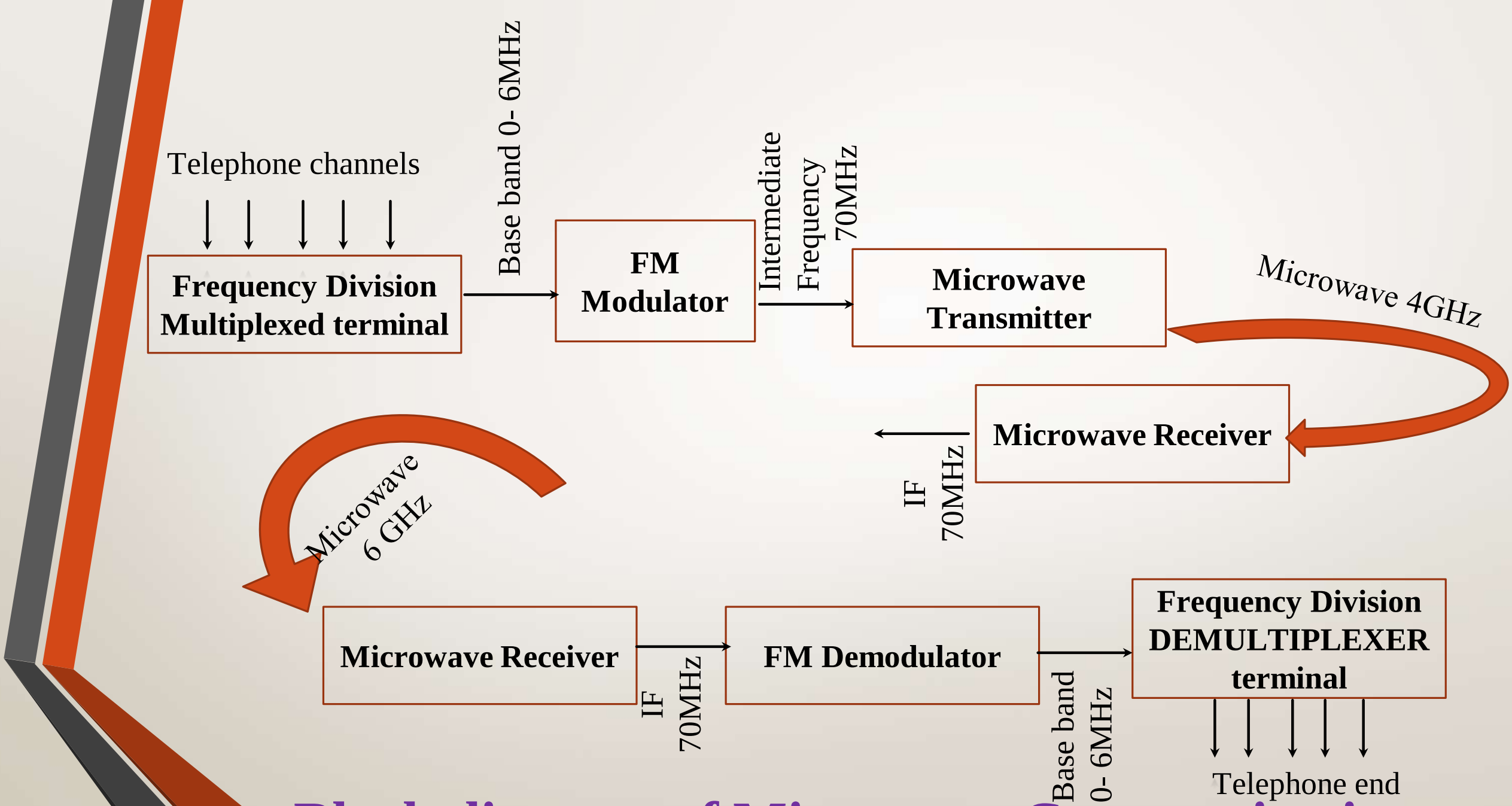
Wired and wireless Communication



Wired Communication/Line Communication	Wireless Communication/Radio Communication
The wired networks require that the cables are connected to each and every one of the computers in the network.	Laptops and other computing devices can move freely within the wireless network because the mobility of the wireless network is better compared to wired networks.
The cost of a wired network is lower compared to the wireless network since Ethernet, cables, and switches are not expensive.	Wireless networks require equipment such as wireless adapters and access points that are quite expensive. The cost of wireless networks is high compared to wired networks.
Wired LAN offers better performance compared to wireless networks. The wired network can offer a bandwidth of 100 Mbps with Fast Ethernet technology.	The maximum bandwidth provided by the wireless network is approximately 11Mpbs.
Transmission capability is limited	Wireless technologies are designed to reduce the time and different type of obstacles created by the cables

Microwave Communication

- Microwave transmission refers to the technology of transmitting information or energy by the use of electromagnetic waves whose wavelengths are conveniently measured in small numbers of centimetre; these are called microwaves.
- This part of the radio spectrum ranges across frequencies of roughly 1.0 gigahertz (GHz) to 30 GHz.
- These correspond to wavelengths from 30 centimetres down to 1.0 cm.
- Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna.



Block diagram of Microwave Communication

Description of Microwave Communication

- Microwave communication offers a large transmission bandwidth ,many thousand of telephone channels along with a few TV channels can be transmitted over the same route using same facilities
- It consists of two terminal stations and one or more repeater stations
- At the sending terminal several thousand telephone channels and one or tow television channels are frequency multiplexed to form the base band signals.
- This signal is amplified and fed through a directional antenna towards a repeater station at ta distance of about 50Km
- At the repeater station, the signal is received on one antenna directed towards the original station

Description of Microwave Communication

- The received signal is down converter to IF and up converter to a new frequency of 6GHZ
- The frequency conversion is done so that the outgoing and incoming signals do not interfere with each other in the repeater stations
- This signal is retransmitted towards the receiving terminal stations where it is down converter to the IF and demodulated to recover the base band signal

Advantage:

- Microwave transmission is that rather than utilizing cables or other physical wires, it utilizes electromagnetic waves with small wavelengths.
- The measure of the wavelengths allows a transmitter to direct microwaves to a beneficiary in a narrow beam, enhancing effectiveness.

Disadvantage:

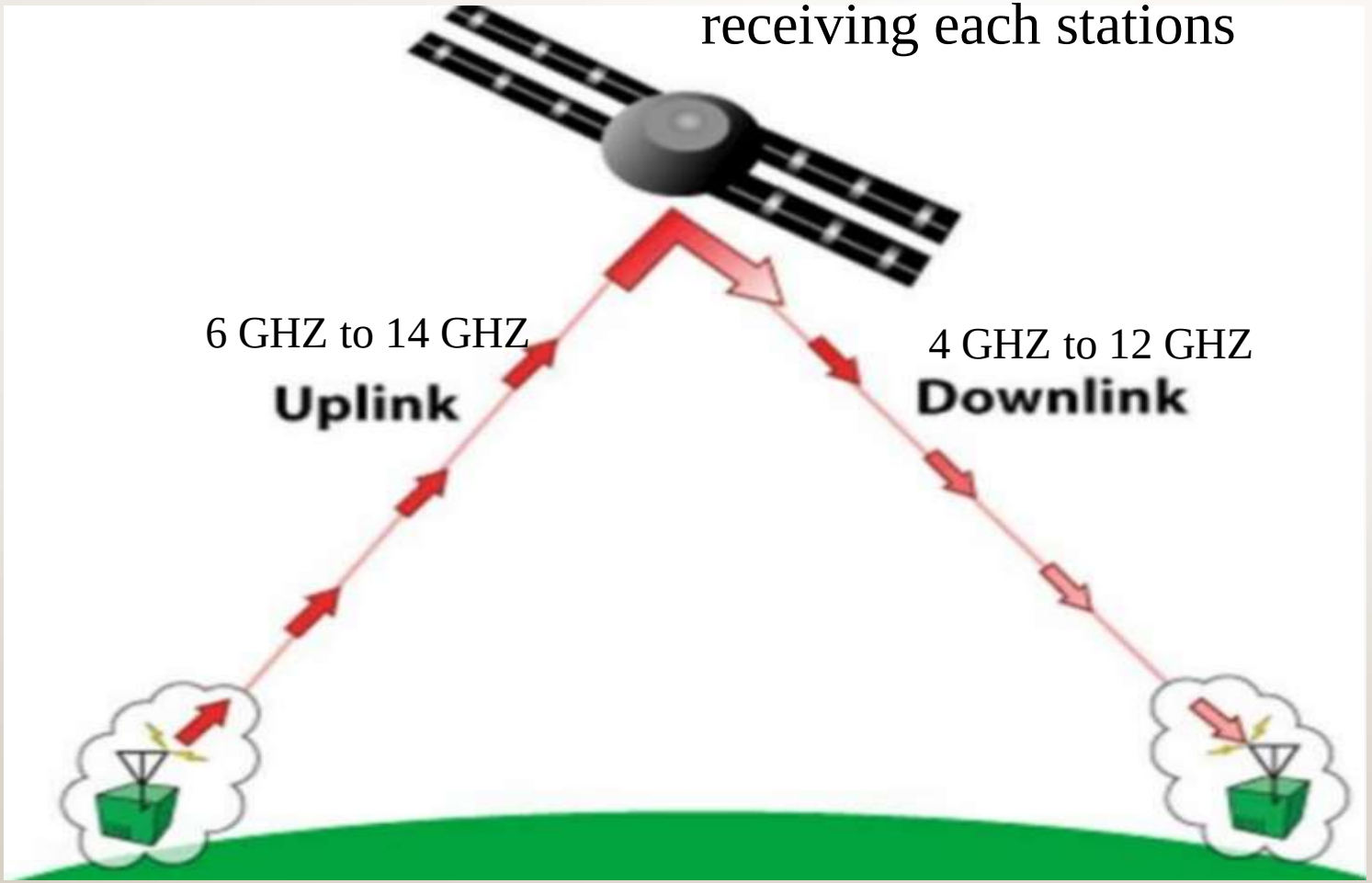
- Microwave towers can exchange data only if they have a clear line of sight between them with no obstacles such as buildings, slopes or trees in the way.
- Incorporate signal absorption by the atmosphere, weather obstruction

Application:

- Telephone networks
- Broadband television networks

Satellite Communication

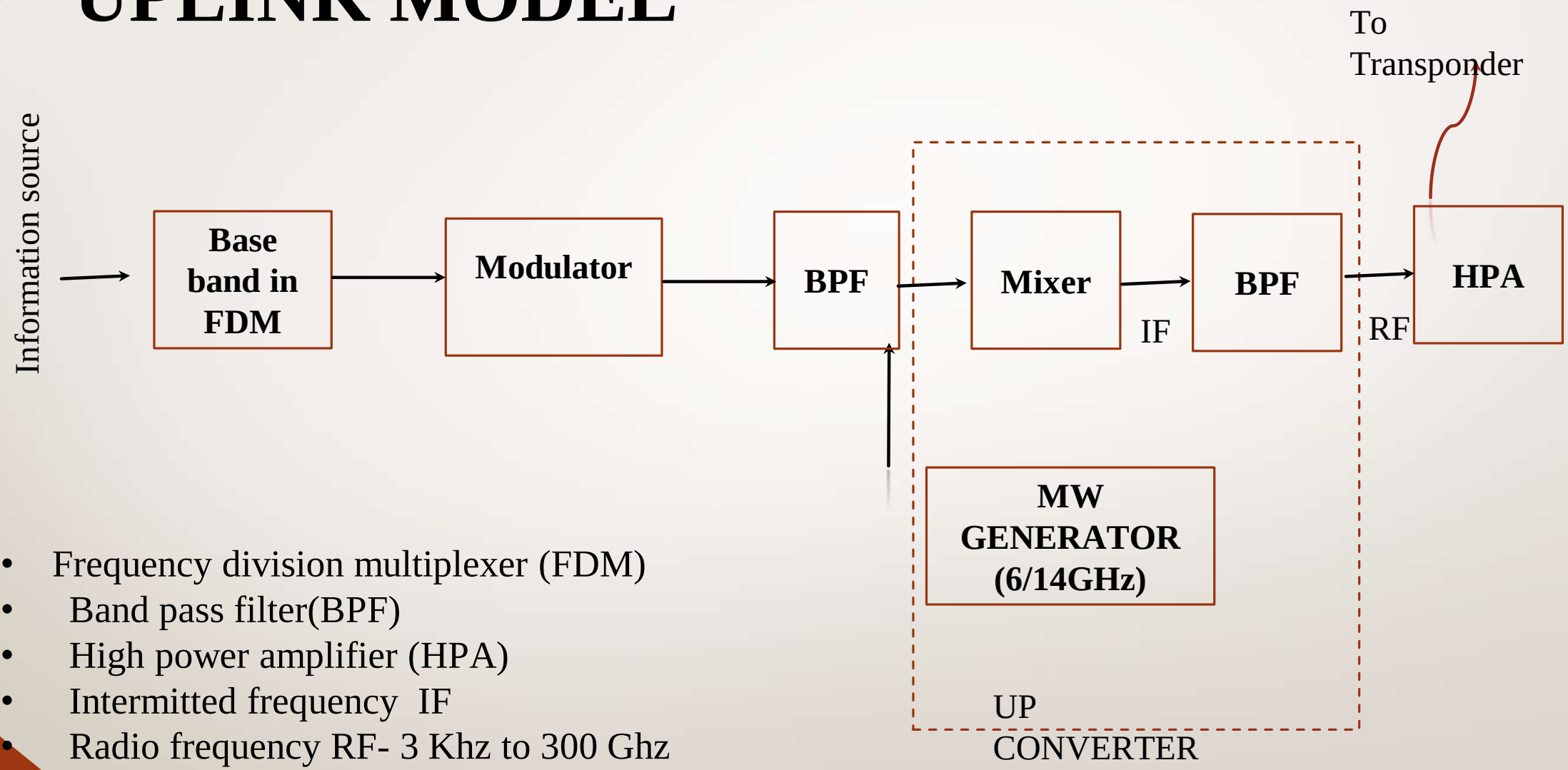
Satellite transponder –It receive signal from the transmitting earth stations, frequency converts, amplifiers and retransmits the signal toward the receiving each stations



Earth Station -1 (Transmitter)

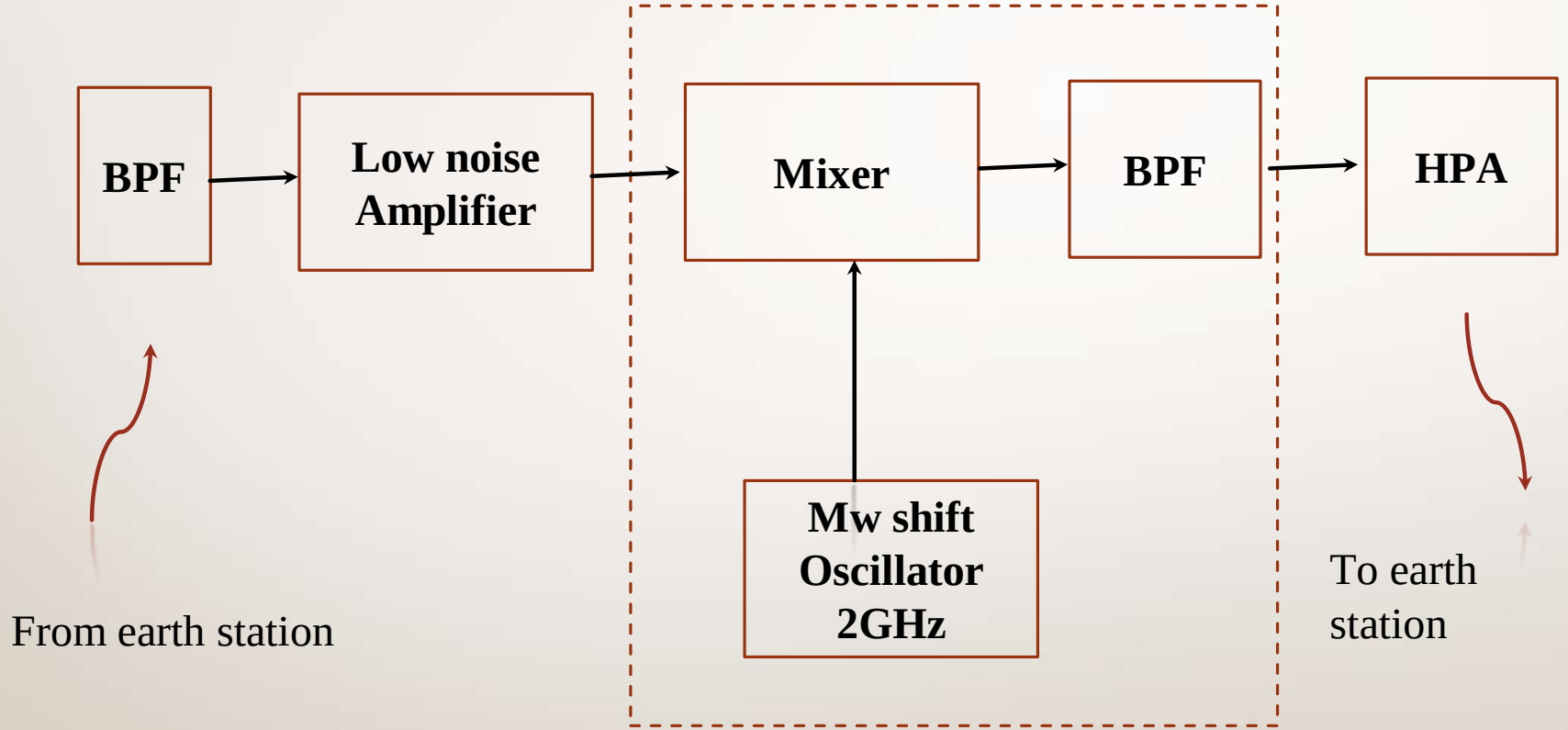
Earth Station -2(receiver)

UPLINK MODEL

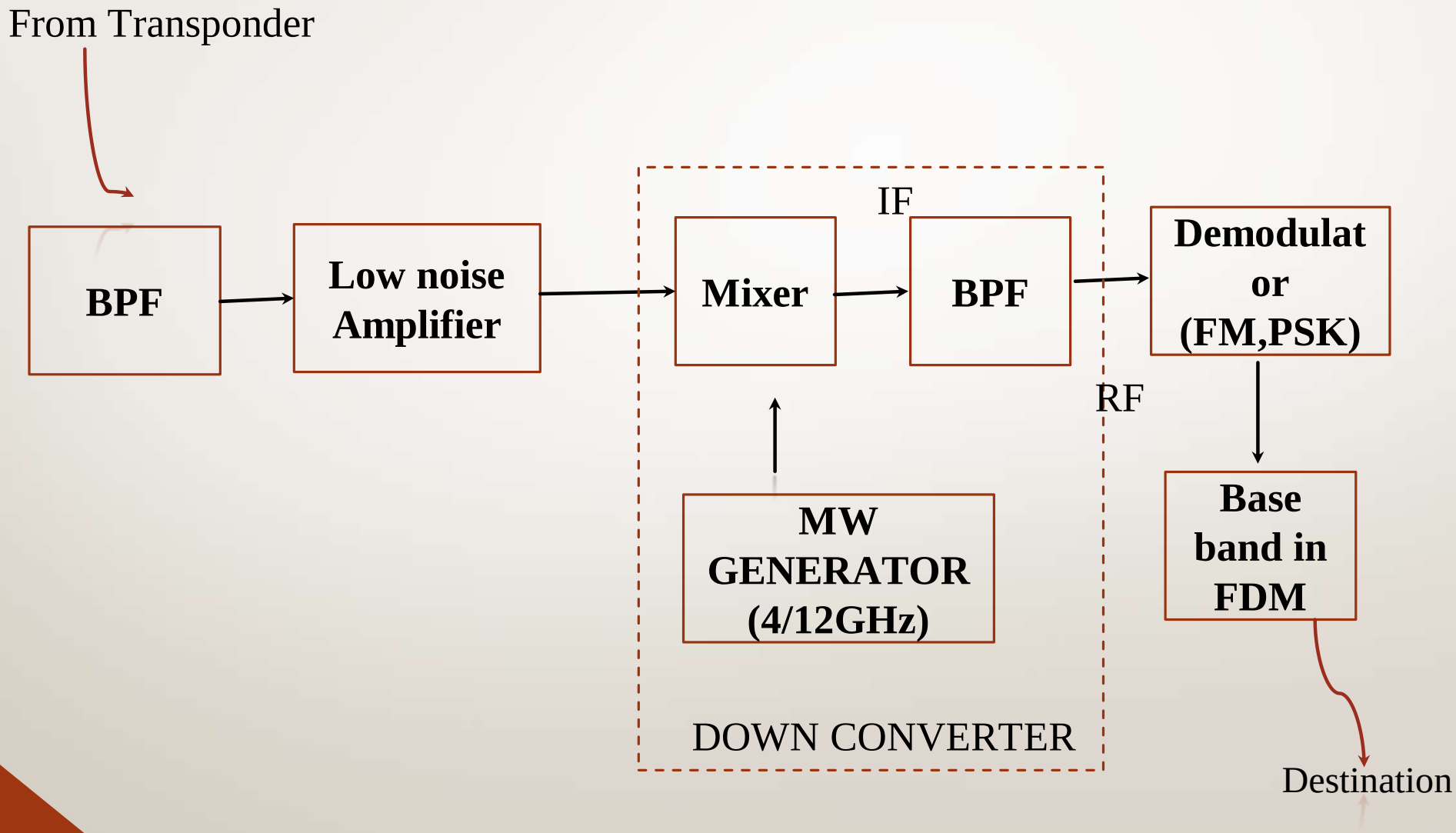


- Frequency division multiplexer (FDM)
- Band pass filter(BPF)
- High power amplifier (HPA)
- Intermitted frequency IF
- Radio frequency RF- 3 Khz to 300 Ghz

SATELLITE TRANSPONDER



DOWNLINK MODEL



Advantage:

- It provides point to Multipoint communication
- It offers telecommunication link which include video, FAX, telegraphy, Telephone etc.
- The satellite can provide line of sight coverage for a large number of users

Disadvantage:

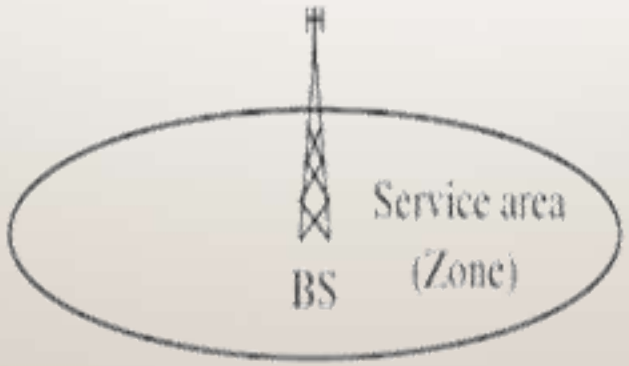
- Initial cost is high
- The malfunction in satellite is highly difficult to correct

Application:

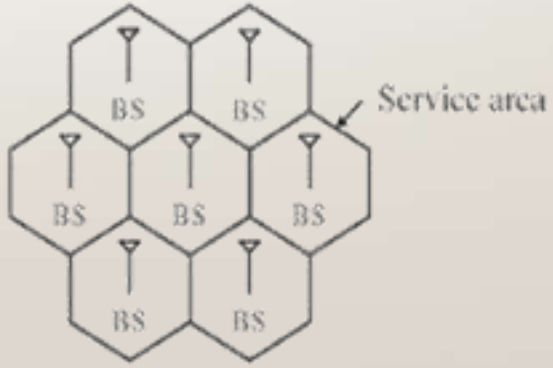
- Mobile networks

Cellular Communication

- **Cellular communication** is based on the geographic division of the communication coverage area into cells, and within cells.(used in mobile phones)
- Each cell is allocated a given number of frequencies (or channels) that allow a large number of subscribers to conduct conversations simultaneously
- In communication, the cellular system replaced a large zone with a number of *smaller hexagonal cells* with a single **BS (base station)** covering a fraction of the area.

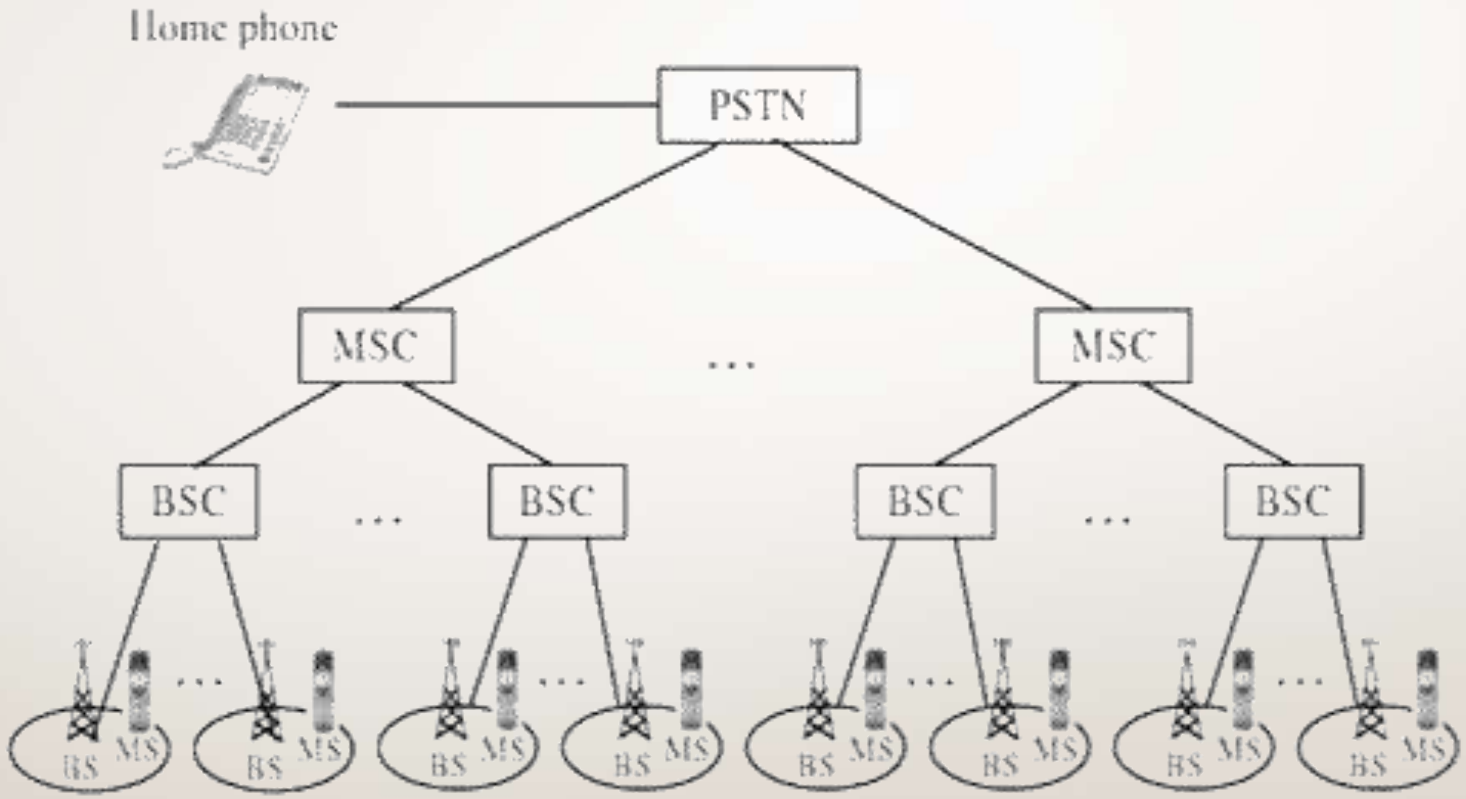


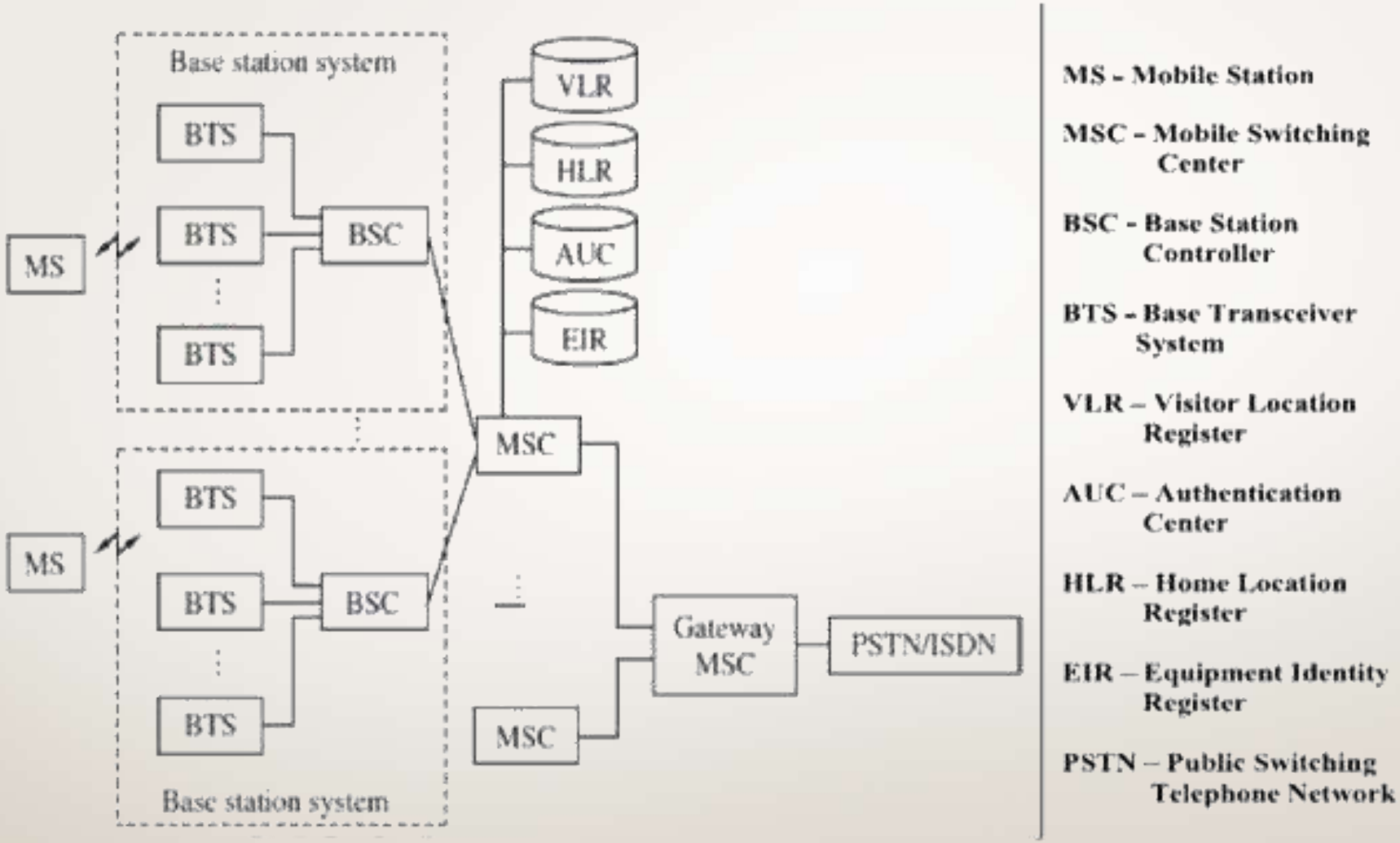
Early wireless system: large zone



Cellular system: small zone

Cellular System Infrastructure





Block Diagram of Cellular System

Working

- In a cellular structure, a **Mobile Station(MS)** needs to communicate with the **Base Station(BS)** of the cell where the MS is currently located and the BS acts as a gateway to the rest of the world.
- Therefore, to provide a link, the MS needs to be in the area of one of the cells (and hence a BS) so that mobility of the MS can be supported.
- Several base stations are connected through hard-wires and are controlled by a **Base Station Controller (BSC),** which in turn is connected to a **Mobile Switching Center (MSC).**
- Several mobile switching centers are interconnected to a **PSTN (Public Switched Telephone Network)** and the ATM (Asynchronous Transfer Mode) backbone.
- A BS consists of a **Base Transceiver System (BTS)** and a BSC. Both tower and antenna are a part of the BTS, while all associated electronics are contained in the BSC.
- The **HLR (Home Location Register)** and **VLR (Visitor Location Register)** are two sets of pointers that support mobility and enable the use of the same telephone numbers worldwide.
- The **AUC (Authentication Center)** unit provides authentication and encryption parameters that verify the user's identity and ensure the confidentiality of each cell.
- The **EIR (Equipment Identity Register)** is a database that information about identity of mobile equipment. Both AUC and EIR can be implemented as individual stand-alone units or as a combined AUC/EIR unit.

- The HLR is located at the MSC where MS is initially registered and is the initial home location for billing and access information.
- In simple words, any incoming call, based on the calling number, is directed to the HLR of the home mobile station where the MS is registered. The HLR then points to the VLR of the MSC where the MS is currently located.

GENERATION	APPROX LAUNCH YEAR	FOCUS
1G	1979	Mobile voice
2G	1991	Mobile voice
3G	2001	Mobile Broadband
4G	2009	Mobile Broadband
5G	2020 (expected)	Ubiquitous connectivity

Advantage:

- High capacity & Less transmission **power**.
- It reduced the **interference** which increases the total system capacity
- More robust against the failure of single components.

Disadvantage:

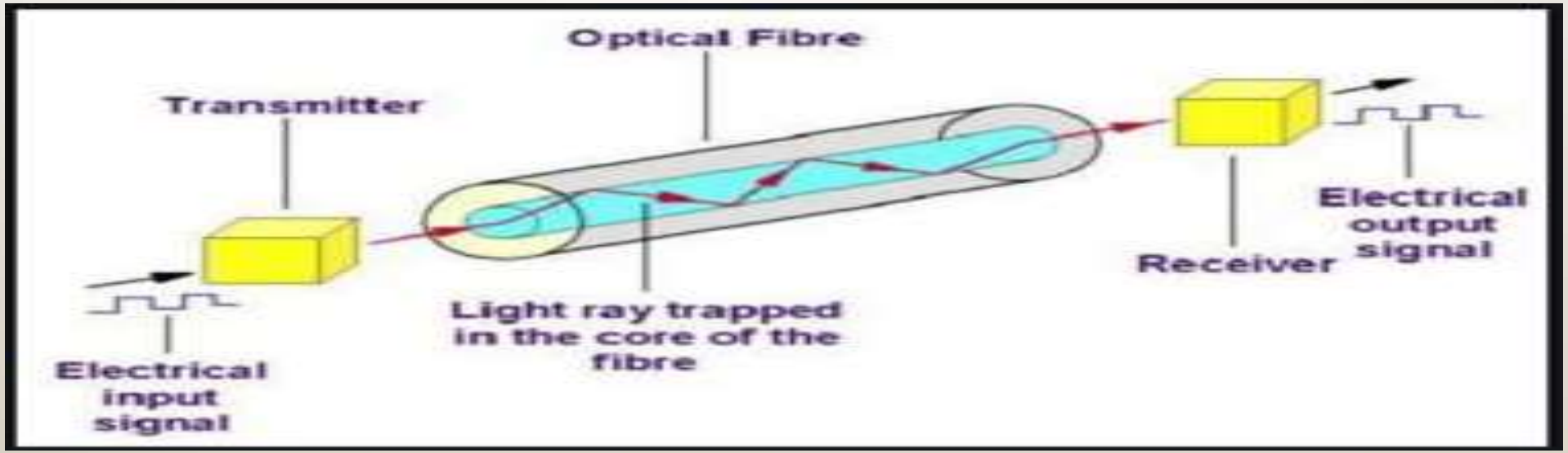
- Small cells require a **complex infrastructure** to connect all base station.
- The mobile station has to perform a **handover when changing** from one cell to another very frequently.
- To avoid interference, **frequency spectrum should be distributed** properly with a very less range of frequency spectrum.

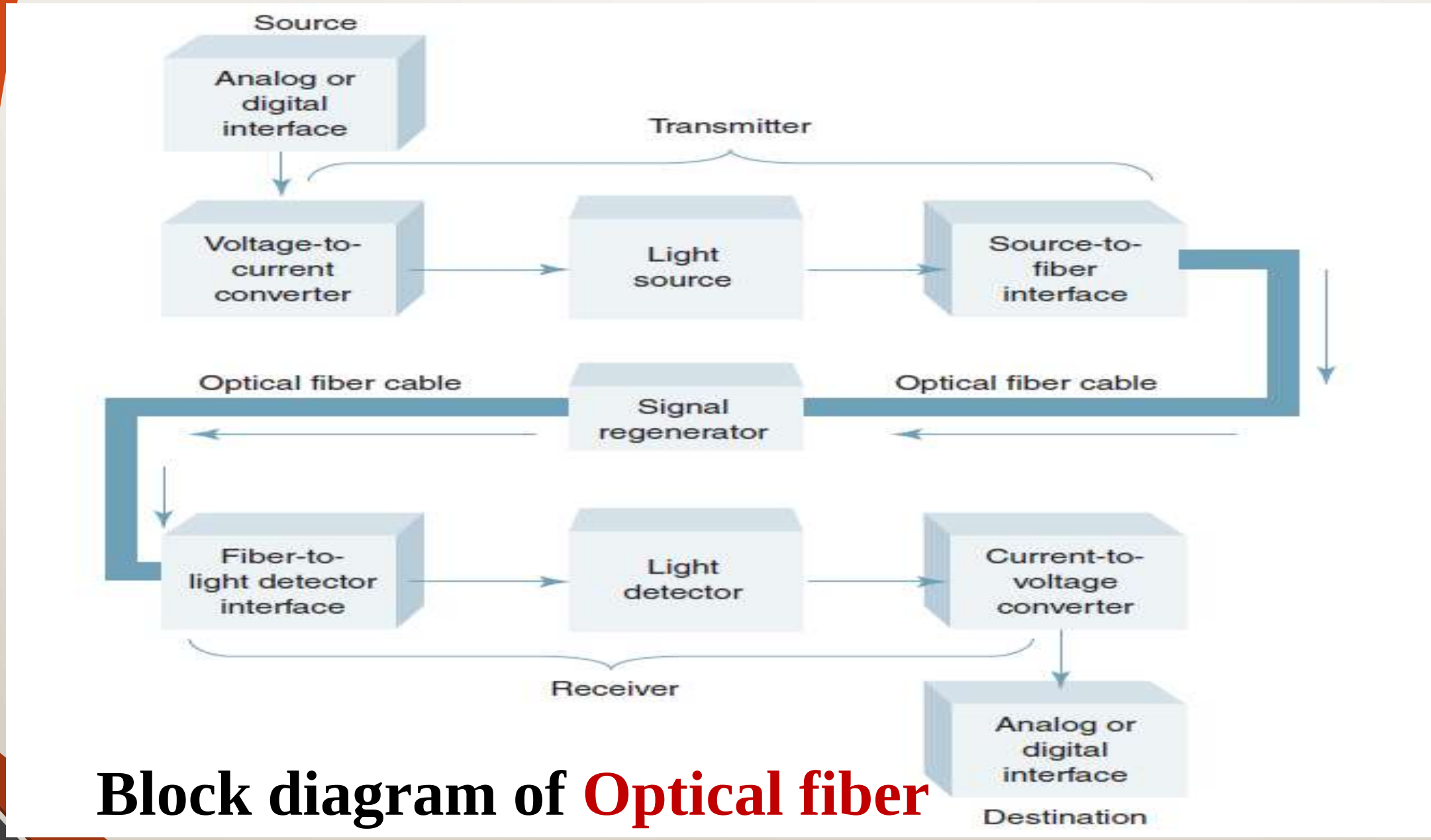
Application

- Global mobile communication
- Acts as navigation
- Connecting remote areas

Optical Fiber Communication

- Fibre optic communication is a communication technology that uses light pulse to transfer information from one point to another through an optical fiber
- The light forms an electromagnetic carrier wave that modulated to carry the information





Block diagram of Optical fiber

Advantage:

- The life of fiber is longer than the life of copper
- There is no necessity of additional equipment for protecting against grounding and voltage problems
- As it does not radiates energy any antenna or detector cannot detects it hence provides signal security

Disadvantage:

- Highly skilled staff are required to handle
- Cost is high

Application

- Medical field
- Used to deduct nuclear radiation
- Long distance communication backbones

THANK YOU..